

The Dairy Milk Sector in Lower Saxony and Germany

Compiled by Max Lesemann, IHK Hannover

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BMEL	Bundesministerium für Ernährung und Landwirtschaft (Federal Ministry for Nutrition and Agribusiness)
DMK	Deutsches Milchkontor (German Milk Office)
IoT	Internet of Things
LVN	Landesvereinigung der Milchwirtschaft Niedersachsen e.V. (State Federation of the Milk Industry Lower Saxony)
MIV	Milchindustrie-Verband (Milk Industry Federation)
OEC	Observatory of Economic Complexity

I. Introduction

The milk production sector is the most important production sector within the German agribusiness and the dairy milk sector the biggest branch within the food industry. In 2018 the share of the dairy milk sector on all animal products has been around 40% and as part of the whole agribusiness around 20%. This shows the economic, political and social importance of the sector (Bundesministerium für Ernährung und Landwirtschaft (BMEL), 2020).

Lower Saxony, as one of the sixteen federal states in Germany, has the second biggest dairy milk production industry in the country behind Bavaria. Around 20% of the milk produced in Germany is produced in Lower Saxony. Geographically, the industry is concentrated close to the coastal area in the north-western part of Lower Saxony. Also, in comparison to the rest of Germany, an overproportioned share of cows, around 70%, has at least a temporarily access to fields (Niedersächsisches Ministerium für Ernährung, Landwirtschaft und Verbraucherschutz, 2020).

In general, the industry is experiencing a change of structure. The amount of dairy milk factories has continually fallen while the amount of cows rose. This means, the production capacities of surrendering companies are taken over by those companies that are growing. Another strong and growing influence on the domestic market is exerted by international trade. This led to several price crises on the milk market in 2009, 2012 and 2015/16, whereas the branch received support by the German government and the European Union. The corona pandemic has also negative impacts on the industry, that's why the EU commission implemented different arrangements to help the sector (BMEL, 2020).

In 2019, Germany has been the member state of the EU with the highest output, followed by France and the UK. Overall, the EU produces more milk products than it is consuming. This is not surprising, because the global market for dairy milk products is still growing, especially in Asia, Europe and North and South America. Half of the German milk producers are participating in international trade. The biggest export excess is generated by the United States, but also countries out of the EU, like China, Japan, Switzerland or Algeria are well-funded trade partners (BMEL, 2020).

This study should help to get an overview of the market with its company and federation structures, as well as statistics about production, international trade and consumption. Future-oriented topics as digitalization, Internet of Things and Industry 4.0 will also be discussed. Additionally, as the probably most important topic of the future, sustainability in the dairy milk sector will get an extra focus. The future of the sector will also be decided by innovations and trends and especially the reaction of the actors of the branch to such.

Besides informing about the sector in Germany and Lower Saxony, another objective is to give an understanding on how and in which part of the industry Colombian enterprises can possibly enter the market or cooperate with German companies. Therefore, in some occasions references to the Colombian market are made.

II. Market

I. Company Structures and Federations

In general, there is a differentiation between milk producing and dairy milk companies. Around 58.000 milk producers rear around 4 million cows which are producing approximately 33 million tons of milk per year in Germany (2020). The companies which are dairy milk are far less with 155 in total. They are generating a revenue of 27 billion Euro with the production of 4,5 million tons of milk, 2,4 million tons of cheese and around 1,4 million tons of other milk products like butter, cream or milk pulver (2019) (MIV, 2020).

German Milk Industry	2015	2016	2017	2018	2019
Dairy Milk					
<i>Revenue (in bill. €)</i>	22,619	21,890	26,011	26,285	26,989
<i>Companies</i>	148	152	153	158	155
<i>Employees</i>	35.163	36.335	37.099	38.411	39.131
Milk Production					
<i>Producers</i>	73.255	69.174	65.782	62.813	59.925
<i>Production (kg per cow)</i>	7.628	7.746	7.763	8.063	8.200
<i>Cows (in mill.)</i>	4,28	4,22	4,20	4,10	4,00

Table 1: German milk industry in numbers 2015 – 2019 (MIV, 2020).

Table 1 shows that the German milk industry has a rising revenue, even though the amount of companies is not growing that much and has even declined from 2018 to 2019. Still, the amount of employees rose constantly, which shows that the market is still growing. On the side of the milk producers, a clearer trend regarding the amount

of companies/producers and the amount of cows is notable. The decline is obvious and very strong during the years. Nevertheless, the production rose. This could lead to the assumption that processes to milk cows got more effective.

Lower Saxony Milk Industry	2015	2016	2017	2018
Dairy Milk				
Companies	23	24	24	23
Milk Production				
Producers	-	-	9.629	9.228
Cows (total)	-	-	865.218	849.192
Cows per Rearing	81,9	85,5	89,9	92,0

Table 2: Lower Saxony milk industry in numbers 2015 – 2018 (Landesvereinigung der Milchwirtschaft Niedersachsen e.V. (LVN), 2020).

Table 2 shows the Lower Saxony milk industry. The trend for the amount of companies that is shown in table 1 can also be seen in table 2. There are not specifically more companies but still the amount of delivered and processed milk rose throughout the years. The national trend of having less milk producers and less cows can also be seen in Lower Saxony. Still, the amount of cows per rearing rose. The assumption can be done, that there are less but bigger facilities to produce milk (LVN, 2020).

As a counterpart, organizer and stakeholder for most of the German members of the milk industry there is the Milchindustrie-Verband (MIV). The MIV was founded in 1912 and is meanwhile the biggest and most important federation for the industry nationally-wise. Around 95% of the dairy milk production and 90% of the export volume are rendered by members of the MIV. Even though it is a national federation, it represents the interests of their members also regionally, in Europe and across the borders of the EU in front of decision makers in politics, economy and science. They provide relevant information about the sector and are also counselling their members even in internal company issues. In order to generate knowledge transfer, the MIV organizes workshops and seminars for their members (MIV, 2019).

On the level of federal states, the Landesvereinigung der Milchwirtschaft Niedersachsen e.V. (LVN) is the federation for all organizations and companies that are part of the production, dairy, trade and consumption of milk in Lower Saxony. It represents the interests of their member on all possible public related events, for

example in schools or international or regional fairs. Their aim is to give a realistic picture and show the value of the milk industry in Lower Saxony (LVN, 2019).

II. Production

According to the MIV, the production of dairy milk products is declining in the German market, as it is shown in figure 1. The decline of -9,40% concerns the production of regular fresh milk and homogenized milk. The same, in terms of the decline, goes for the butter production. Even though the production of butter and related products like buttermilk rose between 2014 and 2015, the decline amounts to -1,22%. The only product group that can record a growth during the period of 2014 until 2018 is cheese products. Hard, semi-hard and cheese, as well as cream cheese, pasta filata cheese and others fall under this product group. The growth amounts to 2,23% for Germany. Other milk products, like concentrated milk or milk powder, were experiencing the steepest decline with -22,01% production-wise (MIV, 2019).

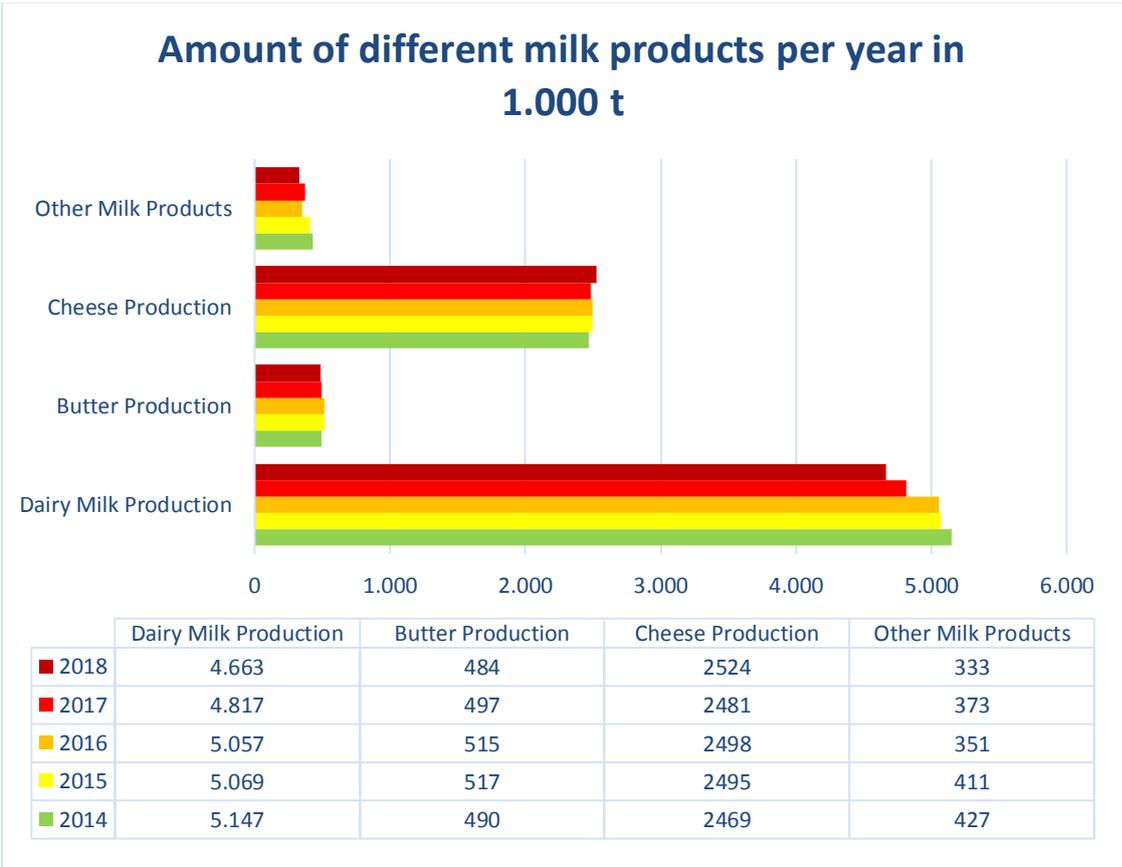


Figure 1: The amount of different milk products per year from 2014 to 2018 in 1.000 t in Germany (based on MIV, 2019).

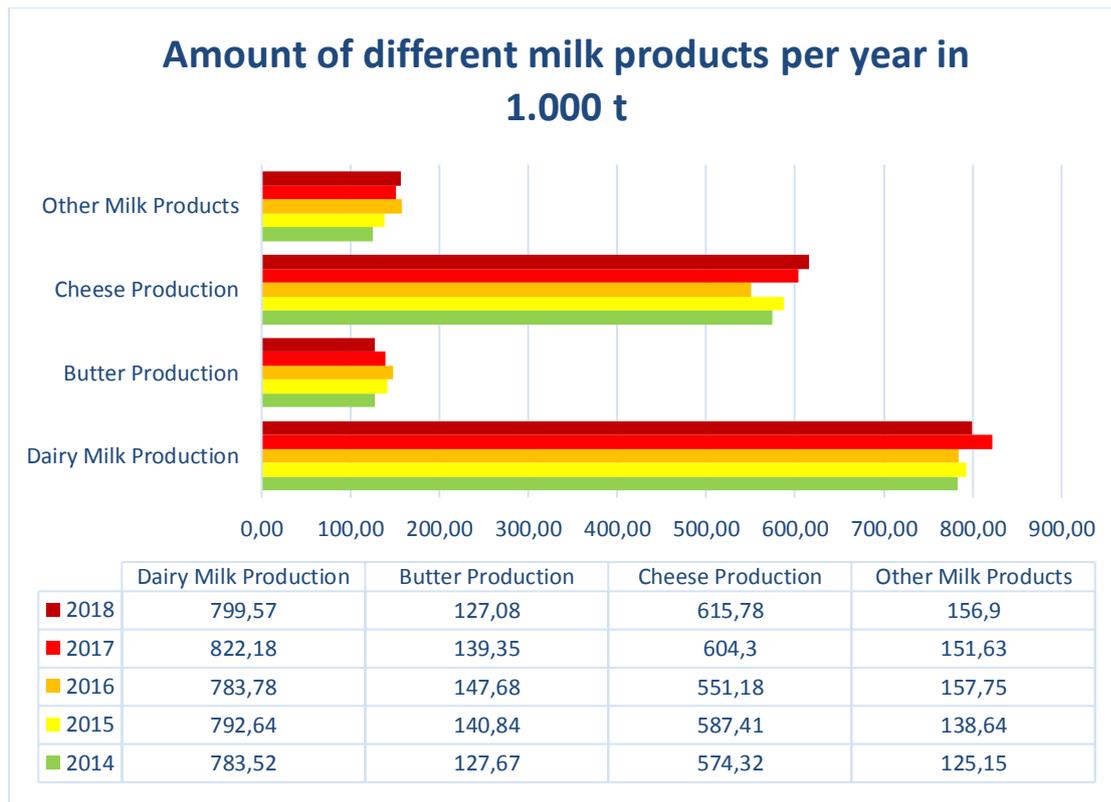


Figure 2: Amount of different milk products per year from 2014 to 2018 in 1.000t in Lower Saxony (based on LVN, 2020)

Figure 2 shows the same statistics as figure 1, but only for Lower Saxony. In comparison to the production of whole Germany, the production for milk products developed in general positively in the federal state. The dairy milk production for example grew from 2014 until 2018 by 2,05%. Nevertheless the peak within this time frame has been in 2017 with a total production of 822.180 t. So, there was a small decline between 2017 and 2018, but the trend is going upwards. The butter production is the only product group which experienced a decline during 2014 and 2018 in Lower Saxony by -0,46%. In 2016 the production rose to 147.680 t per year, but then fell again. Therefore a negative trend for this product group can be seen. However, the cheese production rose significantly by 7,22%. In fact, this is the only product group which has the same trend in Lower Saxony as it has in Germany. The steepest growth has happened in the production of other milk products with a rise of 25,37% (LVN, 2020).

As it is visible in figure 1 and 2, the cheese production seems to be the second biggest production sector of milk products behind dairy milk products like fresh and homogenized milk and also the only production sector which experiences a growth in

the production location Germany as well as in the production location Lower Saxony. Therefore, a special look into this section seems to be useful.

Figure 3 shows the cheese production by different cheese product groups in Germany for the years from 2014 until 2018. The product group with the highest amount of produced cheese is hard, semi-hard and soft cheese. Within the time frame the amount of produced cheese of this kind rose permanently and in total by 2,65%. Cream cheese is the second biggest product group, but the only one which declined in total by -6,01%. Nevertheless, between the last two pictured years 2017 and 2018, the production grew a little bit again from 791.000 t to 797.000 t. Pasta filata cheese, which includes for example mozzarella cheese, is the product group with the biggest amount of growth between the four categories. The production in Germany grew by 19,27%. Other kinds of cheeses had been produced more as well. After a little decline until 2016, the production grew again and in total from 2014 to 2018 by 6,90% (MIV, 2019).

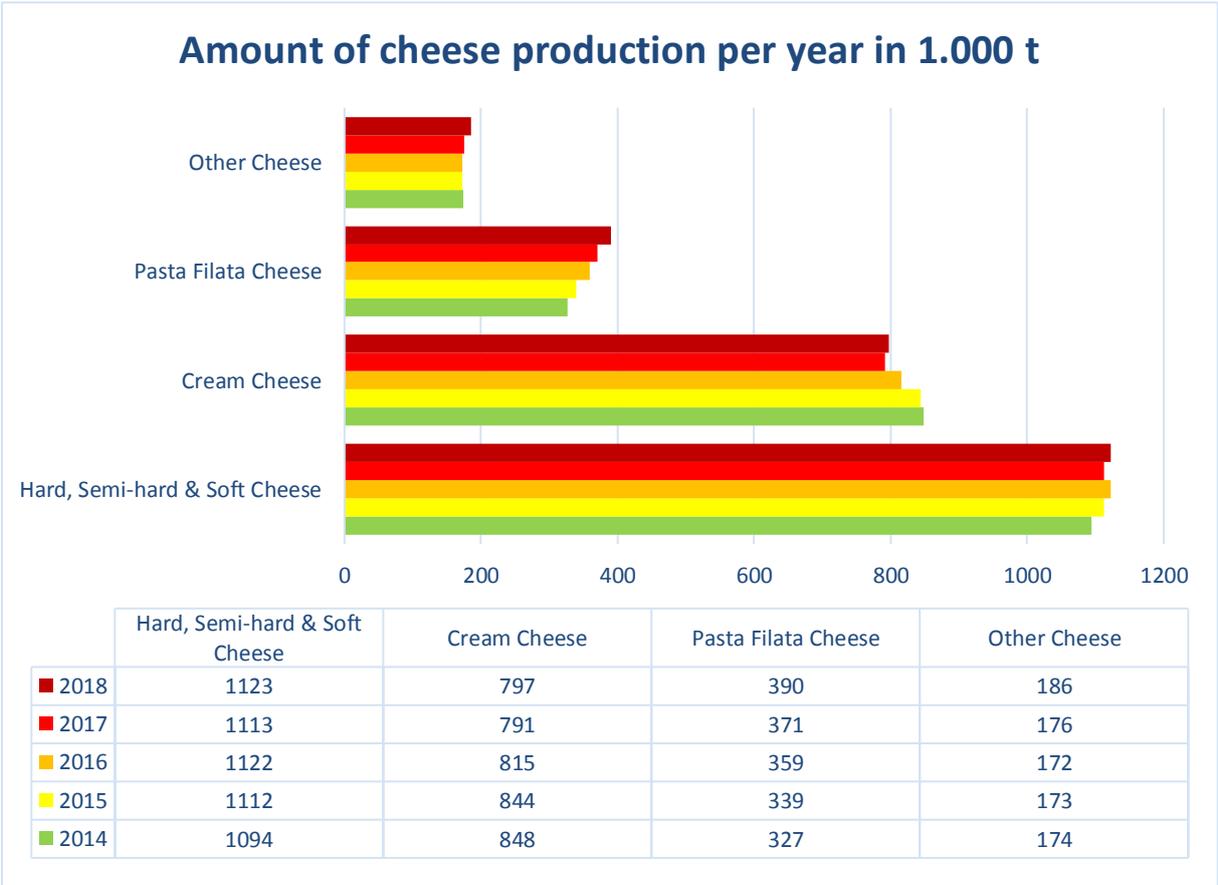


Figure 3: Amount of cheese production per year from 2014 to 2018 in 1.000 t in Germany (based on MIV, 2019)

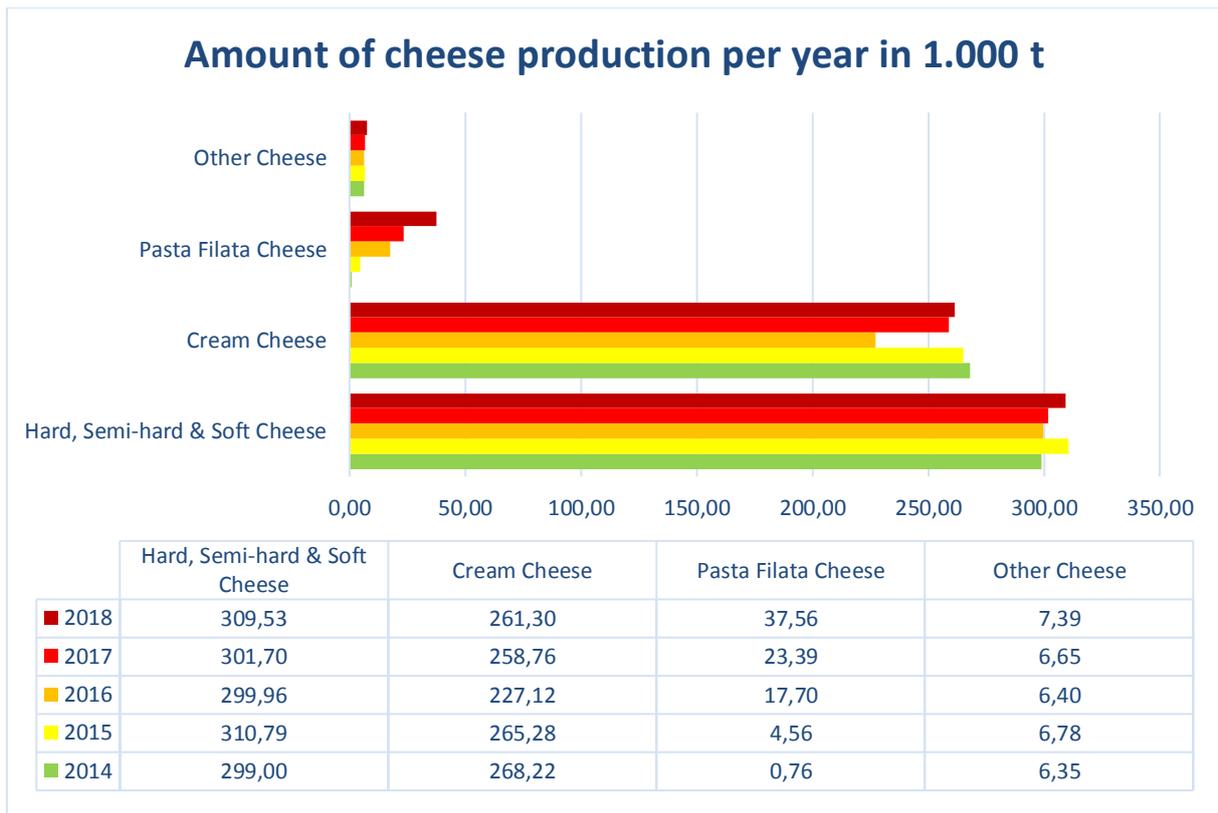


Figure 4: Amount of cheese production per year in 1.000 t in Lower Saxony (based on LVN, 2020)

The amount of produced cheese in Lower Saxony is shown by figure 4. As in Germany in general, also in Lower Saxony the biggest production group of cheese is hard, semi-hard and soft cheese. The development is similar to the development in the whole market, even though there was a small decline between 2015 and 2016. Since then, the production grew permanently and in total by 3,52%. The only production group that was declining in the whole German market was cream cheese and the same development can be seen in Lower Saxony, even though in a smaller amount. The production of this product group declined by -2,58%. The most significant increment happened to the production pasta filata Cheese. From a really small amount of 760 t in 2014 the production rose to 37,560 t in 2018. This is an increase of 4.948,75%. Other cheese products also experienced a growth during the time period by 16,36% (LVN, 2020).

Cost Item	Ct/kg
Buyed Fodder	+ 7,97
Forage Cultivation	+ 2,76
Costs of Animal Husbandry	+ 3,68
Maintenance of Machines & Buildings	+ 4,06
Energy	+ 3,10
Wage Labor	+ 2,59
Staff Costs	+ 2,22
Burden	+ 2,11
Lease	+ 2,44
Write-Downs	+ 5,75
Interests & Taxes	+ 1,38
Income of Selling Cows	- 5,88
Financial Accounting-Related Costs	= 32,18
Labor Costs	+ 12,73
Total Generation Costs	= 44,19
Subsidies	- 3,10
Total Milk Generation Costs	= 41,81
Net Investment	+ 1,58
Total Milk Generation Costs incl. Net Investments	= 43,39

Table 3: Total production costs of 1 kg of dairy milk in Germany 2017 (based on European Milk Board, 2020)

Table 3 shows that the total production costs of 1 kg of dairy milk in Germany in 2017 has been 41,81 €/ct. Including the averaged net investments of 1,58 €/ct that milk producers made per kg dairy milk between 2007 and 2016, the total costs were 43,39 €/ct. Between 2016 and 2017 the price for milk rose by 9,47 €/ct. Still, 11% of the costs could not be covered.

III. International Trade

The production of dairy milk, butter and cheese products is not only produced for the domestic population, but also for the international markets. Table 4 shows the top export countries Lower Saxony exported dairy milk products in 2018 to. The Netherlands were the biggest buyer of those products. The three other European countries Italy, France and Belgium are also important countries for the export of these goods. Interesting enough, China seems to be a big trade partner of Lower Saxony in terms of dairy milk products. It is the only non-european country that is represented in the top-5 lists below (table 4 to 9). So far, Colombia does not buy dairy milk products from producers out of Lower Saxony.

Rank	Country	€
1	Netherlands	€ 272.811.000,00
2	Italy	€ 55.578.000,00
3	China	€ 52.095.000,00
4	France	€ 46.688.000,00
5	Belgium	€ 38.047.000,00
-	Colombia	€ 0,00

Table 4: Top-5 export countries and Colombia for dairy milk products from Lower Saxony 2018 (based on Statistisches Bundesamt, 2020)

Table 5 shows the top export countries for butter products from Lower Saxony. The amount sold is in total far less than the amount for dairy milk products. Nevertheless, the Netherlands, France, Belgium and Italy are again the most important trade partners for Lower Saxony in the butter business. Poland plays also an important role. As in dairy milk products, Colombia does not import any butter products out of Lower Saxony.

Rank	Country	€
1	Netherlands	€ 112.936.000,00
2	France	€ 29.766.000,00
3	Belgium	€ 21.326.000,00
4	Italy	€ 10.492.000,00
5	Poland	€ 9.465.000,00
-	Colombia	€ 0,00

Table 5: Top-5 export countries and Colombia for butter products from Lower Saxony 2018 (based on Statistisches Bundesamt, 2020)

In table 6 the same statistics is shown, but only for cheese products. Again, the Netherlands, Italy and Belgium are the biggest buyers of those goods from Lower Saxony. The United Kingdom and Spain were also a big trade partner for the federal state. Cheese products from Lower Saxony seem to be more of an interest for Colombian enterprises, as they imported those products with a total amount of € 82.000,00 in 2018.

Rank	Country	€
1	Netherlands	€ 103.591.000,00
2	Italy	€ 89.745.000,00
3	United Kingdom	€ 62.191.000,00
4	Belgium	€ 58.325.000,00
5	Spain	€ 51.907.000,00
82	Colombia	€ 82.000,00

Table 6: Top-5 export countries and Colombia for cheese products from Lower Saxony 2018 (based on Statistisches Bundesamt, 2020)

Moving away from the federal state level, table 7 shows the amount of exported dairy milk products from Germany in general. As in table 4, which showed the statistics for the same product group but only for Lower Saxony, four of the top 5 countries are the Netherlands, Italy, France and Belgium. In addition to that, the United Kingdom is the

third biggest purchaser of dairy milk products out of Germany. Colombia holds also a small share of around € 2.622.000,00.

Rank	Country	€
1	Netherlands	€ 898.281.000,00
2	Italy	€ 514.724.000,00
3	United Kingdom	€ 316.812.000,00
4	France	€ 311.144.000,00
5	Belgium	€ 289.675.000,00
76	Colombia	€ 2.622.000,00

Table 7: Top-5 export countries and Colombia for dairy milk products from Germany 2018 (based on Statistisches Bundesamt, 2020)

The four countries which were mentioned before as the most important buyers of German dairy milk products play the same role in the butter export business. The fifth country which is represented in the top 5 is Austria. German butter seems not to be a product Colombian enterprises usually import, which is shown in the small amount of just € 8.000,00 export volume.

Rank	Country	€
1	Netherlands	€ 191.667.000,00
2	France	€ 92.011.000,00
3	Belgium	€ 61.054.000,00
4	Austria	€ 58.183.000,00
5	Italy	€ 53.737.000,00
94	Colombia	€ 8.000,00

Table 8: Top-5 export countries and Colombia for butter products from Germany 2018 (based on Statistisches Bundesamt, 2020)

In contrary to all of the tables 4 to 8, Belgium is not represented in table 9, which shows the top 5 countries Germany exports cheese products to. Austria and Spain are completing Italy, the Netherlands and France in this ranking. For Italy, the German cheese market seems to be very important as it has almost doubled the import volume of the second country in this ranking, the Netherlands. Also, Colombia imported cheese from Germany with an amount of € 233.000,00. In comparison to table 6 that means, that around 35% of the German cheese products in Colombia are from Lower Saxony.

Rank	Country	€
1	Italy	€ 798.551.000,00
2	Netherlands	€ 400.960.000,00
3	Austria	€ 300.745.000,00
4	France	€ 299.376.000,00
5	Spain	€ 242.813.000,00
93	Colombia	€ 233.000,00

Table 9: Top-5 export countries and Colombia for cheese products from Germany 2018 (based on Statistisches Bundesamt, 2020)

According to the Observatory of Economic Complexity (OEC), which is a database to visualize economic complexity and trade flows, Germany was the fastest growing import destination for butter and cheese products from 2017 and 2018 (newest data available at the moment) with a growth of 216% respectively 219% (OEC – Butter & OEC - Cheese, 2020).

IV. Consumption

The consumption of cheese and milk products have taken different paths since 2013 in Germany. While the consumption of dairy milk declined throughout the years, the consumption of cheese products rose more or less constantly.

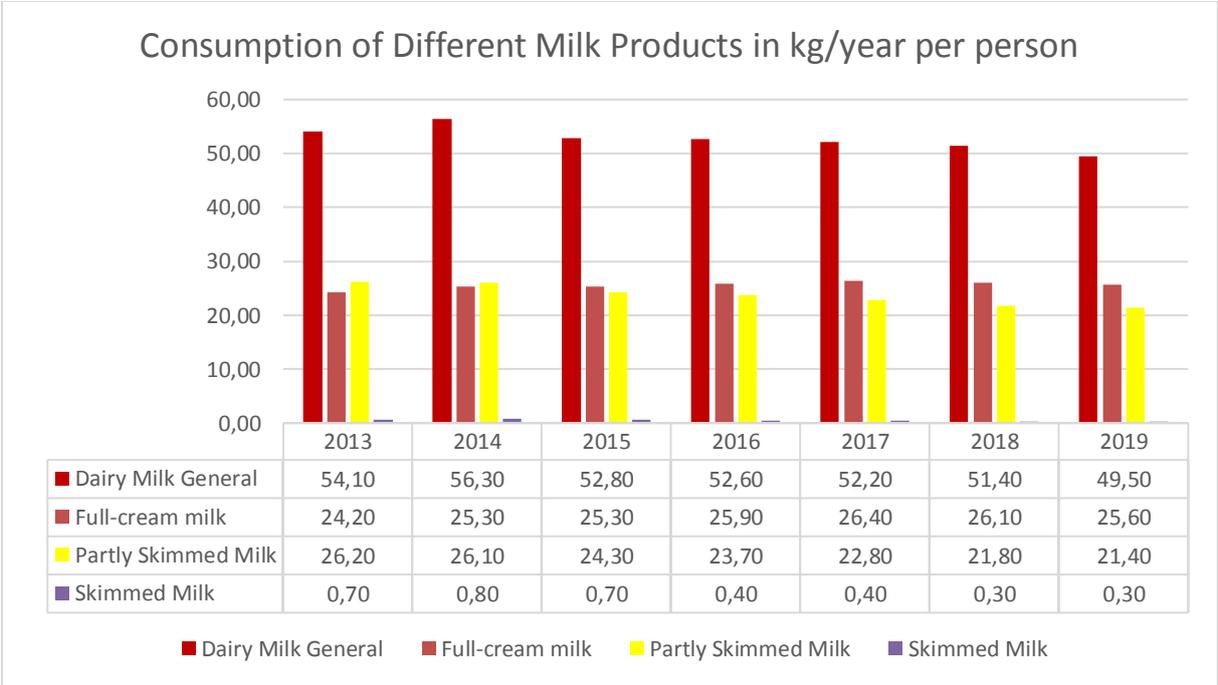


Figure 5: Consumption of different milk products in kg/year per person (values for 2019 are preliminary) (based on MIV, 2020)

Figure 5 shows the consumption of different milk products in kg/year from 2013 until 2019. The values for 2019 are preliminary, because the data is from April 2020. After a short rise in consumption for dairy milk products in general from 2013 to 2014, the consumption declined steadily and in total by -8,50%. Full-cream milk, as a more specific product of dairy milk, is the only product where the consumption rose during the years. From 24,20 kg/year per person the consumption grew to 25,60 kg/year per person. This is a growth of 5,79%. It seems that more fat reduced milk products as partly skimmed and skimmed milk are less interesting for the consumers, as both products experienced a decline of -18,32% respectively -57,14% (MIV, 2020).

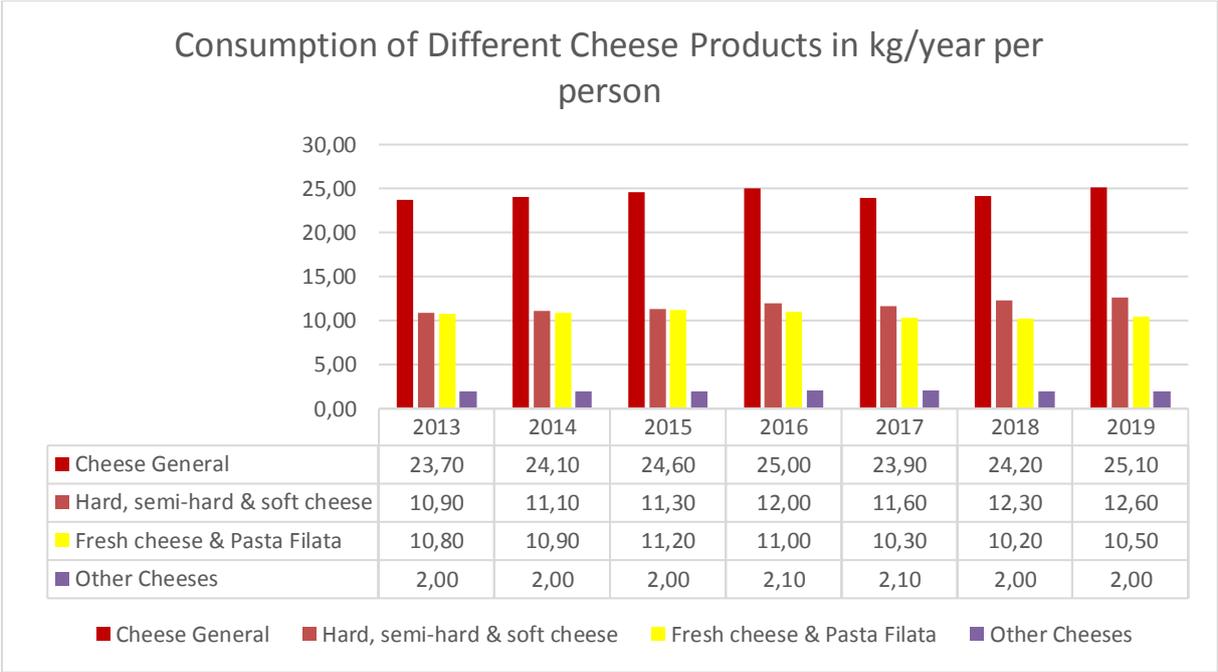


Figure 6: Consumption of Different Cheese Products in kg/year per person from 2013 to 2019 (values for 2019 are preliminary) (based on MIV, 2020)

The cheese consumption, as mentioned before, has experienced a growth from 2013 to 2019. For cheese products in general, the all-time high of 25,10 kg/year per person resulted in a percentage growth of 5,91%. This growth of consumption of cheese products in general has its roots in the growth of hard, semi-hard and soft cheese products. The consumption of 10,90 kg/year rose steadily, except of a small decline from 2016 to 2017, to 12,60 kg/year. This results in a growth of 15,60%. For fresh cheese and pasta filata, which were put together in this data set, a small decline is notable. From 2013 to 2019 the decline has been -2,78%. If we'd look at the data from 2015, where the consumption has its peak at 11,20 kg/year per person, this percentage decrease would have been even more. Other cheeses, which includes for example processed or cooked cheese, has whether experienced a growth neither a decline and stays at a consumption of 2,00 kg/year per person (MIV, 2020).

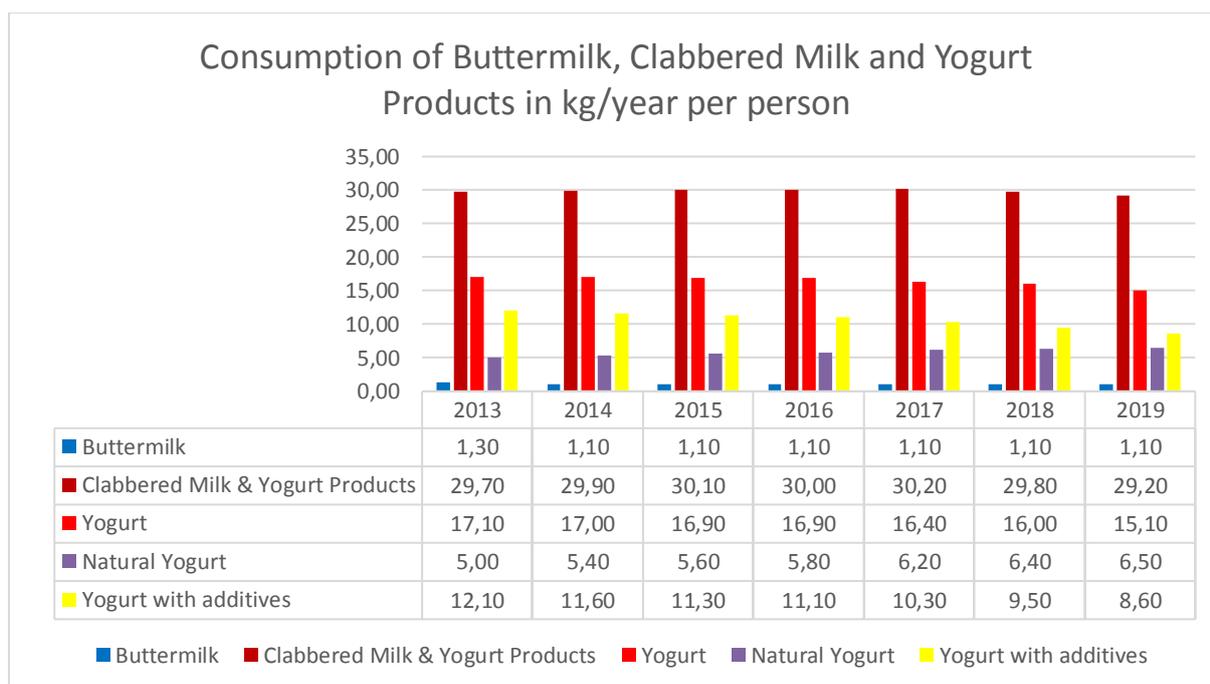


Figure 7: Consumption of buttermilk, clabbered milk and yogurt products in kg/year per person from 2013 to 2019 (values for 2019 are preliminary) (based on MIV, 2020)

Besides the analysis of the milk products as dairy milk and cheese products, there is also data about the consumption of buttermilk and yogurt. While the consumption of buttermilk has just a small share of the overall consumption, it has also declined from 2013 to 2014 and then been steady with 1,10 kg/year per person. In comparison, clabbered milk and yogurt products in general are having a much bigger share. Still, the consumption decreased a little after small increase with its peak in 2017. The total decrease is -1,68%. The decline of yogurt consumption is even more notable. The absolute value decreased by 2 kg/year, which means a percentage decline - 11,70%. Nevertheless, the share of consumption of natural yogurt grew strongly, measured by percentage growth with 30,00%. The decrease of yogurt consumption is therefore not connected to the consumption of natural yogurt, but to the consumption of yogurt with additives, as fruit yogurt for example. Because here, the consumption declined heavily from 12,10 kg/year to 8,60 kg/year per person. This is a percentage decrease of -28,93% (MIV, 2020).

The consumption of butter has not been affected a lot by the changes of consumption of other milk products. After a growth in consumption from 5,80 kg/year in 2013 to 6,1 kg/year per person in 2015 and 2016, it dropped again and fell to its origin of 5,80 kg/year per person in 2019 (MIV, 2020).

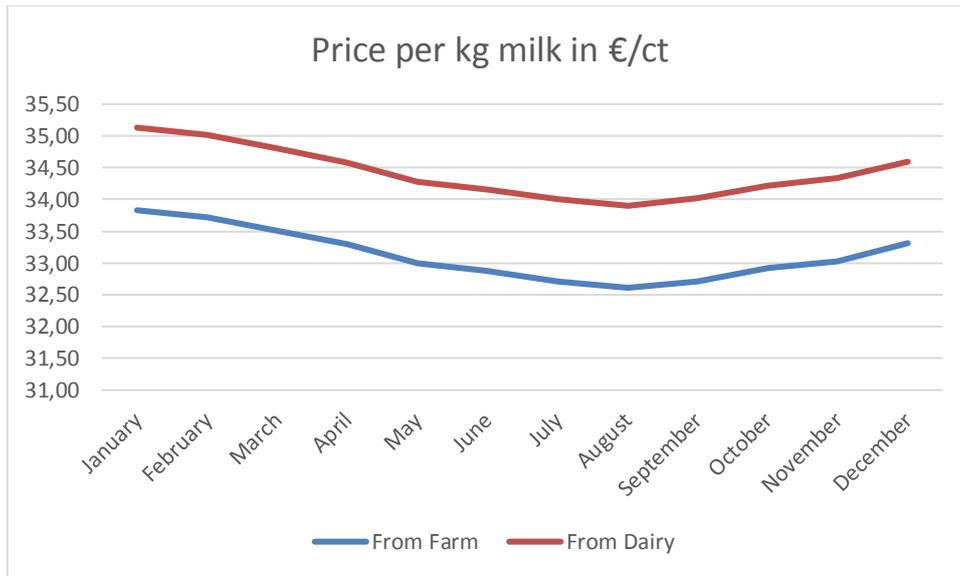


Figure 8: Price per kg milk in €/ct in 2019 in Germany (based on Bundesministerium für Landwirtschaft und Ernährung (BMLE), 2020)

Figure 8 shows the price of one kg milk in €/ct in 2019 in Germany and the place of production, either directly pasteurized at the farm or at a dairy. First of all, it stands out that pasteurized milk directly from the producer is sold with a lower price than milk that is pasteurized at a dairy. Another point that is notable is that the price of milk, independently from the point of sale, has seasonal change. During the summer months the price is lower and with the start of autumn the price rises again (BMEL, 2020).

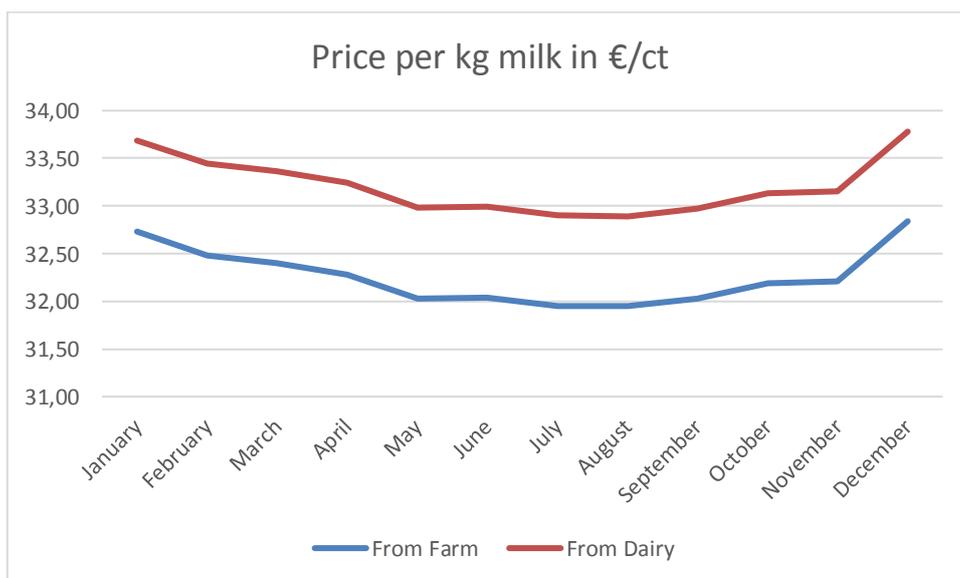


Figure 9: Price per kg milk in €/ct in 2019 in Lower Saxony (based on BMLE, 2020)

Figure 9 shows the same data but with the geographical level of Lower Saxony instead of Germany as a whole. The trend of the two graphs is very similar to the

ones in figure 9. Milk sold from the dairies are more expensive than milk sold directly from the producers. But in general, the prices for milk are lower in Lower Saxony than in Germany. The seasonal trend is also recognizable, even more obvious when it comes to the winter months November and December (BMEL, 2020).



Figure 10: Price per kg milk in €/ct in Germany (MIV, 2020)

Figure 10 shows the changes in prices of dairy milk through the years in Germany. The highest prices for dairy milk could be achieved in 2013 and 2014. After that a rapid decline took action in the years 2015 and 2016 with the lowest point in 2016 with 26,73 €/ct per kg milk (MIV, 2020). The reason for this is that in 2015 the European Union disestablished the so-called “milk quota” which was implemented in the early 1980s to get a better control of the market. Before, milk producers received a stable price for their milk, independently from the global market. This led to an overproduction of milk, butter and other milk products. The “milk quota” regulated the amount of milk each producers was allowed to produce and punished those who overproduced. With the start of the 2000s the EU agreed to disestablish the quota in several steps with the final disestablishment in 2015. The aim was to satisfy the growing demand on milk products on the domestic market but especially on the global market. Particularly the Asian market grew a lot. With the cessation of the “milk quota” the European milk producers started producing again more than the market was demanding, which led to the decline of the price (Europäische Kommission, 2015). After a while, the prices stabilized again and rose to 34,50 €/ct per kg in 2019.

III. Digitalization, Industry 4.0 and Internet of Things in the milk industry

Within the food industry the milk industry has the leading role when it comes to IT-based processes. Still, there are potentials, because most of the processes are automatized but not yet fully digitalized (Sossna, 2018).

An example for digitalized production of dairy milk products is buttermilk. Buttermilk is a seasonal product in Germany, which has high turnovers during the summer months but low turnovers when it turns colder. Sometimes, dairies cannot even produce as much as demanded and therefore they have to rely on experiences from earlier years and are producing and ordering in advance. Even though, the exact moment where the turnovers start to rise cannot be predicted adequately. Because of that, sometimes, potential turnovers cannot be achieved. This moment of not having enough products to sell could be avoided with the merging of different information sources. There could be an algorithm that connects the whole supply chain, where everyone gets the information that supermarket x needs y amount of buttermilk on z date. Starting with the producer, through the dairy, the packaging companies and other suppliers to the supermarket. It is not that far yet, but different digitalization processes are already implemented. An example is predictive maintenance, where parts of machines are being detected that need to be replaced as early as necessary in order to avoid a downtime of the machines. This however leads to a rise of efficiency in the company (Sossna, 2018).

The Deutsches Milchkontor GmbH (DMK) has another example for industry 4.0 in the milk industry. The DMK is the biggest German dairy cooperative. The companies within the DMK are producing around 7 billion kilograms of milk and process it to cheese, dairy products and also baby food or ice cream for example. One spot where industry 4.0 takes place within the DMK are the milk collection trucks. A driver of these trucks runs through different stations during his shift and leaves different data behind during this process. To live up to the quality standards of their products, these processes need to be documented and organized. Therefore the different systems need to be connected so that information can be accessible at any time and place. From checking in and weighing the truck through checking the quality of the milk, pumping out the milk, cleaning the truck, weighing it again and checking it out, all information on every station can be detected (Deutsches Milchkontor, 2019).

Starting point to implement the new technology was the consideration, how the DMK can profit from the possibilities of digitalization. Therefore, six fields of action were identified: Digital Agrar Business, Digital Marketing, Smart Company, Digital Abilities, New Digital Business and Industry 4.0. The focus for industry 4.0 is on efficiency and performance improvement, optimizing quality and predictive maintenance (Deutsches Milchkontor, 2019).

The Internet of Things (IoT) is another technological progress that entered the milk industry. Some milk producers are already using sensors on cows with which they receive useful information about the herd. With the sensor, placed on the collar, the tail or the ears all the vital functions can be controlled and monitored. Therewith, possible diseases can be detected in an early stadium and the perfect time to milk the cows can be identified. Another possibility is to use tracking-collars. With that, the location of every single animal from the herd can be found. With that data, movement patterns can be created and then be evaluated by anomalies. If a cow get separated from the herd, for example, this is a hint that the animal is sick or hurt (Telefonica Business Solutions, 2020). The early detection has not only a positive effect on the efficiency, but also for the animal welfare.

Other sensors can be placed directly into the stomach of the cow. It just needs to swallow it and then transfers all vital and movement patterns. The sensor measures for example the internal body temperature and analyses drinking and eating habits. Based on this data, the farmer receives concrete guidance. The so-called "MooCall" is another application to improve the handling with the cows. It is placed on the tail and analyses the movements of it. Once a cow is in calf and in labor the movements of the tail are changing and the "MooCall" detects these changes. It then sends an alarm to the mobile phone of the farmer, which is most of the times approximately two hours before the calving. This is also a big help for the cows, especially in situations when the farmer would not be around usually, because around 5% to 10% of the calves are dying after birth and the cows need the help of humans in order to prevent that (WEKA Fachmedien, 2019).

But not only in the husbandry and breeding of cows IoT is used. Also in production processes as milking, it can be an improvement. The milking system Calf35 imitates a suckling calf. Normally, the regular pressure curve is used to milk the cow but with this new system the pressure curve of a suckling calf is imitated. As a suckling calf

does not use as much pressure as a normal milking machine would use, the milking process is more gentle for the cow. If the pressure is too high for a longer time, the udder cannot close itself anymore and is therefore a place where bacteria can settle. This leads to infections, diseases and contaminated milk. Again, IoT helps to keep the cows healthy and efficient. Besides milking the cow, the system also collects data as values of pressure or temperature of single milking spots (Software-Journal, 2020).

IV. Sustainability

In 2018 the MIV implemented a sustainability module as a pilot project with the aim of a nationwide use by all members of the federation. The module can be used as a basic tool by dairies to realize a sustainability concept. The three pillars of sustainability (ecology, economy and social) are complemented by the topic of animal welfare to embed the concept even more in the milk production branch and also to give ideas for development processes for single enterprises (MIV, 2018).

Starting with the last pillar of sustainability in the milk industry, animal welfare, it is notable that the ethic perspective on livestock and the relationships between humans and animals has changed. People went from an anthropocentric perspective, where humans are superior to any other animals and can treat them as they wish, to a perspective where it is still okay to keep hold and kill them in order to produce food, but to provide a good life with the satisfaction of the animal's needs. Around 20% are also tending to a vegetarian or vegan nutrition, even though approximately 4% to 5% are in fact vegetarian and 1% are vegan (Höler, von Meyer-Höfer & Spiller, 2019). This change of mind can also be seen in the turnover of dairy milk products. As the consumption of casual dairy milk products declined throughout the years (see figure 5), the consumption of more "special" dairy milk products as organic milk and pasture milk however rose (Mehlhose, Busch & Spiller, 2020). Especially the pasture feeding has a way more positive image within the society than animal housing. It has also a positive effect on the taste and health values (Weinrich, Kühl, Zühlsdorf & Spiller, 2014).

Because the acceptance for the keeping of farm animals declined, the BMEL set up criteria for the future of it. There are different topics among it, like the access to different climate zones, different floorings, dietary intake, grooming or the reduced use of medicaments. The costs for the change of the structures of the whole animal

husbandry industry, including cattle and pig fattening, were estimated at 3 to 5 billion Euros. But the costs for the milk production industry would only be 3% of it (Wissenschaftlicher Beirat für Agrarpolitik, 2015).

A way bigger challenge for the dairy milk industry could be climate protection. Even though the share of the milk industry on the structure change is quite small, the share of the carbon dioxide emission as part of the whole nutrition industry is big. The consumption of milk products costs 0,6t CO₂ per person and year, which is around one-third of all CO₂ emission in the nutrition industry (Wissenschaftlicher Beirat für Agrarpolitik, Ernährung und gesundheitlichen Verbraucherschutz & Wissenschaftlicher Beirat für Waldpolitik, 2016). With 0,6t the emission is almost as big as the emission of the very controversial discussed meat industry with 0,8t CO₂ per person and year. The Eat-Lancet commission recommends therefore a consumption of 90kg dairy milk products per year and person to have a climate-neutral consume, while in Germany the consume is at 360kg per year and person (Willett et. al, 2019).

The processing industry, as well as the retail industry are positive minded about the above mentioned project of the MIV, because they are asking for more transparency regarding sustainability and animal welfare. One part of improving the animal welfare is to change the husbandry of cows from tethered housing to exercise pen husbandry in all participating enterprises until the end of 2030. Besides that, the criteria for quality management were developed towards a more sustainable direction. Existing criteria are additionally vetted with the topics of animal welfare, milk hygiene and operational environment. The results shall be used to determine the frequency of audits and for awarding companies with a certificate (MIV, 2019).

Another important topic regarding sustainability is the use of soy products as fodder, because only 2% of the world wide soy production has a sustainable certification. In fact, the demand for certificated soy rose at the European market during the last year, the willingness to pay a higher price does not exist. A solution for that would be to increase the domestic protein supply and therefore gain a higher independency from imported soy fodder. At least, a partly replacement of soy fodder with domestic protein is possible. With that, a higher amount of non-genetic modified fodder could be reached. In order to fulfill the demands of the consumers for high quality protein in dairy milk products, the cows need to receive an appropriate and sustainable

nutrition. There are different programs that have the aim to improve the domestic and sustainable procurement of soy. Some are focusing on more ecological aspects, like the different use of land, deforestation overseas or use of pesticides, while others are concentrating on social aspects as working conditions or wages. Nevertheless, the overall production of high-protein fodder in the European Union is too less, which is why it is depending on other producing countries, for example from North and South America, where soy products are merely genetic modified. In Germany, there had to be an expansion five to six fold of peas and beans to replace soy (MIV, 2019).

In 2011 the LVN initiated a project called “sustainable milk production” which was then a cornerstone for the sustainability module of the MIV. To detect what sustainability means in terms of milk production they conducted a survey with several milk producers of Lower Saxony. The survey showed that already 91% of the milk producers in Lower Saxony used exercise pen husbandries. In only 6% of the companies the cows were held in tethered housing. Another aspect of animal welfare is pasture feeding. Of course, the regional disparities of pasture feeding are big due to geographical and also labor organizing reasons. Still, in Lower Saxony the share of companies that use pasture feeding is 67%, which is the third biggest share in Germany after North Rhine-Westphalia and Schleswig-Holstein. Generally, there is the trend that companies with smaller herds are less likely to use pasture feeding compared to companies with bigger herds. The study showed that animal welfare plays a central role when it comes to dairy farming because it is an important premise for health and health however is the base for a strong performance of the cows. Animals that are living in more humane facilities are more likely to stay healthy, live longer and have more lactations. Therefore, it is not only ecological but also economical sustainable to provide the best possible animal welfare (LVN, 2014).

Another ecological aspect that is important for sustainability does not regard the cows but the land they are on. In Lower Saxony permanent grassland is very common used as an agricultural area. Permanent grassland is a habitat for many kinds of animals and has a rich amount of nutrients which are less likely washed away by rainwater due to thick plant cover. Also, the bio mass of permanent grassland binds great amount of carbon dioxide and is therefore contributing to climate protection. But the ecological impact such an agricultural area has is depending on the intensity of use. The less intense it is used, the higher is the impact on climate protection. In

Lower Saxony around one-third of all milk producers that are using permanent grassland farm it, at least parts of it, in an extensive way. This means, that big areas of land are used with small herds and less or no use of fertilizers and pesticides. The negative side of using permanent grassland in a completely sustainable way is the quality of the grass as fodder. Because the grass will be cut later to give the possibility for plants and flowers to grow and e.g. birds to breed, it cannot be used for grazing in spring. If the grass cut happens in spring, as it does in conventional grasslands, the grass is more substantial. This leads to better and richer fodder for the cows. So the positive effects on climate protection from extensive land use of permanent grassland have negative effects on the quality of the fodder and therefore on the quality and quantity of milk. This is the trade-off for farmers (LVN, 2014).

Another factor for climate protection is technology, for example during the process of fertilizing. To receive the optimum outcome from the nitrogen within the liquid manure, a high loss of ammonium is to prevent, because the loss of ammonium leads to emissions. The traditional use of liquid manure is to spread it far from the ground, which has the highest ammonium emissions. A better way is to use hoses (10% to 30% less emission) but the best way is a direct insertion in the ground (60% to 80% less emission). Producers from Lower Saxony are using these technologies more often compared to producers from the rest of Germany (40% to 20% for hoses and 9% to 4% for direct insertion) (LVN, 2014).

As the German government has the aim to reduce greenhouse gas emissions until 2050 by 80% to 95%, a change regarding the power supply is necessary. Therefore, 60% of the power supply and 80% of the electricity supply shall be generated by regenerative energy sources. Milk producers from Lower Saxony are participating here as well. Almost every second farm produces its own energy from regenerative sources. In most cases these are solar collectors, some also have biogas plants or wind power plants. When producing milk, energy saving techniques are also used by the producers. Nearly 90% of milk producers using the heat loss through recuperators during the process of milk cooling (LVN, 2014).

Social aspects are also important when it comes to sustainability. It can either be a global topic, with the focus e.g. on equal opportunities or a fair allocation of goods around the globe. On a company-level it can be sufficient wages, occupational and social security, fair working conditions or engagement within the community. The

Thünen-Institut defined special indicators to describe the social situation in milk producing companies such as working time, holidays, wages for non-family full-time workforce, possibilities for apprenticeships and advanced education and social engagement of the operating family (LVN, 2014).

Most of the milk producing companies in Lower Saxony are family-owned and most of the work is done by family members. 73% of the total workforce of the milk producers are family members and most of them however are employed full time. Consequently, the connection of family members towards the daily business of herding a herd of cows is high. Regular holidays or even multiple-weeks holidays are therefore very rare. There is already a big challenge in having one day off per week to prevent work-related stress. In only 37% of the farms the family members have one day off per week and only 60% can go on vacation with an average of 11.5 vacation days. 38% of the companies do not have any day off during the year and are working from Monday to Sunday straight. Even though, there is a relation between vacation days and the size of the cow herd. The bigger the herd, the more vacation days for the family members of the farm. Due to the fact that farms with bigger herds have more employees outside of the family, the flexibility for the family members is higher. The share of full time, part time or temporary employees in milk producing companies that are employing non-family employees is almost even. The amount of non-family employees depends on the size of the company and lies between 1 and 21. An important factor of social sustainability are the wages. As employed family members are living from the earning of the whole company, the focus is more on non-family members. There is a collective agreement for companies from the agribusiness in Lower Saxony. 82% of the companies are also paying at least the amount stated in the collective agreement. Just 18% are paying only partly the wages that are grasped in the collective agreement or less (LVN, 2014).

Due to the fact that milk producing companies are growing and having larger herds, the need for qualified workforce is urgent. To offer apprenticeships is an opportunity to include non-family members into the agribusiness. The training rate, which is the ratio between apprentices and the total amount of employees in a company, in milk producing companies is higher than the German average. The average for all German branches was at the time the study was published at 5,6% and in the milk producing industry at 9% (LVN, 2014).

To engage in community activities is another part of being social sustainable as a company. It means to work for the common purpose or to take responsibility for certain issues. The aim is to strengthen the social cohesion and to promote social integration. To do volunteer work is one opportunity to engage in community opportunities (LVN, 2014). In Germany, the share of the population that engages in volunteer work was 2019 at around 37% (Bundesministerium des Innern, für Bau und Heimat, 2020). Compared to Europe in general it is way above the average of 23% (Europäische Kommission, 2020). Volunteer work can take place for example in sports clubs, in volunteer fire brigades or so called countrywomen clubs. A share of 69% of all milk producing farms in Lower Saxony takes part in such community activities. Besides these activities, where people from the farms act in the community, milk producers also organize events to connect with the community on their farm. This can be court festivals, open door days or visitor orientations (LVN, 2014).

The economic part of sustainability means generally for the society to use resources efficiently and to obtain them to safe economical welfare. From a scientific point of view that means that only the most efficient companies should get access to the three main resources land, capital and human. Of course, for single companies economic sustainability means to stay in the market long-term. For milk producing companies the main operating numbers to describe the economic situation are liquidity, profitability and stability. In order to get an estimation of the company directors regarding their economic sustainability the study conducted a survey (LVN, 2014).

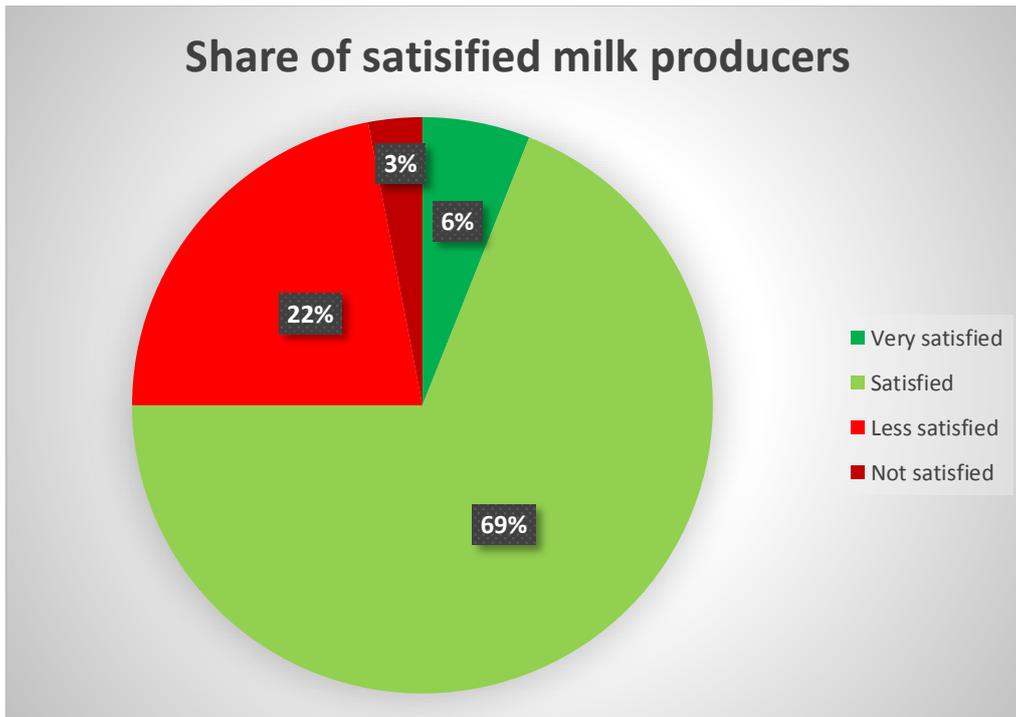


Figure 11: Share of milk producers and their satisfaction with their economic situation in Lower Saxony (based on LVN., 2014)

As shown in figure 11, the share of farmers that are satisfied or very satisfied with their economic situation is 75% in total. A quarter of the interviewed milk producers is either less or not satisfied at all. Nearly the same share (78%) assume that they will be or at least taking it into account that they are in the market in 10 years. This estimation seems also to depend on the herd size, as companies with larger herds are looking to the future with more optimism. This is also shown by the investments made. 71% did investments to modernize their facilities and 67% did it to expand them. The willingness to invest also seem to depend on the herd size as 90% of the farms with larger herds did investments compared to 47% of farms with smaller herds (LVN, 2014).

The willingness to invest is also one part of the willingness of milk producers in general to participate in sustainable activities and implement a sustainability system. A study showed that a very important factor is the recognition on the part of the society, the dairy and the food retail industries, once a producer acts sustainable. This recognition should also reflect in the milk prices. The currently low prices are however another reason for the producers to act sustainable because it stimulates the need to stay competitive. Investments in sustainable assets generate these competitive advantages, which is also noticed by the producers. Nevertheless, they

are not ready to take additional costs for the implementation of a sustainability system. Also the possible image gain for the producer does not have a positive influence on the decision to implement a sustainability system. Still, the pressure the society puts on milk producers to produce sustainable, especially with its changed demands on products, animal welfare and socio-cultural aspects, is a strong motive for them to implement such systems (Luhmann, Schaper, Theuvsen & Weiland, 2016).

V. Innovations and Trends

As figure 5 shows, the consumption of ordinary dairy milk declined during the last years. But the consumers do not drink less milk, they drink different kinds of milk. This can be mixed milk drinks with fruity flavors or a mix between coffee and milk. Nevertheless, the consumption of dairy milk declined and the consumption of plant based milk rose, partly even with a two-digit growth rate (Mehlhose & Spiller, 2020).

The rising demand for vegan substitute products let the food retail industry bring up plant based alternatives for milk such as soy, almond, oat or coco milk. Also, the demand is not satisfied or even declining. The interest of the consumers is still growing and so is the buyership. Besides that, the share of the consumption of plant based milk on milk drinks in general is as big as the share of pasture milk. The high demand on this products can also be noticed in the trading turnovers. In 2018 it rose by 16% to 239.1 mill. €, which was almost a similar growth as in the year before with 17% (Mehlhose & Spiller, 2020).

An advantage of those plant based milk products is that most of them are certificated organic products. But not only nutritionally sensitive people buy them. More and more people seem to attach great importance to a healthy, ethical and ecological nutrition and try to reduce their consumption of animal products. Regarding sustainability and climate protection this is a positive development, because the reduction of the consumption of animal products can reduce the negative effects of the nutrition industry. Even though the different kinds of plant based milk are different in their emission values, water consumption and pollution of waters, the more common sorts as oat, soy or almond milk have considerably less emissions than ordinary dairy milk. Still, this change of eating habits has to take place extensively in order to provide a

sustainable food system considering the growing world population (Mehlhose & Spiller, 2020).

Before the general trend of health and fitness occurred, most of the time the products were bought by people that have food intolerances as lactose intolerances for example. With the start of the above mentioned trend and the social discussion of e.g. sugar reduction in food and drinks, dairy milk products have to be competitive with plant based products in terms of health aspects. Even though the plant based products are varying in their values again, in general they have less calories (dairy milk 65kcal/100g, plant based milk 15-50kcal/100g). But dairy milk has an advantage in terms of protein content, only soy milk has nearly the same content. Regarding the amount of fat, dairy milk is again less healthy than plant based milk. Unsaturated fatty acids are more healthy than saturated fatty acids and plant based milk has merely unsaturated fatty acids whereas dairy milk has more saturated fatty acids. Also, plant based milk gets enriched with vitamins and calcium in order to rise their health values for a vegan nutrition (Mehlhose & Spiller, 2020).

However, to be “vegan” seems not to be a passing fad but a long-term trend. Ethical buying motives come to the fore. A study showed that 10% of the people could be vegan, because they decline animal housing, and another 10% to 15% could be vegetarian, because they decline the killing of animals. Plant based products are therefore an alternative with great potential and could lead to a long-term decline of dairy milk products. Another group of people, so called “flexitarians”, that reduce their consumption of animal products, whether it is meat or milk, consciously, are also more likely to buy plant based products 2 to 3 more times (Mehlhose & Spiller, 2020).

Still, the success of these products will be depending on factors as convenience, taste and costs that are important for the consumers. Besides that for plant based products it will be important that they have beneficial nutritional values and a sustainable environmental tolerance. But due to new technologies there are products on the market that are comparable to dairy milk regarding their look, taste, structure and processing. Additionally there are new high-quality plant based products that are entering the market and it is likely that the consumption of such products will rise in the next years. Therefore the development of substitutes for milk and cheese products determines perspective the growth of the milk production sector. Looking at the raw material costs, the production of plant based fats is a lot cheaper than the

production of milk fats (e.g. canola oil € 700,00/t and butter € 2.800/t). That means that there is a high potential for plant based products to reduce their prices so that more price sensitive customers get access to the products. Research and development for dairy milk alternatives is growing fast and it is expected that the variety of products, the taste and the quality are developing and in the end price reductions are possible (Mehlhose & Spiller, 2020).

A big question for the dairy milk sector is therefore how to react to this development. Some dairies have already taken plant based products into their portfolio whilst others have founded or bought up start-ups. There are chances for dairies, as their bottling and packing technologies as well as distribution are similar for plant based products. Also, producers can adapt to this trend when they are extending their production towards plant raw material. Especially the regional (and ecological) growing of oat, which is the most popular drink of milk alternatives, leads to new chances for example in the communication with consumers regarding sustainable and regional product cycles and their merchandising (Mehlhose & Spiller, 2020).

When it comes to innovations regarding milk products, possible products outside of foodstuff are normally not taken into account. Nevertheless, the company Qmilk was founded in 2011 close to the city of Hannover in Lower Saxony where they produce fibers out of not-drinkable milk. They use milk waste, so milk that it not eatable due to several reasons, which arises in an amount of 2.000.000 t each year in Germany. All materials used to produce the fiber are naturally and the production process does not need a lot of energy, due to a low process temperature, less water use and a fast production in general. Also, the waste that emerges can be reused in the production. Fields for application are for example carpets, wallpapers, speaker cones and industrial textiles in general, because they are hardly flammable and chemical resistant. The fibers can also be used in the production for clothes for people that have allergies or other intolerances towards chemical fibers (Budde, 2017).

VI. Prospect

The present study gives an overview about the dairy milk sector in Lower Saxony and Germany. Besides the production and the consumption a focus was put on company structures and federations as well as international trade market-wise. Important topics as digitalization, IoT and innovations that take place within the sector were

affiliated as well. As sustainability is probably the most urgent topic of our present, it gets revisited in this study as well.

The overview over company and federation structures made clear that there is a change towards less dairies, less producers and less cows towards more employees per company, more revenue and more production per cow. The trend is recognizable for Germany as well as for Lower Saxony. Nevertheless, this is an alarming trend for family-owned businesses and small enterprises as their chances to stay on the market long-term are getting worse due to the intensified purchasing power of bigger businesses. Besides that, the federation structures are strong and a big help for all companies in the dairy sector.

The production of dairy milk products in Germany, except cheese, is declining. For Lower Saxony however the trend is vice versa. Besides a small decline of milk production from 2017 to 2018, the production of milk, cheese, butter and other products rose. This means, that Lower Saxony, as a very important location for dairy milk products in Germany already, strengthens its position and will possibly be even more relevant for the dairy milk production in Germany. Especially the cheese production seems to be growing in Germany as well as in Lower Saxony. A problem for producers and dairies is the final milk price as it is too low to be economically viable.

Regarding international trade between Germany, and Lower Saxony particularly, and Colombia it is to say, that there is lots of potential. Especially cheese from Lower Saxony is a product group that could be even more relevant in Colombia, as most of the German cheese in Colombia is from Lower Saxony. The other way around there also great chances for Columbian cheese producers. Whereas the milk consumption declines in Germany, the cheese consumption is rising. Maybe there are chances for a market entry for Columbian exporters with special Columbian cheese products. Another niche could be natural yoghurt, as the consumption is growing here, but it is probably too small and cost intensive to enter it with products from Columbia.

Digitalization, IoT and Industry 4.0 are relevant topics for the future of the branch. There are already products that make processes more efficient and promote animal welfare. These products will get more importance with and new, even more innovative products will enter the market. Therefore, it makes sense to invest in such

products and regarding a German-Columbian cooperative, to offer e.g. trainings and implement a knowledge exchange.

These products and processes also help to make the industry more sustainable. Ecologic and Economic. Besides that, there are already efforts for a more sustainable branch and the producers and dairies seem to be aware of this important topic. Nevertheless, the biggest need for action are possibly the topics of feeding and work-life balance. A big share of feeding products is soy, due to its rich protein content and therefore a more efficient production. Still, the cultivation is not sustainable as only 2% of the cultivated soy has a sustainability certification and it needs to be important, which rises the CO2 emission of it. A big challenge, not only for the industry, but also for the EU will be to produce similar nutritious food within the member states. Work-life balance for farmers is not very well-marked. Innovations in processes could possibly help to improve that.

Besides actions for sustainability, the biggest challenge for dairy sector in Lower Saxony and Germany will be the mega trend of plant based milk products. The demand for this products is rising as the awareness of the customers for sustainable and healthy food will as well. For Columbian companies there could be a chance to enter the market with plant based products or mixed milk drinks with e.g. special kinds of fruit from Colombia. It shows also, that an entry in the cheese sector, as it is not yet flooded with plant based products, is maybe easier than an entry in the milk sector. For German companies there could be the urgency in the next years to change their production towards more plant based products, which also could be used as fodder for the cows to generate synergy effects.

Even though the dairy milk sector in Germany and Lower Saxony is very big and important, there are chances for Columbian companies to enter the market. Additionally, as the sector is traditionally strong in Germany and Lower Saxony, there are great chances to create a knowledge exchange.

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