

CHANGING SCENARIOS OF DAIRY PRODUCTION

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Dairy production is crucial in the supply of highly nutritious, safe and affordable milk and meat for the ever growing human population. It is therefore essential that the relevant systems are adaptable to the current issues of climate change and the needs of communities who are associated with dairy production in both developed and developing countries. For this purpose an integrated approach by involving consumers, farmers, environmentalists, animal scientists, sociologists, economists, and policy makers is required to achieve the real objectives and benefits of a sustainable dairy production system. However, the sensible use of supplements and herbal additives as the desirable alternatives to the conventional growth promoters may be the key to optimise forage utilisation and reduce nutrient wastage while supply quality dairy products and increase profit margins for the dairy producers. This paper reviews various scenarios which the UK dairy industry will continue to face due to the global climate of a rapid change, uncertainty and financial issues.

Keywords: Dairy production; sustainability; environment; food safety and security

INTRODUCTION

Dairy production is vital in the successful operation of an animal based industry. It provides high quality food which contains essential nutrients to maintain human life during various stages of its physiological development. Dairy production has always been an integral component in different shapes and forms of various human societies. In fact it plays an important role in optimising health and creating wealth for almost all human populations. However, in the past six decades, dairy production practices have changed considerably due to the concerted efforts in improving animal health, nutrition, breeding, management and financial incentives. Nevertheless, these efforts were more beneficial for the developed world where dairy products are oversupplied from fewer but bigger farms. Despite this global increase in dairy together with other food items, about 1 billion people, about 17% of global population, are still regarded as either undernourished or malnourished or poor (FAO, 2000).

While, the corporate dairy production is beneficial in terms of effective management and food security, it has created issues of animal welfare, environment, food safety and social aspects of family farming. The need to use high inputs in the operation of a large scale dairy production can damage animal health, food safety and the environment. Indeed, intensive dairy farming has affected the social aspects of small scale family farmers and their neighbouring communities. Consequently, the modern dairy production practices are under the spotlight of the consumers, conservationists, environmentalists and the policy makers alike. Even the dairy based industries accept that their current practices may not be sustainable.

Therefore, dairy industry need to adopt appropriate measures to help sustain dairy production to suit the dietary needs of the current and future generations of both developed and developing countries.

Although, it could be beneficial for social, economical and environmental issues in different regions, the success of a sustainable dairy production depends upon an integrated and effective approach. The dairy producers, processors and retailers have to adopt better practices by involving suitable animals (cows, buffaloes, goats etc), better breeding, efficient diets, improved forages, well managed grassland and effective energy and water use to suit different situations. This paper will review the changing scenarios of dairy production in relation to the increasing human population in different parts of the world. Within this context, the paper will discuss the opportunities and obstacles that could impact on the development of a more desirable, safe and sustainable dairy production system for the future by using examples from the UK dairy Industry.

Human population and demand for more food

The world human population is predicted to reach 7.6 billion by 2020 where 85% of this increase will occur in developing countries (FAO 2000). If this growth continues, as predicted, then by 2030 over 1.5 billion more people will be added to make the world population of around 8.3 billion (Table 1). Although the population growth will reduce slightly in Asia, it will increase in Africa. Conversely, the growth rate in Europe and North America will stabilise during the same period. It is predicted that Asia and Africa together will represent over 75% of global human population in 2010 and over 79% in 2050.

Table 1. Predicted changes in human populations

Regions	2010	2020	2030	2040	2050
World (Billions)	6.8	7.6	8.3	8.9	9.4
Asia (%)	60.7	60.6	60.1	59.4	59
Africa (%)	14.4	15.7	17.2	18.7	20.2
Asia +Africa (%)	75.1	76.3	77.3	78.1	79.2
Rest of World (%)	24.9	23.7	22.7	21.9	20.8

(FAO, 2000; Chaudhry, 2008)

Consequently, more food supply including dairy products will be needed for export from the developed to the developing world. However, the dependence on dairy exports from the developed countries may not be sustainable due to the changing scenarios of dairy industry worldwide.

It is predicted that most of the population growth in developing regions will occur in urban areas at the cost of rural areas. Nevertheless, it is estimated that the total and agricultural populations will not change in these regions over the next 20 years. This may mean that fewer workers will be available for farm activities perhaps at a higher cost in the future. Conversely, with the predicted increase in the total population including the existing 1 billion undernourished or impoverished or malnourished people, the demand for dairy products alongside other animal derived foods will increase in the very near future (Hall *et al.*, 2001).

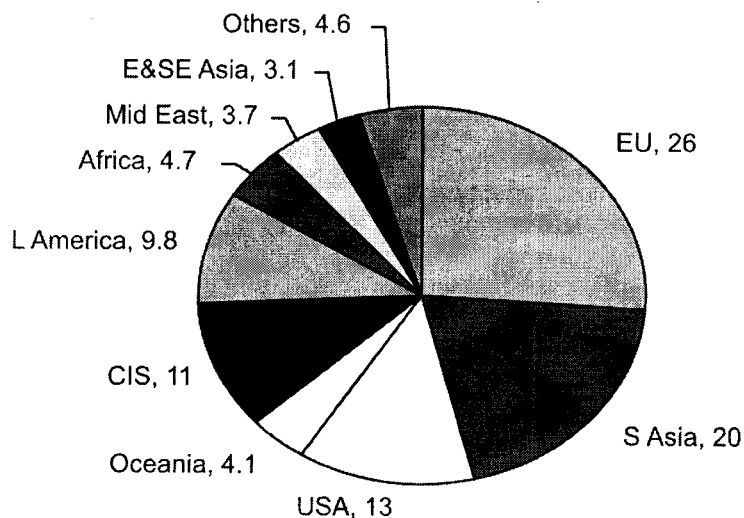
Global distribution of milk production

Figure 1 presents the estimated shares of milk production in different regions of the world. Clearly, Europe (25 member states including UK in 2004) is the largest milk producer with 26% share of the global

market. This is followed by South Asia (mainly Pakistan and India) with over 20% and USA with 11% of the global share of total milk production. It is interesting to note that Europe shares only 8% of global population but it produces more milk than South Asia which holds over 22% of the world population. To satisfy the needs of over 1.5 billion people in South Asia alone, much more milk production is required. This could be achieved by using either the internal resources of milk producing regions or by importing more milk from the milk exporting regions such as Europe. However, the availability of additional milk for export from Europe or UK will depend upon the situation in these regions which are undergoing tremendous pressures of change. Some aspects of these changes in dairy production will be discussed in the following sections by using examples from the UK dairy industry.

The UK dairy industry

The UK dairy industry has been going through significant changes during the last ten years. The recent farming data suggest that total numbers of dairy farms have been reduced but the average herd size

**Figure 1. Global distribution of milk production (FAO, 2004 & Hemme *et al.*, 2008)**

and milk yield per cow have been increased. This is evidenced in Table 2 which shows that the total dairy cow holdings have gradually declined from 36,400 in 1997 to only 16,000 in 2007. This number represents only 44% of the UK dairy holdings that were active in dairy production over a decade ago (*AgrStats, 2008*). The dairy farms are predominantly run as family units and most of these farms are located in areas which get greater rainfall and mild weather. With the decrease in total number from 11.6 to 10.3 million cattle, the current cattle population is about 89% of what was reported in 1997. The reasons of decreased activity in the UK dairy farming are multi-factorial which have increased the cost of milk production and consequently less profit for the industry. The pressures to meet various regulatory and consumer demands have also eroded the confidence of the farming community in farming as a viable business.

However, the UK farmers are facing numerous challenges in a highly competitive and volatile financial market. Some of these challenges are described in the following sections.

Benefits and problems of dairy production

Dairy production is essential in the supply of high quality foods such as milk and meat for human populations. The dairy animals could be the sustainable source of nutrient rich food as they require less or no cereal grains which are an essential energy source for human consumption (*Chaudhry, 2008*). In fact dairy animals are blessed with the rumen which serves as a fermentation tank to convert highly fibrous materials into high quality food such as milk and meat. These fibrous materials are available in huge amounts as renewable resources from pastures, trees, forests, woodlands, crop residues and other agro-industrial by-

Table 2. UK Cattle population since 1997

Items, 000	1997	2001	2003	2005	2007
Dairy cow holding	36.4	29.7	26.6	24.6	16
Cattle + Calves	11633	10602	10517	10392	10304
Dairy	2478	2251	2192	2063	1954
Beef	1862	1708	1700	1762	1698
In-calf Heifers	848	701	680	638	640
All other cattle	6445	5942	5945	5929	6012

(AgriStat, 2008)

During the same period, the average herd size has increased to about 100 milking cows per farm and the average milk production per cow has also increased as shown in Table3. Currently the UK dairy industry is producing about 13-14 billion litres of milk with the estimated value of £8 billion. About 98% of total UK milk production is used for human consumption in various shapes and forms.

products. The conversion of these apparently waste products by the naturally occurring rumen microbes into high quality milk and meat is a highly desirable feature which should be harnessed to utilise fibrous by-products to maintain the sustainability of dairy production. The dairy animals also contribute to the fertility of soils through their faeces and urine and so

Table 3. Trends of Milk Production in the UK

Description	1997	1999	2001	2003	2005	2007
Total Milk, billion Litres (L)	14.14	14.3	14.01	14.35	14.07	13.66
Milk yield /cow, 000L	5.79	5.96	6.35	6.62	6.75	6.91
Net Price pence/L	22.1	18.3	19.3	18	18.5	20
Liquid consumption, billion L	6.75	6.85	6.71	6.66	6.65	6.7
Liquid consumption, % of total	47.7	47.9	47.9	46.4	47.3	49

(AriStats, 2008)

The farm-gate milk price in the UK has recently been increased from 20p/L in January 2007 to about 27p /L in 2008. This is a big increase which offers farmers the opportunity to continue their dairy production activities.

transform some unproductive lands to produce food or cash crops for the human population. However, the current dairy production practices are also blamed for their contribution to the increasing levels of

environmental pollution and so these require special attention to reduce their detrimental impacts (DEFRA, 2008).

Sustainable dairy production and influencing factors

To reduce the high environmental impacts of dairy production it is essential to develop systems that are sustainable. While a sustainable production system must meet the needs of the current populations, it must not reduce the chances of future generations to satisfy their needs. For this purpose it is essential to give careful thoughts and commitment to the regional needs and traditions by involving dietary as well as socio-economic features. Therefore, a multi-factorial approach is required in developing a sustainable dairy production to suit various situations in different parts of the world (Chaudhry, 2008). Figure 2 illustrates the principal segments of this apparently a complex approach in developing sustainable dairy production systems to suit different needs and expectations.

The following sections will deal with some of the major aspects which should help maintain a sustainable dairy production system.

Selection of animals and forages

The selection of a suitable animal and forage should be central to accommodate the recommendations of the Curry Report (2002) and the Sustainable Farming and Food Research Priorities Group. Also, EU Water Framework Directive and Kyoto protocol expect member states to reduce the impact of livestock production on water and air quality by reducing excretions and gaseous emissions of all types. Yan and Mayne (2007) have reported the variable or contrasting impacts of fresh v dry forages, Holstein v Norwegian cows, and first v later lactations on the production of manure and nitrogen from dairy animals on different occasions. Such an experience could help identify the most suitable animals and forages to fit into a sustainable dairy production system. Also, it is possible to reduce reliance on Phosphorus (P) based fertilisers by using new white clover varieties without reducing production (Marshall, 2007). These varieties were more efficient in P utilisation and so had the potential to reduce the environmental impacts of P which is identified as one of the pollutants. Likewise, Abberton *et al.*, (2006) reported that Lotus or Birdsfoot (*Lotus corniculatus*) improved protein utilisation and reduced methane emission and diffused N pollution

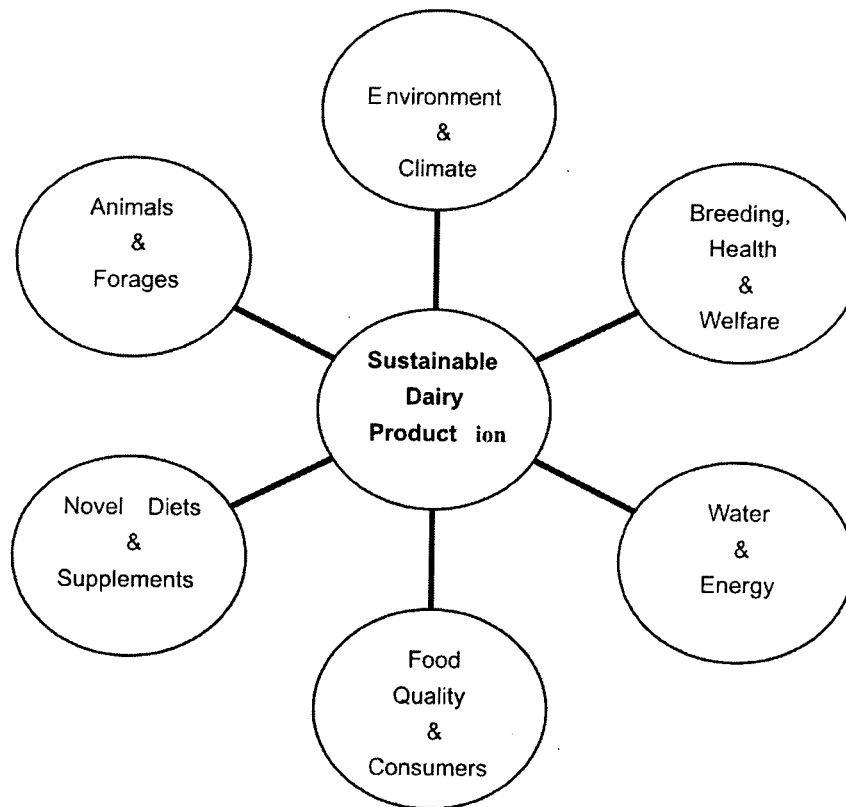


Figure 2. Principal Segments of Sustainable Dairy Production

when it was consumed as a major part of a ruminant diet. Furthermore, variable methane outputs were recorded in sheep, as a model ruminant, while consuming dried forms of either Rhodes grass or Lucerne as the sole diets (Takahashi *et al.*, 1999). Chaudhry *et al.*, (1998) also supported the benefits of dietary manipulations in modifying the methane output from sheep. This suggests that the selection of appropriate forages or feed formulations could help modify the impact of feeding on the environment by ruminants including dairy animals. Mixed swards of ryegrass and white clover could also be beneficial in terms of their persistence, palatability, digestibility and availability for extended grazing (Tedstone, 1997). Other grasses, legumes and whole crop cereals should be tested as alternative forages for their suitability to maintain a sustainable dairy production with minimum environmental impacts. The suitability of goat and buffalo are being tested to produce specialised milk for allergy sufferers in the UK. Similar approaches could be tested by involving local animals and forages to optimise relevant dairy production systems in Pakistan and other countries worldwide.

Improved forage utilisation

Forage or grass based dairy production is recognised as the most cost-effective and sustainable system. The Environmental Stewardship Scheme requires the UK farmers to maintain well managed pastures and grasslands which could add high value by producing premium quality dairy and meat products and yet maintain biodiversity and clean environment (Hopkin *et al.*, 1997; DEFRA, 2008). It is possible to improve forage production, increase utilisation and reduce nutrient wastage by mixing grass with legumes in pastures. The UK Government funded research (DEFRA, 2002) showed 41% more growth and 18% more grass cover (kg /ha) for grazing in new leys of mixed swards containing white clover plus ryegrass than the other averages of the same farms. The extension of grazing time on these pastures in spring by 62 days (started on 9 Feb v 12 April) was able to reduce the use of silage but increase milk production and income per dairy cow on a pre-selected farm. This farm was also able to reduce fixed costs of machinery, transport, labour, purchased feed and bedding etc with a total cost savings of £36000 for a 100-cow herd which was equivalent to about 5 pence saving per litre of milk in 2000. This margin of profit would vary depending upon the price structures of feeds and fuel worldwide. However, it is vital to avoid overgrazing which could damage the quality of soil and re-growth potential of these forages.

Novel diets and supplements

When the quality of fresh, dried or ensiled grass is good, the non productive dairy animals may not require

supplements. However, when mature forages are available as the main diet, the productive animals must also receive extra supplements. This situation requires careful selection of a supplement not only to enhance forage utilisation and animal performance but also to reduce nutrient wastage to mitigate the environmental impacts of the changed feeding practices. The supplements are known to improve pasture utilisation and enhance performance of dairy animals when grazing on pastures (Bargo *et al.*, 2003). As grass is deficient in some minerals, the production and health of dairy animals could be compromised if grass fed animals did not receive relevant supplements. By using molasses or moist food co-products or specialised minerals for grass fed animals, the nutrient deficits of grass and even straw could be compensated for dairy animals (Underwood & Suttle, 2001; Chaudhry *et al.*, 2001a, b). Recently, Chaudhry (2008) observed variable forage degradability *in vitro* in the presence of two different formulations of molasses based supplements in a rumen simulated system. This study emphasised on the value of matching a supplement with particular forages to maximise the performance of forage consuming animals. Also, substantial increases in the forage intake and growth of Holstein-Friesian heifers were observed when these heifers were offered nutrient rich feed blocks on self help basis during grazing on mature ryegrass swards (Chaudhry *et al.*, 2005). Although expansion in the bio-fuel industry is creating concerns about food security, its by-products such as distillers grains offer opportunity for their use as novel supplements for forage based dairy production systems.

Value of crop and biofuel residues

Recent increase in the use of sugarcane, cereals and oil seeds to produce bio-fuels has caused worries about their availability as dietary constituents or supplements for dairy production. It is therefore essential for the feed and dairy industry to explore alternative feeds for dairy production. Crop residues, cereal straws, bushes and tree leaves could supply complementary nutrients in a forage based dairy production especially when there is a shortage of grasslands and pastures. However, to maximise their utilisation, the nutritive value of these alternative forages must be improved using biochemical pre-treatments (Chaudhry, 1998) or physical processing (Rezaeian *et al.*, 2006) or spices as novel supplements (Khan & Chaudhry, 2008). Conversely, the current efforts to use fibrous biomass to produce bio-fuels could restrict the availability of these crop residues as a useful nutrient source for ruminant animals. However, the residues from the bio-fuel industry could become new source of nutrients to meet the demands of a sustainable dairy production (Lodge *et al.*, 1997).

Animal breeding, health and welfare

New developments in animal breeding can help produce dairy animals which resist diseases, maximise nutrient usage, produce less pollution and yet maintain the quality of dairy foods. Such developments may help reduce the cost of animal diseases which is estimated as % of total production cost of about 17% for the developed and 35% for the developing countries. The need to produce disease resistant animals becomes even more important with the European ban on the in-feed use of antibiotics for farm animal growth and production. Therefore, the selection of an animal species (e.g. buffalo v cattle v goat) or a breed (Holstein v Jersey) with improved disease resistance or other quality traits to match realistic production targets would be much more acceptable. Crossbreeding to exploit desirable characteristics of complementary nature in different breeds to produce a dual purpose breed with favourable features may also suit specific situations (Freyer *et al.*, 2008). For this purpose, the breeders may have to be sensitive to animal welfare issues and the needs of a region or a country when selecting an existing species or breed or testing the improved traits of these animals to match a dairy production system. These improved traits should prepare the animals for adaptation to the rapidly changing scenarios of dairy production worldwide.

Climate change and socio-economic aspects

The perceived impact of climate change on seasons in the form of unpredicted droughts and floods is a matter of global concern for people and policy makers alike. While dairy animals are blamed more than other animals for their impact on climate change, the potential influence of climate change on food and feed supply is also predicted. Therefore, policies to address matters concerning climate change are needed for the sake of reliable food production systems. For this purpose, selection and propagation of novel plants and appropriate animals to suit different tropical and temperate regions would be required to sustain a desirable dairy production system. While this system must remain cost effective for the dairy industry, it must not interfere with animal welfare and the social fabric of farm workers and consumers. Therefore, careful planning can help develop a dairy production system that do not harm the environment and yet conserve energy and maintain the supply of quality water and food for human consumption.

Product quality and consumers

With the increasing awareness about the health aspects of dairy products, the consumers are demanding dairy products that are affordable, traceable, healthy and safe for their consumption. Also, the consumers expect dairy farmers to do this without harming the environment and animal welfare. This is

challenging but the dairy industry has to accommodate the consumer expectations in their future practices to maintain a sustainable dairy production in the UK and beyond.

Water, energy and credit crunch

The water and energy usage has to be managed effectively to maintain a viable dairy production system. This is even more relevant in the current scenario of worldwide financial crisis and credit crunch which may also affect the dairy industry in almost all parts of the world. The UK dairy industry has already started to undertake additional measures to improve their water efficiency. Many of the dairy farmers have invested in water saving practices by either reduction in water use or by recycling or reusing some of their water. Consequently, the UK dairy farmers are ahead of their other agricultural or horticultural counterparts in delivering cost and environmental benefits for their farms. It is estimated that the water used per litre of milk produced in the UK is up to 200 litres less than other dairy producing countries including Australia, Denmark and Italy (Waterwise, 2008). Efforts to improve energy efficiency are also underway by using energy saving devices and practices at the farms. The dairy farmers can use on-farm anaerobic digestion to convert their animal manure and food waste into renewable energy for their farm and use bio-fuels to operate their agricultural vehicles.

The future dairy production and conclusions

In the next decade the UK dairy industry will continue to change its shape, size and general outlook. This change will determine the impact of dairy production on the environment, food quality and food security. For example, the end of milk quota in 2015 will influence the EU wide competition and the loss of export subsidy on dairy products in 2013 will affect the price structure of these dairy products. Therefore, it is expected that the dairy farmers will try to reduce their costs by improving efficiency and increasing dairy herd sizes to the range of 300-1000 per farm. Rising feed, fuel and fertiliser prices will reduce margins for the farmers who therefore have to increase their reliance on grass based systems by reducing the use of purchased feed to produce milk. Careful use of new technologies and knowledge of feeding, breeding, economics and environment could help the UK to play a leading role in the global sustainability of dairy production to meet the demands of growing human population in years to come.

ACKNOWLEDGEMENTS

Thanks to the organizers of the International Dairy Conference at the University of Agriculture, Faisalabad for their invitation to present this paper.

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