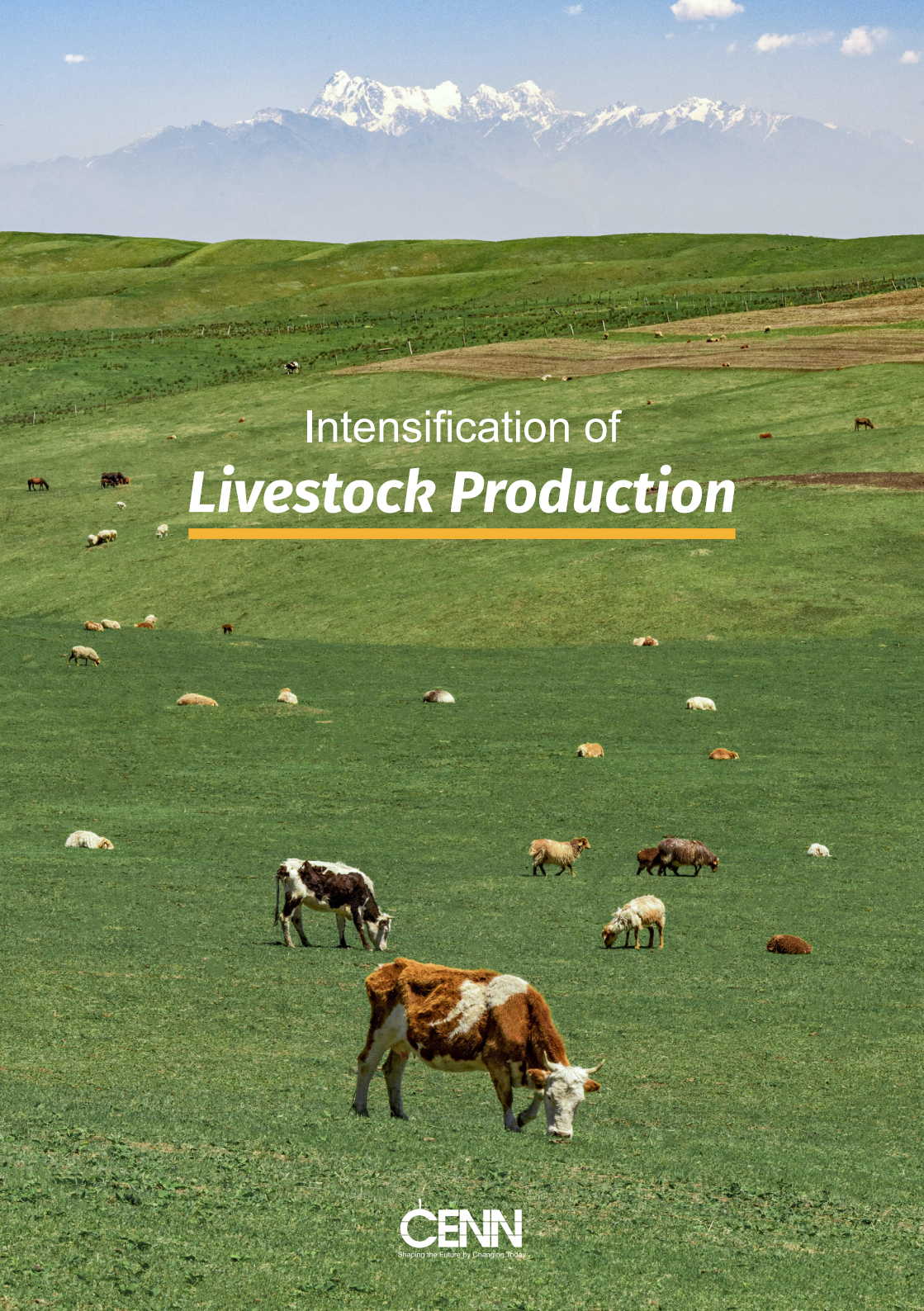
Intensification of
Livestock Production
CENN
Shaping the Future by Changing Today

Intensification of
Livestock Production

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Contents

1. INTRODUCTION

Livestock production in the majority of the regions of Georgia is not intensive as natural pastures are the primary source of cattle feed.

It is noteworthy that, in the developed world, cattle breeding is developing via intensification, which implies an increased production rate compared to the increase in the number of animals. For example, in these countries, the average annual increase in the number of cows in recent years has been 0.2%, while milk production has increased by 2.1%.[1]

As of 2020, 925 000 heads of dairy cows have been recorded in Georgia. The country produces 569 000 tons of milk and the average lactation milk yield of a dairy cow is 1574 litres[2].

It should be noted that the natural and economic conditions of the majority of regions in Georgia are favourable for the development of cattle breeding through its intensification. Therefore, the fulfilment of the potential of the sector highly depends on our ability to utilize the international experience and modern technologies available.

Proper nutrition of cattle plays an important role in the intensification of milk and beef farming, as the welfare and proper nutrition of cattle determine the milk productivity of cows by 70-80%, and the genotype by 20-30%.

The efficiency of milk and meat production is significantly affected by the quality of forage and proper nutrition of cows. Expenditures on animal feeding account for more than 70% of the cost of producing livestock products. Currently, in Georgia, cattle feeding relies mainly on natural pastures, and as the animal feed industry is not developed in the country, it thereby increases the pressure on pastures.

In most regions of the country, cattle feed from natural pastures accounts for about 60-80% of the total nutrition of cattle. The productivity of natural pastures is low. In recent years, the use of pastures and grass productivity

1 Dairy Farmer Guide. Published by the Agency for Production and Promotion of Georgian Farm Products, Tbilisi 2008.

2 GeoStat, Agriculture and Food Security, available at: https://www.geostat.ge/en/modules/categories/196/agriculture, date accessed 12/15/2021.

sharply decreased, mainly due to a large number of cattle and a lack of pasture improvement methods[3].

Over the past 30 years, pasture improvement measures have not been carried out. Overgrazing and the irrational use of pastures lead to decreased grassland yields. As a result, the grass cover is degrading and a significant portion of pastures is becoming unusable. The majority of summer and winter pastures are eroded and covered with non-edible weeds, preventing the growth of livestock production.

Measures directed at the improvement of pastures and their rational use should be implemented throughout Georgia. To provide livestock farms with the required amounts of forage, feed production should be intensified first through increased yields of forage crops. Forage crops that produce higher yields at lower costs should be planted and used.

The cost of feed production can be reduced through increased yields, which can be achieved by selecting proper grass varieties, using organic fertilizers, amelioration and mechanization of the processes.

Cattle nutrition and feeding rations are not balanced as most dairy and beef cattle are not provided with adequate nutrition, especially in winter. Modern technologies for the production of winter fodder are not introduced in farms, available pastures are degraded and are often not provided with the necessary amount of water for cattle. Forage shortage and irrational use reduce milk and meat productivity and the economic efficiency of their production.

In addition, the genetic potential of local dairy and meat cattle breeds is low; inbreeding occurring during the last 25-30 years drastically reduced the efficiency of breed improvement. As a result, high meat and milk yielding breeds can hardly be found in the country.

One of the main reasons for the low productivity of cattle is the lack of breeding activities, meaning that no efforts are being made for the improvement of local breeds. Cattle are not being selected based on desired breeding traits, cattle breeding is carried out without clearly defined determinations, and therefore locally available genetic resources are on the verge of extinction.

3 Tortladze. Levani, Dairy and Meat Production Guide (Catalog) for Farmers and Livestock Specialists, Tbilisi, 2013.

For the most part, reproductive management is lacking and animal diseases are rampant.

The mechanization level of livestock farms is quite low. Only 10% of the total number of dairy cattle are milked using milking equipment and most of the cattle are not provided with proper nutrition and housing.

With this in mind, to rapidly increase the productivity and sustainability of dairy and beef farming, this sector should be intensified, which involves measures to increase production in the shortest possible time, reduce the cost for milk and beef production and increase the income of farms, factoring in the local situation.

The experience of countries where the livestock sector has been successfully intensified indicates that genetic improvement of local cattle breeds combined with appropriate nutrition can lead to a 60% - 300% increase in milk productivity.

It should be noted that in different regions of Georgia, livestock farming practices vary due to climatic conditions and therefore, the level of intensification of livestock production will be different depending on environmental conditions, requiring a differentiated approach when selecting suitable methods.

For the intensification of livestock production, fodder supply and local cattle breeds should be improved, adequate conditions for animal housing should be established and the mechanization level of livestock farms should be increased.

The intensification of the livestock sector will also contribute to the alleviation of pressure on the environment and namely, on pastures.

2. Intensive use of local cattle breeds taking into account lowland and mountainous conditions

2.1 Milking and dual-purpose cattle breeds

Brown Caucasian cattle breed

Pic. 1.
Brown Caucasian cow

In most regions of Georgia, around 90% of cattle are the Brown Caucasian cattle breed, while 20% are different crossbreeds[4]. Brown Caucasian is a dual-purpose cattle breed used for both milk and beef production. This breed is characterized by its ability to survive, tolerate and move long distances in search of food.

Another advantage of this breed is its high-fat content in milk (4.2-4.5% on average). Their hooves and knees are strong, which is essential for a pasture-based farming system. The main disadvantages of the Brown Caucasian breed include low productivity and low reproductive rate, resulting in low milk and meat yields. The average lactation milk yield of this breed is 2600-3100 kg.

4 Prof. L. Tortladze, Dr. G. Khatiashvili, DIVERSITY AND PERFECTION OF GEORGIAN LOCAL CATTLE, Vol. 3 No. 3: 2005, 06/16/2014.

Table 1. *Productivity of the Brown Caucasian breed*

Lactation	Live weight, kg			Milk yield in 305 days, kg			Fat content, %		
	Average	**Max**	**Min**	Average	**Max**	**Min**	Average	**Max**	**Min**
I Lactation, kg	402	500	350	2600	4208	1944	3,93	4,36	3,61
II Lactation, kg	453	580	370	3184	5135	2351	3,90	4,90	3,60
III Lactation, kg	469	600	400	3556	6049	2648	3,90	4,68	3,60

The Brown Caucasian breed is bred in South Caucasus countries and Dagestan by crossbreeding with the local Brown Swiss cattle breed.

The standard weight for cows is 370-430 kg, for bulls - 570-680 kg. The male calves are characterized by their high growth potential and beef production. In the case of intensive feeding, the weight of calves reach 456 kg at the age of 15 months and the slaughter quantity is 59%.

The Brown Caucasian breed is recommended both for mountainous and lowland regions of Georgia. The genetic potential for milk and beef production of this animal can be improved through crossbreeding with Brown Swiss or Simmental breeds.

Georgian mountain cattle breed

Pic. 2. *Georgian mountain cattle*

Georgian mountain cattle are an endemic breed widespread in mountainous regions of Georgia. The weight of cows is 180-230 kg, maximum weight – 300 kg. The weight of newborn calves is 15 kg. The animals have different colours: 51% are black, 24% - red, 15% - black-spotted and 8% - red spotted. ***Georgian mountain cattle are a dual-purpose breed used both for milk and beef production;*** carcass percentage is 51.2%.

Currently, Georgian mountain cattle account for 16.2% of the total amount of cattle in Georgia[5].

5 L. Tortladze, A. Chkuaseli, G. Khatiashvili, The diversity of local cows in Georgia and their perfection. „Protection of Agrobiodiversity and Sustainable Development of Agriculture" (Proceedings of the International Conference), Tbilisi, 2010.

Advantages of Georgian mountain cattle are its high adaptive capacity to high mountainous and foothill conditions, and its ability to graze on steep mountain slopes.

Table 2. *Productivity of the Georgian mountain cattle breed*

	Average	Maximum	Minimum
Milk yield per I lactation (kg)	530	822	243
Milk yield per II lactation (kg)	626	1050	339
Milk yield per III lactation (kg)	666	1189	329
Average fat content %	4.25	6.4	3.2
Milk yield in conditions of improved nutrition (kg)	1942	2850	918

The disadvantages include low productivity and low adaptive capacity to different climate conditions.

The Georgian mountain breed is recommended for the mountainous regions of Georgia. The genetic potential for milk production of this cow can be improved through crossbreeding with the Jersey cattle breed.

Megrelian Red cattle breed

Pic. 3. *Megrelian Red cattle*

The Megrelian Red cattle breed has been bred by the Kvaratskhelia brothers since the 1860s. Megrelian Red cattle are well adapted both to alpine and wetland conditions. The average weight of adult cows is 277.4 kg, maximum weight - 358 kg, bulls - 380-420 kg, newborn calves – 15-17 kg. Currently, about 17,500 heads of Megrelian Red cattle have been recorded in Georgia[6].

The advantages of the Megrelian Red cattle breed include its high adaptive capacity to different conditions; intake of low-quality feed (including wetland vegetation); and its high quality of milk (the average fat content varies between 3.71-5.71%). The disadvantages of the breed include low milk and beef productivity.

6 Ibid

Table 3. *Productivity of the Megrelian Red cattle breed*

	Average	Maximum	Minimum
Milk yield per I lactation (kg)	765	1115	251
Milk yield per II lactation (kg)	797	1589	175
Milk yield per III lactation (kg)	875	1904	184
Average fat content, %	4.45	6.17	3.29

The Megrelian Red cattle breed is recommended for waterlogged areas of Western Georgia and mountainous regions. The genetic potential for milk production of this cow can be improved through crossbreeding with high productive breeds including Jersey and Estonian Red, while the genetic potential for beef production can be enhanced through crossbreeding with the Angus breed.

2.2 Improvement of local cattle breeds reproduction and artificial insemination

Breeding activity is one of the most important factors for the improvement of local cattle breeds. The selection of animals is a set of measures aimed at changing the hereditary traits of an animal into the desired direction and is a key activity in inbreeding. For this purpose, the following shall be undertaken:

1. Selection of animals with desired productivity;
2. Selection of animals for mating;
3. Optimization of conditions for livestock housing and feeding.

In inbreeding activities, special attention is paid to the selection of a breeding bull, as the impact of the bull on the improvement of breeds is greater than the impact of a cow. Ideally, one cow produces 8-10 calves during its productive lifetime, while several thousands of calves can be produced from a single bull during a shorter period of time if the artificial insemination method is used.

To improve cattle breeds, the practice of animal identification and registration should be improved in livestock farms, as this is the only way to identify cattle with high genetic potential and select them for breeding.

- The breeding value of bulls is determined through the assessment of the milk productivity of their offspring. It means that the breeding bull is tested for the quality of its offspring based on their milk yield, the content of fat and protein in milk, live weight and exterior;
- They are assessed for reproductive ability and the weight of new-born calves;
- Most of them are characterized by a high ability to transmit high productivity to offspring[7].

Each bull is assigned by sire indexes - the estimate of the hereditary potential of a bull for milk production or any other trait expressed by PTA. For example, PTA Milk (lbs) 820 is a predictable ability to transmit productivity to offspring from this bull and it is measured (milk) in pounds, i.e., the offspring from this breeding bull will produce at least 820 pounds (372 kg) more milk.

Pic. 4. *Breeding bull*

7 N. Gotsiridze, Source of Knowledge, Milk and Beef Production Technology, Chapter 5 – Breeding. Tbilisi, 1997.

The use of breeding bulls allows for the increase of milk productivity in a relatively short period of time, which means that the offspring of these bulls will produce more milk, or will have a higher fat and protein content in the milk.

For example, the following productivity growth rates were achieved in developed countries through the use of breeding bulls: the average milk yield per cow in Israel in 1939 was 3847 kg, while by 2003 this figure increased up to 10426 kg, i.e., the productivity increased 4 times; in the USA during the last 50 years milk yields increased 3 times and more[8].

Main breeding traits of dairy cows include:

- pedigree (quality of parents)
- lactation yield of cows
- fat and protein content in milk
- the shape of udder and milking speed
- calving duration of productive use of cows
- fertility

The main breeding traits of beef cattle include:

- pedigree (quality of parents)
- growth (live weight), exterior and constitution
- the daily gain in weight (after weaning from milk feeding)
- carcass percentage (%)
- easy calving
- beef quality (marble)
- fertility

Breeding opportunities to some extent depend on the type of raising. For example, in the case of extensive raising (nomadic or pasture-based), when cows are in contact with a bull, mating can hardly be controlled. Under conditions of such arbitrary selection, in addition to lower productivity offspring, there is a high risk of inbreeding.

8 Authors group, Universal, Breeding activities in dairy cattle farming, Tbilisi, 2009.

Inbreeding is the breeding of individuals or organisms that are closely related genetically. For example, when a breeding bull breeds with his mother, sister and offspring, it results in a drastic reduction in genetic diversity and many negative consequences, namely:

- Decreased milk and meat productivity by an average of 10% per generation
- Decreased fertility
- Embryo mortality at an early stage of their development
- Increased mortality of calves
- Birth of defective and small, weak calves
- The weakened immune system of offspring
- Dramatically increased risk of fatal genetic abnormalities

Breeding of dairy and beef cattle, i.e., improvement of breeding and productive qualities, can be accomplished via three methods: natural mating, artificial insemination and embryo transplantation.

2.2.1 Natural mating

Natural mating involves the mating of cows with a breeding bull. Usually, in this case, the cow's heat and pregnancy periods are not planned and their mating (fertilization) occurs spontaneously (depending on seasons). During the natural mating period, the permissible load per breeding bull is 30-40 cows. At first glance, natural mating is the cheapest way of breeding and quite good results can be obtained if mating animals are properly selected. However, this method has several disadvantages, limitations and threats, namely: unintentional inbreeding, the spread of sexually transmitted diseases, wrong time for pregnancy (at an early age or during the wrong season), maintenance of costs for the keeping of a breeding bull, etc.

2.2.2 Artificial insemination of animals

Artificial insemination is the technique in which semen with living sperm is collected from the selected high-performing breeding bull and introduced into the female reproductive tract at the proper time of a cow's heat cycle with the use of instruments.

At special breeding farms, breeding bulls are carefully selected according to their exterior, health and genetic potential. Semen with living sperm is periodically collected and examined for various infectious or genetic diseases to make sure that the sperm is of the highest quality.

Artificial insemination has the following advantages for cattle breed improvement:

- *Artificial insemination is less expensive (compared to the maintenance costs of a breeding bull)*
- *Breeds can be improved easily and in a shorter time, resulting in rapidly increasing milk and meat productivity*
- *As the sperm of a breeding bull can be kept frozen for years, the breeding bull can be selected based on the productivity of its offspring*
- *Artificial insemination increases the chance of fertilization*
- *A broader choice of breeding bulls with desired hereditary potential (milk production, content of fat and protein in milk)*
- *Birth seasonality can be better planned*
- *Accidental, unwanted mating is avoided*
- *Heifers produced by way of artificial insemination are easy to maintain, heifers of different ages and weights can be sent to pastures without the risk of their early mating and pregnancy*
- *Sexed semen can be used to produce calves of the desired sex*
- *Farmers keep a sharp lookout for the cow's reproduction cycle, make records and thus contribute to improved farm management*
- *When selling offspring produced by way of artificial insemination, the name and breeding value of a breeding bull can be indicated if relevant records are available*
- *The risk of spread of infectious (brucellosis, tuberculosis) and venereal diseases are reduced significantly*
- *Zero risk of inbreeding*

The advantages of artificial insemination exceed the benefits of natural mating. This is also proved by international practice, especially in countries where the productivity of both dairy and beef cattle has been increased significantly.

2.2.3 Reproduction

Reproduction of cattle in farms is a process involving the recovery and increase of the cattle population through their reproduction and rearing quality breeding calves.

Notwithstanding the insemination method - natural or artificial - to be used for cattle breeding, knowledge of the breeding cycle of the cattle and relevant processes is important for the success of reproduction and, therefore, for the improvement of livestock productivity.

This first involves proper rearing of heifers, which means the determination of proper age and live weight for the first insemination. ***To ensure maximum milk productivity of local breeds, the first insemination of heifers should occur when their live weight exceeds 350-380 kg (large-sized breeds) and 200 kg (small-sized breeds).***

Heifers that are inseminated at live weights that are too low cannot gain proper weight until the birth of a calf, resulting in complicated calving and low milk yields.

Crossbreeding of local cattle breeds with high-production breeds will result in the following:

- *Genetic improvement of cattle, manifested by increased yields and quality of milk and meat, easier maintenance, increased milking intensity, improved fertility, and prolonged productive lifetime*
- *Breeding of cows suitable for an automatic milking system*
- *Breeding high productive breeds that are adapted to local climate conditions*

3. Improved livestock nutrition in lowland and mountainous areas based on local conditions

3.1 Nutrition of dairy cows in lowland and mountain areas

The efficiency of milk production is significantly determined by quality forage and the proper nutrition of cows. The cost of animal feed accounts for more than 70% of the cost of milk produced throughout Georgia.

Feed and feeding are also very important for maintaining animal health, as 95% of non-communicable diseases are related to feeding quality and feeding systems.

Proper feeding of dairy cattle involves meeting animals' demand for nutrients, minerals and vitamins.

When fed a deficient, unbalanced feed, the animal consumes those substances from its body that are lacking in its ration. As a result, the animal weakens and its productivity and reproductive capacity are reduced.

The feeding ration of dairy cattle should be determined taking into account the live weight and age of the animal, daily milk yield, fat content of milk and feed intake.

Locally available and inexpensive ingredients, including hay from natural pastures, waste from grain and vegetable processing and food enterprises should be included in the feeding ration.

Due to variability in geographic and climatic conditions and feeding methods, the following methods of cattle rearing are recommended: stall housing, pasture-based and combined pasture-based and a stalled housing system.

In a stall housing system, the cattle are kept indoors where feed is provided.

In pasture-based systems, for most of the year, the cattle are kept outside in pastures for grazing.

Under a combined stall housing and pasture-based system, in spring and summer periods the cattle are kept in herds in pastures, while in fall and winter – installs.

For the most mountainous regions, a stall housing system is recommended for fall and winter periods, as the productivity of pastures at that time of year is decreased significantly.

In spring and summer, when pastures are covered with grasses and can provide all the nutritional components with an animal needs, a pasture-based system is recommended.

In the majority of lowland regions of Georgia, for most of the year, the pasture-based system can be applied.

In livestock farms of Georgia where high productive dairy and beef cattle breeds are kept, feeding patterns and the diet of animals should remain unchanged during the year, which means keeping livestock in a stall housing system.

Table 4. *Recommended composition of a daily feeding ration for a dairy cow in the stall housing system (for lowland regions)*

Daily milk yield, kg	Live weight, kg	Daily diet, kg (weight)				
		Meadow hay	Wheat straw	Corn silage	Barley+corn grain, 50/50	Sunflower cake
8	300	5	2.5	13	0.5	-
10		5	3	16	1.0	-
12		5	3	16	1.0	0.5
16		5	3	20	2	0.5
8	400	5	3	15	0.9	-
12		5	3	19	1.5	0.5
16		5	3	26	1.0	1.5
20		6	3	25	2.8	1.0
8	500	5	3	16	1	0.5
12		5	3	20	2	0.5
16		6	3	22	2.5	1.0
20		6	3	26	3.5	1.0

Table 5. *Recommended composition of a daily feeding ration for a dairy cow in the pasture-based system (for lowland regions)*

up to 10 – 20 kg daily milk yield			
Feed Daily diet, kg (weight)	300	400	500
Green grass	35	42	45
Concentrate barley+corn grain, 50/50	1.5	2	2.5

Table 6. *Recommended composition of a feeding ration for a dairy cow in the stall housing system (for mountainous regions)*

Daily milk yield, kg	Live weight, kg	Daily diet, kg (weight)				
		Meadow hay	Silage from natural grasslands	Vitamins and min-erals	Barley+corn grain, 50/50	Sunflower cake
8	430-470	7	23	0.150	1	0.5
10		8	25	0.150	1.5	0,5
12		10	30	0.150	2.2	1
16		11	33	0.150	2.5	1

Table 7. *Recommended composition of a feeding ration for a dairy cow in the pasture-based system (for mountainous regions)*

up to 10 – 20 kg daily milk yield			
Feed Daily diet, kg (weight)	300	400	500
Green grass	30	37	40
Concentrate barley+corn grain, 50/50	0.7	1.5	2

To ensure the availability of feed for dairy cattle using available pastures, their quality must be improved through sowing cereal and legume grasses and planting artificial pastures. Cattle feeding can be enriched with proteins through legume grasses, which should be given to animals after they are cut and dried.

If cattle are kept on pastures, the following shall be taken into account: when shifting to the pasture-based system, during the first days in the morning, cows should be given 1-2 kg of solid feed per day before sending them out to pastures to improve digestion and avoid diarrhoea.

The feeding of milk cattle should also include concentrated feed (corn, barley, wheat), the daily amount of which should increase gradually.

3.2 Feeding (fattening) beef cattle in lowland and mountainous areas

The duration of the fattening period for beef cattle depends on the breed of the animal, nutrition pattern and live weight.

Fattening calves aged less than 12 months is most effective in terms of cost. At the beginning of fattening the live weight of calves is 120-150 kg on average and the process ends when their live weight reaches 300-350 kg.

Daily weight gain of fattening animals depends on the level of nutrition and the quality of forage. They should be provided both with solid feed and concentrates. It is recommended to castrate those bull calves that are selected for fattening, as in similar conditions the daily weight gain of castrated calves exceeds that of uncastrated animals by 15%.

The following systems of fattening are recommended for beef cattle: tie-stall housing, pasture-based and feedlots (in herds or cages).

If livestock is fattened in tie-stall housing and fattening area, animal feed should be prepared and delivered to the farm. For this purpose, various feed processing machinery is required.

A pasture-based system is the most cost-effective system. If animals are kept on pastures, they should be provided with adequate feed through the pasture-based feed.

Based on climate conditions of specific regions of Georgia, the following methods of fattening are recommended:

1. Fattening on natural mountain pastures (grazing)
2. Fattening on the so-called green conveyor, a combination of natural and sown pastures
3. Fattening on natural pastures with the provision of additional green forage and concentrates
4. Fattening on perennial artificial pastures and provision of prepared feed (hay, silage, concentrates, etc.) or wastes from grain and vegetable processing and food enterprises in winter

The monthly weight gain of calves of local breeds on high-quality pastures is 18-20 kg, and 23-25 kg if concentrates are provided additionally.

In a pasture-based system, cattle should be sent out to pastures when the height of grasses reaches 12-15 cm. To maintain the quality of a pasture, rotational grazing is recommended.

If the animal does not reach a desirable weight, it shall be kept in the stalls.

During intensive fattening of cattle, the share of concentrated feed in its diet should be 40-45%.

The feeding ration may include all types of feed (e.g., green grass, hay, straw, combined feed, cereals, sunflower press cake, mill offal, waste of food processing enterprises, etc.).

The use of a milk substitute is recommended for fattening calves. The milk substitute must be provided twice a day, 3 kg per portion. As the animal grows, it gets used to forage and grain-based feed and therefore, the amount of milk in the feeding ration will be gradually reduced.

Grain bran or special combined feed (for calves), as well as good quality hay, or shredded green grass should be freely available for fattening calves.

The feeding ration of local breed fattening beef cattle should be selected in such a way as to ensure that the daily weight gain of a calf is not less than 600-650 grams.

During the second period of beef cattle fattening, the animals should be kept in the stall and fed in such a way as to ensure that their daily weight gain is 700-800 grams. The diet should consist of solid and silage feed. At the same time, the share of grain or combined feed should be at least 25 - 30%.

Table 8. *Diet of calves of local breeds*

Month	Decade	Live weight by the end of the month	Daily meal, kg (be weight)		
			Concentrate	Hay	Silage
IV	I decade	85	1,5	1,5	2,5
	II decade		1,5	1,5	3,0
	III decade		1,5	1,5	3,5
V	I decade	100	1,5	2,0	4,0
	II decade		1,2	2,5	4,5
	III decade		1,2	2,5	5,0
VI	I decade	115	1,0	3,0	6,0
	II decade		1,0	3,0	7,0
	III decade		1,0	4,0	9,0

Fattening cattle that are kept in stalls should be provided with mineral and vitamin supplements.

The use of multimineral lick blocks containing all the necessary minerals, vitamins and various biologically active substances is recommended.

If livestock grazes in a grassy pasture that is rich in grasses and legume plants, the animals do not require additional minerals and vitamins.

However, in summer, when the quality of grasses declines, animals are not provided with adequate nutrition and therefore lick blocks can be used, as they contain proteins and minerals that help improve rumen microflora and increase appetite.

Pic. 5. *A lick block*

Urea molasses mineral blocks – lick blocks are useful both for fattening beef cattle and for dairy cattle, which are fed with medium and low-quality grasses, silage, straw and hay.

The daily weight gain of fattening animals is very slow, especially when they are fed with low-calorie food if urea molasses is not included in their diet. The daily weight gain of a fattening animal, the diet of which includes urea molasses mineral blocks, increases up to 300 grams.

3.3 Production of high protein content hay from legumes (alfalfa)

For significantly improved animal feeding, especially during the winter season, it is recommended to produce legume hay.

Production of quality solid feed is a precondition for the development of both dairy and beef cattle breeding in lowland and mountainous areas, ensuring the increase of milk and meat productivity and financial profitability. Production of alfalfa hay to increase milk and meat productivity is the best solution for most regions of Georgia, as alfalfa hay contains nutrients and proteins in large amounts. Production of alfalfa hay is recommended in all regions of Georgia except for high mountainous areas.

Alfalfa is a perennial (5-7 years) plant in the legume family. Alfalfa is a drought-resistant species that is characterized by intensive growth in spring and summer. Some varieties of alfalfa also can tolerate winter frosts. Alfalfa develops a deep root system in a short period, which allows it to obtain maximum yields in case of minimum rainfall (550 mm annual rainfall).

Pic. 6. *Alfalfa in winter*

Some species of alfalfa in winter are active, and some are passive.

Those species that are active in winter do not stop growing during the winter season, they just slow down the growth rate and continue active vegetation in spring. Therefore, this species can be harvested more times than other traditional alfalfa varieties.

Pic. 7. *Winter active Alfalfa in Alazani Valley, Kakheti*

Considering the soil types and climate of Georgia, alfalfa can be harvested at least twice per agricultural season and obtain an average of 3500-5000 kg of hay per hectare. In the case of irrigation, it is possible to have 3-4 harvests and 10000-13000 kg hay per hectare.

The following factors are important for alfalfa hay production:

- Soil cultivation - The selected area should be ploughed to a depth of 22-25 cm and thoroughly prepared for sowing using a cultivator or harrow.

- Soil fertilization - For this purpose, the application of mineral fertilizers superphosphate (500 kg per ha) and ammophos (200 kg per ha) is recommended.

- Sowing - Alfalfa should be sown in early spring (first half of March) or fall (September). 20-25 kg of seeds per hectare is required. The depth of the sowing should be a maximum of 2 cm. Deep sowing significantly reduces crop yields.

Alfalfa seeds can be planted by hand or with a sewing machine after the soil is perfectly prepared. When planting by hand, it is recommended to sow seeds that are mixed with sand in advance, as alfalfa seeds are very small.

If a sowing machine is used, soils should be compacted before and after planting. To protect alfalfa from weeds, usually, cereals, mainly barley or oats (80-100 kg/ha) are planted together with alfalfa. After cutting cereal crops, only alfalfa will be left.

Pic. 8. *Sprouts of alfalfa under barley*

Pic 9. *Grown alfalfa after cutting barley*

- **Crop care** - After sowing, often soil crust develops which prevents sprouting of germinated seeds on the soil surface. Therefore, harrowing or watering is recommended.
- **Alfalfa mowing** - In the first year, weeds actively grow in alfalfa plantations, so the first mowing should occur before grass flowering. The resulting hay is very delicate and nourishing, as it consists mostly of leaves – the most nutritious part of the plant. Alfalfa can be cut with a mowing knife or using a mowing machine. Cut grasses should be put in heaps until dry, then pressed or stockpiled and stored.
- **Pests and diseases** - Parasitic plant dodder causes serious problems for alfalfa. This weed should be controlled from the very beginning to avoid the dispersal of its seeds when sowing alfalfa. Field rodents damage roots of this plant, therefore various protective measures should be considered.

Alfalfa fields should not be grazed!

Based on climatic conditions of high mountainous regions of Georgia, the cultivation of the following forage crops is recommended for the improvement of available pastures and grasslands:

The following cereal and leguminous grasses are recommended:

- Fescue, Ryegrass, Timothy, Cock's foot, Red clover, Trefoil, White clover

3.4 Silage production technolog

Pic. 10. *Corn silage in plastic sacks*

Pic. 11. *Making corn silage in silage trenches*

Silaging is the most cost-effective method of solid forage production.

Silage can be produced from annual and perennial cereals and leguminous plants. It can be made from a green mass of corn, sorghum or alfalfa. Silaging is a process of fermentation resulting in an acidic mass (PH 4,2).

High-quality silage stimulates the appetite of cattle, improves digestion and provides the body with vitamins and minerals.

Cereals, including corn, sorghum, oats, etc. are easily silageable plants. Legumes that contain small amounts of sugar, such as alfalfa, sainfoin, clover, etc. are hardly silageable fodders.

High-quality silage rich in proteins can be produced from the mix of cereals and legume grasses (e.g., 75-85% corn + 15-25% alfalfa). The humidity of the green mass should be within 65-70%. It should be chopped, pressed and wrapped tightly.

Small quantities of silage can be made in plastic bags. In plastic bags, green mass can be easily pressed and air removed as much as possible. This method is recommended for small farms (3-5 heads of cows with their calves).

If all rules for making and storing silage are followed, it can be fed to cattle in 25-30 days.

Pic. 12. *Making silage in polyethene bags, Lagodekhi municipality, village Tsodniskari*

High-quality silage is readily eaten by cattle, as it contains nutrients in optimum proportions and at the same time helps digestion of other ingredients.

The share of silage in a daily diet of dairy cattle in winter should be within 30-50%.

Dairy cattle with 300-350 kg live weight can be given 25-35 kg of silage a day, 6-12 months old calves – 4.5 kg, older calves – 7-8 kg, new-born calves can be given silage from 1.5 months.

Feeding with a combination of silage and other ingredients in proper amounts significantly increase the productivity of milk and meat.

It should also be noted that using available food processing waste (beer brewing waste, corn distillation waste, molasses, apple juice waste) can further contribute to increased productivity of milk and meat.

4. Sustainable Management of pastures

4.1 Rotational grazing system

For livestock farming to become more intensive and milk and meat production profitable, it is recommended to introduce highly productive cattle breeds, feed animals with a balanced ration all year round and create appropriate housing conditions.

The most cost-effective method for improving livestock productivity is the effective use of available pastures. For proper management of pastures, the introduction of rotational grazing is recommended.

Rotational grazing helps:

- Improve grass growth and productivity
- Reduce soil erosion
- Increase grass intake and reduce losses
- Protect animals from parasitic diseases
- Increase productivity by 20-25%
- Improve the reproductive capacity of animals
- Raise healthy young stock
- Increase animal load on 1 ha of pasture from 4-5 cows to 7-10 cows.

Principles of rotational grazing

- The pasture should be divided into 5-6 equal-sized paddock
- Paddocks should be fenced with an electric fence
- Each paddock should be used during 5-7 days and then the cattle should be moved to another paddock, and so forth

If cattle are kept on pastures:

- rotational grazing practice shall be introduced
- each paddock should be used during 5-7 days
- paddocks should be loaded depending on pasture yields
- in case of low pasture yields, animals should be given additional feed

- shifting cattle from stall feeding to pasture grazing should be done gradually, otherwise, the animal may suffer from: diarrhoea, distension (tympanites), early pregnancy losses can be also expected
- It should also be taken into account that pasture overloading will cause overgrazing of the grass cover leading to soil erosion, destruction of grass species and biodiversity. As a result, the yields of nutrition plants will be reduced
- Watering points should be provided on pastures, at noon the cattle should move to these sources of water
- Watering points should be located under trees or within a constructed shelter
- It is advisable to locate cattle insecticide treatment stations at watering points

It should always be kept in mind that:

- On paddocks that are fenced with electric fences, grazing should start after the morning dew dries (especially on pastures where legumes dominate)
- Newly cut, wet green mass of legume grasses (e.g., alfalfa) shall not be given to cattle
- In case of distension (tympanites) veterinary service should be immediately used.

Pic. 13. *Cattle watering and insecticide treatment site*

4.2 Improvement of available pastures

The quality of natural pastures and grasslands in most regions of Georgia is low and can hardly meet the feed requirements of animals, especially in winter. However, the milk and meat productivity of natural pasture-based farming systems can be increased through the improvement of available pastures and grasslands, specifically by sowing legumes and grain crops.

Table 9. *Recommended plant species for the improvement of pastures and grasslands*

	Soil pH >6.5	Soil pH <6.5
Pastures	fescue, cat grass, trefoil, ryegrass, sulla	antas, frontier, erica, margarita
Grasslands	clover, alfalfa, fescue, cat grass, trefoil, ryegrass, sulla	antas, frontier, erica, margarita, sirosa
Crop rotation for arable lands	jester, sava, antas, dolichos	antas, frontier, erica, margarita, dolichos

On improved pastures and grasslands, excessive grazing and mowing should be avoided. Grasses should be cut before they begin flowering and flowering plants should not be grazed. Grazing should be resumed when seeds are developed and dispersed on the ground.

When improving pastures and grasslands, before seeding grasses, the soil pH should be examined. The pH of soils should be suitable for plants selected for sowing. It is recommended to apply lime on highly acidic soils.

Along with alfalfa and clover, a leguminous plant Wilpena sulla is recommended for the improvement of the quality of grasslands. This species is characterized by a high content of proteins, its yield is 80 tons per ha per season, does not cause distension and is well-adapted to alkali soils.

Perennial grasses, especially legumes sown on pastures can increase hay productivity by 25-30 % and protein content in the hay – by 50%.

4.3 Manure management

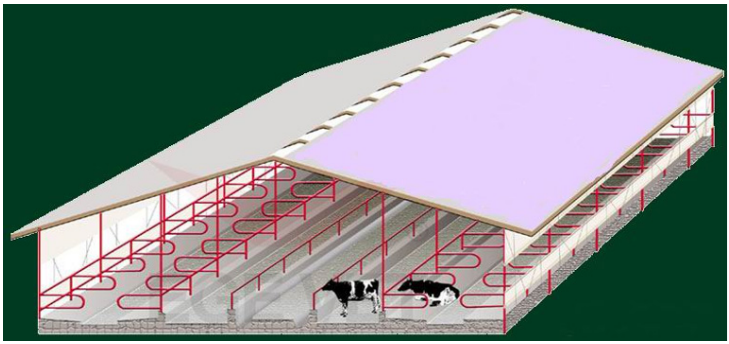
Proper manure management is one of the important issues towards the intensification of livestock farming.

Application of cattle manure in agricultural crop production increases yields of grain crops (corn, wheat, barley) by 15%-25%.

By using 15 tons of manure per 1 ha of pasture, the productivity of pastures may increase by 80-150%.

5. Intensification of cattle farming (cow housing)

5.1 Dairy and beef cattle housing



Pic. 14. *Cattle housing, free stall system*

Intensification of cattle caring and rearing also involves the improvement of cattle caring and rearing methods. The following systems of livestock farming are recommended:

- Pasture-based system
- Stall housing system
- Combined pasture-based and stall housing system

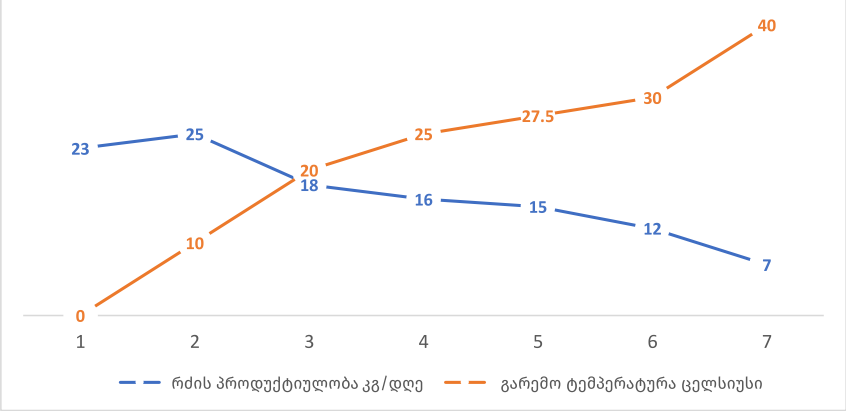
If cattle are kept indoors, both a free-stall housing system and a tie-stall housing system can be used. Under free-stall housing systems, cattle have free access to feed and water provided in the diet at any time of the day.

The advantage of a free-stall housing system is reduced labour costs. Under these systems, instead of providing feed and water directly to the animals, they are allowed to move freely over the entire area of the building and have free access to feed and water.

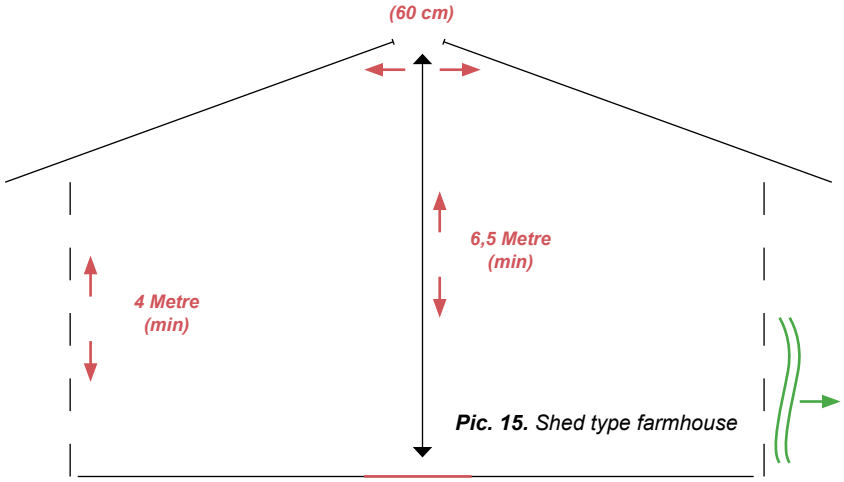
The advantage of a tie-stall housing system is that when cows are individually tethered in distinct stalls, all cows receive feed based on their daily milk yield and therefore the competition between them does not occur.

Temperature control should be considered when planning the design of a farm building, as air temperature has a strong influence on the milk productivity of dairy cattle. The optimum temperature for ensuring high milk yields is +15-200C.

Table 10. *Influence of air temperature on milk productivity*[9]



To achieve maximum milk productivity of cattle, simple shed type farmhouses are used. Dimensions are shown in the picture below.



Pic. 15. *Shed type farmhouse*

9 Robert Lang, Professor at the University of Tropical Agriculture, Australia.

Pic. 16. *Free stall housing system*

Pic. 17. *Tie-stall housing system*

5.2 Calf housing

To prevent calf diseases, individual housing for calves should be designed and built or individual pens for calf rearing should be purchased.

Pic. 18. *Individual pens for calf rearing*

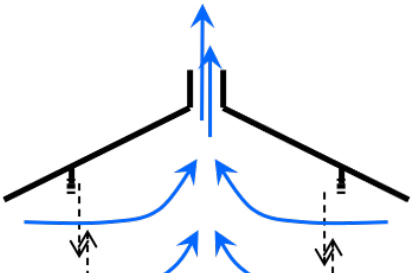
5.3 Ventilation system for farm buildings

The main purpose of ventilation is to create an optimal microclimate for both cattle and people within a livestock farm building.

A cool and dry, rather than warm and humid, microclimate is recommended for dairy cattle. The absence of a ventilation system is one of the common problems of existing livestock farm buildings. If most of the ventilation ducts releasing air from the farm building are closed and those absorbing fresh air is lacking, the microclimate in the farm building will be highly unfavourable for high-yielding cattle due to high temperatures and high concentrations of ammonia and methane. In such conditions, animals are prone to heat stress and bacteria grows rapidly, leading to some diseases. Milk-fed calves are especially sensitive to the microclimate of a farm building. Cases of pneumonia due to an unfavourable microclimate among milk-fed calves are frequent.

It is recommended to equip farm buildings with natural ventilation systems. For this purpose, movable side walls (so-called curtains) that regulate the microclimate and temperature of the farm building using natural ventilation can be used.

Pic. 19. *Movable side walls (curtains)*



Pic. 20. *Principle of natural ventilation*

5.4 Cattle watering

Water is the most important nutrient for milking dairy cows as water is needed for milk secretion and metabolism. If cows have inadequate water intake, their feed intake will be depressed. ***High-yielding lactating cows need an average of more than 130 litres of water per day, which should be available to the animal all day.***

Lack of water in the body of dairy cattle leads to the following symptoms:

- intestinal obstruction
- reduced urination
- reduced feed intake
- restlessness (mooing)
- loss of live weight

It should be taken into account that the well-balanced nutrition of a cow cannot fully utilize its potential for milk production if the animal is not provided with adequate quality and quantity of water.

Pic. 21.
Automated water bowl

5.5 Rules for hand and automati milking

Mechanization of livestock production is one of the important aspects of livestock intensification. Special emphasis should be put on the automatization of milking processes to improve the quality of milk and reduce costs.

Pic. 22.
Milking unit

<u>The following rules should be observed during hand and automatic milking:</u>

1. Keep milking cow in clean conditions
2. Keep milking equipment clean
3. Wash hands thoroughly before milking
4. Wash teats and thoroughly wipe them with a clean towel
5. Use separate towels for each cow or use disposable towels
6. Before milking, stimulation and massage of teats are required
7. Get rid of foremilk; foremilk should not be mixed with milk yield
8. Disinfect teats after milking
9. Milk should be cooled to 4^0C

Pic. 23. *Milking procedures*

6. Economic analysis of extensive and intensive farming methods in dairy and beef cattle breeding

Table 11. *Economic analysis of intensive milk production method (for the farm with 10 milking cows)*

Income	Unit	Quantity	Unit cost (GEL)	Total (GEL)
Sales of milk	litre	76,250	1.30	99,125
Sales of cows	cow	8	800	6,400
Total income				105,525
Variable costs				
Grazing	Ton	-	-	-
Alfalfa hay	Ton	18.25	280	5,110
Own concentrate	Ton	10.95	300	3,285
Concentrate	Ton	21.90	1,100	24,090
Sunflower cake	Ton	3.65	1,200	4,380
Barley	Ton	-	800	-
Total feed costs	Ton	91.25	300	27,375
Veterinary treatment costs				64,240
Artificial insemination	Cow	10	200	2,000
Energy costs	Cow	10	90	900
Contingencies	Cow	10	90	900
Total other costs	Cow	10	100	1,000
Total variable costs				4,800
Gross Margin				36,485
Fixed costs				
Labour costs	Person	1	6,000	6,000
Costs of milk cooling			120	1,200
Costs of the automated milking system			150	1,500
Building maintenance costs			200	200
Total fixed costs				8,900
Net profit				27,585

Table 11 shows that, in case of application of the intensive method of milk production involving improvement of cattle feeding and caring practices, the milk yield for the lactation period (305 days) of a cow will be 7625 litres, while feed costs will amount to 6424 GEL. The net yearly profit of a farm keeping 10 heads of milking cows will be 27,585 GEL.

Table 12. *Economic analysis of extensive milk production method (for the farm with 10 milking cows)*

Income	Unit	Quantity	Unit cost (GEL)	Total (GEL)
Sales of milk	Litre	15,250	0.80	12,200
Sales of cattle	Cow	8	250	2,000
Total income				14,200
Variable costs				
Grazing	Ton	83.85	-	-
Grass hay or straw	Ton	15.10	150	2,265
Own concentrate	Ton	-	300	-
Concentrate	Ton	4.53	1,100	4,983
Sunflower cake	Ton	-	700	-
Barley	Ton	-	650	-
Silage	Ton	-	600	-
Total feed costs				7,248
Veterinary treatment costs	Cow	10	30	300
Artificial insemination	Cow	10	-	-
Energy costs	Cow	10	20	200
Contingencies	Cow	10	30	300
Total other costs				800
Total variable costs				8,048
Gross Margin				6,152
Fixed costs				
Labour costs	Person	-	3,000	-
Costs of milk cooling			50	500
Costs of the automated milking system			90	900
Building maintenance costs			100	100
Total fixed costs				1,500
Net profit				4,652

Table 12 shows that, in case of application of the extensive method of milk production, the lactation yield of a cow will be 1525 litres, while feed costs will amount to 725 GEL. The net yearly profit of a farm keeping 10 heads of milking cows will be 4652 GEL.

Table 13. *Economic analysis of intensive meat production method (for the farm with 20 beef cattle)*

Income	Unit	Quantity	Unit cost (GEL)	Total (GEL)
Sales of cows	Head	20	5,000	100,000
Sales of milk	Litre	-	1.3	-
Total income				100,000
Variable costs				
Grazing	Ton	70.69	-	-
Alfalfa hay	Ton	28.99	280	8,118
Concentrate	Ton	-	1,100	-
Own concentrate	Ton	44.70	700	31,293
Sunflower cake	Ton	-	1,200	-
Barley	Ton	-	800	-
Silage	Ton	67.10	300	20,131
Total feed costs				59,542
Veterinary treatment costs	Cow	20	100	2,000
Artificial insemination	Cow	20	50	1,000
Energy costs	Cow	20	20	400
Contingencies	Cow	20	80	1,600
Total other costs				5,000
Total variable costs				64,542
Gross Margin				35,458
Fixed costs				
Labour costs	Person	1	4,800	4,800
Building maintenance costs			120	2,400
Total fixed costs				7,200
Net profit				28,258

As the meat productivity of cattle is determined by the average daily weight gain, in case of application of the intensive method of meat production during the calf rearing process involving the improvement of feeding and caring practices, the average daily weight gain will be 1300 grams. Table 13 shows that the yearly profit of a farm rearing 20 heads of beef cattle will be 28,258 GEL.

Table 14. *Economic analysis of extensive meat production method (for the farm with 20 beef cattle)*

Income	Unit	Quantity	Unit cost (GEL)	Total (GEL)
Sales of cows	Head	20	2,000	40,000
Sales of milk	Litre	-	0.80	-
Total income				40,000
Variable costs				
Grazing	Ton	115.87	-	-
Alfalfa hay	Ton	24.16	280	6,765
Concentrate	Ton	-	1,100	-
Own concentrate	Ton	14.50	700	10,147
Sunflower cake	Ton	-	1,200	-
Barley	Ton	-	800	-
Silage	Ton	-	300	-
Total feed costs				16,912
Veterinary treatment costs	Cow	20	30	600
Artificial insemination	Cow	20	-	-
Energy costs	Cow	20	20	400
Contingencies	Cow	20	50	1,000
Total other costs				2,000
Total variable costs				18,912
Gross Margin				21,088
Fixed costs				
Labour costs	Person	1	3,000	3,000
Building maintenance costs			120	2,400
Total fixed costs				5,400
Net profit				15,688

Table 14 shows that imbalanced nutrition and a deficient diet affect the daily weight gain of cattle, which is 550 grams on average, while under an intensive method of meat production, this index reaches 1300 grams. This is reflected in the income of the farms. In the case of using the extensive method of meat cattle fattening, the net profit of a farm keeping 20 heads of beef cattle will be 15,688 GEL instead of 28,258 GEL, which can be expected if an intensive method of beef cattle rearing and caring is applied.

Proud to be diverse