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- preservation of rural values -

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SUSTAINABILITY OF DAIRY FARMING SYSTEMS IN CENTRAL SERBIA[1]

Rade Popovic[2], Marija Knezevic[3]

Abstract:

Two dairy production systems with biggest share in total milk production in Central Serbia are small farms with tie stall barn and small farms with grazing period. In the article are examined their main system characteristics, sustainability and integration in dairy supply chain. Three dimension of sustainability were explored by chosen indicators on farms sample in Kolubara district. Economic sustainability is low since average entrepreneur's profit is negative for both production systems, although small dairy farms with grazing period encountered less negative profit because advantages in feeding costs. Rate of dairy production systems viability is 25%. Social sustainability declined over last decade. Small dairy systems are discriminated by ability to get dairy subsidies. Demographic viability is low, especially for small farming system with grazing period, where it is 25%. Small farming systems are dispersed over all territory and don't make big pressure on ecology and natural resources.

Key words: dairy, family farms, system, sustainability, Serbia

Introduction

Goal of this paper is to describe and analyse the most numerous dairy production systems in Central Serbia and its sustainability. Research was conducted in first half of 2012 in Kolubara district. There was several reasons way this district was picked up. First, it is part of Sumadija and western Serbia region which is the most important in milk production and account for 50.3% of all cows in Republic of Serbia. Density of cows in district is the highest in Serbia. Measured in cows/km^2 it is 17.1, or 0.25 cows/ha of agricultural land. Second, availability of pastures and meadows in Kolubara district is quite similar like as average in Central Serbia. Third, small dairy family farms are dominant type of farms in dairy production.

Eight dairy family farms with heard size 1 to 5 cows were interviewed. Questionnaire with focus on 2011 production year, and some social and ecological aspects of farming system is filled out on each farm. Based on gathered data and later phone calls with interviewed farmers, economic dairy budgets are completed. According those results economic sustainability is examined through chosen indicators. Besides that, also ecological and social sustainability is researched.

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Production systems and sustainability

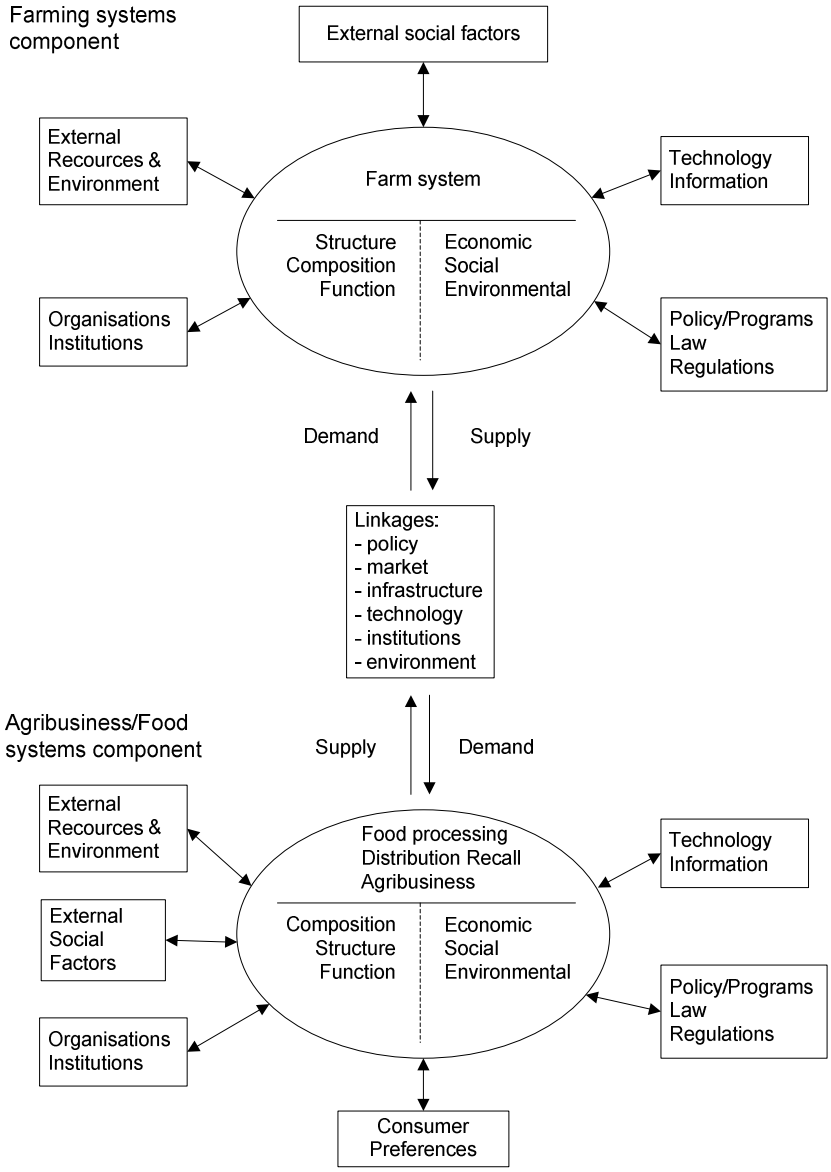
System is usually defined as a group of elements with strong functional relationship between them and at same time limited or not-existent relationship with surrounding elements or systems. Stimulus from outside focused on any one system element, results in whole system response.

In wide context, production (farming) system is set of: technical, technological, organisational, economical and social factors (Krstic, Lucic, 2000). Because of that, better understanding of farming system asks for multidisciplinary approach. Farming system includes several elements: inputs and outputs, a boundary, an external environment and process for transforming inputs into outputs (Shadbolt, Martin, 2005). Outputs, main product and by-products are result of process of transforming inputs with nature state (climate conditions, presence diseases). Collateral benefits or problems could be created, depend of type of production system. Examples of benefits could be enhancement of rural landscape or better conditions for rural tourism, etc. As problems usually are recognised: nitrate contamination of groundwater, manure odour, pesticide runoff, etc. System boundary could be understood as difference between what is under management control and what is not.

Production system can be analysed with static and dynamic approach. Static analysis of production system gives less information and not well holistic understanding, since it is one specific time picture. Dynamic farming system research builds understanding of the interactions, interdependencies and responses under changing conditions between parts of whole system (Malcolm et al. 2012).

Farming systems could be seen in wider scope as a part of food chain system. In Figure 1, farming system is shown as a part of integrated food chain. Understanding long term sustainability of farm systems, even if it is looking in narrow economic aspect, is hard without whole picture of food system. Farm is not an isolated island and its relations with other participants of food chain could be competitive or cooperative. Integrated food system has strong two-sided relationship between parts of food chain that helps in improving strength of weakest elements. Boundaries of farming system are consisted from same group of elements, as boundaries in other parts of food chain systems. All five groups of elements (Figure 1) influencing in certain way on farming system as well as on whole food chain. But through cooperative action on horizontal and vertical level between farms, food processing companies and retailers, it is possible to make reverse influence on elements of boundaries.

Figure 1. *Components and linkages in integrated food system from farm to consumer*



Source: Shadbolt, Martin, 2005.

Dairy farming systems are very diverse worldwide. They varied in range from low input – low output (New Zeland dairy farms) to high input – high output (California dairy farms), or from organic to conventional, or from mixed to specialized, etc. Comparing dairy farms worldwide IFCN Dairy Research Centre (Hemme, 2011) defined six dairy production systems: farms with stanchion barn, farms with free stall barn, feedlot farms, grazing farms, small scale farms and future farms. First five are well known production systems. Future farms represent those production systems which can be expected to develop in specific region according present circumstances.

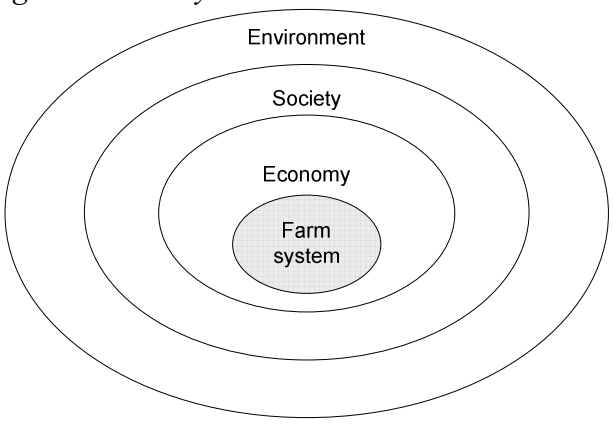
Goss et al. (2010), analysing dairy sector in Republic of Serbia, defined four dairy production systems: small upland farms, small lowland farms, medium farms and large lowland farms. First two production systems dominate in Serbian dairy sector and especially in Central Serbia. Their basic characteristics are: herds with 1 to 5 cows, mostly Simmental breed, low milk yield, usually more than 5 lactations, cows are tethered in barns and milked by hand or portable machine, milk is used for: calves, formal market (dairy plants), and informal market

(farm family needs, sold as a row milk or dairy products from farm or on local market). The main difference of those two production systems is that small upland farms use pasture in period from May to October.

Beside diversity, dairy production systems are one of the most complex in agriculture. Complexity is result of more elements in production system, stronger interactions and interdependencies among elements, longest biological and supply lags, etc.

Sustainable farming systems can be defined as socially responsible practice that allows economic viability of farm, maintaining resources and ecosystems in same or improved shape for future generations. Generally, sustainability of agricultural production lies on three dimensions: economic, social and ecological. All dimensions are equally important and relationship between them are numerous and complex. Economic dimension of sustainability is concerned with efficient use of farm resources, viability and competitiveness of farm. Social dimension of sustainability is twofold. From one side, society has responsibility to provide equal opportunities for farm families compared with non-farm families in sense of support fair living standard and access and use of services and resources. From other side, farmers have responsibility in ethics of agricultural production (use of sustainable production technologies, food safety, etc). Ecological dimension of sustainability is the most important since previous two dimensions are human creation and they are changeable over time. Manner of resources use (land, water, air, biodiversity, etc.) should ensure its equal quality and quantity for future generation.

Figure 2. *Model of strong sustainability*



Source: Adapted according Shadbolt, Martin, 2005.

Strong concept of sustainability (Figure 2) is based on ecologic primacy and don't allow substitution between environmental and either or other two components (Shadbolt, Martin, 2005). According same authors, sustainable farming system has four properties: productivity, stability, resilience and equity. Productivity is ratio of produced output per unit of resource used in monetary or physical terms. Stability is ability of farm system to maintain stable productivity, during small disturbing forces. Resilience is property which allows farming system to survive severe and unpredictable disturbing forces. Resilience takes in account resistance to disturbing forces and time and rate of recovery. Equity means securing balance in distribution of cost and benefits from productivity of the system through present and between present and future generation of farmers.

The main problem in applying concept of sustainability to specific farm production system is how to choose proper indicators for all three dimensions. Many approaches and models of

sustainability measurement were developed and tested in dairy sector, especially during first decade of XXI century. Every one researcher find hard to measure sustainability in dairy sector. The most used indicators for economic dimension were: entrepreneur's profit, operating profit margin, return to labour (Ndamby, Steglich, Hemme, 2011), farm viability, market return (Dillon, Hennessy, Hynes, 2009) etc. Same groups of researchers, as indicators for social dimension of sustainability applied: importance of government payment in farm income, market return, hours per worker per year, employees per 100 t of milk, and demographic viability. For measurement of ecological dimension of sustainability were used: carbon footprint, water footprint and stocking rate.

Dairy production systems in Central Serbia

Small farms with herd from 1 to 5 cows produce the most of milk in Serbia. Although its number decreasing over years, according data from 2009, they still account for 77% of all cows, produce 68% of milk and delivers 59% of milk to dairies (Gross et al. 2010). Neglecting of such production structure in recent years leaded to some decisions of agricultural policy makers that weren't beneficial for this part of dairy sector. The most of small dairy farms lost possibility to get milk premiums in period from 2009 to 2012.

Following findings of Goss et al. (2010) focus in this paper is on two dairy production systems that exist in range of herd size 1 to 5 cows. Name of production systems will be here modified according results of field research in Kolubara district. Two identified dairy production systems are: small farm with tie stall barns (SF – TSB) and small farm with grazing period (SF – GP). Close explanation of chosen production systems is given in Figure 3.

Figure 3. *Characteristics of dairy production systems practiced on small farms, based on results from 8 farms*

Factor	**Small farms with tie stall barns**	**Small farms with grazing period**
Milk yield **- For human use** **- For calf includ.**	 From 2,800 to 5,000 l From 3,400 to 5,200 l	 From 2,000 to 4,500 l From 2,700 to 4,500 l
Breed	Dominantly Simmental	Dominantly Simmental
Breeding	Artificial insemination with 1.8 attempts in average	Artificial insemination with 2.5 attempts in average
Calving	Through all year	Prefer. winter or early spring
Calves	0.93 calves per cow, sold on market after 10 days or 2-3 months depends of market situation, female reared for replacement as needed	0.92 calves per cow, sold on market after 10 days or 2-3 months depends of market situation, female reared for replacement as needed
Culling rate	6 – 7 years	6 years
Labour	330 hours/cow/year	300 hours/cow/year
Bulk feed	Whole year fed in barn with mainly corn silage or corn stover, red clove hay, seldom meadow hay and feed by-products.	Grazing from May to November; in rest period use mostly meadow hay, red clove hay and seldom corn silage
Concentrate	From 4 to 5.5 kg concentrate	From 3.5 to 4.5 kg

	mainly mixed on the farm from own cereals, roasted soybean and bought: soybean meal, wheat bran, sunflower shell, mineral supplements	concentrate mixed on the farm from own cereals and bought: soybean meal, wheat bran, sunflower shell, mineral supplements
Housing	Cows tied all year round in stalls barn	Cows tied in stalls barn during winter and raining days
Milking	Cows are milked two times in the barn by portable machines without pulsators	Cow are milked two times in the barn by hand or portable machines without pulsators
Milk collecting	Several close living farmers collect milk on one farm in cooling tank provided by dairy plant	Several close living farmers collect milk on one farm in cooling tank provided by dairy plant
Milk marketing	Dairy plant	Dairy plant and local market

Source: Own research

The main difference between those two production systems is in chosen feeding, milking and marketing subsystems. Other subsystems are similar as breeding, calves rearing, milk collecting and housing. Looking on output side significant difference exist in milk yield of those two production systems.

Economic sustainability of small dairy farming systems

Profitability of production system is the most utilised indicator of economic sustainability. In this case both production systems (Figure 4) encountered negative entrepreneur profit, although small farms with grazing period had lower loss. Source of negative profitability has to be looked in characteristics o production systems.

SF – TSB has higher milk yield and higher milk subsidies. In this production system even farm with 3 cows, because of higher milk yield, succeed to reach quarterly minimum of delivered milk, and got milk premium. Comparing production systems there is no significant difference in average milk price (28.61 RSD/l for SF – TSB and 27.93 RSD/l for SF – GP). Main reason for that lies in low milk quantity and quality. Seven farms delivered less than 15,000 litres milk per year and didn't receive quantity stimulus from dairy processors. Milk quality ranged between 1st and 2nd class, among all farms. On cost side SF – TSB had significantly higher costs mainly because of higher bulk feed cost, as well as bedding, labour and building costs.

SF – GP comparing with SF – TSB achieved moderate revenue, but on cost side reached significantly lower cost that more than saturate difference in revenue. Sources of higher cost competitiveness lies in bulk feed, bedding and labour. Sundries costs are lower since more farmers milk cows by hand. Interest on fixed capital is considerable as SF – GP use specific land area for grazing.

Figure 4. *Summary of selected average financial data of two farming systems in 2011 in Central Serbia* (in RSD/cow/year)

	Small farms with tie stall barns	**Small farms with grazing period**
REVENUE	**156,160**	**140,153**
Milk	105,053	98,984
Calves	22,149	19,985
Manure	15,000	15,000
Subsidies	13,958	6,184
COSTS	**185,734**	**155,289**
Variable cost	**100,817**	**75,465**
Concentrates	30,255	30,908
Bulk feeds	44,831	24,814
Bedding	5,345	3,053
Water	*372	*379
Insemination	2,625	3,396
Vet. service and medicines	1,714	2,115
Dairy sundries	6,344	2,862
Contract work	643	1,077
Interest on operative capital	8,689	6,860
Fixed cost	**84,917**	**79,824**
Labour	33,212	29,987
Machinery and equipment	8,723	8,515
Buildings	10,089	6,258
Heard depreciation	8,029	7,600
Drainage fee	274	265
Insurance	0	0
Overhead cost	5,499	2,002
Interest on fixed capital	19,366	25,462
Farmer's income	**31,156**	**47,173**
Entrepreneur's profit	**-29,574**	**-15,136**
Viability	**-27.807**	**-7.685**
* only one from four farm is paying for water		

Source: Own research

Viability of farm systems is defined here based on works of Hennessy (2004) and Frawley and Commins (1996), cited in Dillon, Hennessy and Hynes (2009). An economically viable farm has (a) the capacity to remunerate family labour at the average agricultural wage, and (b) the capacity to provide an additional 5 per cent return on non-land assets. In lack of data for average agricultural wage there is for family labour applied same price as for paid labour (150 RSD/hour). Viability is analysed for one year, though it is always better option to take in account data for long term period. Both farming systems showed negative results, although SF-GP had less negative results. Analytical data showed that in analysed group of dairy farms by one farm in each group were viable in 2011, and it is same farms as in Figure 5. A result is very low rate of viability, only 25% in samples.

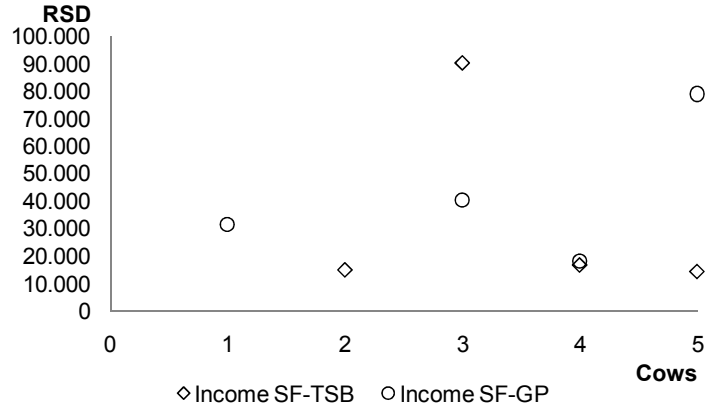
Two from eight farms earn entrepreneur's profit (Figure 5). Average entrepreneur's profit ranges from – 44.087 to 18.336 RSD per cow. There should bear on mind that first level of competition for dairy enterprise on farm is other farm enterprises. If farms couldn't reach zero or positive entrepreneur's profit in midterm period, expected reaction of farmers could be to redirect resources from dairy to some other more profitable enterprises. Situation is worsened in 2012 where severe drought caused significant yield drop, and feed prices increased over 50% in second half of the year. With modest increase of milk price, economic situation for small dairy production systems in Central Serbia in 2012 is not bright at all.

Figure 5. *Entrepreneur's profit on eight dairy farms in Kolubara district (in RSD/cow/year)*

Source: Own research

All examined farms had a positive net farm income, as it presented in Figure 6. Range of income was from 14,147 to 89,971 RSD per cow. But, only two farms succeed to cover opportunity costs for unpaid family labour and owned capital. Reason for difference among farmer's income and profit in dairy enterprise is in share of owned resources. Small farms use resources that are mostly owned by farmers. In dairy enterprise works solely family labour. Only during crop harvesting season and manure disposal farmers employ additional external labour. Farmers do not use loans from bank. In SF – TSB about 50% of used land is rented, till SF – GP produce milk using only owned land.

Figure 6. *Farmer's income on eight dairy farms in Kolubara district (in RSD/cow/year)*



Source: Own research

Social sustainability of small dairy farming systems

Social sustainability of small dairy production systems is examined from two sides. First is responsibility of society for dairy farms that can be measured through importance of subsidies, which create equal opportunities for farmers comparing with other rural entities, and support fair living standard. Several years ago, government changed focus in agricultural policy for dairy farmers. Before that, all registered farms could apply for milk premium. In 2009 only farms with 4 and more cows could satisfy condition with at list 2,500 litres of delivered milk to dairy per quartile, to be able to apply for premium. In later years minimum of delivered milk were increased, and this further decreased ability of small farms to get premiums. Motivation for government to change policy was to increase milk quality and amount of milk delivered, and to shrink total dairy subsidies. In dairy sector where small dairy farms with up to 5 cows are dominant in total milk production, expected goals were not fully reached. Amount of delivered milk were not increased, quality of milk increased but mainly because of dairy company investment in cooling tanks installed on farms, total milk premiums cut for 61%, and total milk production decreased for 3.7% just in 2009. From about quarter of million dairy farmers in Serbia only 9,000 in 2009 and 5,975 in next year received milk premiums.

Importance of government payment in farm income is one of most used indicators to measure social sustainability. Three farms in SF – TSB production system received partially or fully subsidies. In SF – GP production system just one farm received partial subsidies. Problem here is low farmer's income from dairy operation in both farming systems, what is proved by low rate of viability. In this case using of mentioned indicator will not give a sense. That's why a social sustainability is measured by level of discrimination in subsidies availability, comparing small farm production systems with bigger one. In Figure 7 it is shown, with assumption of 3.300 litres of delivered milk for bigger dairy production system, that SF – GP is the most discriminated by 85% or more in its ability to get subsidies.

Figure 7. *Discrimination level in subsidies availability*

	Unit:	Bigger dairy production system	SF – TSB	SF – GP
Milk yield	l milk/cow/year	4,000 – 6,500	3,791	3,648
Milk delivered	l milk/cow/year	3,300 – 6,200	3,016	2,817
Milk price	RSD/l	32.50	28.61	27.93
Subsidies: Premiums	RSD/cow	16,500	9,219	6,184
Genetically improvement	RSD/cow	25,000	7,143	0
Subsidies per cow	RSD/cow	41,500	16,362	6,184
Discrimination level	%	0%	61%	85%

Source: Own research

Social sustainability, from other side is measured by two indicators: demographic viability and hours per worker and year. According Dillon, Hennessy, Hynes (2009) demographically viable farms are those with at least one household member below 45 years of age.

From examined farms only one operator in each production system don't expect to be in dairy production in next 5 years. But reality is even more pessimistic since average operators' age is 64 years in SF – TSB and 60 in SF - GP. Successors exist on 6 of 8 farms, but its intention to keep dairy production on farm is week. Only 2 successors in SF – TSB intended after taking over the farm to continue with milk production. On SF – GP only on one farm successor intend to continue dairy production. Derived rates of demographic viability are very low, 50% and 25% respectively.

Hours per worker and year indicates working conditions on farm. According Ndamby, Steglich and Hemme, (2011) average expected number of hours per farmer throughout a production year is from 2,000 to 2,200. Working hours above that level indicates deterioration of working conditions as an aspect of social sustainability. Looking only on dairy enterprise in SF – TSB farmer spends in average 330 hours per cow and year, while in SF – GP it is 300 hours per cow and year. Counting working hours in field and hours spent in dairy enterprise it can be concluded that both farming systems are from this aspect sustainable.

In addition it can be mentioned that the SF – GP are located more out of settlements than SF – TSB. The most usually additional source of cash on the farm is pension from one of farm family member.

Ecological sustainability of small dairy farming systems

From observed data, ecological sustainability is here measured with stocking rate, as indicator of production intensity. Level of maximum production intensity that can be treated as bottom level of sustainability is set by Ndamby, Steglich and Hemme in 2011, on 1 to 1.2 livestock units per hectare. Density of cow/ha on SF – TSB and SF – GP is 0.44 and 0.38 respectively, that is significantly lower from proposed level.

Dairy manure is used completely as fertiliser on own farm land in both production systems. Manure is disposing in inappropriate places nearby barns that allows nitrate licking in groundwater. Application of manure on farmland fields is usually two times per year for all farms. From these aspects it can be concluded that both small dairy farming systems are ecologically sustainable.

Integration of dairy value chain

Dairy chain in Serbia is consisted from about quarter million of dairy farms, almost 200 dairy processors and several big retail chains. Some previous researches (Popovic, 2008, Popovic, Radovanov, 2010) reviled that Serbian dairy value chain is not well integrated and market power is moved to retailers in recent years. Prerequisite for a value chain to be integrated is transparent flow of information, materials, and existence of horizontal and vertical cooperation among participants in chain.

Small farm production systems, since producing individually lower quantity and quality of milk, become less important for bigger processors. Low milk prices and lack of subsidies pushed small farmers more on informal market. The focus of activities in last decade was to improve size and productivity of commercial dairy family farms (with at least 10 cows in herd). Leading examples are companies Imlek, Mlekara Subotica and Somboled providing

loans and consulting service for dairy farmers to obtain additional cows, new barns and milking equipment. Cooperating with farmers, dairy companies aim to secure quantity and quality of milk supply. In addition, such attempts partially increase efficiency of all dairy food chain.

Beside these several very positive examples, dairy supply chain in Serbia is not integrated. That is mean that from farm supply companies across dairy farms, dairy processing companies, retailers and to consumers there is still no behaviour in sense of understanding "whole picture".

Conclusion

Small dairy farms are still the most important part in structure of milk production in Serbia. Sustainability of small dairy farms system is emergent area and should attract greater interest. Rate of decrease in milk production of such farming systems wasn't saturated with increase of production in medium and large dairy production systems in recent years. Result was decrease in total milk production by average rate 2% in last five years.

Undoubtedly, according results of examined indicators, both small dairy farm production systems have problems in economic and social sustainability. Applied indicators for economic dimension of sustainability reviled negative average entrepreneur's profit in SF – TSB and SF – GP. Some farms in both production systems succeeded to realised profit. SF – GP compared with SF – TSB, beside lower revenue, thanks to significant advantages in costs of feeding subsystem reached lower loss. All farms have positive income but in average it is not sufficient to cover family labour cost calculated by average agricultural wage. Because that, economic viability is very low with just 25% rate. Agricultural policy discriminate SF – TSB and SF – GP by 61 and 85 % respectively in dairy subsidies availability. Demographic viability of farms has low rates 50% (SF – TSB) and 25% (SF – GP). Farmers are aged with no successors on each farm and weak intention to continue with dairy production. Working conditions on farms are sustainable with amount of working hours per year below maximum level.

In case of ecological sustainability those production systems don't make big pressure on environment and a use of resources is on ecologically sustainable manner. Density of livestock units per hectare is significantly smaller than proposed level.

Milk supply chain is not well integrated in Serbia, and small dairy farming systems are even less integrated. Government and dairy processing companies have been losing interest for small dairy farms since last five years. Dairy farms with bigger herds are able to use benefits of economics of scale i.e. lower average costs per litre of produced milk, received full dairy subsidies, and higher milk prices because of better milk quality and higher quantity.

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