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REVIEW ARTICLE

Current situation and the development of the dairy industry in Jordan, Saudi Arabia, and Syria

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Abstract The development of the dairy industry plays an important role in the economy of Middle Eastern countries. Judged by its growth rate, the dairy industry is viewed as one of the most progressive food industries in the Middle East. During the early 1970s, countries established executive programs to promote dairy farming; the major objective was to attain self-sufficiency in milk production. A massive investment was set up for importing top class cattle, complying with top industry operating standards, and a simultaneous introduction of the latest technology in processing, packaging, and distributing. Milk production has grown tremendously at rates of 6.6% and 4.9% in Syria and Saudi Arabia, respectively, between 2002 and 2007, which resulted in these nations being almost self-sufficient. Regarding Jordan, milk production has not yet met this target. An excessive growth in the dairy industry is quite noticeable in this region with an expanding capacity for exports. The aim of this study is to show the most recent trends and future prospects of the dairy industries in Syria, Saudi Arabia, and Jordan. It also attempts to investigate the drivers for the development of milk production, consumption, and trade in the region.

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Introduction

Despite the prominence of petroleum in the region, agriculture still plays a prominent role to most economies in the Middle East (DeRosa 1997). Agricultural and rural populations consist of 44.2% of inhabitants in Middle Eastern countries (AOAD 2007). Thus, the livelihood and social welfare of the largest segments of population in the region are still deeply rooted in agriculture and the rural economy. Consequently, the agricultural sector has a potentially significant role to play in achieving higher sustained growth and economic development in the Middle East.

According to Moran (2005), dairying originated from the Middle East, between 7000 and 6000 BC, and from there milk consumption spread to the Mediterranean, Europe, Indian subcontinent, and to other parts of the world.

Milk and dairy products are very important sources of food in the Middle East due to their nutritional value. It is also the cheapest source of animal protein and contributes strongly in the subsistence of a wide number of producers and families in the peri-urban and rural areas (AOAD 2003). In the last decades, the consumption of dairy products increased at extremely high rates. Currently, the per capita consumption of dairy products is 117, 78, and 55 kg in Syria, Jordan, and Saudi Arabia, respectively (Alammouri 2006; MOA 2006; NCB 2006); see the map in Fig. 1. This is still lower than in the industrial world, but much higher than in most African, Asian, and Latin American countries. Increased consumption of dairy products was mainly influenced by the increasing per capita income and a fast growing population of 2.5%, 2.9%, and

Fig. 1 Map showing the main milk producing areas in Syria, Jordan, and Saudi Arabia

3.5% in Syria, Jordan, and Saudi Arabia, respectively, creating a growing effective demand (FAO, 2003a, 2005; MEP 2006).

The Middle East is considered as one of the world's largest importers of dairy products from Europe, the United States, and New Zealand. The region also has a strong growth rate of 4.6% in dairy imports (EII 2002). In 2005, about 11.206 million tons worth US $3.531 million were imported by the Arab world, despite the availability of agricultural resources required to achieve self-sufficiency in milk and dairy products (Abdel Fatah and Hassan 2008). To reduce the region's dependence on imported dairy products, many Middle Eastern countries started to promote their local dairy sectors. Governments focused on modern capital-intensive large-scale dairy production to supply the urban consumers. This kind of production is highly dependent on huge imports of concentrate feed and fodders, particularly in the arid and semi-arid areas of the Middle East.

In these countries, the dairy sub-sector is one of the most central components of the livestock sector. Dairy cow population is estimated at 773,000, 50,000, and 111,600 cows for Syria, Jordan, and Saudi Arabia, respectively (NCAP 2008; MOA 2006; FAO 2008). Figure 2 shows milk production from sheep, goat, cows, and camels.

Despite the importation of improved breeds, technology, and feedstuff, self-sufficiency has not yet been attained in Jordan and Saudi Arabia. However, the situation is different in Syria, where the country is almost self-sufficient in terms of milk and dairy products.

During the last decades, local governments have motivated the dairy industry. Syria, Jordan, and Saudi Arabia have imported high-yielding dairy cows from USA, Europe, Australia, and other countries. In Saudi Arabia which has an arid climate, the last 10 years may be viewed as the highest period of growth and development in dairy production in the history of the Middle Eastern countries. During this period, the dairy industry established itself as one of the most progressive food industries in this region. This industry has contributed to the regional economy by reducing imports and expanding its exports. Due to the long tradition of consuming milk and milk products in the Middle East, the potential for further development in the dairy sector of this region is greatly possible.

Dairy sectors development

An analysis was made using the International Farm Comparison Network (IFCN) Dairy Sector Model to investigate evolution of the dairy sectors in Syria, Jordan, and Saudi Arabia. This model is a tool which analyzes dairy sector developments in individual countries, aggregated form for specific regions and worldwide from the

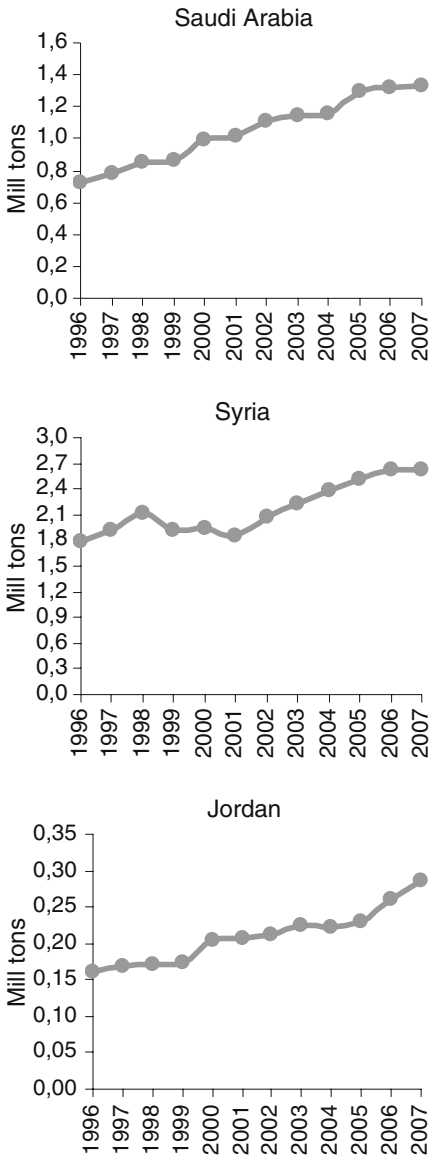

Fig. 2 Milk production trends in Syria, Jordan, and Saudi Arabia from 1996 to 2007. All figures include milk from cows, sheep, goats, and camels combined. Figures are in million tons

year 1996 till date. Results are shown in Table 1. In spite of the lower milk productivity per cow in Syria, milk production is growing faster (6.6%) than in Saudi Arabia (4.9%) and Jordan (5.4%). This could be attributed to the growth in the dairy cow number in Syria by an average of 5.4% throughout the period of 2002–2007; while in Saudi Arabia, it was lower, with an average growth rate of 1.5% for the same period. However, average dairy cow productivity is much higher in Saudi Arabia compared to Syria. In Almarai and Al-Safi farms located in Saudi Arabia, cows produce more than 10,000 l of milk per cow per year, while average dairy cows in Syria produce about 1,600 l per cow per year.

A higher growth rate in milk consumption was noticed in Jordan than in Syria and Saudi Arabia, during the period 2002–2007. The driver for this is the increase in per capita consumption of 6.7% annually in Jordan compared to 1.9% and 0.3%, respectively, in Syria and Saudi Arabia. The growth consumption of dairy products was highest in Jordan (9.5%) and lowest in Saudi Arabia (2.8%) for the same period. Table 1 shows the annual regional changes in Syria, Jordan, and Saudi Arabia throughout 2005–2008.

One of the major drivers for growth in the total consumption is the growth in gross domestic products (GDP) and population. In Jordan and Saudi Arabia, growth in GDP was higher than in Syria, in spite the fact that the total consumption in Syria is higher than in Saudi Arabia.

There is a clear variation in the volume of milk delivered to dairy factories in 2007. In Syria, modern processing plants process only 5% of the produced milk, the rest is processed on-farm using traditional methods. Usually it is processed into yogurt, cheese, laban, and labneh (FAO 2003a); see Table 2 for typical dairy products explanations. In Jordan and Saudi Arabia, milk delivered to dairy processing plants account for 94% and 95%, respectively, from the total milk produced. Unlike in Saudi Arabia and Jordan, dairy farming in Syria is predominantly driven by small-scale production systems with high on-farm consumption, meaning that milk production is mainly for subsistence. According to the International Trade Center (2008), both imports and exports are growing in all three countries in terms of volume and value in different rates.

Milk production from small ruminants in Syria and Jordan

Milk production from sheep and goats is also growing in Syria and Jordan. In 2007, milk production in Syria from sheep and goat were estimated at 873,000 and 96,000 tons, respectively, and was greatly lower in Jordan (20,000–32,000 tons) due to the lower sheep and goat population (MOA 2007).

Cattle breeds in Syria and Jordan

Based on the FAO statistics (FAO 2003a), there are several cattle breeds used for milk production in Syria. The Friesian, local improved, local Akshi, and local Shami cattle made up 15.4%, 66.07%, 17.4%, and 1.1% of the total number of cattle and produce 25.8%, 67.6%, 5.6%, and 0.9% of the total milk volume, respectively. The indigenous livestock breeds of Syria are well adapted to the arid conditions in the degraded steppe vegetation of the country (Bourn 2003).

There are two indigenous local breeds found in Jordan in addition to crossbred, Shami and Akashi (NCARE 2002). In 2007, local cows comprised only 4% of the total dairy

Table 1 Annual changes in the dairy sectors in Syria, Jordan and Saudi Arabia from 2002 to 2007

Item	Syria	Jordan	Saudi Arabia
Milk production (%)	6.6	5.4	4.9
Cow number (%)	5.4	5.5	1.5
Milk yield per cow (%)	1.2	-0.1	3.3
Total consumption (%)	4.7	9.5	2.8
Population (%)	2.5	3.5	2.9
GDP per capita (%)	2.72	4.97	4.08
Per capita consumption (%)	1.9	6.7	0.3
Milk delivered to dairy in 2007 (%)	5.0	94	95
Per capita milk consumption (kg/year/capita)	117	78	55.1
Self sufficiency in milk production in 2007 (%)	93	57	53
Population (million people)	19.7	5.8	24.3
Exports in 2006 (million US$)	124	62.3	403
Imports in 2006 (million US$)	113	123	1.020

Adapted from Hemme (2008)

cattle in Jordan (MOA 2007); farmers have replaced their local cows with high yielding Holstein Friesian cows.

Growth in milk production

In line with the rapid growth in population, there is an increasing demand for milk and milk products. Total milk produced in 2007 was estimated at 2.63, 0.28, and 1.34 million tons in Syria, Jordan, and Saudi Arabia, respectively (FAO 2008; Hemme 2008; MEP 2007). For Syria, self-sufficiency levels changed from 88% during the period of 1999–2003 reaching to 93% in 2006 (AOAD 2008). In Jordan, self-sufficiency has changed significantly from 35%, in 1980, to 57% in 2006 (MOA 1993; MOA 2006). In Saudi Arabia, the self-sufficiency was 53% in 2007 (Hemme 2008).

In Syria, dairy farms are scattered all over the country. About 60% of cow milk is delivered to urban markets by small-scale farms located in semi-urban areas. Milk transportation is done by a series of trailers. In Jordan and Saudi Arabia, most dairy farms are concentrated in one region and are highly capital intensive. In Syria, about 95% of dairy farms belong to small-scale extensive or mixed farming systems, while large farms only represent 5% of the total farms in the country, where the government owns 3% and the rest is owned by the private sector. In the case of Jordan, currently, Holstein Friesian cows represent 96% of the total population of dairy cows in the country (MOA 2007). Milk is basically produced by intensive or semi-intensive dairy farming systems owned by private farms. About 52% of milk is produced by intensive dairy farms located in the Al-Dhulel region of the eastern desert. In Jordan, there are only 605 dairy farms. The number of cows has also changed in Jordan; in 1981, Friesian dairy cows were 6,000 and by 2006, there were 50,000 dairy cows (MOA 2006).

Saudi milk production has increased from 165,000 tons in 1970 to 1 million tons in 1999 reaching 1.34 million tons in 2007, with an annual growth rate of 4.9%. There are very few dairy farms in Saudi Arabia compared to Syria and Jordan, though the number of cows per farm is very big. Literature shows that the biggest dairy farm in the word named Al-Safi is located in Saudi Arabia (AL-Otaibi and Robenson 2002). Growth in milk yield per cow is highest in Saudi Arabia (3.3%) compared to Syria (1.2%) while this growth was negative (−0.1%) in Jordan.

The recent Saudi statistics show that there are only 30 big dairy farms in the country and most are large dairy cattle operations using modern capital intensive production and processing technology (MEP 2006). Many farms are located in Al-Kharj area, near to the capital Riyadh. This area has a less humid climate which is more conducive for cattle rearing.

The dairy industry

The industrial production of liquid milk has developed processing milk in the past two decades in Syria. There are two types of dairy processors: the public and the private dairy processors. There are 41 private dairy factories which are basically found in Damascus and Aleppo. With a total production capacity of 94,263 tons of milk per year, the production capacity of these dairies is about 30% of the total cow and goat milk production in Syria (Grad 2000; FAO 2003a; AOAD 2003). The country has three public dairy processors located in Damascus, Homs, and Allepo, having a production capacity of 44,500 tons of milk per year (GOFI 2008). Their processing volumes are lower than their potential capacity (Grad 2000), though they are still using relatively old technologies. Milk in public dairies is processed to sterilized and pasteurized milk, ghee, butter,

Table 2 Definition of some traditional dairy products in the Middle East

Product name	Description	Flavor	Fermentation	Method of preparation
Baladi cheese	White brine cheese with soft to semi-hard in texture	Acidic flavor	Fermented	Obtained by isolating the fermented cheese from the residual whey
Danao	Combination of fresh juice flavors and milk	Sweet	Not fermented	NA
Ghee	Yellowish liquid butter	Nutty flavor	Not fermented	Obtained by clarification of milk fat at high temperature
Ghishta	White soft cream	Creamy flavor	Not fermented	Composed of the higher-butterfat layer skimmed from the top of milk before homogenization
Jameed	Balls in form of a hard stone	Slightly salty flavor	Fermented	Produced by straining heated buttermilk in cloth mesh bags, kneading and salting the formed paste, then shaping and drying in the sun
Laban	White, liquid fermented milk similar to kefir	Slightly sour flavor	Fermented	Obtained by lactic acid fermentation
Labneh	Concentrated or strained yogurt	Slightly sour flavor	Fermented	Produced by removing a proportion of the whey from cow's milk yogurt until fat and total solids contents of 9% to 11% and 23% to 25% respectively, are attained
Zabadi	White to light cream in color (yogurt)		Fermented	NA

Sources: Ganguli and Jain 1972; Tamime and Robinson 1999; Haddadin 2005; Shaker et al. 2007; Al Omari et al. 2008; Al-Safi 2008

NA not applicable (standard method)

fruit-flavored milk, kashkaval cheese, akawi cheese, other processed cheese, and yogurt. In winter, when the supply of milk decreases, the dairy factories shift to use imported powdered milk in order to meet the market needs and to keep producing continuously during the year.

The leading private processing companies are: Karam, Syrian-Finish Company, Al Mourouje, and Syrian-Saudi Company. These companies produce cheese, sterilized and pasteurized milk, yogurt, labneh, and other products.

Unlike in Syria, the Jordanian modern dairy factories use both fresh and powdered milk. About 95% of produced milk is delivered to dairy factories of which 52% is provided by the Dairy Breeders Association located in the eastern part of the country. In Jordan, there are 21 modern dairy factories, which are located mostly in the regions of milk production and the surrounding of the big cities. These factories process fresh milk, which comes from dairy farms as well as powdered milk into yogurt, laban, labaneh, cream, baladi cheese, flavored-yogurt, ice cream, pasteurized milk, butter, and jameed (see Table 2). The three biggest companies processing milk in Jordan are Hammodeh dairy, Danish-Jordanian dairy, and Teeba (Alqaisi et al. 2009).

From national statistics, it is clear that the informal sector is playing an important role in milk production and processing in Syria. The dairy processing plants in both Saudi Arabia and Jordan process most of the milk produced in the country. A very little quantity of milk is consumed on the farms or by the producing families.

In Saudi Arabia, the dairy industry is more capital intensive than in Syria and Jordan. Most of the dairy companies have their own plants and distributing systems. The full range of pasteurized fresh dairy products of the Western countries is equally available in Saudi Arabia (Fishwick 2004).

In Saudi Arabia, the three major producers of liquid milk are Almarai, Al-Safi, and NADEC. These companies account for almost all the sales of fresh, pasteurized milk and have nearly 90% of the market of Laban and 94% of the market of yogurt (AL-Otaibi and Robenson 2002). They produce their own fresh milk and have their own dairy farms, while other milk producers such as Jamjoom import large quantities of powdered milk. There are other factories which collect raw milk from farms scattered throughout the country. There are approximately 16 dairy factories in the Riyadh province, 14 in the eastern province, and eight in the western region. The rest are scattered throughout other parts of the country.

Dairy imports

The consumption of milk and dairy products has been increasing during the last years in all countries. In Syria, the increase in demand has led to an increase in the importation of dairy products. In terms of volume, Syrian imports of dairy products changed from 19,000 tons in 2000 increasing up to 45,000 tons in 2006. Syrian imports of dairy products traditionally consist of powdered milk, butter, and cheese. Syria imports milk powder from France, New Zealand, the Netherlands, Poland, Maldives, and Belgium. Jordan imported 21,363 tons of different dairy products in 2006. Jameed demand is growing tremendously as it is used in

social activities and has a high consumer preference. Jameed industry has also developed recently in Jordan in the solid and liquid forms. Jordanian imports of jameed and cheese are expected to grow from 2008 onward. The growth rate of dairy imports to Jordan has increased by 4% throughout the period 1996–2006. In 2006, dairy import volumes decreased by 3% in Jordan and by 9% in Saudi Arabia.

Growth in Saudi domestic market demand is tremendously higher than in Syria and Jordan. Saudi Arabia is a relatively open destination for international trade in dairy products and is traditionally a net importer of dairy products. In terms of volume, dairy imports increased to 98% from 179,000 tons in 1999 to 354,000 tons in 2005, with an average growth rate of 10.3% between 1999 and 2005.

It is also observed that there were no yogurt imports to Saudi Arabia in 2005. There is a trend towards self-sufficiency for yogurt production and probably exportation.

In terms of value, Syrian imports of dairy products rose from US $49 million in 2003 to US $113 million in 2006 (AOAD 2008; ITC 2008). The Saudi imports expanded almost threefold in the last 10 years to 2003 (NCB 2004). Imports rose by 110% from US $453 million in 1999 to US $1.02 billion in 2006 (ITC 2008). NCB (2006) reported that in 2006, dairy import value grew up by 15% and estimated that for 2008, dairy imports will reach US $1.3 billion. The imports were much lower in Jordan as compared to Saudi Arabia where imports were US $123 million in 2006 and having an estimated growth rate of 15%.

Dairy exports

Dairy exports also grew considerably in all countries. Syrian exports of dairy products have slowly expanded in the last years in both monetary terms (US-$) and in volume as well. In terms of volume, exports increased from 5,000 tons in 2000 to 16,000 tons in 2006. Major exported dairy products are Jammed and white-cultured cheese. The level of exports is still very low compared to Saudi Arabia where dairy exports are increasing at a higher rate. This might be because of the small quantities that are processed by the public and private dairy factories in Syria with moderate infrastructure and technology and higher on-farm consumption levels, with lower percentage of milk delivered to dairy. In Saudi Arabia, the processing units are more developed and sophisticated technology is used with higher percentage of milk delivered to dairy. Jordanian exports of dairy products are increasing steadily. The most common dairy products exported from Jordan are jameed and white cheese.

Saudi exports of dairy products have noticed a rapid expansion between 1995 and 2006 in terms of volume and value. The most common dairy products exported are unsweetened milk, cream, sweetened milk, yogurt, laban, other milk cream, fresh cheese, fresh fermented cheese, solid and semi-solid cheese, low-fat solid milk, and other cheese. The main destinations of these exports are the neighboring gulf countries, Iraq, Jordan, Lebanon, Yemen, and selected African markets.

In terms of volume, Saudi exports of dairy products expanded nearly sixfold during the period of 1992–2002 (NCB 2004). It is reported that there was an increase in the Saudi dairy exports by 26.4%, reaching 112,000 tons in 2004 (NCB 2006). Saudi export of dairy products was estimated at 119,000 tons in 2005. There are indications that the export market for Saudi dairy products will spread geographically and exports to places such as Iraq and Kuwait will continue as reported by Sadi and Henderson (2007).

In terms of monetary value, Syrian exports also increased from US $6.87 million in 1999 to US $124 million in 2006 due to an increase in production and export of concentrated and sweetened milk. In the same year, the Jordanian exports were estimated at US $62.3 million. The main destinations of Jordanian exports are Saudi Arabia and United Arab Emirates. Saudi exports have increased from US $115 million in 1998 to US $403 million in 2006 and grew faster than Jordan and Syria. In 2006, the Saudi exports of dairy products grew up to 25% in value terms.

Largest producers in the Middle East

As explained in previous parts, the dairy industry is growing rapidly in the Middle Eastern countries. In case of Saudi Arabia, market demand is expected to grow at 5% annually until 2010. It is expected that the volume of demand for dairy products will reach 1.6 million tons in the same year (NCB 2006). The capital intensity is much more important for Saudi dairy industry than Jordan and Syrian dairy industry because two dairy farms, Almarai and Al-Safi dairy companies which are considered as the largest in the world, are located in Saudi Arabia (Al-Otaibi and Robenson 2002; Almarai 2008).

Almarai is a well-known Saudi Arabian dairy company and was founded in 1976. Today this becomes the largest producer and exporter of milk and dairy products in the Middle East. Almarai has been considered as a significant contributor to the evolution of industry and commerce in the Arabian Peninsula, particularly in the development of agriculture and dairy production. The company operates across seven modern dairy farms. Almari has accolades including being the first dairy farm in the world to gain reputation as International Organization for Standardization 9002 accreditation. Almarai farms have over 38,000 dairy

cows and some other 27,000 female calves that are reared to join the milking herd after the birth of their first calf. Almarai intends to further expand their herd size to 100,000 cows within the period between 2008 and 2012 (Almarai 2008). The company production capacity is 1.8 million liters of milk per day with approximate annual milk packaging capacity of 500 million liters. Almarai owns 700 chilled sales vans and 40 sales depots as well as 34,000 retail outlets throughout the Gulf States. It has a market share of 40% and has generated a consolidated net profit of US $178 million in 2007, an increase of 43.6% in comparison to the same period of 2006 (Almarai 2008). It made a net profit US $293 in the first 9 months of 2008. Almarai entered the third phase of its expansion in 2006, a 5-year (US $1.2 billion) plan intending to purchase small or underperforming dairies. The company's total revenue through sales and acquisitions grew in 2007 by 36.7% to US $1.007 billion.

The main dairy products include laban, milk (fresh and evaporated), trinned cheese, labneh, ghishta (cream), yogurt, cheddar and processed cheese, zabadi, butter, and ghee. Zabadi is a natural set yogurt and Almarai is the third biggest product after laban and milk. Probiotic culture laban and milk are some of the products which contribute positively to overall health and help in maintaining a healthy digestive system (Almarai 2008). Saudi Arabia's biggest dairy producer has finalized the acquisition of a 75% stake in Jordan's Taiba Investment and Advanced Food Industries Company in 2008. This is the first cross-border acquisition for Almarai and it intends to expand outside its home market. About 25% of Almarai raw milk produced is pasteurized and packaged in plastic bottles and degradable paper containers of various sizes. A further 60% is fermented to make Laban (Sadi and Henderson 2007). In terms of product quality, Almarai processing plant was declared the world's best in 1998 (Arla 2003).

Al-Safi dairy company is another big company located in Saudi Arabia; Al-Safi is part of the Al Safi organization. Al-Safi dairy farm comprises of 3,500 ha of land and having more than 36,000 Holstein Friesian cattle producing a total of 600,000 l of milk daily. Al-Safi market share is 36% from the total dairy market in Saudi Arabia, and it is expanding in the Arabian Gulf countries (Al-Safi 2008). Danone International acquired 50.1% of the shares in Saudi Al-Safi foods, which own the Al-Safi dairy (Al-Otaibi and Robenson 2002). Al-Safi Danone main products include milk, yogurt, laban, and fresh cream. In addition new products such as Danao, Danino, Safio milk, and Rashaka (Table 2) were introduced. The most recent dairy products are Activia and Actimel which are fresh and healthy laban and yogurts. They have a unique probiotic culture, *Bifidus essensis*, which facilitates digestion (Al-Safi 2008).

Current challenges and future outlook

This section will elucidate the prominent features of the dairy industry in the three countries and will give a projection for dairy production growth in the period between 2008 and 2012. Projection of growth in milk production was made by using the IFCN dairy sector model. Figure 3 shows the projected development in milk production per country.

Milk production is expected to grow by 6.6% for Syria, 5.4% and 4.9% for Jordan, and Saudi Arabia, respectively. Syrian milk production throughout 2008–2012 is expected to grow. Projection has been done based on an annual growth rate of 6.6%. This trend suggests that the dairy industry in the country was productive and has not attained self-sufficiency in many of the products but also had an excess of exports.

The small scale production system in Syria will be the major supplier for dairy industry. In terms of volume, Syria will be the biggest producer among these countries, followed by Saudi Arabia while milk production is growing in lower rate in Jordan. The major driver in milk production growth is basically the growth in national herd number by 5.4%, 5.5%, and 1.5% in Syria, Jordan, and Saudi Arabia, respectively. As the GDP and population rate are increasing in all countries in different rates, it is expected that the demand for dairy products will also grow.

In 2007, total area allocated for cereal production (wheat, barley, sorghum, millet, and sesame) in Saudi

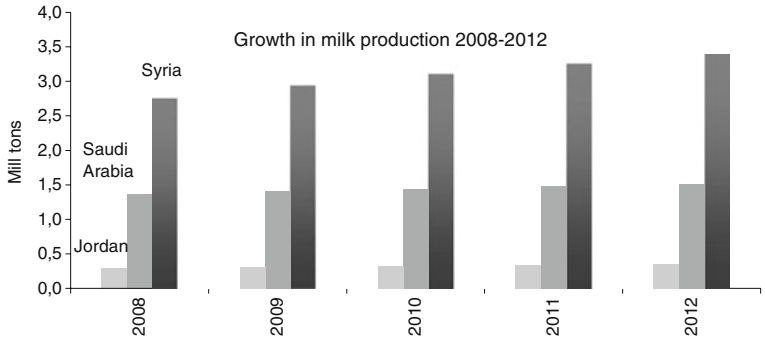

Fig. 3 Projected milk production in Syria, Saudi Arabia, and Jordan (2008–2012). Source: Hemme 2008

Arabia was estimated at 582,071 ha and produced about 2,966,953 tons. In the same year the area allocated for fodder production, estimated at 151,301 ha of land produced about 2,687,791 tons of different types of fodders (MEP 2007). In Syria, total fodder production in 2006 was estimated at 9,374,000. The Syrian total fodder production (on dry matter basis) was estimated at 9,374,000 tons, with total digestible nutrients of 4,085,000 tons and 418,000 tons of digestible protein (NCAP 2008). The total deficit in all fodder resources was estimated at 2,756,000 tons. The available fodders for large animals in Jordan (excluding the agricultural by-products) were 492,000 tons only (Harb 2008).

In all countries, increasing feed prices were a major risk factor in the dairy industry. This also continues to be one of the major risk factors as all countries rely basically on imported feedstuff in feeding animals. Additionally, the availability of water resources, particularly in Saudi Arabia and Jordan, will be a limiting factor in fodder production.

The dairy industries of Syria, Jordan, and Saudi Arabia face major challenges which can be summarized as follows:

- Elimination of all kinds of subsidies under the World Trade Organization rules has slashed the agricultural input subsidies and led to an increase in the cost of milk production for the local dairy industry in all the three countries. For example, slash of feed subsidies in Jordan led to increased feed prices by more than 80% (Hemme 2008).
- Fluctuation in profit margin in milk (income over feed cost[1]) due to the volatility in milk and feed prices.
- Shortage in water resources. This region has very low rainfall of less than 300 mm per annum and semi-arid to arid climate which make water availability very low.

Directions to industrialize dairy production in Syria will be promising in this stage of growth to improve milk quality, packaging services, marketing systems, and transportation tools.

For the Syrian dairy sub-sector, there is a possible move to a more intensive production system based on the use of improved cows to improve milk production, improved feeding techniques, improved processing conditions, developed cooperation among small-scale farmers, and the use of more farm-produced fodders (FAO 2003b).

Reduction of the existing risk could be possible by shifting some of the area for fodder and cereal cultivation in Saudi Arabia from high water consumption regions to lower water consumption regions and the cultivation of crops with lower water requirements and cost. The marginal cost of water is relatively high in Jordan compared to other countries of the world. In addition to water shortage, dairy production in Jordan has other constraints such as shortage of feed resources and extreme climatic conditions which hamper dairy development. More than half of the Jordanian milk is concentrated in Al-Dhuleil, which is an area that is unsuitable for fodder production, leading to high production costs from high feed prices. Adapting alternative dairy farming systems in areas where at least part of the feed could be grown on-farm would be helpful to improve existing feeding systems and reduce feed cost which represents more than 55% of total milk production (Hemme 2008). In addition, establishing a modern dairy factory by the Dairy Breeders Association in Jordan will expand the market potential for dairy producers and reduce the monopoly of big dairy factories.

There is seasonal fluctuation in demand and supply chain, as majority of dairy products consumed in Saudi Arabia like laban and labneh are fresh and very perishable and are thus more susceptible to market volatility. Secondly, the recent cut in custom duties to 5% on dairy imports in Saudi Arabia is a constraint to the dairy industry because it induces more competition from foreign suppliers. However, the Saudi dairy companies are large and strong enough and are able to compete with foreign companies. The Saudi dairy farms are now world class and their products are of international standard. Merging of small farms can also increase the competitive strength of the Saudi market. The difference between demand and supply could be minimized by producing UHT milk which has a long shelf life.

Conclusion

The dairy industry of Middle Eastern countries is growing and there is evidence that it will continue to grow in spite the lack of fodder and water resources. Growth in milk yield is driven by some factors, especially, the national GDP and population growth. The dairy industry is more capital intensive in Saudi Arabia than in Syria and Jordan. Only 5% of milk is delivered to dairy factories in Syria compared to 94% and 95% in Jordan and Saudi Arabia, respectively. Dairy exports and imports are growing faster in Saudi Arabia than in Jordan and Syria. Maintaining the growth in milk production in the Middle East can be accomplished by finding better production systems and alternative feeding programs which could reduce the cost of milk production. Additionally, an improvement of the current agricultural policies to favor dairying and improve the sustainability of natural resources will be solicited.

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