Forage production and use in the dairy farming systems of Northern Italy

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Abstract

In the Po river valley, which represents the largest plain area of Northern Italy, the two main dairy farming systems are associated with cheese production: one for Grana Padano (GP) cheese using silage as the main forage source, and the other for Parmigiano-Reggiano (PR) cheese using hay, where silage fodders are banned to prevent *Clostridium* contamination and potential swelling defects in the cheese with the lengthy seasoning times. Maize silage is the mainstay forage base for fresh milk and GP cheese forage systems. Farm forage self-sufficiency is not always possible, mainly due to dry seasons and/or the practice of maize monoculture. In addition to the difficulties arising from low quantity production, problems of fodder safety (e.g. mycotoxins contamination of maize grain) and nutritional value occur. Regulations in force for PR production set the minimum level of dry matter intake from hay at 50% of dairy cows' rations. Difficulties arise in optimizing nutritional values and dry-matter intake when poor quality forages are available. Research is ongoing to evaluate the optimal alfalfa-grass mix, investigating how to maximize forage nutritional value and digestibility. Moreover, both dairy farming systems are highly dependent on imported feedstuffs: soybean from overseas, maize and other starch grains. Ongoing research activities are seeking to establish whether maize or soybean can be partially replaced by other crops (e.g. sorghum, triticale, grains with high protein content, alfalfa and grain legumes).

Keywords: alfalfa, cereals, dairy, forage, maize, permanent meadows

Introduction

Italy has confirmed its position as the country with the highest number of PDO (protected designation of origin) and PGI (protected geographical indication) certifications granted by the European Union. As at 31 December 2014, Italy had 268 PDO and PGI products, cheese being particularly important with 47 certifications (MiPAAF, 2014).

Grana Padano (GP) and Parmigiano-Reggiano (PR) are the two main Italian PDO cheeses, using more than 40% of the milk produced in Northern Italy and most of the milk from the areas of origin: 32 provinces in Lombardy, Emilia-Romagna, Veneto, Piedmont and Trentino Alto-Adige in the case of GP, and the provinces of Parma, Reggio Emilia, Modena, part of Bologna in Emilia Romagna and part of Mantua in Lombardy for PR.

GP and PR are undoubtedly based on high output dairy farming systems: farms have average productivity of 30.7 kg milk cow^{-1} day^{-1} in GP and 23.7 kg milk cow^{-1} day^{-1} in PR (AIA, 2013).

Even though changes in agricultural systems over the twentieth century have led to high levels of milk production based on increasing inputs and specialization of farms and agricultural districts, both systems are still effectively integrated crop-livestock systems: mixed farming and territorial systems based on the simultaneous utilization of crops and animals, where the recycling of livestock manure as a fertilizer, even within the limits imposed by the Nitrates Directive (91/676/EEC), is the basic means of fertilizing crops. Forage crops represent a substantial share of farmland but a high input of feed concentrates (around 10 kg cow^{-1} day^{-1}) is typical.

The possibility of using silage to feed animals and the favourable climatic conditions have tied the GP production area, which is mainly north of the Po river, to maize silage. The PR production area, south of the Po river, is mainly characterised by alfalfa and grass utilised to produce hay. In fact, in the PR system, silage fodders are banned in order to prevent *Clostridium* contamination and potential swelling defects in the preservative-free cheese subjected to lengthy seasoning.

The objective of this work is to describe the forage systems associated with the GP and PR production, their special characteristics, strengths and weaknesses. This paper used data from representative dairy farms belonging to the two production areas, monitored by CRPA (the Research Centre on Animal Production) in the LIFE+ projects Climate ChangE-R (Reduction of greenhouse gases from agricultural systems of Emilia-Romagna, LIFE12 ENV/IT/000404) and AQUA (Achieving good water quality status in intensive animal production areas, LIFE09 ENV/IT/000208): 10 case studies from the GP system and 10 from the PR system.

CRPA's databases have been used for the description of forage crop characteristics, as well as the results of a number of agronomic experimental trials conducted to test the production responses and nutritional values of some crops whose whole above-ground biomass and/or grains can be used as livestock feed (trials financed by the Emilia-Romagna Region, Regional Law 28/98).

Climatic conditions and cropping systems

The Po valley has a continental climate with relatively hot and humid summers and relatively cold winters. Rainfall ranges from 500-600 mm year^{-1} in the eastern area, around the Po river delta, to 800-1000 mm year^{-1} in the western area and in the foothills, with much higher values in the Alps and the Apennines. The highest rainfall is recorded in autumn, but April and May also have quite high average rainfall which can have a negative effect on the hay harvest. Over recent years the area has experienced more rain and reduced snowfall.

Two factors that need to be taken into account when determining land production potential are irrigation availability and altitude. Water availability is greater north of the Po river, thanks to the presence of the Alps. Conditions are less favourable south of the Po, where the Apennines are not able to guarantee the same quantity of water resources. This explains why 80% of the agricultural land to the north of the Po is irrigated whereas in the south riverside a lesser area is irrigated.

The main cropping systems in Northern Italy are cereals and forages, generally with high yields and high nitrogen uptake. Cropping systems in the plains of Northern Italy are closely linked to livestock type: dairy cattle, beef cattle or pigs.

Maize (*Zea mays* L.) is the main crop, and is used for grain or for silage. In pig farms and in the PR cheese production area, maize is mainly cropped for grain.

Where the soil and other conditions are suitable, dairy farms develop a two-crops-per-year cropping system: maize for silage (early-medium maturing hybrids) in combination with Italian ryegrass (*Lolium multiflorum* Lam.) or winter cereals for silage production. Maize is also a key crop for manure utilisation, particularly before ploughing. Nevertheless, silage maize is increasingly used, in combination with cattle manure, to feed biogas plants producing methane via anaerobic digestion (Fabbri *et al.*, 2013). In the last decade the cultivation of sorghum (*Sorghum bicolor* L. Moench) and triticale (*Tritico secale*) has increased, having a 'plastic' use in both livestock farms and biogas plants.

Forage crops take up most of the land on dairy farms. The most commonly used forage crops are alfalfa (*Medicago sativa* L.), permanent meadows, autumn-winter grass such as Italian ryegrass, winter wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L.), triticale and summer grasses such as maize and sorghum.

Alfalfa production in Northern Italy represents an important resource for dairy cattle farms because of the amounts of protein and fibre it guarantees. Due to its resistance to drought, thanks to a deep root system, it is particularly suitable in the south riverside of the Po, where water availability is reduced. The most common rotation is made up of alfalfa for three to five years followed by a winter cereal (wheat or barley) or Italian ryegrass. The subsequent crop could be maize, tomatoes or another winter cereal. This rotation allows the use of livestock manure to fertilize soils: farmyard manure before ploughing and slurry before ploughing or as a top dressing.

The Grana Padano forage system

Maize silage is the mainstay forage for the production of either fresh milk or milk for GP cheese. Maize hybrids used for silage production are mainly late- or very late-maturing types (FAO 600 and 700). Where maize is cultivated in combination with Italian ryegrass (double annual crops), medium-late (FAO 500-600) or early (FAO 400-500) maturing maize hybrids are used and harvested for silage production. Maize production is usually high when water is not a limiting factor; silage production ranges between 21-25 Mg dry matter (DM) ha^{-1} (Table 1).

Heavy soils are ploughed in autumn, and other soil types in spring or autumn. Livestock manures are usually spread before soil tillage, to be incorporated into the soil. Mineral fertilizer distribution takes place just before or in combination with sowing (NPK fertilizer) and as top dressing (N). Dairy farms where manure is available apply mineral fertilisers (mainly urea) at a rate of about 100 kg N ha^{-1}. Farms relying strongly on manure fertilisation tend to skip mineral N and P fertilisation before sowing. Therefore, the total or the largest part of mineral N is applied to maize as top dressing.

Italian ryegrass is a forage crop which has traditionally played an important role in the GP forage system: production is about 5-7 Mg DM ha^{-1}, with N uptake of 75-105 kg ha^{-1}. The double-crop system is able to produce 23-27 Mg DM ha^{-1}, with total N uptake of 290-340 kg ha^{-1}.

Table 1. Average yield and N uptake for the main types of maize in the Italian northern plain (Source: unpublished data from Pioneer Hi-Bred Italia, modified by AGROSELVITER University of Turin. Reference years: 2004-2008).

	FAO class	Number of measurements	Average	1st quartile	Median	3rd quartile
Yield (Mg dry matter ha^{-1})						
Irrigated	(FAO 400-500)	82	22.1	20.4	22.1	23.6
	(FAO 600-700)	1,478	22.9	20.7	23.0	25.1
Not irrigated	(FAO 400-500)	11	18.9	18.1	20.1	20.7
	(FAO 600-700)	163	20.0	17.5	20.5	22.6
N uptake (kg ha^{-1})						
Irrigated	(FAO 400-500)	65	254	234	254	271
	(FAO 600-700)	1,007	266	241	267	292
Not irrigated	(FAO 400-500)	11	217	208	230	237
	(FAO 600-700)	163	243	212	249	274

On GP farms, the use of alfalfa is considerable, representing 34.4% of the total UAA (Utilised Agricultural Area) even though GP feed rations are mostly based on maize silage, which takes up 21.7% of crop area (Figure 1).

The Parmigiano-Reggiano forage system

On PR farms, alfalfa occupies about half the UAA (47.6%). The second-most common crop, with a share of 26.4%, is winter wheat (Figure 1), which is mostly sold for grain and has limited use as a forage.

Permanent meadows, which are still found on the less-intensive farms, are generally cultivated without irrigation in the hills and with surface irrigation in the plains. When irrigated, permanent meadows provide an average of 13 Mg DM ha^{-1}, well distributed over 5-6 cuts, while 2-3 cuts are common in non-irrigated meadows with an average production of 5-6 Mg DM ha^{-1}, which is concentrated in the spring. During the season the floristic composition varies: in spring cuts the forage mainly consists of grasses and in summer cuts it is mainly legumes. The forage is turned into hay or used in cowsheds as fresh green forage.

The permanent meadow area is declining to the benefit of alfalfa. The presence of meadows and annual grasses in the PR forage system increases its sustainability from the environmental point of view because such crops are able to make the best use of the nitrogen provided with manure, thus depleting nitrates in the soil and in the soil water (Mantovi *et al.*, 2007). In fact, the permanent meadow is usually fertilized

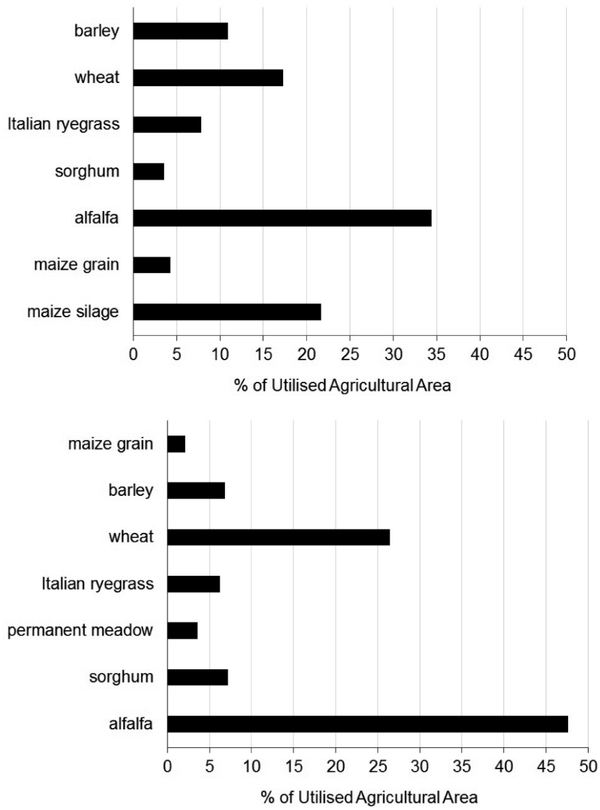

Figure 1. Area of crops in farms producing milk for Grana Padano (A) and Parmigiano-Reggiano (B), average values for representative dairy farms monitored by CRPA.

using farmyard manure, applied on the sward in the autumn-winter, and the liquid manure is applied throughout spring-summer after mowing.

These meadows have in many cases a long history (decades or centuries) and represent an important reservoir of biodiversity, holding a high number of plant species. Moreover, they represent a carbon sink since the soils accumulate organic matter. These are among the reasons of the CAP Greening criteria for preserving permanent meadows.

Alfalfa (*Medicago sativa* L.) is the mainstay crop in the PR cheese area, contributing to sustainable agriculture as a result of its productivity of feed protein per unit area, which is the highest among forage and grain legumes (Huyghe, 2003).

On the plain, alfalfa is grown for about 4 years and then the land is ploughed during the summer and prepared for sowing in the autumn (for example, with common wheat or Italian ryegrass) or in the spring (e.g. with maize). In hilly areas, alfalfa stands generally last longer (up to even 6 or 7 years) and grasses tend to prevail over time. This helps to increase the sustainability of the system, limiting soil erosion and allowing the possibility of spreading manure.

In Northern Italy, 4 or more cuttings of alfalfa (up to 6 or 7 under irrigation) can be harvested annually. Alfalfa yield varies according to the age of the crop and the availability of water. As a general rule, alfalfa achieves its highest production levels in the second year of cultivation (Table 2).

Various studies have shown that forage quality is affected by the growth stage (Nordkvist and Åman, 1986; Yu *et al.*, 2003), the cultivar (Griffin *et al.*, 1994) and the growing conditions (e.g. rainfall, temperature, soil characteristics and treatments (Mathison *et al.*, 1996)). To obtain high forage quality, alfalfa should be cut at the beginning of the flowering phase when the ratio between dry matter, protein content and fibres quality are optimal (Tabaglio *et al.*, 2006). After this stage the Neutral Detergent Fibre (NDF) becomes quite high (Table 3).

Table 2. Average yield of alfalfa in the Italian northern plains and hills (source: Ligabue *et al.*, 2005).

	1st year	2nd year	3rd year	4th year
Plains (Mg dry matter ha^{-1})				
Irrigated	10-11	16-18	13-14	10-12
Not irrigated	7-9	13-15	11-13	9-11
Hills (Mg dry matter ha^{-1})				
Not irrigated	3-5	8-10	6-8	3-5

Table 3. Characteristics of an alfalfa stand cut at different stages during the third year of cultivation (source: unpublished data from CRPA/ Prosementi, project QualeMedica, year 2012).[1]

Harvesting date	Phenological stage	Kalu and Fick (1981) score	Dry matter yield (Mg DM ha^{-1})	NDF (%)	Crude protein (%)	Crude protein yield (kg ha^{-1})
4 May	Late vegetative stage	2.2	5.8	38.1	19.1	1,108
10 May	Late vegetative stage	2.3	6.5	40.5	17.1	1,111
15 May	Early bud	2.7	6.4	41.5	16.8	1,075

[1] DM = dry matter; NDF = neutral detergent fibre.

Alfalfa is traditionally managed without the use of herbicides or by limiting their use to the first year. This management gives rise to the significant presence of grass species taking advantage of the moisture present in the soil, particularly in the first and second cut. Current trends towards more specialised forage crops tend to separate the production of alfalfa and grasses. As a consequence, alfalfa stands are treated with herbicide to ensure pure forage and high yields over time.

Haymaking, particularly in the spring cuttings when climatic conditions are often adverse (high rainfall), is the most critical stage of forage production. Losses can reach 30%, 40% or more of the protein produced in the field. The production of high-quality hay is dependent on the reduction of these losses and this can be achieved by low-temperature dehydration of wet harvested forage. The most widespread conservation technique, even today, is haymaking. Hay is stored in round or square bales of different weights.

As with the GP district, in the PR area the cultivation of wheat forage is gaining ground. In this case the biomass is usually cut for hay at the grain-milk stage and the hay is used to feed the more productive animals. When weather conditions prevent haymaking at the best vegetative stage for cutting the wheat, some farmers opt for grain production, often stored in the farm and used after crushing.

Grana Padano and Parmigiano-Reggiano ration characteristics

Maize silage, with an average administration of 23 kg cow^{-1} day^{-1}, is the forage basis of cattle feed rations in the GP system (Table 4). Alfalfa is the second-largest ingredient at 2 kg cow^{-1} day^{-1} of the first cut and 4.8 kg cow^{-1} day^{-1} of other cuts. The average dry matter intake for lactating cows is 23 kg DM cow^{-1} day^{-1}.

Table 4. Ingredients and nutrients in GP and PR typical TMR for dairy cows, average values for representative dairy farms monitored by CRPA.[1]

Ingredients (kg head^{-1} day^{-1})	**GP**	**PR**
Alfalfa hay (first cut)	2	4.5
Alfalfa hay (other cuts)	4.8	6.9
Maize silage	23	-
Lolium sp. silage	1	-
Sorghum silage	0.5	-
Triticale silage	0.5	-
Italian ryegrass hay	-	1
Permanent meadows hay	-	0.5
Wheat hay	-	0.6
Wheat silage	0.5	-
Concentrate	9.5	11
Dry matter intake	23.0	22.5
Nutrients		
Crude protein (%DM)	14.0	14.8
Starch (%DM)	21.3	26.4
Sugar (%DM)	4.8	6.1
NDF (%DM)	36.0	31.8
dNDF (24 hours) (%NDF)	46.5	44.8
ADF (%DM)	22.3	22.9
ADL (%DM)	3.6	3.8
Net energy of lactation (Mcal kg^{-1} DM)	1.63	1.63
Ash (%DM)	7.5	8.5

[1] ADF = acid detergent fibre; ADL = acid detergent lignin; NDF = neutral detergent fibre; DM = dry matter.

The PR farms rely heavily on alfalfa hay in the rations, including the use of the first cut (with the presence of grasses), in amounts of more than 11 kg cow^{-1} day^{-1}.

The significant difference between the diets adopted in the two systems is represented by the presence of silage in GP, particularly maize silage. The production costs per hectare of maize silage are higher than for other forage crops; however, the former is able to provide a high yield harvested and made into silage in a single operation.

Production costs for GP rations have been estimated at 0.144 Euro per litre of milk produced, as compared with 0.177 Euro for the litre of milk used for PR (Santini and Ottolini, 2012).

TMR (Total Mixed Ration) composition analysed using the NIRS predictive technique identified significant differences in the starch content of the rations (21.3% DM in GP vs 26.4%DM in PR) mainly due to the different use of concentrates. The high quantity of maize silage in the GP rations has a significant bearing on the NDF (36.0% DM in GP vs 31.8% DM in PR) and digestibility over 24 h (46.5% DM in GP vs 44.8% DM in PR). The higher use of hay results in a difference in ash contents: greater in the PR rations (7.5% DM in GP vs 8.5% DM in PR).

Table 5 sets out the average characteristics of the maize silage and alfalfa hay. Maize silage achieves good quality levels with starch content over 32% DM and NDF digestibility at 24 hours around 50% NDF. The first alfalfa cut includes grasses. For this reason, crude protein content is higher in other cuts (11.0% DM first cut vs 17.3% DM other cuts) as well as NDF digestibility at 24 hours (39.1% NDF first cut vs 34.9% NDF at other cuts).

The forage quality confirms that it would be desirable to organise haymaking of alfalfa on a more rational basis, anticipating the cut up to the green flowering bud stage. Regarding concentrate feed, with maize as the main amilaceous component and soybean as the source of protein, both GP and PR forage systems have a limited self-sufficiency.

Problems and opportunities

The degree of fodder self-sufficiency is sometimes a problem for the milk production systems of Northern Italy, mainly due to dry seasons and the maize monoculture which, in addition to low yields, has also caused problems of fodder safety and nutritional quality.

Table 5. Qualitative parameters of forages (source: unpublished data from CRPA, three-year-period from 2012 to 2014).

Nutrients[1]	Maize silage (370 samples)	Alfalfa first cut (175 samples)	Alfalfa other cuts (280 samples)
Crude protein (%DM)	7.8	11.0	17.3
Starch (%DM)	32.1	1.9	1.5
Sugar (%DM)	0.8	7.6	7.0
NDF (%DM)	37.7	54.0	42.1
dNDF (24 hours) (%NDF)	50.2	39.1	34.9
ADF (%DM)	23.8	39.7	35.9
ADL (%DM)	2.7	6.6	7.7
Net energy for lactation (Mcal kg^{-1} DM)	1.71	1.17	1.28

[1] ADF = acid detergent fibre; ADL = acid detergent lignin; NDF = neutral detergent fibre; DM = dry matter.

Mycotoxin contamination of maize grain

The contamination with aflatoxin of a large part of maize produced in those agricultural areas subjected to heat stress and drought, especially in the years 2003, 2013 and 2014, has created extremely severe problems for the feed industry and the milk-cheese production chain. In particular, the most-used components in livestock feed, maize grain and its derivatives (gluten, gluten bran, etc.), are among the raw materials at the highest risk of contamination.

It was necessary to obtain non-contaminated maize from both EU and extra-EU markets with a significant increase in production costs. The doubts over the quality of farm-produced maize has forced farmers to make unusual replacements and variations in rations at the expense of ruminal functionality and milk quality. In this situation, the replacement of maize starch with a source having similar nutritional characteristics, such as that of sorghum, has provided an alternative without risks in the composition of cattle rations.

Alfalfa and high crude protein grains

Alfalfa could be useful for a partial replacement of soy protein in dairy cattle diet. It is important to improve the haymaking by scheduling early cuts, which in addition to increasing crude protein contents have a better amino acid profile when managed properly (Table 6).

In addition to providing energy, some cereals are valuable for their protein content and their amino acid profiles. Wheat and barley grains contain a high protein level and greater contents of essential amino acids than maize (Lanzas *et al.*, 2007). NRC (2001), indicate lysine content of 0.27%DM for maize grains and levels of 0.34 and 0.46% DM for grains of winter wheat and barley respectively. Similar values have been reported by Sauvant *et al.* (2002): 0.27% DM for maize, 0.35% DM for winter wheat and 0.42% DM for barley.

Grains with high protein content were cultivated in experimental trials conducted by CRPA in 2014 within the PR production area, near Modena. Barley (11 cultivars), winter wheat (4 cultivars) and triticale (3 cultivars) were compared. Yield and quality characteristics for the three cereals are reported in Table 7. The average protein content for the 18 cultivars was 12.1% DM, with the highest values recorded for wheat and triticale cultivars (over 13%). The starch content for the same cultivars was also high, around 75% DM.

Table 6. Amino acid composition (g 100 g^{-1}) (source: tissue, milk and bacterial from Lanzas *et al.,* 2007. Soybean meal from Sauvant *et al.,* 2002 and alfalfa from Masoero *et al.,* 2015, personal communication, unpublished).

	Milk protein	Ruminal bacteria	Soybean meal	Alfalfa hay[1]
Methionine	2.71	2.68	0.83	1.45
Lysine	7.62	8.20	6.08	3.87
Arginine	3.40	6.96	7.96	4.25
Threonine	3.72	5.59	3.03	4.36
Leucine	9.18	7.51	6.13	6.78
Isoleucine	5.79	5.88	4.25	4.07
Valine	5.89	6.16	3.79	5.12
Histidine	2.74	2.69	2.27	2.84
Phenylanine	4.75	5.16	3.88	4.50
Tryptophan	1.51	1.63	1.64	3.11

[1] Average values from 60 samples from various cuts.

Table 7. Average yields and characteristics of grains with high protein content (source: unpublished data from CRPA, Specie e varietà project, reference year 2014).[1]

Cereals	Grain yield (Mg ha^{-1})	DM yield (Mg DM ha^{-1})	Crude protein (g kg^{-1} DM)	Starch (g kg^{-1} DM)	Crude fibre (g kg^{-1} DM)	Crude fats (g kg^{-1} DM)
Winter wheat	5.60	4.81	134	752	15.4	13.3
Barley	8.26	7.19	113	400	40.3	19.9
Triticale	7.10	6.16	134	765	13.6	11.9

[1] DM = dry matter.

It is important to note that the production of grain legumes has never taken off in the Po valley; neither for soybean nor for grain legumes such as field pea (*Pisum sativum*) or field bean (*Vicia faba minor*). The reason is mainly the low and unreliable productivity of grain legumes with respect to the profitability of other crops.

Silage and hay from cereals other than maize

Research is underway to investigate the possible partial replacement of maize silage, using sorghum, triticale and other winter cereals. Sorghum is becoming an important crop for silage because it adapts to conditions of limited water availability, allowing the production of fodder in areas where maize experiences dryness and mycotoxin contamination. Sorghum is a multi-purpose cereal of potential interest for several food and non-food uses (Piluzza *et al.*, 2013). Different types are distinguished with specific morphological characteristics: grain sorghum, fibre sorghum, sweet sorghum and others. Silage sorghum can reach the dry matter production of maize, with the content of structural carbohydrates (NDF) around 50% and the starch from few percent (fibre cultivars) up to 20-25% DM (in grain cultivars). Crude protein content is generally lower than in maize and varies between 5 and 6% DM, whereas ash contents are around 7-9% DM.

In particular for the PR forage system, research is being carried out to investigate the optimal use of alfalfa combined with good quality grasses. In this context the hay from winter cereals can be a valuable resource.

In experimental trials conducted by CRPA in 2014 within the PR area, 14 wheat forage cultivars were cut at different growth stages. Biomass yields varied from about 30 to 50 Mg ha^{-1}, with an average dry matter level of 32.7%. Dry matter yields varied from 9 to 15 Mg DM ha^{-1}, with higher values recorded for late cuts (soft dough growth stage). Although wheat is considered to be a forage crop that provides carbohydrates in the diets of dairy cows, the average level of protein was 11.9% DM at head emergence, rapidly decreasing to dough development in kernel (Table 8). Managed wisely and when unaffected by unfavourable weather conditions, the resulting forage production has very balanced carbohydrate components characterised by different fermentation speeds.

Table 8. Average yields and characteristics of wheat forage (source: unpublished data from CRPA, Specie e varietà project, reference year 2014).[1]

Growth stage	DM yield (Mg DM ha^{-1})	Protein (g kg^{-1} DM)	Starch (g kg^{-1} DM)	NDF (g kg^{-1} DM)	ADF (g kg^{-1} DM)
Head emergence	8.6	119	20.4	557	370
Milk development in kernel	12.8	88	26.3	532	377
Dough development in kernel	15.1	58	42.4	526	410

[1] ADF = acid detergent fibre; NDF = neutral detergent fibre; DM = dry matter.

Conclusions

Grana Padano and Parmigiano-Reggiano are the two main Italian PDO cheeses using more than 40% of the milk produced in Northern Italy and almost all the milk from the areas of origin. They are based on high-output dairy farming systems with high average productivity (30.7 kg milk cow^{-1} day^{-1} in GP and 23.7 kg milk cow^{-1} day^{-1} in PR; AIA, 2013).

In the GP system, based on maize silage which guarantees high production of forage with high energy value, problems such as forage self-sufficiency and safety are currently addressed by varying the monoculture through the use of other cereals (sorghum, triticale and other winter cereals). While they cannot guarantee the same high-energy value as maize, these cereals can have a role in the production of silage and protein-enriched grains.

In the PR system, where hay is the base of TMR because the regulations set at 50% the minimum level of dry matter to be obtained from hay (in the rations of dairy cows), the main problem is optimising the alfalfa-grass mix. For this reason, in recent years there has been a progressive specialisation of forage crops: alfalfa is increasingly cultivated in pure stands to obtain high quality protein forage while grasses, which provide the necessary fibre in the ration, come from permanent meadows or pure stands of Italian ryegrass or winter wheat.

In both systems, the production of grain legumes is not significant because of poor and unreliable productivity, meaning they are still highly dependent on soybean imports. Research activities are ongoing to improve the quality characteristics of crops, reducing as much as possible the energy use for soil tillage while adapting the systems to climate change.

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