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Market Study on Livestock Fodder Production and Demand in Mongolia

German – Mongolian Cooperation Project Sustainable Agriculture

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Executive Summary

The current fodder market

Mongolia's fodder market (as of 2016) is MNT 321 billion, with domestic production accounting for 97 percent. Fodder supply totalled 1.4 million tons in 2016, including 1.2 million tons of roughages worth MNT 239 billion and 102 thousand tons of concentrates worth MNT 66 billion, in addition to 144 thousand tons of hand-made fodder and natural salt and saline prepared by herders.

Fodder buyers include herders, state and local governments and intensified and semi-intensified livestock farms, which mainly consist of dairy, beef, pig and poultry farms. As the fodder reserves of the local governments are supplied to herders the fodder consumers are herders on one hand, and intensified livestock farms on the other. Herders use fodder, on a seasonal and non-regular basis, as a supplement to grazing. Feedstuffs used by herders include hay, green fodder and bran. Intensified livestock farms use hay, straw, green fodder, silage and waste potato and vegetables as roughages and waste grain, bran and industrially manufactured compound feeds as concentrates.

Herders account for 85.5% of total roughage consumption and 21.1% of total concentrate consumption. The roughage consumption consists of 1 million tons of hay and 5.7 thousand tons of green fodder with a combined worth of MNT 205 billion. The concentrate consumption is MNT 14 billion, and consists of 25 thousand tons of bran.

Intensified livestock farms account for 14.5% of total roughage consumption and 78.9% of total concentrate consumption. The roughage consumption is MNT 34.6 billion, and consists of 84 thousand tons of hay, 35.7 thousand tons of straw, 39.6 thousand tons of green fodder 7.9 thousand tons of silage and approx. 3 thousand tons of waste potato and vegetables. The concentrate consumption is MNT 52 billion, and consists of 13 thousand tons of waste grain, 34.7 thousand tons of bran and 28.9 thousand tons of compound feeds.

Key findings of the market analysis are summarized below.

Fodder supply in 2016	
Types of fodder supplied	Forages: Hay, straw, green fodder (oat, barley, rye, Sudan grass, mixtures), Succulent fodder: Silage, waste potato and vegetables Hand-made fodder: Mixtures of pasture plants, partly enriched with minerals and concentrates Mineral fodder: Natural salt and saline Concentrates: Waste grain, bran, compound feed (mixed concentrates)
Total amounts of fodder supplied	Roughages (forages + succulent fodder): 1.19 million tons Hand-made fodder: 38.1 thousand tons Mineral fodder: 105.6 thousand tons Concentrates: 102 thousand tons
Domestic fodder production	Roughages: 1.18 million tons Hand-made fodder: 38.1 thousand tons Mineral fodder: 105.6 thousand tons Concentrates: 94.3 thousand tons, incl. 27.1 thousand tons of compound feed
Fodder Imports	Roughages (forages): 10.9 thousand tons Concentrates: 7.7 thousand tons

	(in addition to 24.3 thousand tons of raw materials for industrial fodder production)
Number of fodder factories	11
Combined annual production capacity of fodder factories	172.4 thousand tons
Total capacity of industrial fodder production (fodder factories + mills)	266 thousand tons
Fodder consumption in 2016	
Fodder consumption of herders	Roughages: 1 million tons Hand-made fodder: 38.1 thousand tons Mineral fodder: 95 thousand tons Concentrates: 25.3 thousand tons
Fodder consumption of intensified and semi-intensified livestock farms	Roughages: 170.2 thousand tons Mineral fodder: 10.6 thousand tons Concentrates: 76.7 thousand tons
Current volume and structure of the fodder market	
Total market volume (monetary value of fodder supply)	MNT 321 billion
Market structure by types of fodder	Roughages 75%, mineral fodder 21%, concentrates 5% (Hand-made fodder is excluded since it has no market value)
Market structure by origin of fodder	Roughages: 98% domestic supply 98%, 2% imports Mineral fodder: 100% domestic supply Concentrates: 92% domestic supply, 8% imports Total: 97% domestic supply, 3% imports
Market structure by share of commercially traded amounts	Roughages: 51% traded, 49% non-traded (self-prepared for own consumption) Mineral fodder: 10% traded, 90% non-traded Concentrates: 99% traded, 1% non-traded Total: 58% traded, 42% non-traded
Market structure by consumers	Roughages: herders 85.5%, livestock farms 14.5% Mineral fodder: herders 90%, livestock farms 10% Concentrates: herders 21.1%, livestock farms 78.9% Roughages + concentrates: herders 71.6%, livestock farms 28.4%
Monetary values of fodder consumption by consumers	Herders: MNT 232.8 billion (incl. MNT 6.6 billion spent on fodder supplied through Local Government Reserves) Livestock farms: MNT 88.1 billion

Estimated market potential for additional domestic supply of fodder

Model calculations were used to establish a metabolizable energy based fodder balance in intensified livestock farming. According to these calculations, current rates of total fodder sufficiency are 71% for dairy and beef farms, 53% for pig farms and 68% for poultry farms. The rates of domestic fodder sufficiency are 70% for dairy and beef farms, 51% for pig farms and 55% for poultry farms. Full fodder sufficiency of intensified livestock farms will require 172 to 186 tons of roughages and 131 to 133.5 tons of concentrates. In relation to domestic fodder supply 2016, the projected additional requirements are

28 and 41 thousand tons of roughages and 64 to 67 thousand tons of concentrates, with a combined worth of MNT 47 billion to MNT 50 billion.

In pastoral livestock production, fodder consumption per animal is unlikely to increase as the number of animals has been continuously increasing at the current level of herders' fodder consumption and the mortality of adult animals has been below 3% since the 2010 dzud. Along with increasing number of animals, however, herders' fodder requirements are expected to increase by 5 to 10 percent per year. Estimated additional requirements of herders are 50 to 100 thousand of hay, 1 to 2.5 thousand tons of bran and 300 to 600 tons of green fodder per year, with a combined worth between MNT 7 billion and MNT 14 billion.

Based on above projections, the total potential capacity of the fodder market at the current numbers of herders, livestock farms and the current number of animals is estimated at MNT 370 billion. Currently, 87% of this capacity is utilized. The currently unutilized market capacity offers a potential turnover of MNT 14.5 to 27 billion for fodder cropping and a market volume of MNT 31 to 46 billion for industrial supply of concentrated fodder.

Market constraints

Major constraints in fodder supply and consumption include:

- Limited capacity of hay production due to overgrazing of pastures;
- Limited capacity of straw supply due to the preferred use of straw in mulching;
- Hesitance of crop farms and most fodder producers to grow fodder crops in general, and crops used in industrial fodder production in particular, due to insecure sales and prices in relation to low yields and high production costs;
- Lack of arable land, equipment and funds for fodder cropping among herders and intensified livestock farms;
- Underconsumption of green fodder, silage and concentrated fodder, which is mainly caused by:
    - Lack of motivation and know-how of herders to use forages other than hay and concentrates other than bran,
    - Lack of know-how and poor management of intensified livestock farms resulting in inadequate fodder rations and overall insufficiency in animal feeding,
    - Low productivity of animals, and
    - Low purchasing power of herders with less than 500 animals and small- to medium-sized livestock farms.
- An additional obstacle identified in industrial fodder production is the relatively high import tax on raw materials.

Policy analysis

Most of challenges listed above are addressed by government policies manifested in the State Policy on Food and Agriculture (SPFA) and the Mongolian Livestock Program (MLP), and accordingly, responded to by the following measures defined in the Government Action Plan (GAP) 2017-2020:

- Establishment of new fodder factories in crop and intensified livestock farming regions;
- Increasing hay and fodder reserves of aimag and soum governments;
- Provision of equipment for haymaking and small-scale fodder production at subsidized prices and/or on credit to herders and farmers;
- Allocation of equipment for small-scale fodder production and crop land to intensified livestock farms;
- Seed multiplication of new fodder crop varieties;
- Provision of pesticides and fertilizers for fodder cropping at subsidized prices;

- Inclusion of fodder crops in wheat rotations; and
- Allocation of soft credits to intensified livestock farms.

The implementation of the SPFA and the MLP through the GAP 2017-2020 during the coming years is expected to result in an overall increase of domestic fodder production as well as improved fodder consumption of herders and intensified livestock farms. However, the following weaknesses in the overall policy framework and planned GAP 2017-2020 measures were identified:

- While overuse of pastures has already become serious threat to the environment and the future of livestock production the government is promoting increased haymaking from pastures;
- Despite the above limitation in hay supply and the need to primarily use straw in mulching rather than in animal feeding the policies do not demonstrate a clear strategy to increase green fodder and silage consumption to repress hay and straw consumption;
- While most of the equipment for small-scale fodder production (crushers, mixers and pelleting machines) that was distributed to herders and livestock farms by the previous governments are not used the current government is planning distribution of more equipment for small-scale fodder production;
- While the existing fodder factories and mills are only utilizing 38% of their combined fodder production capacity the government is planning the establishment of 4 new fodder factories;
- The policies aiming for increased fodder cropping lack a value chain perspective in contrast to the fact that the main concern of crop farms relates to insecure marketing of fodder crops and despite an exemplary value chain model introduced by the fodder producer Mind Tech;
- Given the lack of know-how resulting in poor farm management and inadequate animal feeding among the majority of herders and intensified livestock farms, the effectiveness of soft credits and other instruments of policy support is likely to be limited since these measures are not supplemented by measures facilitating improved access of herders and farmers to information, training, practical demonstrations and advisory services.

Policy implications

Policy implications derived from the constraints and challenges identified are summarized below.

1. Limit the use of hay and straw in animal feeding, and promote production of green fodder and silage:
    - Establish emergency reserves of green fodder at local governments,
    - Establish soum-level green fodder production units as public-private-partnerships (PPPs) between soum governments and herders/farmers;
    - Discontinue distribution of subsidized haymaking equipment to herders and farmers, and distribute seeds of green fodder crops and allocate equipment and crop land for green fodder cropping to soum governments, herder cooperatives, the suggested soum-level PPPs and intensified livestock farms instead;
    - Allocate crop land, seeds and equipment at subsidized prices to intensified livestock farms.
2. Reward fodder cropping by crop farms:
    - Reward crop farms growing fodder crops with a higher subsidization of pesticides and fertilizers;
    - Reward wheat growers growing fodder crops in rotation with higher subsidy on wheat.
3. Establish value chains of fodder crops:

- Provide support e.g. soft credits and tax benefits to food processors utilizing nutritious fodder crops such as rape, soy and white mustard as raw materials and produce wastes that can be used in animal feeding;
- Encourage exports of the nutritious fodder crops specified with the condition that the wastes are imported back to Mongolia for use in animal feeding;
- Specify that a certain share of soft credits provided to intensified livestock farms shall be spent on purchase of fodder crops from domestic crop farms, and facilitate the supply through the Fund for Supporting Crop Production;
- If the suggested soum-level PPPs for green fodder production cannot be established, facilitate supply of green fodder by crop farms to emergency fodder reserves of local governments.

4. Support existing fodder producers before creating additional production capacities
    - Delay the planned establishment of new fodder factories until at least 50% of the existing fodder production capacity is utilized;
    - Discontinue distribution of subsidized equipment for small-scale fodder production;
    - Provide support e.g. soft credits and tax benefits to industrial fodder producers;
    - Reduce import taxes on essential ingredients of industrial fodder production.
5. Establish a functioning extension service structure
    - Train the livestock specialists at soum-level Animal Health and Breeding Units (AHBUs) in providing information and advice on improving animal feeding to herders;
    - Provide the AHBUs with information materials and manuals on fodder preparation and use in pastoral livestock production for use in informing and advising herders;
    - Restore the former Extension Centres at the aimag Departments of Food and Agriculture in crop and intensified livestock farming regions, and demonstrations;
    - Create a position at the MoFALI in charge of agricultural extension services;
    - Facilitate regular training of intensified livestock farmers on fodder production and livestock feeding;
    - Specify that a certain share of soft credits provided to intensified livestock farms shall be spent on advisory services provided by certified farm advisors.
6. Strengthen the overall institutional framework around fodder production
    - Elaborate and implement a subprogram on “Livestock Fodder”;
    - Promote applied research on fodder production and animal feeding;
    - Support herder and farmer cooperatives producing fodder for own consumption or contracting crop farms for growing fodder crops;
    - Collect and publish reliable statistics on fodder production;
    - Discontinue using the Fodder Unit scale, and introduce energy- and protein-based fodder valuation scales at both academic and policy levels instead.

Recommendations to the German-Mongolian cooperation project “Sustainable Agriculture”

- Consult MoFALI on possible contributions of the project to the implementation of the GAP 2017-2020;
- Address selected issues of relevance from this study through follow-up studies, expert consultations and related activities. Suggested issues include technical and economic feasibility of fodder cropping, impact of hay production on overgrazing and the humus balance of pastures, and the lack of a value chain perspective in agricultural policies targeting fodder cropping;

- Based on the findings of this study, facilitate a multi-stakeholder dialogue to discuss challenges faced by the stakeholders and identify options for collaboration and collective actions;
- Facilitate knowledge transfer through activities such as publishing of a reference book on fodder cropping and animal feeding (in printed and electronic versions), farmer training, training of trainers and field demonstrations;
- Conduct pilots to demonstrate practical approaches for improving domestic fodder production and animal feeding, such as extension services for intensified livestock farming, soum-level production of green fodder through collaboration between the local government and herders/farmers, and collaboration with the Institute for Plant and Agricultural Sciences in acclimatization of fodder crop varieties and seed multiplication.

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Abbreviations

AHBU	Animal Health and Breeding Unit
EUR	Euro
FM	Fresh Mass
FU	Fodder Unit
GAP	Government Action Plan
GDP	Gross Domestic Product
IPAS	Institute of Plant and Agricultural Sciences
LLC	Limited Liability Company
ME	Metabolizable Energy
MJ	Megajoule
MLP	Mongolian Livestock Program
MNT	Mongolian Tugrik
MoFALI	Ministry of Food, Agriculture and Light Industry
MULS	Mongolian University of Life Sciences
NEL	Net Energy for Lactation
NSO	National Statistics Office
RNB	Rumen Nitrogen Balance
SHU	Sheep Head Unit
SPFA	State Policy of Food and Agriculture
UB	Ulaanbaatar
USD	United States Dollar

1. Introduction

1.1 Background

Mongolia's economy is based on mining and agriculture. The mining boom in the early 2010s was expected to result in a rapid economic development. However, after the massive price fall of minerals during the recent years the country has now acknowledged that an economic miracle from mining alone is unlikely to happen. Increased and export-oriented agricultural production is seen as an essential pillar of the economic development, and improved productivity and competitiveness of the crop and livestock sectors are recognized as the key to establish Mongolia as a major supplier of agricultural products.

A major obstacle in increasing the productivity of livestock production is insufficient production and consumption of livestock fodder. Increased domestic fodder production is also required to balance the current overuse of pastures. The need for increasing domestic production and consumption of livestock fodder is recognized and addressed in major policy documents that set the priorities in the agricultural sector such as the State Policy on Food and Agriculture (2015 to 2025) and the Mongolian Livestock Program (2010 to 2021). The policy goals defined in the SPFA and MLP are addressed by the current government through a comprehensive set of measures defined in the Government Action Plan for the period 2017 to 2020.

This study is a contribution of the German-Mongolian cooperation project "Sustainable Agriculture" to the current political dialogue on improving domestic fodder production and livestock feeding. It was commissioned by the project within its mandate to support sustainable agriculture in Mongolia through professional dialogue and delivery of professional advice for adaptation of the legal and institutional frameworks in the agricultural sector to the sustainability needs.

1.2 Concept and limitations of the study

This study aims to inform stakeholders of Mongolia's market for livestock fodder about the current trends in the market as well as potentials, opportunities and constraints for future development of domestic fodder production and fodder consumption in the livestock sector. While the study concludes with implications for agricultural policies and the German-Mongolian cooperation project "Sustainable Agriculture" itself the largely quantitative market analysis is also intended to provide private sector stakeholders such as industrial fodder producers with an analytic overview of the capacity and constraints of the fodder market as to assist them in making informed decisions and improving their commercial performance. Main objectives of the study are:

- To quantify and characterize the current market of livestock fodder and its segments;
- To estimate market potentials and for increased domestic supply of fodder (roughages and concentrates);
- To identify and analyse major opportunities and constraints for increasing domestic supply of fodder and fodder consumption in livestock production; and
- To review the current policy framework in relation to the opportunities and constraints identified; and
- To formulate policy implications and recommendations to the German-Mongolian cooperation project "Sustainable Agriculture".

Given its purpose to analyse the fodder market in the wider context of the dynamics in the livestock sector as well as the current policy frameworks this study is a market system study rather than a market study intended to inform the development of marketing strategies for certain products. A major limitation of this study is that it does not analyse consumer behaviour and pricing of feedstuffs. Further, the study concludes with implications for policies rather than for marketing of certain products.

1.3 Material and Methods

This study was commissioned in May 2017 and conducted in the period June to October 2017. The study used a combination of quantitative and qualitative research methods. The basic quantitative methods applied were descriptive analysis of statistics and other numerical data, and model calculations. Model calculations were conducted to:

- Simulate population dynamics of dairy and beef cattle, pigs and poultry in order to determine approximate numbers of animals differentiated by sex and age within each population (Appendix 9.2); and
- Assess the fodder utilization of intensified livestock farms in relation to their total fodder requirements through energy-based fodder balancing in order to estimate the potential for increased fodder consumption in intensified livestock farming.

The qualitative method used for data collection was semi-structured interview, using guiding questions provided in Appendix 9.4 in a non-fixed order. Interviews were conducted with 88 persons from Ulaanbaatar and 6 aimags in the period July to September 2017. Respondents in Ulaanbaatar and Tuv, Selenge, Khentii and Dornod aimags were interviewed in person, and respondents in Uvurkhangai and Uws by phone. Each interview continued for 10 to 15 minutes. The respondents consisted of specialists, fodder producers, fodder trader, crop farmers, livestock farmers and herders. The respondents are structured below.

- Experts (17 persons): consisting of crop, livestock and fodder specialists of MoFALI, fodder and animal nutrition specialists of MULS, and crop specialists of aimag governments in 3 aimags (Selenge, Khentii, Dornod) and livestock specialists of aimag governments in 6 aimags (Tuv, Selenge, Khentii, Dornod, Uvurkhangai and Uws);
- Large-scale industrial fodder producers (8 persons): Altan taria, Nuudel tejeel, Orgio, Bayalag emeelt, Mind tech, Khishigten Nuudelchin, Altai group, Tumen shuvuut;
- Mills and small-scale fodder producers (13 persons): 2 producers in Tuv aimag, 1 in Selenge, 3 in Khentii, 1 in Dornod, 3 in Uvurkhangai and 3 in Uws;
- Fodder traders – private persons and cooperatives (7 persons): 2 in Ulaanbaatar, 1 in Tuv aimag, 1 in Selenge, 2 in Khentii, 1 in Dornod;
- Crop farms growing fodder crops (5 persons): 2 in Selenge, 2 in Khentii, 1 in Dornod;
- Crop farms without fodder cropping (5 persons): 2 in Selenge, 1 in Khentii, 2 in Dornod;
- Dairy and beef farms with fodder cropping (8 persons): 2 in Ulaanbaatar, 2 in Tuv aimag, 2 in Khentii and 2 in Dornod;
- Dairy and beef farms without fodder cropping (6 persons): 2 in Ulaanbaatar, 1 in Tuv aimag, 1 in Khentii and 2 in Dornod;
- Pig farms with fodder production (2 persons): 1 in Ulaanbaatar, 1 in Tuv aimag;
- Pig farms without fodder production (2 persons): 1 in Ulaanbaatar, 1 in Tuv aimag;
- Poultry farms with fodder production (2 persons): 2 in Ulaanbaatar;
- Poultry farms without fodder production (3 persons): 2 in Ulaanbaatar, 1 in Dornod;
- Herders, without fodder production (10 persons): 2 in Tuv aimag, 2 in Selenge, 3 in Khentii, 3 in Dornod.

Sources of secondary data used in this study included agricultural and customs statistics, study reports, annual reports and presentations of MoFALI, scientific papers and presentations, laws, government resolutions and policy documents, and websites of fodder producers in addition to technical and reference books from Mongolia, Russia and Germany.

The study was conducted from neutral perspective. Nevertheless, a certain level of subjectivity cannot be excluded since the author himself has engaged as an advisor for intensified livestock farms since 2007.

2. Overall context of the fodder market

2.1 Overview of the livestock sector

The livestock sector in Mongolia contributes 84% of the gross agricultural output, 10% of the GDP and 6.6% of export revenues as of 2016. The sector not only provides food, fodder and fibre but also employment and income to 56% of rural households. Total output of the livestock sector in 2016 was approx. MNT 3.5 trillion (EUR 1.3 billion). Major outputs included 400 thousand tons of meat, 891.5 million litres of milk, 27.4 thousand tons of sheep wool, 9.4 thousand tons of cashmere, 1.7 thousand tons of camel wool and 14 million pieces of hide and skin (NSO, 2017).

Due to low soil fertility and low precipitation livestock production is dominated by pastoral livestock herding in its traditional form, which is also known as nomadic livestock production (Figure 2.1). In this subsistence-oriented extensive farming system the pasture presents the main source of forages for the animals. Seventy-one percent of Mongolia's territory is used by herders for grazing animals free of charge. Herders migrate up to 15 times a year in order to provide their animals with fresh pastures[1]. Due to low productivity of animals utilization of production inputs is kept at a minimum and the main function of supplementary feeding, which is seasonal and non-regular, is to prevent animal losses in winter and spring (cf. section 5.2).

Figure 2.1: Typical spring camp of a herder (his mobile home *ger* shown in the background)

The privatization of livestock during the country's transition from a centrally planned to a market economy in the 1990s resulted in a massive expansion of the livestock sector: the number of animals grew from 24.7 million in 1989 to 44 million in 2009, and reached a historical peak at 61.5 million in 2016. Except the *dzud*[2] years between 2000, 2001, 2002 and 2010, the rate of annual growth has been between 2 and 16 percent during the last 27 years. The rationale of herders has been to keep as many animals as possible in order to balance possible or actual animal losses and keep up with increasing consumption expenses. As cashmere has been established as a major cash commodity due to increased domestic and Chinese demand the number of goats increased at 399% (Figure 2.2).

[1] Whereas, in many areas seasonal migrations have been meanwhile reduced as a result of overgrazing. In some peri-urban areas herders only move twice a year.

[2] Extremely harsh weather conditions causing mass losses of animals in winter and spring.

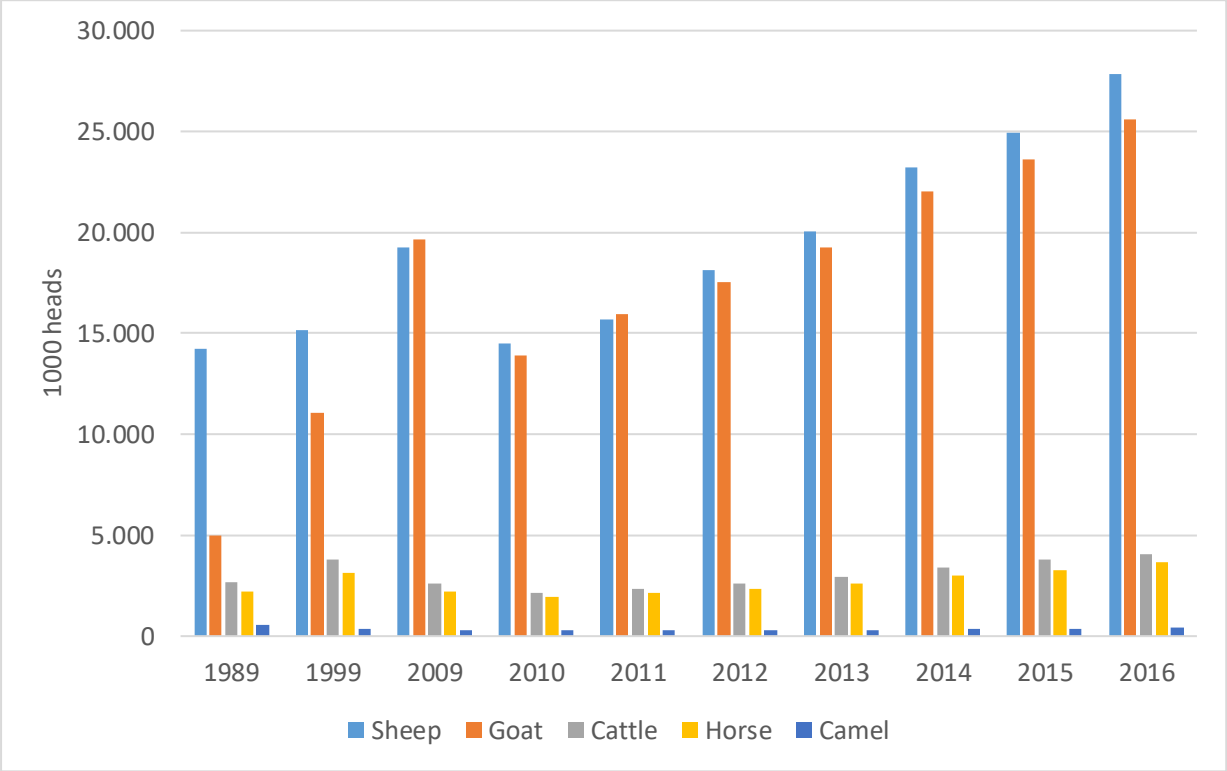

Figure 2.2: Number of animals between 1989 and 2016

Sources: NSO 2000, 2001, 2011 und 2017.

The current livestock population consists of 87% sheep and goats and 13% cattle, horses and camels (Table 2.1).

Table 2.1: Total number of animals, 1000 heads

Species	2012	2013	2014	2015	2016
Sheep	18,141	20,066	23,215	24,943	27,857
Goat	17,559	19,228	22,009	23,593	25,575
Cattle	2,585	2,910	3,414	3,780	4,081
Horse	2,330	2,619	2,996	3,295	3,636
Camel (Bactrian)	306	322	349	368	401
Total	**40,921**	**45,144**	**51,983**	**55,980**	**61,549**

Quelle: NSO 2016

Pastoral livestock herding is a family business. Even though there are approx. 1200 herder cooperatives registered the members of these cooperatives individually run their livestock herding businesses. There are 160,650 herder households as of December 2016[3]. At the total number of 61.5 million animals, a statistically average herder household possesses 383 animals, consisting of 173 sheep, 159 goats, 25 cattle, 23 horses and 2 camels. In fact, herder households with 201 to 500 animals are widely considered as the "average herder households". In 2016, this group accounted for 35% of all herder households, compared to herder households with less than 200 animals accounting for 43% and those with more than 500 animals accounting for 22%, respectively (Table 5.2).

[3] Agricultural statistics differentiate between households with livestock and herder households. Households with livestock are those that own livestock but only engage in livestock herding as a supplementary occupation or do not engage at all. Herder households, on the other hand, are households for which livestock herding is both the primary occupation and the primary source of income.

Table 2.2: Number of herder households, grouped by number of animals, in the period 2012 to 2016

Herder households	2012	2013	2014	2015	2016
Total number	146,081	145,311	149,735	153,085	160,650
Number of herder households with					
up to 100 animals	44953	40976	36393	35246	36336
101 to 200 animals	38262	35705	34906	34315	33519
201 to 500 animals	45682	47467	51580	53218	55575
501 to 999 animals	13669	16372	20190	22034	25459
1000 to 1499 animals	2950	3983	5505	6827	7989
1500 to 2000 animals	370	555	802	970	1177
2001 or more animals	195	253	359	475	595

Sources: NSO 2017.

The quantitative increase in the livestock herd since 1990 has not been accompanied by improvements of livestock productivity. Withdrawal of public investments in breeding and veterinary services along with the breakdown of former state-supported collective farming in *kolkhozes* and *negdels* led to deterioration of livestock breeds and increased the frequency of animal disease outbreaks. An average native Mongolian cow has a body weight of approx. 250 kg and lactation yield of approx. 500 litres, compared to 450 kg body weight and approx. 2500 litres of lactation yield of a crossbreed dairy cow (NSO, 2011).

The 238% increase in the number of animals since 1990 has been enabled by free-of-charge use of pastures, but it has caused overgrazing to become a serious threat to the future of pastoral livestock production. Estimations of the share of overgrazed areas in total pasture areas range from 65 to 95 percent (Tserendash, 2000; MSRM, 2010; SDC, 2015; Nyambat & Gerelkhuu, 2017). It is clear to both herders and decision makers that the limited carrying capacity of pastures contrasts with the continuous increase in the number of animals, which, in view of increasing consumption expenses and rural-urban disparity in living standards, arises from necessity rather than ambition of herders. The need for replacing the quantity-oriented paradigm with a quality-oriented one e.g. through improving animal genetics and encouraging semi-stationary livestock production in addition to enforcing controlled use of pastures is well recognized at the policy level. Yet, no significant interventions have been made so far. An attempt of the government to charge animal tax from herders as an indirect fee for pasture use in 2015 ended up as a matter to be settled by local governments, and eventually failed.

A sub-sector within the livestock sector that is relatively capital-intensive and less vulnerable to climate risks is intensified livestock farming (incl. semi-intensified dairy and beef farming). This farming system is characterized by three main traits: keeping of pure- or crossbred animals, specialization of production and permanent or seasonal keeping of animals in barns. The data published by NSO and MoFALI on the numbers of intensified livestock farms and farm animals in 2017 differ. According to MoFALI (2017), which we believe to be a more reliable source, there are 4053 dairy, beef, milk goat, pig and poultry (chicken) farms with 993 thousand animals. The number of animals per farm ranges from 18 pigs for a family farm to 21,025 chickens for a poultry farm enterprise (Table 2.3).

Neither MoFALI nor NSO has published data on the geographic distribution of the farms in 2016 or 2017. Latest available data were published by NSO in 2016 and refer to 2015. Based on these data, the main locations of intensified livestock farms include capital city Ulaanbaatar and peri-urban areas surrounding Ulaanbaatar and aimag centres. Besides Tuv and Selenge aimags, which are the nearest aimags from Ulaanbaatar and well connected to both car and rail roads, Khentii, Bulgan and Uvurkhangai were among the aimags with highest numbers of intensified livestock farms as of 2015 (Table 2.4).

Table 2.3: Number of intensified livestock farms and farm animals as of 2017

Livestock farms	Number of farms	Number of animals	Ø number of animals per farm
Dairy farms	1,472	60,998	41
Beef farms	175	14,974	86
Milk goat farms	47	1,219	26
Pig farms (enterprises)	70	17,723	253
Pig farms (family farms)	980	17,981	18
Chicken farms (enterprises)	40	841,005	21,025
Chicken farms (family farms)	1,269	39,109	31

Source: MoFALI, 2017.

Table 2.4: Numbers of intensified livestock farms and farm animals in top five areas with highest number of farm animals in each segment (2015 data)

Aimag	Number of animals	Share in total animals	Number of farms	Share in total farms
Dairy farming				
Ulaanbaatar	19,262	28.1%	225	15.6%
Tuv	15,557	22.7%	260	18.1%
Khentii	8,403	12.3%	15	1.0%
Selenge	5,190	7.6%	102	7.1%
Uvurkhangai	3,666	5.4%	271	18.8%
Beef farming				
Selenge	6,730	32.3%	10	4.0%
Ulaanbaatar	5,608	26.9%	97	39.1%
Sukhbaatar	1,782	8.5%	4	1.6%
Tuv	1,160	5.6%	20	8.1%
Orkhon	1,011	4.8%	13	5.2%
Pigs				
Ulaanbaatar	17,000	56.8%	9	2.7%
Tuv	4,900	16.4%	28	8.5%
Selenge	1,169	3.9%	14	4.2%
Khentii	880	2.9%	2	0.6%
Bulgan	760	2.5%	11	3.3%
Poultry (chicken) farming				
Ulaanbaatar	380,700	50.0%	5	2.0%
Tuv	311,000	40.8%	9	3.7%
Selenge	19,020	2.5%	7	2.9%
Khentii	16,110	2.1%	2	0.8%
Bulgan	8,309	1.1%	19	7.8%

Source: NSO, 2016.

Dairy farming as a private business emerged in Mongolia after the privatization of formerly state-owned dairy farms between 1992 and 1996. Until the late 2000s, it was only a family business, with the largest farm having 140 cows. Since 2009, however, larger farms have been established by milk processors and investors from non-food sectors, e.g. the 300-cow farm of Monfresh LLC in Khentii aimag, the 600-cow farm of MAX group and the 300-cow farm of Nuudelchin group. The large farms have introduced new cattle breeds such as Montbeliarde or German Black-and-White, and new technologies such as freestall barns. Most farms with more than 100 cows have integrated fodder cropping as well (Figure 2.2).

Figure 2.3: Fodder cropping equipment of Nuudelchin farm

Yet, dairy farming is still dominated by family farms. According to model calculations in Appendix 9.2, dairy farms have approx. 30 thousand cows in total, and approx. 80% of these cows (incl. 10% of approx. 7500 purebred cows) are in the possession of family farms with usually less than 50 cows. The average herd size of family farms is 15 to 20 cows. Most family farms are non-mechanized, and lack land and equipment for fodder cropping. Prevalent breeds of crossbred cattle among dairy farms are Alatau (a Kyrgyz crossbreed of Brown Swiss) and Black-and-White of Russian and German origin (Figure 2.3). Average milk yields of pure- and crossbred cows are estimated at 18 and 8 litres per day (MoFALI, 2017).

Figure 2.4: Alatau cows of a 20-cow dairy farm

Beef farms are less intensified than dairy farms as beef cattle are usually kept on open rangelands for most of a year, and in primitive barns or shelters during the winter. It is actually difficult to define a beef farm since many beef cattle operations, listed as “farms” in statistics are merely the owners of the cattle while the cattle are actually kept by local herders. What distinguishes beef farming from pastoral livestock production is that the cattle are pure- or, mostly, crossbreeds, and fed on a regular basis and with higher rations in addition to grazing. Most prevalent beef cattle breeds are Kazakh White Head and Selenge, both crossbreeds of Hereford and introduced in Mongolia in the 1970s and 1980s. Since 2000, Angus and Limousine breeds, and lately, Simmental and Montbeliarde cattle have been increasingly raised at beef farms. The common practice in beef farming is, however, to buy breeding bulls e.g. Angus or Simmental bulls, and crossbreed them with Mongolian cattle since raising an exclusively purebred herd would be too expensive. Hence, purebreds at beef farms are breeding cattle while the cattle fattened are crossbreeds. Furthermore, about a half of the beef farms are merely feedlots i.e. they do not have breeding cattle altogether, but buy young bulls and heifers for fattening from herders and other dairy or beef farms. The largest beef farm in Mongolia is owned by Gatsuurt LLC in Selenge aimag. The farm has a mixed pure- and crossbred herd of an estimated 3000 Angus and Limousine cattle.

Fodder cropping by beef farms is, except for a few large farms, uncommon. The slaughter age for cattle is between 18 and 30 months, depending on cattle breed and feeding intensity. Carcass weight ranges between 150 and 230 kg for crossbreeds, and from 200 to 350 kg for purebreds.

Pig and poultry farming are urban agricultural businesses with high capital intensity. Whereas, there are also family-owned small pig and poultry farms which are less intensive and not mechanized compared to large mechanized farms. Broadly, non-mechanized family farms have less than 200 pigs or 1000 hens. Poultry and pig farms produced approx. 120 million eggs, 1440 tons of chicken (meat) and approx. 3000 tons of pork in 2016 (MoFALI, 2017). Fodder cropping and even production of compound feed is practiced by some large pig and poultry farms. Examples are the 3000-pig farm Zurgaan Khoshuu LLC and the poultry farm Tumen Shuvuut with 80 thousand hens that produce mixed compound for own consumption (Figure 2.5).

Figure 2.5: Mixed compound manufactured by Zurgaan Khoshuu pig farm in Tuv aimag

2.2 Overview of feedstuffs and fodder suppliers

Fodder production in Mongolia can be broadly categorized in Fodder preparation from natural resources, Fodder cropping and Industrial fodder production. An overview of feedstuffs produced in each category and producers/suppliers is provided in the following subsections.

2.2.1 Fodder preparation from natural resources

This category includes haymaking and preparation of hand-made fodder and natural salt and saline.

Hay is made of pasture grass. Certain pasture areas are reserved for haymaking by local governments in each soum, and protected from grazing in summer. Local herders are allowed to possess or use haymaking areas. Persons and entities other than local herders are charged certain fees. The amount of fee depends whether the haymaker has ownership rights over the haymaking area or not. Since local governments are usually hesitant in allocating ownership of haymaking areas, except to local herders, haymaking by persons and entities from outside the local herder community is usually based on a one-time land use contract, for which a fee between MNT 5000 and MNT 10,000 per ha is charged.

Hay yields greatly vary in different geographic regions of Mongolia. Highest yields of 0.8 to 1.2 tons FM per ha are attained in steppe and forest-steppe regions while in high mountain and semi-desert regions the yield is approx. 0.5 to 0.8 tons FM per ha but can be lower. Hay yields are also influenced by weather conditions each year.

It is generally recommended that haymaking should start as early as around the end July in order to ensure high quality of hay. In Northern provinces with relative high pasture and hay yields haymaking by local herders already begins in early August, sufficient rainfall before August provided. But in most areas haymaking does not begin until the end of August or even mid-September due to low yields in August and/or delayed preparations e.g. repairs of equipment, logistics etc. An estimated 80 to 90% of the total amount of hay supplied annually is made between the end of August and the end of September.

The quality of hay mostly depends on region and timing of haymaking. Energy contents per kg FM hay in steppe and forest-steppe regions[4], measured in metabolizable energy (ME) for ruminants, range between 5 and 7 MJ ME.

The total amount of hay production has stabilized around 1 to 1.2 million tons during the last years. The 2016 supply was 1.1 million tons (according to MoFALI, 2017). Approximately a half of this amount is prepared by herders and farmers and another half is prepared by commercial haymakers (mostly crop farmers) and sold on the commercial market. Hay is mostly baled in square bales, which are supposed to weigh 25 kg per each, but usually do not exceed 20 kg (Figure 2.6).

The price of commercially traded hay starts at MNT 3000 per bale when sold locally, or MNT 4000 to 5000 when transport costs are added. The price rises to around MNT 5000 to 6000 in November-December, and reaches MNT 7000 to 8000 in spring, but occasionally goes up to MNT 10 thousand or beyond, depending on the wintering situation.

Besides hay, feedstuffs prepared from natural resources include the so-called hand-made fodder and natural saline. Hand-made fodder is basically dried mixtures of especially nutritive pasture plants such as *Allium* species, often enriched with minerals such as salt or ashes, and occasionally also with concentrates such as bran and locally available waste grain. It is only prepared by herders for their own use, and not traded commercially. Natural salt and saline as a supplementary mineral fodder are also prepared by herders for their own use, but a small amount (approx. 10%) is commercially traded. The amounts of hand-made fodder and salt & saline prepared in 2016 were 38.1 and 105.6 thousand tons, respectively (MoFALI, 2017).

[4] Steppe and forest-steppe regions are specifically referred to because most intensified livestock farms are located in those regions.

Figure 2.6: Hay trade among herders in Khovd aimag, Buyant soum

2.2.2 Fodder cropping

The position of fodder cropping in the crop sector is quite insignificant as it only accounts for 6% of total sown areas and 7% of the total yield as of 2016 (Figures 2.7 and 2.8). This relationship emerges from the dominance of wheat cropping, which results from the comparative advantage of wheat cropping caused by the government subsidy on wheat. Wheat is subsidized by the government in order to maintain self-sufficiency in flour and keep it affordable because flour is widely consumed in Mongolia, thus declared a strategic product.

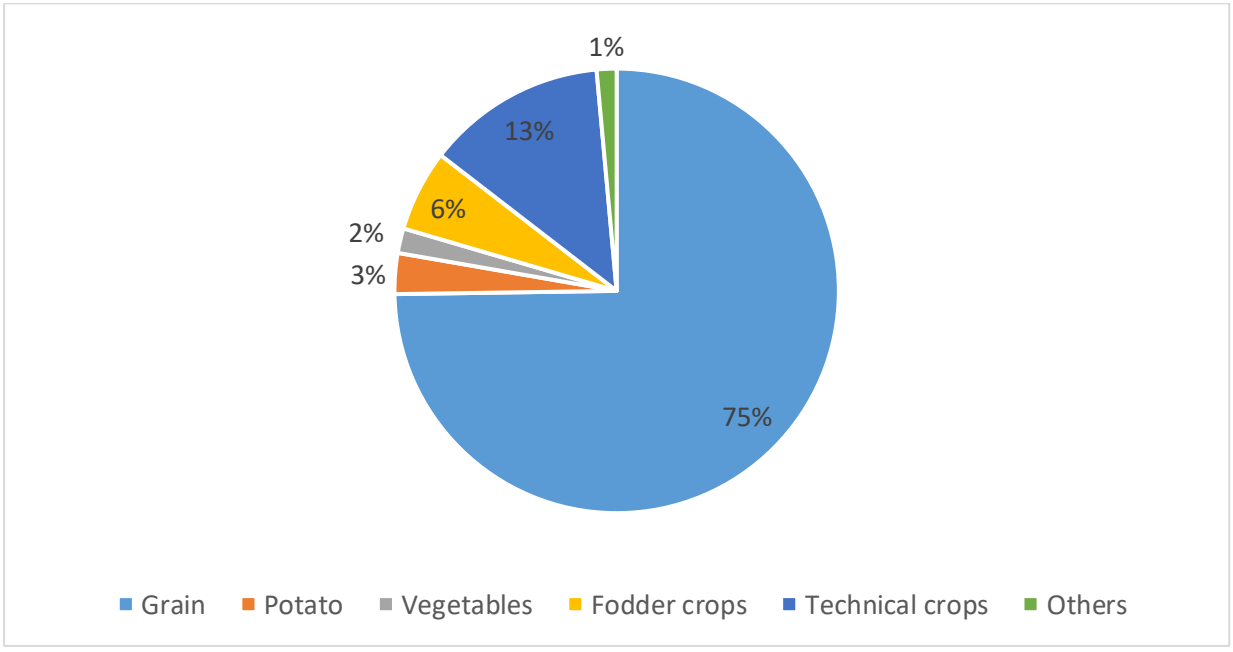

Figure 2.7: Structure of crop production by sown area in 2016

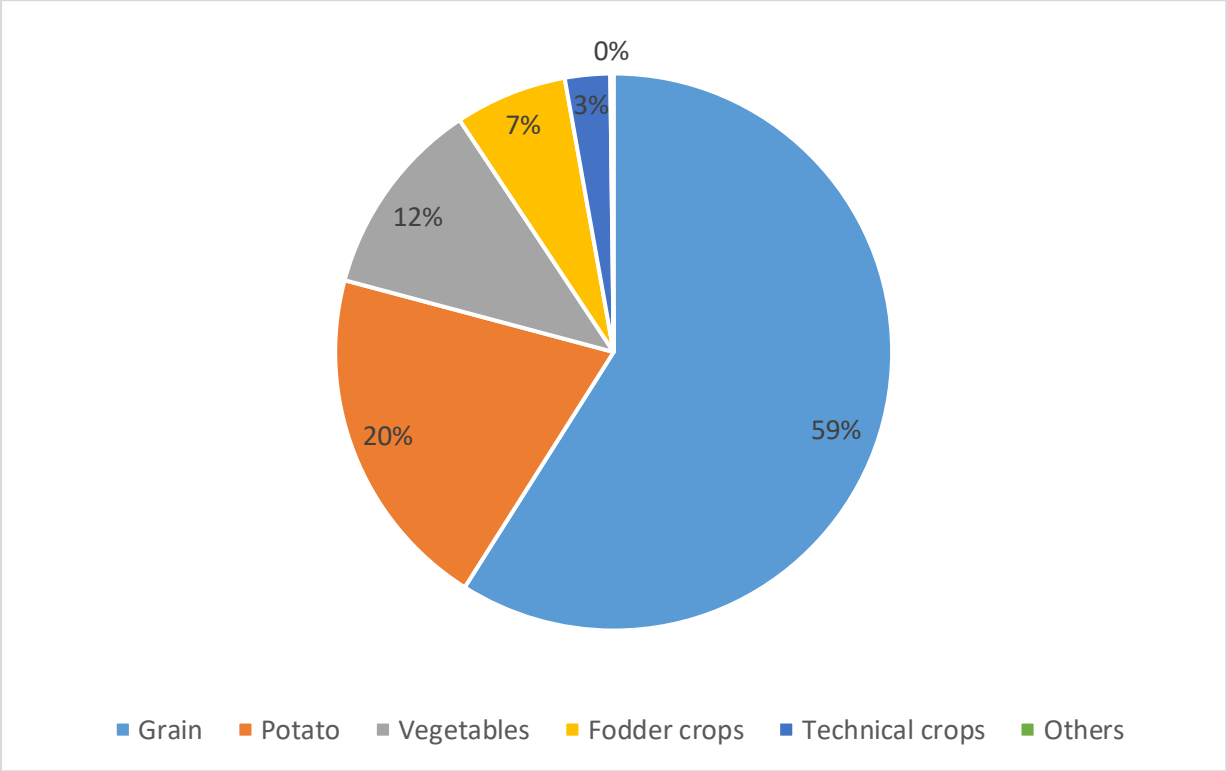

Figure 2.8: Structure of crop production by total yield in 2016

Nevertheless, fodder cropping increased by 117% during the last 5 years and reached nearly 30 thousand hectares in 2016. The total yield of fodder crops was 53.4 thousand tons (Table 2.5).

Table 2.5: Overview of fodder cropping in the period 2012 to 2016

Fodder crops	2012	2013	2014	2015	2016
Sown area, ha					
Annual green fodder crops	9,424	10,500	9,023	11,244	19,311
Perennial crops	2,860	2,364	3,789	4,377	3,986
Silage crops	1,196	1,348	2,965	4,648	256
Other crops	303	144	1,200	3,572	6,341
Total area	**13,784**	**14,390**	**16,976**	**23,841**	**29,893**
Fodder yield, tons					
Annual green fodder crops	30,077	29,697	24,547	38,468	34,393
Perennial crops	9,964	8,038	7,963	8,850	11,263
Silage crops	6,178	3,879	9,236	1,344	2,222
Other crops	0.5	1,024	2,533	519	5,546
Total area	**46,219**	**42,638**	**44,278**	**49,181**	**53,424**

Sources: NSO 2017.

Fodder crops were grown in all 21 aimags and in Ulaanbaatar, on areas ranging between 7 and 7452 hectares per aimag. Aimags with more than 1000 hectares of sown areas of fodder crops in 2016 include Dornod (7452 ha), Tuv (5626 ha), Selenge (5458 ha), Sukhbaatar (2020 ha), Uws (1980) and Arkhangai (1442 ha). The composition of these aimags indicates a more or less equally distributed production of fodder crops in Western, Easters and Central regions of Mongolia (Figure 5.3).

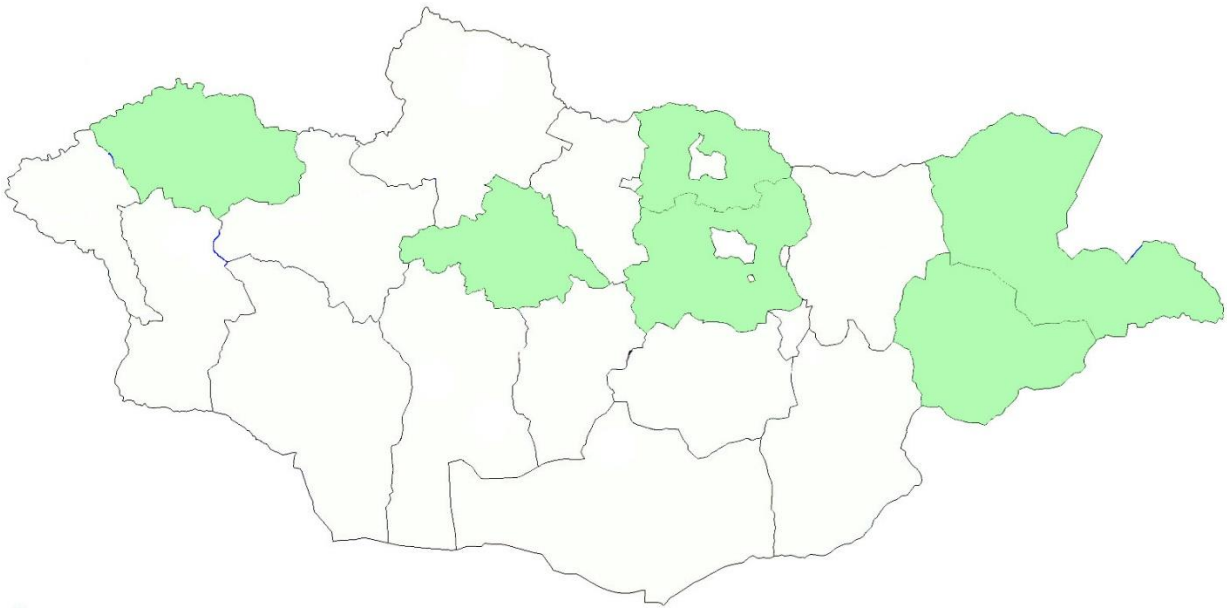

Figure 2.9: Aimags with more than 1000 hectares of sown areas of fodder crops in 2016

The crops within the broad categories used in statistics, as shown in Table 2.5, include (exact proportions of each crop within the categories are unknown):

- Green fodder: Mostly oat, but also barley, rye, Sudan grass and mixtures of these crops;
- Perennial crops: Mostly alfalfa, but also brome grass and clover;
- Silage crops: Maize and sunflower;
- Other crops: Pea, soy, rape and white mustard.

Green fodder crops were grown in all aimags except Darkhan-Uul and in Ulaanbaatar in 2016. The sown areas ranged from 4 hectares in Dornogobi to 5533 hectares in Selenge. Perennial crops (grasses) were grown in 14 aimags on areas between 0.1 (Dornogobi) and 1671 hectares (Uws). Silage crops were grown 8 aimags on areas from 0.3 to 214 hectares. Other fodder crops were grown 7 aimags and in Ulaanbaatar on areas between 2 and 4320 hectares.

Fodder cropping in most aimags consists of oat and alfalfa cropping, supplemented with small plots of barley, rye, maize, brome and Sudan grass. Largest varieties of fodder crops are grown in Selenge aimag, which is one of the main cropping areas, Tuv aimag and Ulaanbaatar. These three areas not only account for approx. 50% of green fodder production and over 90% of silage crops, but also the only areas where unconventional fodder crops such as pea, soy, sunflower and white mustard are grown (MoFALI, 2017). This is clearly related to the relatively high concentration of intensified livestock farms in these areas (cf. section 2.1.

The figures presented in Table 2.5 should be considered as to provide a broad overview of fodder cropping rather than to inform on exact sown areas of crops in each category. For example, barley is captured as a green fodder crop but it is a common ingredient of mixed silages. The category “other crops” captures rape in some aimags but it is unknown what percentage of rape yields is actually used in animal feeding. Furthermore, statistics on grain cropping include oat cropping as well, and it is unclear what criteria are used to define a certain percentage of oat as grain and the remaining share as green fodder. Adding to this confusion is the fact that a certain percentage of oat is also used in industrial fodder production. Finally, the amount of waste potato and vegetables, which are commonly used in pig feeding, is not included anywhere in agricultural statistics.

The lack of reliability of NSO statistics on fodder cropping having been explained, MoFALI also publishes figures on fodder supply from cropping, and these figures often differ from NSO figures. The MoFALI figures for 2016 included:

- Straw 35.7 thousand tons (in contrast to 9.1 thousand tons according to NSO) and
- Green fodder 22.3 thousand tons (in contrast to 34.4 thousand tons according to NSO).

After cross-checking the different figures provided from different sources with farmers and fodder suppliers we came to the conclusion that the NSO figure on green fodder supply (34.4 thousand tons) is more realistic than the MoFALI figure, given that 1) even though a significant share of oat yields are used in industrial production that amount can be covered by the amount of oat categorized as grain, and 2) oat is grown countrywide, not only by crop farmers but also by livestock farmers and herders so that a large share of oat is used locally as green fodder.

As for straw, the MoFALI figure (35.7 thousand tons) is more realistic in relation to the amount of grain yielded in 2016 (483.5 thousand tons) than the NSO figure. In addition to straw, waste grain i.e. grain that is not purchased by mills or distilleries due to poor quality is used in animal feeding. The amount of waste grain used in animal feeding in 2016 is estimated at 7.2 thousand tons (NSO, 2017). Finally, based on our interviews with pig farmers we estimate the amount of waste potato and vegetables used in pig feeding in 2016 at approx. 3000 tons.

2.2.3 Industrial fodder production

According to MoFALI, there are 116 fodder production facilities in 18 aimags and in Ulaanbaatar, of which 68 are currently in operation, as listed below (MoFALI, 2017):

- Arkhangai: 3 in total, 2 in operation,
- Bayan-Ulgii: 3 in total, none in operation,
- Bulgan: 10 in total, 6 in operation,
- Dornod: 2 in total, 1 in operation,
- Dornogobi: 4 in total, 3 in operation,
- Dundgobi: 2 in total, 1 in operation,
- Gobi-Altai: 1 in total, 1 in operation,
- Khentii: 11 in total, 6 in operation,
- Khovd: 3 in total, 2 in operation,
- Khuvsgul: 10 in total, 9 in operation,
- Orkhon: 8 in total, 7 in operation,
- Selenge: 7 in total, 6 in operation,
- Sukhbaatar: 2 in total, none in operation,
- Tuv: 8 in total, 5 in operation,
- Umnugobi: 3 in total, none in operation,
- Uvurkhangai: 28 in total, 9 in operation,
- Uws: 5 in total, 5 in operation,
- Zavkhan: 1 in total, 1 in operation,
- Ulaanbaatar: 5 in total, 4 in operation.

Most of the fodder production facilities are located in Central Mongolia. Aimags with no fodder production facilities include Bayankhongor, Darkhan-Uul and Gobi-Sumber (Figure 2.10).

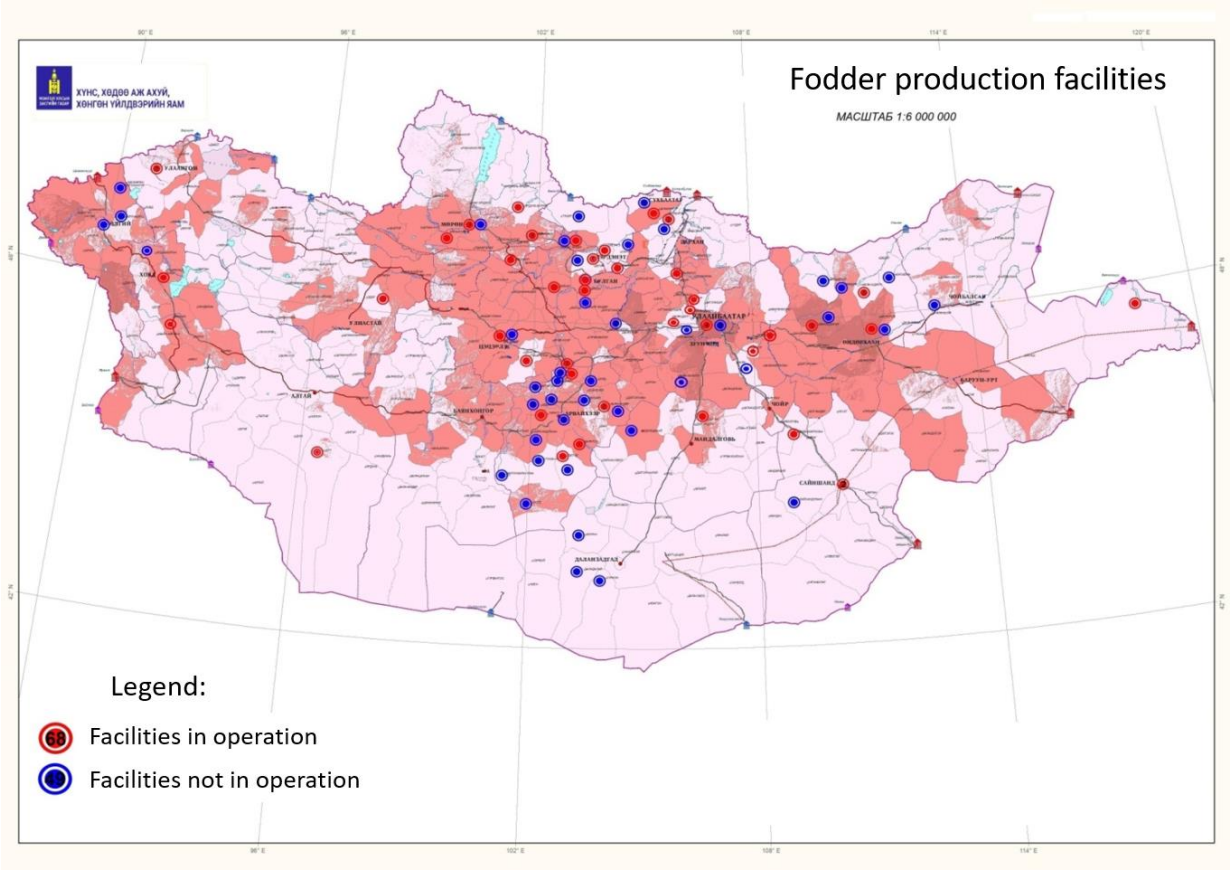

Figure 2.10: Location map of fodder production facilities

Source: MoFALI, 2017.

The MoFALI-list, however, contains numbers of not only fodder factories and plants and mills but also equipment for fodder preparation such grain crushers and fodder mixers. The fodder production capacity of all facilities registered by MoFALI totals 374 thousand tons per year (Table 2.6).

Table 2.6: Overview of fodder production facilities registered by MoFALI

Type of facility	Number of facilities	Products	Approximate combined production capacity, t per year*
Fodder factories and plants	11	Bran, pellets, mixed concentrates (compound feed), protein concentrates	175 thousand tons
Mills with fodder mixers	5	Bran, mixed fodder	7 thousand tons
Mills	34	Bran	106 thousand tons
Small mills with pelleting equipment	2	Bran, pellets	1.5 thousand tons
Pelleting equipment	5	Pellets	7.5 thousand tons
Grain crushers	7	Crushed grain	17 thousand tons
Fodder mixers	41	Mixed fodder	60 thousand tons
Other	11	Green fodder, hay, lick stone	N/A

Source: MoFALI, 2017.

* The production capacities of 1 fodder factory/plant, 1 mill with fodder mixer, 4 mills, 1 pelleting equipment, 1 grain crusher and 25 fodder mixers are unknown, thus not included.

The MoFALI list needs to be complemented by the fodder plant Orgio, which is operated by the pork farm Ajigana LLC and produces chicken fodder for the farm's consumption. Including Orgio, the fodder production facilities that are in operation include 11 factories and plants, 32 mills, 2 pelleting machines, 5 grain crushers and 16 fodder mixers, in addition one entity specializing in baled green fodder and 2 entities with unknown products. The combined fodder production capacity of 62 fodder production facilities that are in operation and with production capacities registered at MoFALI is approx. 338 thousand tons per year (Table 2.7).

Table 2.7: Overview of fodder production facilities that are in operation as of 2017

Type of facility	Number of facilities	Products	Approximate combined production capacity, t per year
Fodder factories	11	Bran, mixed concentrates (compound feed), incl. pellets, protein concentrates	172 thousand tons
Mills with fodder mixers	4	Bran, mixed fodder	3.7 thousand tons
Mills	26	Bran	87 thousand tons
Small mills with pelleting equipment	2	Bran, pellets	1.5 thousand tons
Pelleting equipment	2	Pellets	2.9 thousand tons
Grain crushers	5	Crushed grain	11.5 thousand tons
Fodder mixers	16	Mixed fodder	60 thousand tons
Other	3	Green fodder, unknown	N/A

Source: MoFALI, 2017.

Pelleting, grain crushing and fodder mixing at small scale (usually by farmers and herders themselves) and green fodder production hardly qualify as industrial fodder production. Hence, including mills, the number of industrial fodder producers in Mongolia is 41 and their combined fodder production capacity is approx. 263 thousand tons.

How much of the total fodder production capacity is actually utilized and what percentage bran as a major product takes in the total amount of fodder produced is unknown. Annual bran production is estimated by the fodder specialist of MoFALI at 70 to 80 thousand tons. Annual production of concentrates other than bran (pellets and compound feeds) is estimated by MoFALI at approx. 21.7 thousand tons for 2016. In summary, industrial fodder production in Mongolia, as of 2016, is approx. 100 thousand tons.

Gurbazar et al. (2017), Togtokhbayar et al. (2017) and fodder producers who participated in our interviews estimated that approx. 20 to 30 percent of the industrial fodder production capacity is actually utilized. An exception is Ajigana LLC, which operates the Orgio fodder plant at nearly 100% capacity for supplying fodder to its own poultry herd. Also, Khishigten Nuudelchin, Tumen Shuvuut and Altan shish supply fodder to their own farms (Tumen Shuvuut – 80 thousand hens, Nuudelchin – 300 dairy cows plus bulls, heifers and offspring, Altan shish/Zurgaan khoshuu – 3000 pigs), and they are assumed to utilize 40 to 50 percent of their production capacity. Overall, approx. 38% of the total operational capacity of fodder production is being utilized.

Six out of the 11 fodder factories and plants in operation are located in Ulaanbaatar. The total fodder production capacity of these facilities is 117 thousand tons per year. Four fodder production plants with a combined annual production capacity of 51 thousand tons are located in Tuv and Selenge aimags. In addition, Altai group built a new plant for pelleted fodder production in Dornod aimag with an estimated annual production capacity of 4.5 tons in 2017. Concentrates for ruminants are produced by 10 factories (excluding Orgio), pig fodder by 4 factories, poultry fodder by 6 factories and horse fodder by 6 factories (Table 2.8).

Table 2.8: Products and production capacities of fodder factories in operation

Type of facility	Location	Products	Animals targeted	Production capacity, 1000 tons per year
Altan taria	UB	Bran, pellet, compound feed	Ruminants, pig, poultry	43.8
Tumen shuvuut	UB	Pellet, compound feed	Poultry, horse	36.5
Bayalag emeelt	UB	Pellet, compound feed	Poultry, horse	14.6
Nuudel tejeel (Mill house)	UB	Bran, pellet, compound feed	Ruminants, horse	9.6
Orgio	UB	Pellet, compound feed	Poultry	5.0
Mind tech – Ulaanbaatar	UB	Protein concentrate	Ruminants, pig, poultry	7.3
Khishigten nuudelchin	Tuv	Pellet, compound feed	Ruminants, horse	5.5
Altan shish	Tuv	Pellet, compound feed	Pig, ruminants	14.6
Mind tech – Selenge	Selenge	Protein concentrate	Ruminants, pig, poultry	23.7
Urantsatsal	Selenge	Pellet	Ruminants, horse	7.3
Altai group	Dornod	Pellet	Ruminants, horse	4.5
Total capacity				**172.4**

Tumen Shuvuut grows fodder crops on 100 hectares and Khishigten Nuudelchin on approx. 600 hectares. All the other factories buy all raw materials needed for fodder production. An estimated 80% of raw materials is purchased domestically and the remaining 20% is imported. Major raw materials imported include maize, soy, soy and rape expeller, premixes (vitamin and mineral supplements) and amino acids.

2.3 Policy framework

2.3.1 Overview of policy goals and support measures implemented in the period 2012 to 2016

Policy goals and objectives related to domestic fodder production are defined in the "State Policy on Food and Agriculture" (SPFA) and the "Mongolian Livestock" program (MLP).

Relevant objectives defined in the SPFA (for the period 2016 to 2025) include:

- Allocation of crop land to intensified livestock farms for fodder cropping;
- Increasing production of fodder and adoption of new technologies;
- Introduction of fodder crops in crop rotations;
- Increasing fodder supply to intensified livestock farms; and
- Acclimatization of protein-rich fodder crops, and establishment of seed reserves.

The quantitative indicators for evaluation of the SPFA include one indicator related to fodder production, which targets an increase in the share of compound feed in total fodder production from 0.7% in 2014 to 10% by 2025.

Relevant objectives defined in the MLP (for the period 2010 to 2021) include:

- Increasing domestic capacity for compound feed production and small-scale fodder production;
- Supporting fodder cropping and utilization of crop by-products in animal feeding;
- Introduction of new technologies for hay and fodder conservation without quality losses;
- Increasing emergency reserves of hay and fodder in rural areas; and
- Allocation of haymaking areas in Khangai region and haymaking equipment to herders in the Gobi region, in which haymaking is not possible.

The following quantitative indicators are defined to measure improvement of domestic fodder production through the MLP:

- Number of hay and fodder reserves and fodder production plants at aimag and soum levels is increased from 38 in 2008 to 150 by 2015;
- Amount of domestic fodder production is increased from 560.5 thousand tons of Fodder Unit (FU) in 2008 to 900 thousand tons FU by 2021;
- Percental share of industrial fodder in total domestic fodder production is increased from 9.6% in 2008 to 40% by 2021.

According to NSO (2017), domestic fodder production reached 698 thousand tons of FU 2016[5]. MoFALI (2017) reported that, at its current capacity, industrial fodder production is able to contribute 30% of total fodder production. The total number of fodder production facilities has reached 116 (cf. section 2.2.3). Hay and fodder reserves are built and managed by local governments in all 21 aimags and in Ulaanbaatar, but the number of soums and districts with such reserves is not disclosed.

Hay and fodder (bran) reserves at aimag and soum governments are purchased by the government each year, and distributed to herders in need of emergency assistance during winter and spring at reduced prices, or occasionally free of charge. The total amounts of hay and bran reserves of local governments are defined by a government resolution on winter preparation in the agricultural sector each year. During the years 2014 to 2016, the total hay and bran reserves of local governments countrywide averaged 23.9 thousand tons and 4 thousand tons, respectively. In 2016, the total amounts were 20.4 thousand tons of hay and 4.6 thousand tons of bran (MoFALI, 2017). The reserves are usually exhausted each year, primarily distributed to areas, in which harsh weather conditions in winter and spring threaten with mass losses of animals.

For increasing domestic fodder production, the government spent approx. MNT 7.6 billion on allocating equipment for haymaking (tractors, scythes and balers) and small-scale fodder production (crushers and mixers) to herders and intensified livestock farms at subsidized prices between 2012 and 2016[6]. The intervention benefited 593 intensified livestock farms in addition to an unspecified number of herders (MoFALI, 2015 and 2017). The number of grain crushers and fodder mixers registered at MoFALI is provided in section 2.2.3. The inventory of haymaking equipment includes 7101 tractors, 8394 horse- and tractor-mounted mowers and 558 balers (MoFALI, 2017).

As intensified livestock farms are major buyers of fodder in general and the main buyers of industrially produced concentrates and compound feeds in particular, government support for intensified livestock farms can be seen as indirect support for industrial fodder production. In this regard, the government allocated soft loans and purebred animals to a total value of MNT 71 billion (EUR 28 million) to both existing and new livestock farms between 2012 and 2016. The soft loans were provided from three major sources in addition to MoFALI's regular budget (MoFALI, 2015, 2016 and 2017):

[5] Measuring fodder production in FU is a questionable issue. The FU is a unit that is supposed to express the nutritional value of all feedstuffs on a universal scale (A conversion sheet is available in NSO, 2017). One FU equals the approximate nutritional value of one kg oat (Togtokhbayar et al., 2005). The FU scale was introduced in Mongolia in the 1950s. Meanwhile, energy- and protein-based fodder valuations have been introduced, at least at the academic level. However, the NSO and the MoFALI still use the FU scale. A major problem with this scale is the difficulty in measuring FU-values of industrially produced fodder. The FU-values of more than 20 different feedstuffs produced industrially are unknown, basically because it is impossible to measure the nutritional value of those feedstuffs, most of which are mixtures of different grains and legumes enriched with various minerals and vitamins, at a scale based on a single crop.

[6] The period 2012 to 2016 is referred to because it is the period covered by the action plan of the previous government. The action plan of the current government, which was formed in 2016, covers the period 2017 to 2020 (see below).

- Development Bank of Mongolia/ "Chinggis" bond (2013): MNT 13.4 billion soft loans (interest rate 8%) to 7 dairy farms;
- Subprogram "Price stabilization of staple foods" (2013): MNT 38.1 billion soft loans (interest rate 3.8%) to 14 beef farms, 4 pig farms, 2 poultry farms, 3 sheep farms and 1 mixed livestock farm;
- Program for "Supporting Intensified Livestock Farming" (2012 to 2015): MNT 10.5 billion soft loans (interest rate 2.4% to 5%) to livestock farms (number of beneficiaries not disclosed); and
- MoFALI (2012 to 2016): MNT 8.3 billion soft loans (interest rate 2.4% to 8%) to 554 farms and purebred animals worth MNT 443.4 million to 317 farms.

Due to lack of reliable data we cannot quantify a correlation between government support for intensified livestock farming and industrial fodder production. However, the assumption that the above interventions facilitated an increase in industrial fodder production is supported by the fact that 6 out of 11 industrial fodder producers in Mongolia were established after 2013, which is the year with highest amount of investment in intensified livestock farming. These 6 producers are: Khishigten Nuudelchin (2014), Bayalag emeelt (2014), Mind tech Ulaanbaatar (2014), Mind tech Selenge (2015), Altai group (2016) and Nuudel tejeel (2016).

Khishigten Nuudelchin itself received a soft loan from the Development bank and invested a part of it in fodder production. Other than that, none of the industrial fodder producers participated in our interviews (Altan taria, Orgio, Bayalag emeelt, Nuudel tejeel, Orgio, Mind tech, Tumen shuvuut, Altai group) has received any support from the government for fodder production. Yet, the poultry farms Tumen shuvuut and Ajigana (which operates the fodder factory Orgio) and the Zurgaan khoshuu pig farm (which operates the fodder factors Altan shish) are among the beneficiaries of the Price Stabilization subprogram, so we may assume that some of the credit amounts they received were, at least indirectly, invested in industrial fodder production too.

2.3.2 Overview of support measures defined in the Government Action Plan 2017 to 2020

The current government of Mongolia was formed in in July 2016. The government program for the period 2016 to 2020 was approved in September 2016, and the government action plan (GAP) for the period for 2017 to 2020 in October 2016. We identified 13 measures defined in the GAP that are relevant for domestic fodder production, and categorized them in measures with direct relevance, measures with indirect relevance and measures towards overarching goals with relevance for fodder production. The budget of all 13 measures totals MNT 72.3 billion and is supposed to be covered by a combination of state budget, local governments' budget and external funds (Table 2.9). Possible impacts of the measures in each category on fodder production are briefly discussed below:

1) Measures with direct relevance for fodder production

The measure we identified in this category is establishment of fodder factories in crop and intensified livestock farming regions, in combination with supporting seed multiplication of fodder crops. Possible impacts of these measures are increased fodder production capacity in crop and livestock farming regions and increased domestic availability of seeds for fodder cropping.

2) Measures with indirect relevance for fodder production

The measures identified in this category are further divided into measures in the livestock sector and measures in the crop sector. Relevant measures in the livestock sector include:

- Establishment of emergency reserves of hay and fodder;
- Building of storage facilities for hay and fodder;
- Renewal of equipment used in intensified livestock farming and hay and fodder preparation; and
- Credit support to intensified livestock farms, pastoral beef and mutton production and feedlots.

The government-funded emergency reserves have basically consisted of hay and bran so far, and the planned storage facilities will probably be used for the emergency reserves. Hence, the first two measures on the above list will have some impact on the domestic hay supply, but a rather insignificant impact on industrial fodder production, except for bran production. In 2016, the emergency reserves only absorbed 2% of hay and 8% of bran supplied domestically.

The 3rd measure in the list implies continuation of MoFALI's provision of equipment for haymaking and small-scale fodder production. The measure could enable a certain number of herders and livestock to make hay for own consumption. The impact of this measure on fodder production other than haymaking, however, will be probably weak because there is no guarantee that equipment supplied for small-scale fodder production is used too. As indicated in section 2.2.3, only 23 out of 43 enterprises with grain crushers, pelleting machines and fodder mixers actually use the equipment.

Credit support to intensified livestock farms will have positive impacts on the fodder market as it will increase the overall demand for fodder. Hence, this measure might very well prove to be the most effective intervention in the livestock sector with regard to the need to increase domestic fodder production.

Measures in the crop sector with relevance for fodder production include:

- Allocation of pesticides and fertilizers to fodder crop growers at subsidized prices;
- Introduction of new crops in crop rotations;
- Increasing total sown areas; and
- Seed multiplication of fodder crops and legumes.

Allocation of pesticides and fertilizers at subsidized prices is a meanwhile standardized instrument of policy support in the crop sector. Not only crop farms but also livestock farms growing fodder crops are eligible to receive a discount. The discounted prices have been, on average of the recent years, approx. 60% of the market prices of pesticides and fertilizers. In addition, farmers are only required to pay an advance payment of 30% at the time of purchase, and the remaining value can be paid off after the harvest. The scheme has proven very useful for crop farmers who have limited liquidity at the time of sowing. The subsidization of pesticide and fertilizer use will obviously continue to benefit crop farms and livestock farms with fodder cropping until 2020.

The government is aiming to increase crop rotations (in contrast to the current wheat monoculture) to a level at which the share of secondary crops grown in rotations would account for 20% of total sown areas. While the GAP does not specify what crops should be introduced in rotations as secondary crops (to the main crop wheat) the SPFA defines fodder crops as the preferred secondary crops. The policy makers are aware of the need for increasing fodder cropping and benefits of legumes, which are mostly protein-rich fodder crops, for soil fertility. Hence, we can assume that this measure will potentially increase fodder cropping.

The government is also targeting an overall increase in sown areas through utilization of abandoned arable land. This measure (or rather objective) could be linked to the need for fodder cropping, especially in remote areas in Western and Eastern regions, where transportation of fodder crops from the Central region is expensive. However, this would require not only that fodder crops are not only required but also that there is a realistic, purchasing power based demand for fodder crops in those regions.

The next measure planned is adaptation and seed multiplication of 5 fodder crop varieties. Increased domestic availability of seeds will clearly benefit growers of fodder crops.

3) Measures towards overarching goals with relevance for fodder production

Relevant measures in this category include:

- Implementation of the SPFA and the 2nd phase of the MLP; and
- Implementation of a new version of the Program for Supporting Intensified Livestock Farming.

Implementation of the 1st measure in this list will affect domestic fodder production within the relevant objectives the SPFA and the MLP, as listed in section 2.3.1. Most SPFA and MLP objectives with relevance for fodder production are basically covered by the GAP measures assigned to the previous categories. However, there is one SPFA-objective that may or may not be targeted by the GAP 2017-2020, which is "allocation of crop land for fodder cropping to intensified livestock farms". This objective is not necessarily linked to an overall increase in sown areas, which is the measure with closest connection in the GAP. In fact, it is unclear how the government is planning to achieve this objective and what the outcomes of allocating crop land to livestock farms would be.

As for the 2nd measure planned, no information has been disclosed on the design and contents of the new version of the Program for Supporting Intensified Livestock Farming yet. The only information available by the time being (October 2017) is that the program is budgeted with a sum of MNT 14 billion (EUR 5.6 million), to be composed of contributions from the state budget, the local governments' budget and external funds.

In a final conclusion, the need for increasing domestic production and consumption of livestock fodder is well recognized and addressed through a set of measures with direct and indirect relevance in the GAP 2017-2020. The implementation of the SPFA and the MLP as well as a new version of the Program for Supporting Intensified Livestock Farming will be complemented by a number of measures in the livestock and crop sectors that address relevant issues beyond the scopes of these programs. The priorities defined in the GAP with regard to domestic fodder production are:

- Increasing industrial fodder production through establishment of new fodder factories in crop and intensified livestock farming regions;
- Increasing hay and fodder reserves of aimag and soum governments;
- Increasing haymaking by herders and farmers through allocation of equipment at subsidized prices and/or on credit;
- Supporting fodder production by intensified livestock farmers through allocation of equipment for small-scale fodder production and crop land;
- Increasing fodder cropping through seed multiplication of new fodder crop varieties, provision of pesticides and fertilizers at subsidized prices, and inclusion of fodder crops in wheat rotations; and
- Increasing the fodder demand in intensified livestock farming through allocation of soft credits.

Table 2.9: Measures defined in the Government Action Plan 2017-2020 for improving fodder production (selected and categorized by relevance)

Measures planned	Indicators (Targets for 2020)	Budget, MNT million
Measures with direct relevance for fodder production		
Establishment of fodder factories in crop and intensified livestock farming regions, and Supporting seed multiplication of fodder crops.	4 regional fodder factories are established, and Seeds of fodder crops are renewed and fodder cropping is increased.	20,000[4]
Measures in livestock sector with indirect relevance for fodder production		
Establishment of emergency reserves of hay and fodder, and Building of storage facilities for hay and fodder.	20 storage facilities for hay and fodder are built in areas lacking storage capacities.	5,500[3]
Technology renewal and introduction of innovations and leasing services in intensified livestock farming and hay and fodder preparation	Equipment used in livestock production renewed by at least 20%, and Rate of introduction of advanced technologies and related innovations has reached 15%.	3,200[4]
Supporting intensified beef farming raising high-productivity breeds	At least 40 intensified beef farms raising high-productivity breeds are supported.	4,000[2]
Credit support to intensified dairy and beef farms in peri-urban areas	At least 40 intensified dairy and beef farms have received soft credits.	1,200[4]
Credit support to pig, poultry and bee farming and fisheries	At least 20 pig, poultry and bee farms and fisheries have received soft credits.	600[2]
Support pastoral beef and mutton production and fattening of young animals.	At least 20 enterprises introducing technologies for pastoral beef and mutton production and fattening of young animals are supported.	4,000[4]
Measures in crop sector with indirect relevance for fodder production		
Allocation of pesticides and fertilizers to crop farms (incl. fodder crop growers) at subsidized prices	Pesticides and fertilizers are distributed at subsidized prices.	14,680[1]
Introduction of new crops in crop rotations	Secondary crops grown in rotations cover 20% of sown areas.	2,000[1]
Improving utilization of arable land in the Central region, and utilization of abandoned arable land in other regions	Cultivated arable land has reached 600 thousand ha in Central, 70 thousand ha in Western, 190 thousand ha in Eastern and 100 thousand ha in Khangai region.	-
Seed multiplication of acclimatized, drought-tolerant and high-yielding varieties of grain, oil and fodder crops and legumes	9 crop varieties, incl. 5 fodder crop varieties, are acclimatized and seeds are multiplied.	2,300[1]
Measures towards overarching goals with relevance for fodder production		
Implementation of the State Policy on Food and Agriculture and the "Mongolian Livestock" program (2nd phase)	Achievement of goals defined in the SPFA and the MLP has reached 80%.	14,000[4]
Implementation of a new program for "Supporting Intensified Livestock Farming "	A new program for "Supporting Intensified Livestock Farming" is elaborated by 2017 and implemented through 2020.	800[4]

[1] State budget, [2] State and local budgets, [3] State budget and External funds, [4] State budget, local budget and external funds.

3. Fodder supply

3.1 Total fodder supply

Mongolia's total fodder production has been between 1.3 and 1.5 million tons during the last five years. Hay production has accounted for 75 to 80 percent. In addition, hand-made fodder and natural salt and saline have taken a combined share of 10 to 13 percent. Excluding these feedstuffs made of natural resources, fodder production would have been between 186 tons on average, with forages and concentrates accounting for 38 and 62 percent, respectively (Table 3.1).

Table 3.1: Fodder production in Mongolia in the period 2012 to 2016, 1000 tons

Fodder	2012	2013	2014	2015	2016
Hay[1]	1182.7	1122.5	1221.2	1014.5	1100
Straw[1]	39.2	21.7	22.7	44.7	35.7
Green fodder[2]	30.1	29.7	24.5	38.5	34.4
Silage[1]			3.5	3.1	7.9
Waste potato and vegetables[3]	N/A	N/A	2.5 to 3.5	2.5 to 3.5	2.5 to 3.5 (average 3.0)
Hand-made fodder[1]	56.9	45.9	37.4	42.5	38.1
Natural salt and saline[1]	113.6	143.5	117.6	124.1	105.6
Waste grain (wheat)[2]	14.4	10	6.8	6.1	7.2
Bran[4]				70 to 80	70 to 80 (average 75)
Compound feed (Mixed concentrates)	41.9	40.7	29.6	25	27.1

Sources: [1] MoFALI 2017; [2] NSO 2017; [3] Estimated by author; [4] Estimated by MoFALI fodder specialist.

Imports of fodder and fodder ingredients totalled 69 thousand tons in 2015 and 43 thousand tons in 2016. Ingredients for industrial fodder production included maize, barley, soy, bone meal, starch and brewery wastes, wastes of soy oil production and other non-specified wastes used in animal feeding. In addition, approx. 50% of waste grain was used in industrial fodder production. The estimated amount of imported fodder directly used in animal feeding was 30 thousand tons in 2015 and 18.6 thousand tons in 2016 (Table 3.2).

Table 3.2: Fodder imports in 2015 and 2016, tons

Fodder	2015	2016
Hay	-	20.0
Oat (green fodder)	9,288.8	10,913.1
Waste grain (wheat grain)	18,316.3	5,892.6
Compound feed	2,438.5	1,814.8
Total amount	**30,043.7**	**18,640.5**

Source: Mongolian Customs 2017.

According to Gurbazar et al. (2017), approx. 95 percent of the compound feed imported is used in poultry feeding. They also defined China, Russia and the USA as the main exporters, accounting for 45%, 32% and 14% of the total fodder imports in Mongolia, respectively.

3.2 Monetary value of fodder supply

The consumer price based monetary value of total fodder supply in 2016 was MNT 321 billion (USD 128 million). Domestic supply accounted for 97% of this value (Table 3.3).

Table 3.3: Monetary value of total fodder supply in 2016

Fodder	Amount, t	Price range, MNT 1000 per t	Average price, MNT 1000 per t	Total value	
				MNT million	USD 1000[5]
Domestic supply: Roughages					
Hay	1,100,000	100 to 350	200	220,000	88,000
Straw	35,700	80 to 150	100	3,570	1,428
Green fodder	34,400	200 to 400	250	8,600	3,440
Silage	7,900	200 to 400	250	1,975	790
Waste potato and vegetables	3,000	150 to 300	200	600	240
Domestic supply: Concentrates					
Waste grain	7,200	250 to 450	350	2,520	1,008
Bran[1]	60,000	450 to 650	550	33,000	13,200
Compound feed[2]	27,100	500 to 1200	750 to 1000	25,352	10,141
Domestic supply: Other					
Hand-made fodder[3]	38,100				
Natural saline	105,600	100 to 200	150	15,840	6,336.0
Domestic production subtotal	**1,419,000**			**311,457**	**124,583**
Imports[4]					
Hay	20		95	1.9	0.761
Oat (green fodder)	10,913		409	4,469	1,788
Imports					
Waste grain	5,983		289	1,703	681
Compound feed	1,815		1,829	3,320	1,328
Imports subtotal	**18,641**			**9,493**	**3,797**
Total	**1,437,641**			**320,950**	**128,380**

[1] - Amount of bran supply was adjusted from an assumed total production of 70 plus thousand tons to 60 thousand tons of net supply, considering exports of approx. 10 to 15 thousand tons per year.

[2] – The total price of mixed concentrates results from estimations of fodder use by herders and livestock farms in chapter 4.

[3] – Pricing is impossible since there is no record of trade with hand-made fodder, which is prepared by herders for their own use.

[4] – Prices of imported fodder were derived from their total prices stated in customs reports.

[5] – The exchange rate used in MNT to USD conversion is MNT 2500 per USD 1 (2016 average).

Total fodder trade in 2016 was approx. MNT 188 billion (USD 75 million), with trade of domestically supplied fodder accounting for 95 percent. The market value of fodder prepared by herders, livestock farms and integrated crop-and-livestock farms in 2016 i.e. the balance between total fodder supply and total fodder trade is approx. MNT 133 billion (Table 3.4).

Table 3.4: Monetary value of fodder trade in 2016

Fodder	Amount, 1000 t	Share of traded amount, %	Trade amount, t	Total value	
				MNT million	USD 1000
Domestic supply: Roughages					
Hay	1,100,000	50%	550,000	110,000	44,000
Straw	35,700	40%	14,280	1,428	571
Green fodder	34,400	50%	17,200	4,300	1,720
Silage	7,900	5%	395	99	40
Waste potato and vegetables	3,000	90%	2,700	540	216
Domestic supply: Concentrates					
Waste grain	7,200	70%	5,040	1,764	706
Bran*	60,000	100%	60,000	33,000	13,200
Compound feed	27,100	100%	27,100	25,352	10,141
Domestic supply: Other[7]					
Natural saline	105,600	10%	10,560	1,584	634
Domestic production subtotal	**1,419,000**		**687,275**	**178,067**	**71,227**
Imports: Roughages					
Hay	20	100%	20	1.9	0.761
Oat	10,913	100%	10,913	4,469	1,788
Imports: Concentrates					
Waste grain	5,893	100%	5,893	1,703	681
Compound feed	1,815	100%	1,815	3,320	1,328
Imports subtotal	**18,641**		**18,641**	**9,493**	**3,797**
Total	**1,437,641**		**705,916**	**187,560**	**75,024**

3.3 Structure of fodder supply

3.3.1 Structure of total fodder supply

As of 2016, roughages account for 75% of the total monetary value of the market. Hay being the main roughage produced, traded and consumed, and natural saline being widely used as a mineral fodder, the fodder market is dominated by feedstuffs directly made of natural resources (Figure 3.1).

Mongolia's fodder market is vastly dominated by domestic supply, with imports only contributing 3% to the total fodder supply. However, this can be relativized if considering that domestic supply itself is dominated by feedstuffs directly made of natural resources. In the case of concentrates, imports accounted for 8% of the supply in 2016 (Figure 3.2).

[7] Hand-made fodder is excluded since it is prepared by herders themselves and there is no record of its trade, hence making pricing impossible.

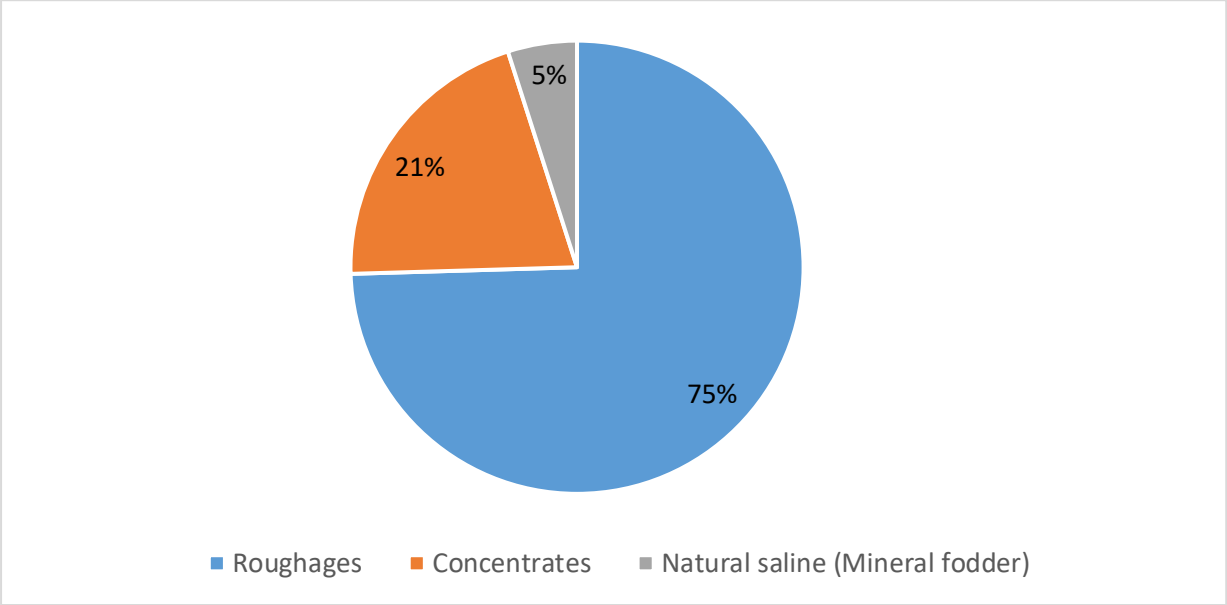

Figure 3.1: Overall structure of total fodder supply, measured in monetary amount, in 2016

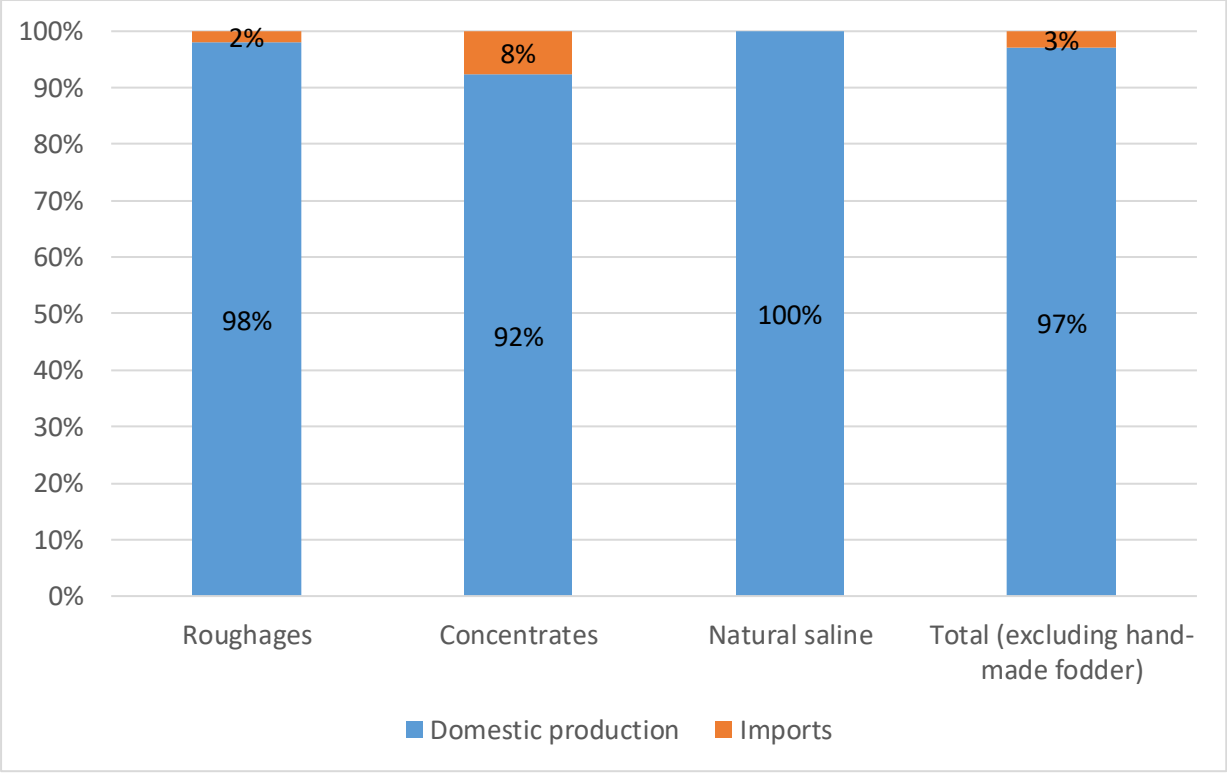

Figure 3.2: Shares of domestic production and imports in the monetary value of total fodder supply in 2016

Nearly a half of the roughages and 90% of natural saline supplied are prepared by herders and farms themselves, hence not commercially traded. Concentrates, on the other hand, are almost exclusively supplied through commercial trade. The share of waste grain that is produced by crop-land-livestock farms for their own use, hence not traded, in the monetary value of total concentrate supply in 2016 is estimated at 1 percent (Figure 3.3).

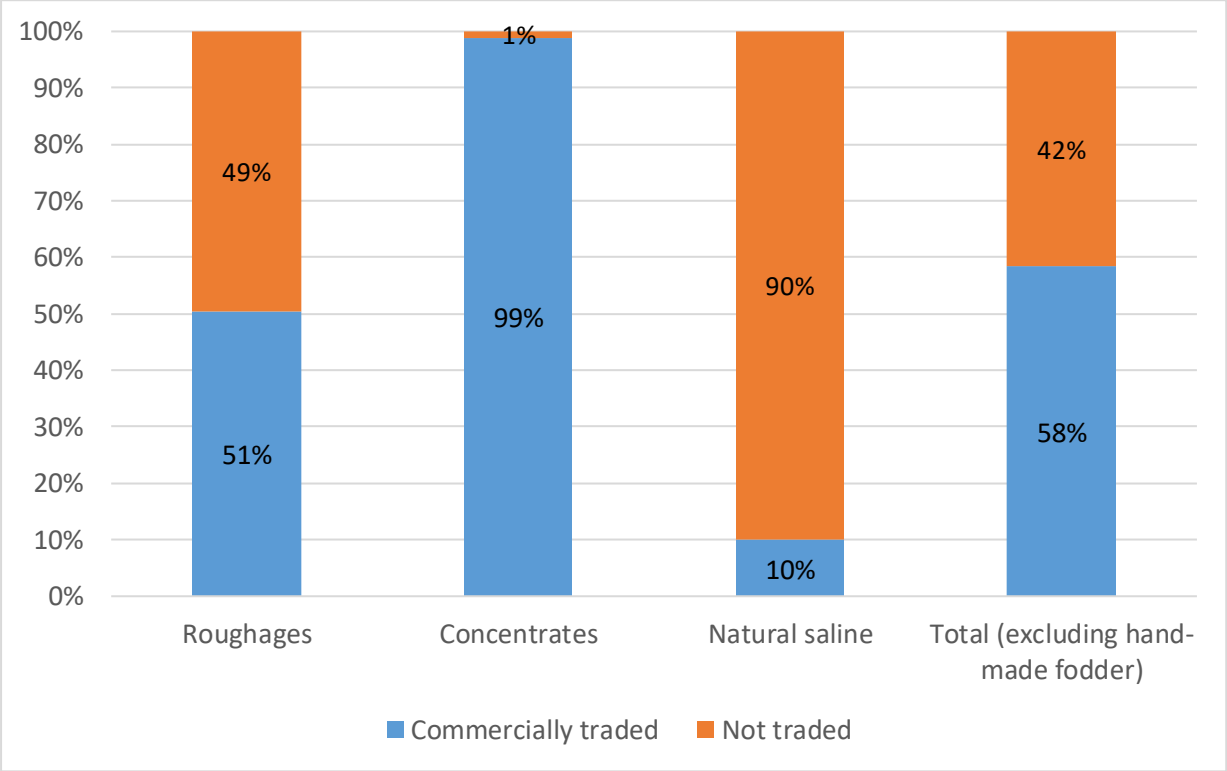

Figure 3.3: Shares of commercially traded and non-traded fodder in the monetary value of total fodder supply in 2016

3.3.2 Structure of domestic fodder supply

The total value of domestic fodder supply in 2016 was MNT 311 billion (cf. section 3.2). Roughage supply was worth MNT 234.7 billion and concentrate supply MNT 60.9 billion. The market value of natural saline, although mostly prepared by herders for their own use, was approx. MNT 16 billion (Figure 3.4).

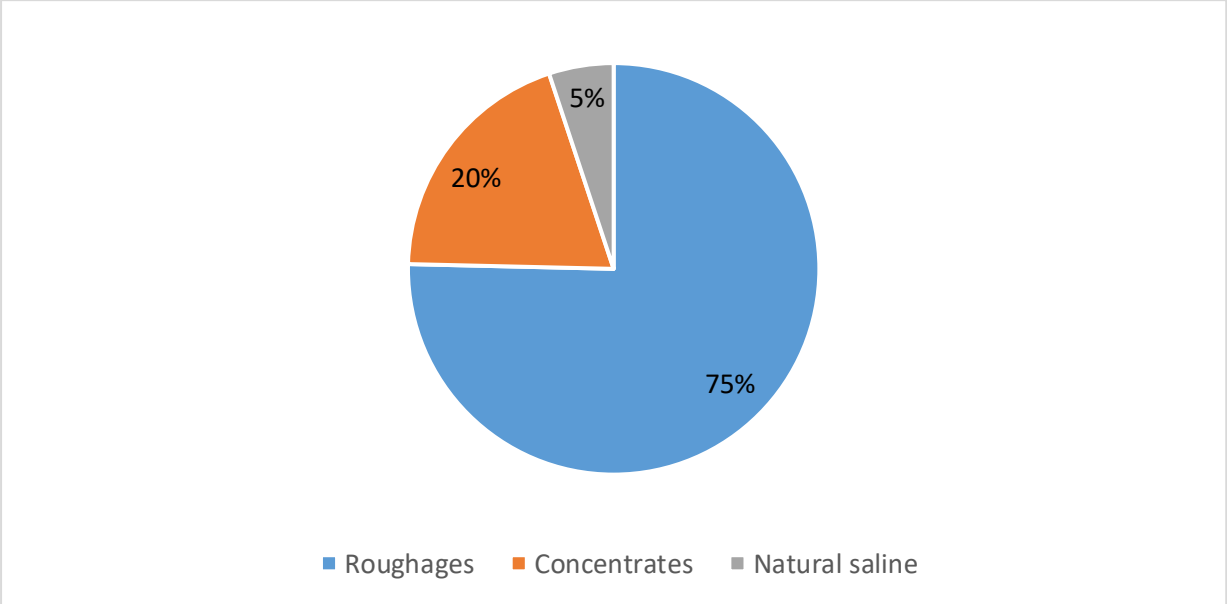

Figure 3.4: Overall structure of domestic fodder supply measured in monetary value in 2016

Domestic supply of roughages in 2016, measured in monetary amounts, largely consisted of hay supply (MNT 220 billion). The combined market value of straw, green fodder and silage used in ruminant and

horse feeding, and waste potato and vegetables used in pig feeding, on the other hand, was approx. MNT 15 billion, equalling 6% of the total value of domestically produced roughages.

Domestically supplied concentrates include waste grain, bran and compound feed. The combined market share of 7.2 thousand tons of waste grain and 60 thousand tons of bran supplied in 2016 was 46 percent. Compound feed, with a 54% share, dominated domestic supply of concentrates (Figure 3.5).

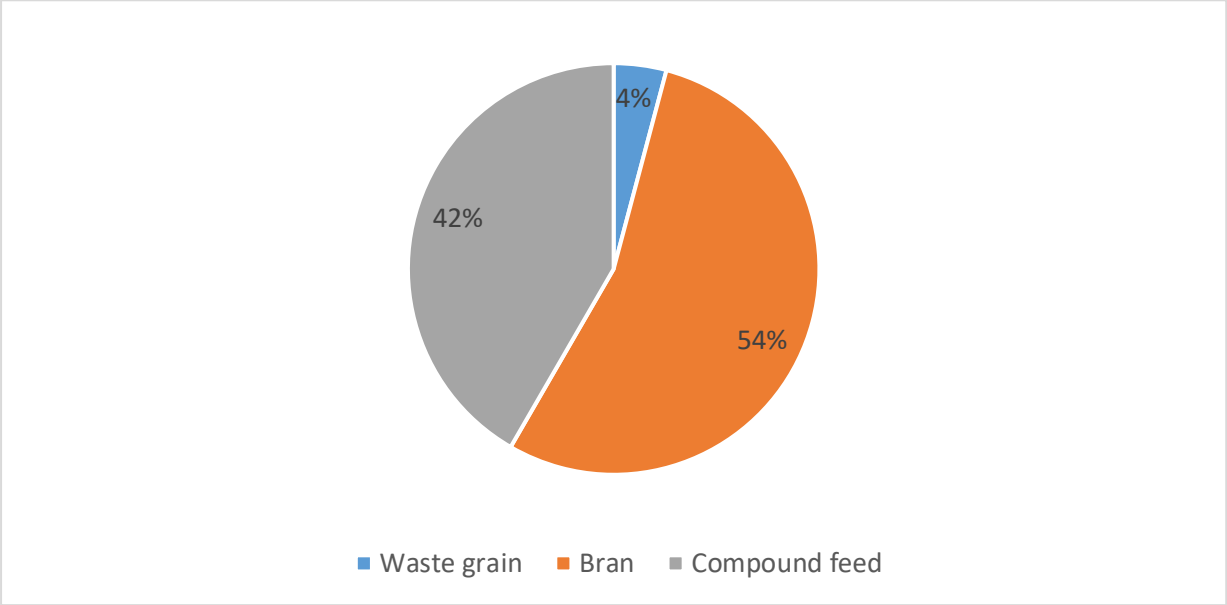

Figure 3.5: Structure of domestic supply of concentrates measured in monetary value in 2016

4. Fodder consumption

4.1 Fodder consumption in pastoral livestock production

Based on the findings of the studies carried out by Erdenebolor (2013), Erdenebolor and van de Fliert (2014), Khadbaatar (2015) and Erdenebolor (2017) as well as the herder interviews conducted in this study, we can estimate that herder households, depending on their income levels, spend approx. 5 to 20 percent of their annual incomes on livestock. The expenditures on livestock include, besides haymaking and fodder purchase, wages for assistant herders, purchase of veterinary products and fees for veterinary services, costs for fuel and other materials required for seasonal migration, and construction and renovation of barns and shelters. Out of the total expenditures on livestock, approx. 30 percent are spent on preparation/purchase of hay, green fodder and bran for supplementary feeding of animals during winter and spring.

Incomes of herder households are proportional to the number of animals per herder household (cf. section 2.1). Our model calculation demonstrates that the average annual incomes of herder households in different animal number categories range from MNT 6.9 million (for households with less than 100 animals) to MNT 53.7 million (for households with more than 1000 animals). Annual expenditures on livestock are between MNT 104,243 and MNT 3,219,546 per herder household. A statistically average herder household with 341 animals spends approx. MNT 2.9 million on livestock in total, including MNT 883 thousand for fodder preparation and/or purchase. The total amount of fodder expenditures of all herder households in 2016 was approx. MNT 142.2 billion (Table 4.1).

Hay being the most accessible and affordable fodder, approx. 90% of herders' expenditures on fodder are spent on haymaking and hay purchase. Since hay yields are different in different regions and many herders lack haymaking equipment (renting is difficult since the owners need to use the equipment at the same time), however, an estimated 50% of the total expenses on fodder are spent for haymaking and 40% are spent hay purchase. Haymaking costs herders approximately a half of the commercial price of hay, which is MNT 200 thousand per ton. Hence, the estimated amounts of MNT 71 billion spent by herders on haymaking and MNT 57 billion spent on hay purchase in 2016 should have been turned to 711.2 and 284.5 thousand tons of hay. In total, herders' fodder expenditures in 2016 resulted in the use of approx. 995.7 thousand tons of hay.

Herders are not used to using mixed concentrates, primarily because they are expensive. Bran, on the other hand, is commonly used. Approximately 8 percent of herders' total expenditures are spent on bran purchase. The amount of bran purchased by herders in 2016 was approx. 20.7 thousand tons.

About one percent of herders' fodder expenditures is used on green fodder, whereas this figure does not reflect the unavailability of green fodder in many regions of Mongolia. The total amount of green fodder used by herders in 2016 was approx. 5.7 thousand tons. The remaining one percent of herders' fodder expenditures is used on preparation of hand-made fodder, and preparation and purchase of natural salt and saline. Herders' shares in the total consumption of hand-made fodder and natural saline are estimated at 100% and 90%, respectively.

The total amounts of hay and bran reserves of local governments in 2016 were 20.4 thousand tons and 4.6 thousand tons of bran, respectively (cf. section 2.3.1). Since these amounts were distributed to herders, they should be included in herders' fodder consumption in 2016.

In summary, fodder consumption in pastoral livestock production in 2016 consisted of 1 million tons of hay, 25 thousand tons of bran and 5.7 tons of green fodder, in addition to 38 thousand tons of hand-made fodder and 95 thousand tons of natural saline.

Table 4.1: Estimated incomes and fodder expenditures of herder households (based on 2016 statistics)

Parameters	Categories of herder households by number of animals				
	Up to 100	**101 to 200**	**201 to 500**	**501 to 999**	**1000 or more**
Number of herder households	36,336	33,519	55,575	25,459	9,761
Number of animals per households					
Sheep	20	59	148	360	795
Goat	24	68	150	326	600
Cattle	10	13	22	45	86
Horse	4	12	20	42	93
Camel	0	0	1	6	20
Total	**58**	**152**	**341**	**779**	**1594**
Income per household, MNT					
Animal and meat sales	2,078,571	3,689,643	7,205,357	15,856,071	32,598,214
Milk sales	980,000	1,274,000	2,156,000	4,410,000	8,428,000
Cashmere sales	253,440	718,080	1,584,000	3,442,560	6,336,000
Wool, hide & skin sales	137,514	343,779	779,571	1,805,914	3,796,893
Side businesses and social welfare[8]	3,500,000	3,500,000	3,000,000	3,000,000	2,500,000
Total annual income, MNT	6,949,526	9,525,501	14,724,929	28,514,546	53,659,107
Expenditures on livestock per household					
Average share relative to total annual income	5%	15%	20%	20%	20%
Amount per household, MNT	347,476	1,428,825	2,944,986	5,702,909	10,731,821
Expenditures on fodder per household					
Average share relative to total expenditures on livestock	30%	30%	30%	30%	30%
Amount per household, MNT	104,243	428,648	883,496	1,710,873	3,219,546
Total expenditures on fodder, MNT million	3,788	14,368	49,100	43,557	31,426
Total expenditures of all herder households on fodder, MNT million			**142,239**		

[8] Side businesses are non-regular and include transportation, commercial haymaking, sewing and baking, and seasonal off-farm employment of household members. Social welfare payments include pensions and children's allowances.

4.2 Fodder consumption in intensified livestock farming

The gross amounts of fodder available for intensified livestock farms are estimated after subtracting the amounts consumed by herders incl. the amounts distributed through local government reserves from the total amounts supplied. Accordingly, the amount of roughages and concentrates available for intensified livestock farms totalled 246.9 thousand tons in 2016. In addition, approx. 10.6 thousand tons of natural saline were available. Given the overall negative fodder balance in intensified livestock farming (cf. section 5.1) we assume that these available amounts approximately equalled the amounts consumed by livestock farms.

An estimated 89% of roughages available for intensified livestock farms is consumed by dairy and beef farms. The main roughage for pig farms is waste potato, partly enriched with other root and leafy vegetables and industrial wastes.

The main concentrate fed to dairy and beef cattle is bran. However, larger dairy and beef farms, especially those with integrated crop farming, also utilize some waste grain in addition to approx. 10% of compound feeds supplied.

Pig and poultry are fed waste grain and compound feeds as concentrates, whereas the concentrate consumption of poultry farms is much higher than that of pig farms. Up to 95 percent of imported concentrates are used in poultry feeding. Also, Togtokhbayar et al. (2017) estimated that 64% of domestically supplied compound feeds is used in poultry farming. Furthermore, based on our interviews with poultry farms and crop farms we estimate that 60% of the domestic supply of waste grain is used in poultry farming (Table 4.2).

Table 4.2: Structure of fodder consumption by intensified livestock farms

Fodder	**Gross amount consumed in 2016, t**	**Estimated share in total consumption of available amount, %**			
		Dairy and beef farms	Pig farms	Poultry farms	Other farms*
Roughages					
Hay, domestic	83,927	90%			10%
Hay imported	20	90%			10%
Straw, domestic	35,700	90%			10%
Green fodder, domestic	28,710	90%			10%
Green fodder, imported	10,913	90%			10%
Silage, domestic	7,900	100%			
Waste potato and vegetables, domestic	3,000		100%		
Roughages subtotal	**170,171**				
Concentrates					
Waste grain, domestic	7,200	20%	15%	60%	5%
Waste grain, imported	5,893	5%	15%	80%	
Bran, domestic	34,711	85%	10%		5%
Compound feed, domestic	27,100	11.0%	24%	64%	1.0%
Compound feed, imported	1,815	1.0%	3%	95%	1.0%
Concentrates subtotal	**76,718**				
Total	**246,889**				

* "Other farms" include milk goat farms, sheep fattening operations (feedlots) and racehorse farms.

4.3 Structure of total fodder consumption

Based on the estimations in sections 4.1 and 4.2, we can conclude that 86% of roughages, 25% of concentrates, 100% of hand-made fodder and 90% of natural saline supplied in 2016 were consumed by herders. Fodder consumption of livestock farms, on the other hand, consisted of 170.2 thousand tons or roughages, 76.7 thousand tons of concentrates and 10.6 thousand tons of natural saline.

The combined fodder consumption of milk goat farms, sheep fattening operations and racehorse farms (summarized as "other farms") only contributes 9% of total roughage consumption and 3% of total concentration consumption of intensified livestock farms. Hence, the focus of analysis is placed on dairy, beef, pig and poultry farms. These farms account for 16% of total fodder consumption in Mongolia and 89% of the total fodder consumption in the intensified livestock farming sector. The total amounts of roughages and concentrates fed to dairy and beef cattle, pigs and poultry in 2016 were 154 thousand tons and 74 thousand tons, respectively. The pattern of fodder consumption is shaped by the relatively high roughage and bran consumption of dairy and beef farms and high concentrate consumption of poultry farms. Pig farms are positioned in between (Table 4.3).

Table 4.3: Structure of fodder consumption by quantity (2016 data)

Fodder	Amount supplied, t	Herders' consumption, t*	Consumption of intensified livestock farms, t				
			Dairy and beef farms	Pig farms	Poultry farms	Other farms	Farms total
Roughages							
Hay, domestic	1,100,000	1,016,073	75,534			8,393	83,927
Hay imported	20		18			2	20
Straw, domestic	35,700		32,130			3,570	35,700
Green fodder, domestic	34,400	5,690	25,839			2,871	28,710
Oat, imported	10,913		9,822			1,091	10,913
Silage, domestic	7,900		7,900			0	7,900
Waste potato and vegetables	3,000			3,000		0	3,000
Subtotal	**1,191,933**	**1,021,762**	**151,244**	**3,000**	**-**	**15,927**	**170,171**
Concentrates							
Waste grain, domestic	7,200		1,440	1,080	4,320	360	7,200
Waste grain, imported	5,893		295	884	4,714	-	5,893
Bran, domestic	60,000	25,289	29,504	3,471	0	1,736	34,711
Compound feed, domestic	27,100		2,981	6,504	17,344	271	27,100
Compound feed, imported	1,815		18	54	1,724	18	1,815
Subtotal	**102,007**	**25,289**	**34,238**	**11,993**	**28,102**	**2,385**	**76,718**
Other							
Hand-made fodder	38,100	38,100					
Natural saline	105,600	95,040					10,560
Subtotal	**143,700**	**133,140**					**10,560**
Total	**1,437,641**	**1,180,192**	**185,481**	**14,993**	**28,102**	**18,312**	**257,449**

* Including the amounts distributed as emergency assistance from local government reserves.

If measured in monetary value, the total fodder consumption of pastoral herders (incl. consumption of hay and bran reserves of local governments) in 2016 was MNT 232.8 billion. Herders' share in total fodder consumption was 70.5% and that of local governments 2 percent. The value of the fodder

consumption of intensified livestock farms was MNT 88.1 billion. This equalled a 27.5% share in the total fodder consumption. Within the intensified livestock farms, dairy and beef farms accounted for 58%, pig farms for 10% and poultry farms for 27% of the total value of fodder consumption, respectively. Dairy and beef farms spent an estimated MNT 49.9 billion, pig farms MNT 8.8 billion and poultry farms MNT 23.4 billion on fodder in 2016 (Table 4.4).

Table 4.4: Structure of fodder consumption in monetary value

Fodder	Total consumption, MNT million	Herders' consumption, MNT million	Consumption of intensified livestock farms, MNT million				
			Dairy and beef farms	Pig farms	Poultry farms	Other farms	Farms total
Roughages							
Hay, domestic	220,000	203,215	15,107			1,679	16,785
Hay imported	1.902		2			0	2
Straw, domestic	3,570		3,213			357	3,570
Green fodder, domestic	8,600	1,422	6,460			718	7,178
Oat, imported	4,469		4,022			447	4,469
Silage, domestic	1,975		1,975			0	1,975
Waste potato and vegetables	600			600		0	600
Subtotal	**239,216**	**204,637**	**30,778**	**600**	**-**	**3,200**	**34,579**
Concentrates							
Waste grain, domestic	2,160		504	378	1,512	126	2,520
Waste grain, imported	1,703		85	255	1,362		1,703
Bran, domestic	33,000	13,909	16,227	1,909		955	19,091
Compound feed, domestic	25,352		2,236	5,528	17,344	244	25,352
Compound feed, imported	3,320		33	100	3,154	33	3,320
Subtotal	**65,534**	**13,909**	**19,085**	**8,170**	**23,372**	**1,358**	**51,985**
Other							
Hand-made fodder							
Natural saline	15,840	14,256					1,584
Subtotal	**15,840**	**14,256**					**1,584**
Total	**322,238**	**232,802**	**49,864**	**8,770**	**23,372**	**4,558**	**88,148**

Since hand-made fodder is exclusively prepared and consumed by herders and the consumption of natural saline is irrelevant for energy-based fodder balancing in the next chapter, the following analysis is focused on the consumption of roughages and concentrates.

The combined total value of roughages and concentrates consumed in 2016 was MNT 305 billion. Herders' consumption accounted for 71.7% and the consumption of intensified livestock farms for 28.3 percent. The consumption of dairy and beef farms accounted for 16.3% of the total consumption and 57% of the consumption in the intensified livestock farming sector. Next to dairy and beef farms, poultry farms consumed fodder worth MNT 23.2 billion, and contributed 27% of the fodder consumption of all intensified livestock farms and 8% of the total fodder consumption (Figure 4.1).

Total roughage consumption in 2016 was worth MNT 239.2 billion. The market for roughages is dominated by herders, whose consumption, including the value of hay distributed from local government reserves, totalled MNT 204.6 billion or 85.5% of the total consumption. Intensified livestock

farms, on the other hand, contributed 14.5% of the total roughage consumption with a combined consumption worth MNT 34.6 billion. Within the monetary value of roughage consumption in the intensified livestock farming sector, dairy and beef farms accounted for 89%, pig farms for 1.7% and goat and horse farms and sheep fattening operations for a combined 9.3 percent. The share of beef and dairy farms in total roughage consumption in Mongolia was 12.9 percent (Figure 4.2).

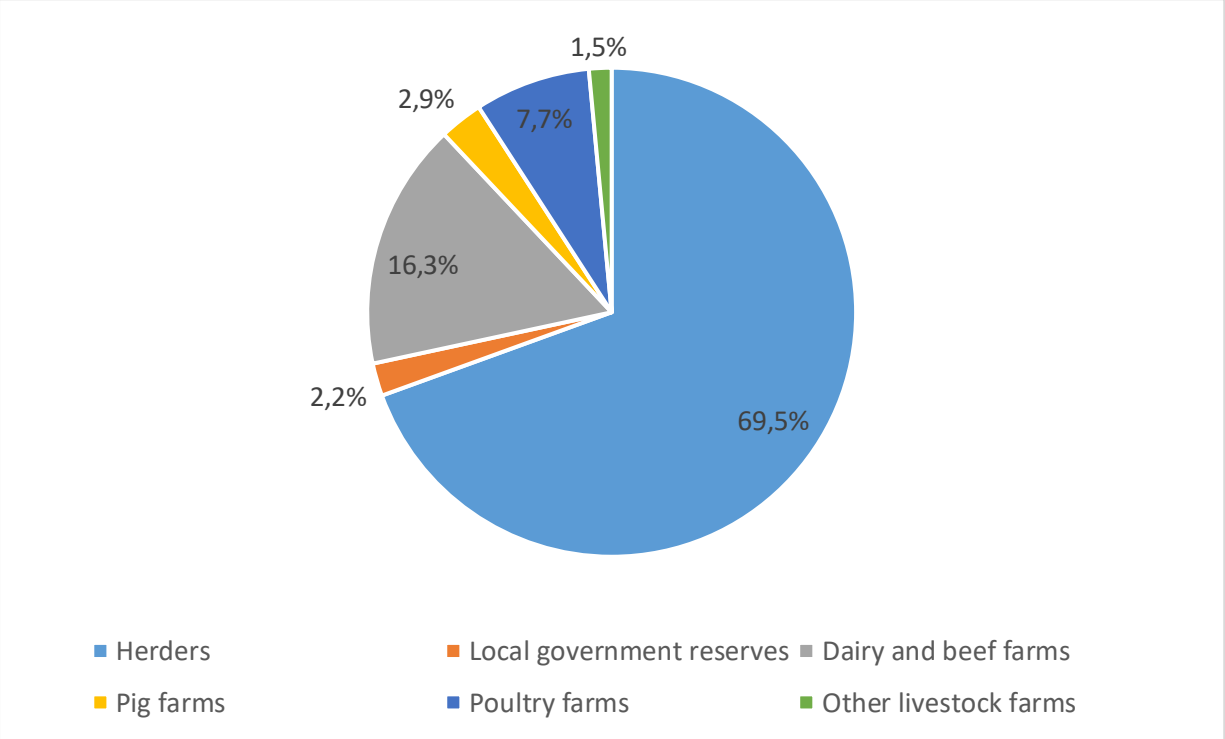

Figure 4.1: Structure of total consumption of roughages and concentrated fodder measured in monetary value (2016 data)

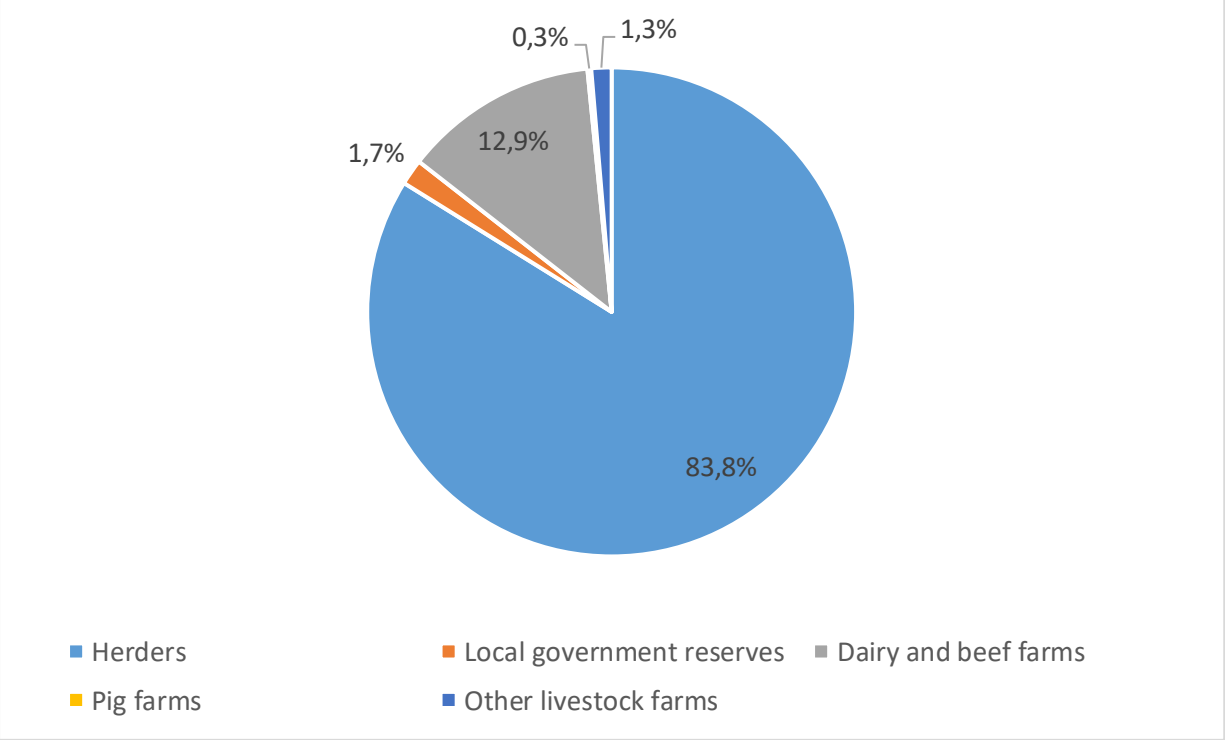

Figure 4.2: Structure of roughage consumption measured in monetary value (2016 data)

Total consumption of concentrated feed was worth MNT 65.9 billion in 2016. Unlike the roughage market, the market for concentrates is clearly shaped by the consumption of intensified livestock farms. Herders' bran consumption accounted for 21.1%, compared to a 78.9% percent combined contribution of intensified livestock farms. Poultry farms are the biggest consumer of concentrated feed. The concentrate consumption of poultry farms in 2016 totalled MNT 23.4 billion and equalled a 35.3% share in the total consumption. Next to poultry farms, dairy and beef farms consumed concentrates worth MNT 19.1 billion, compared to a MNT 13.9 billion consumption of herders. Pig farms spent approx. MNT 8.2 billion on concentrates, accounting for 15.7% of the concentrate consumption in the intensified livestock farming sector and 12.4% of the total consumption of concentrates in Mongolia. The combined concentrate consumption of goat and racehorse farms and sheep fattening operations was approx. MNT 1.4 billion (Figure 4.3).

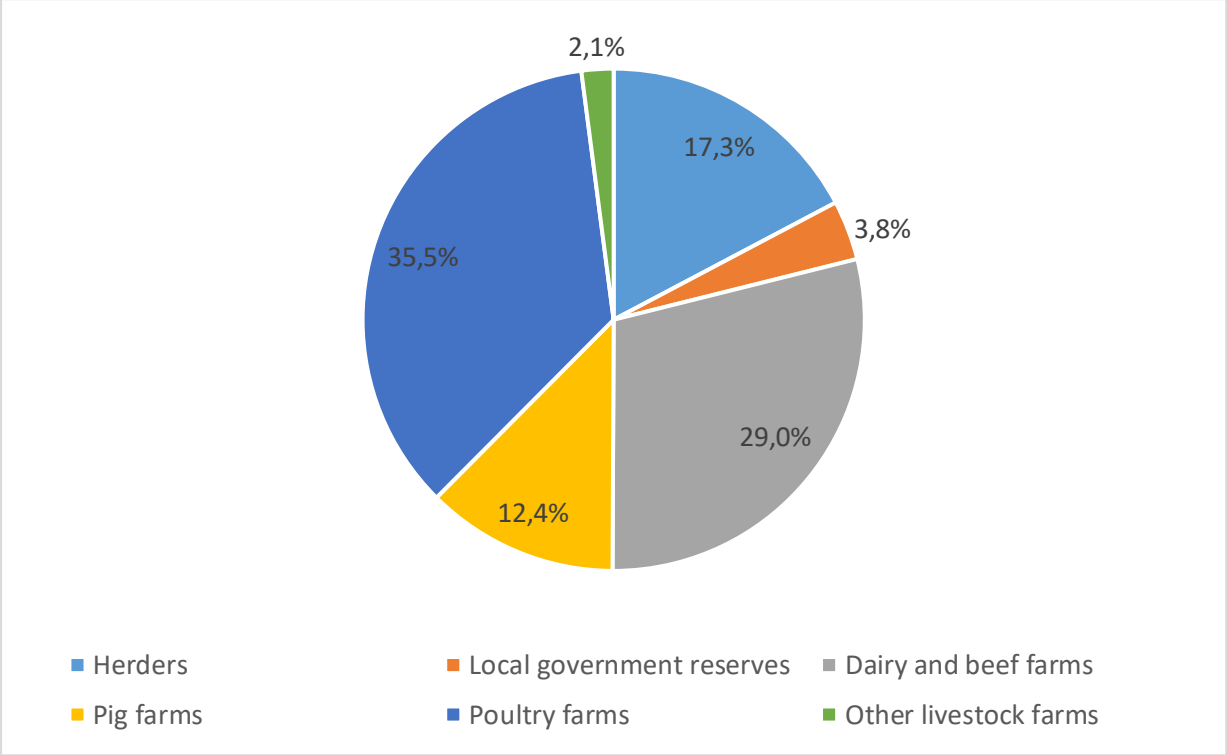

Figure 4.3: Structure of concentrated fodder consumption measured in monetary value (2016 data)

The total 2016 consumption of industrial fodder, consisting of bran and compound feeds, was MNT 61.7 billion. The shares of herders and intensified livestock farms in the total consumption were 23% and 77%, respectively. The biggest consumers were poultry farms with a 33% share (MNT 20.5 billion) in total consumption, followed by dairy and beef farms (MNT 18.5 billion). The industrial fodder consumption of pig farms was worth MNT 7.5 billion (Figure 4.4).

Total bran consumption in 2016 was MNT 33 billion. Dairy and beef farms consumed bran worth MNT 16.2 billion and contributed 49% of the total consumption, followed by herders with a 42% contribution, which includes the consumption of bran distributed by local governments as emergency assistance. Pig farms spent an estimated MNT 1.9 billion on bran purchase, and contributed 6% to the total consumption (Figure 4.5).

Compound feeds are only consumed by intensified livestock farms. The 2016 total supply was 28.9 thousand tons, worth MNT 28.7 billion. Poultry farms are the biggest consumers of mixed concentrates, followed by pig farms. The combined share of poultry and pig farms in the total consumption of mixed concentrates in 2016 was 91 percent. Estimated amounts of consumption by poultry and pig farms were approx. 19.1 thousand tons and 6.6 thousand tons, or in monetary value, MNT 20.5 billion and MNT 5.6 billion, respectively. Dairy and beef farms consumed approx. 3000 tons of compound feeds worth MNT

2.3 billion, hence contributing 8% of the total consumption. Goat and racehorse farms and sheep fattening operations accounted for the remaining 1% of the compound feed consumption (Figure 4.6).

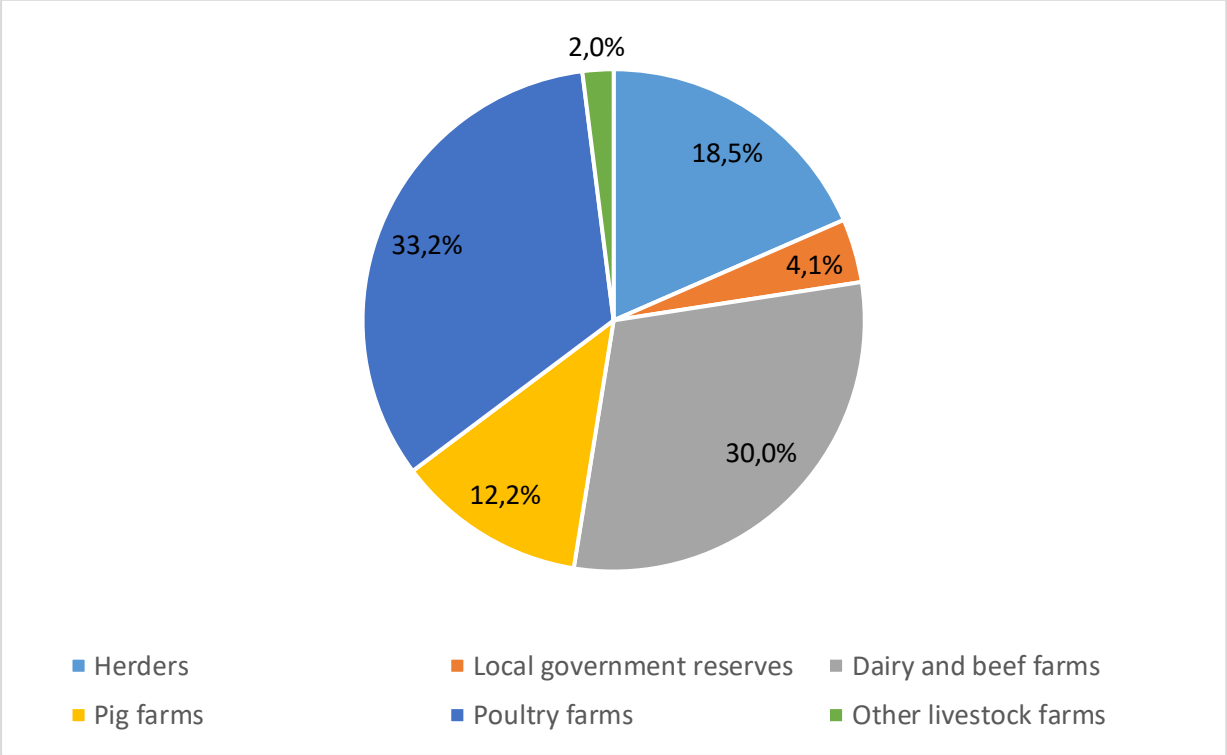

Figure 4.4: Structure of industrial fodder consumption measured in monetary value (2016 data)

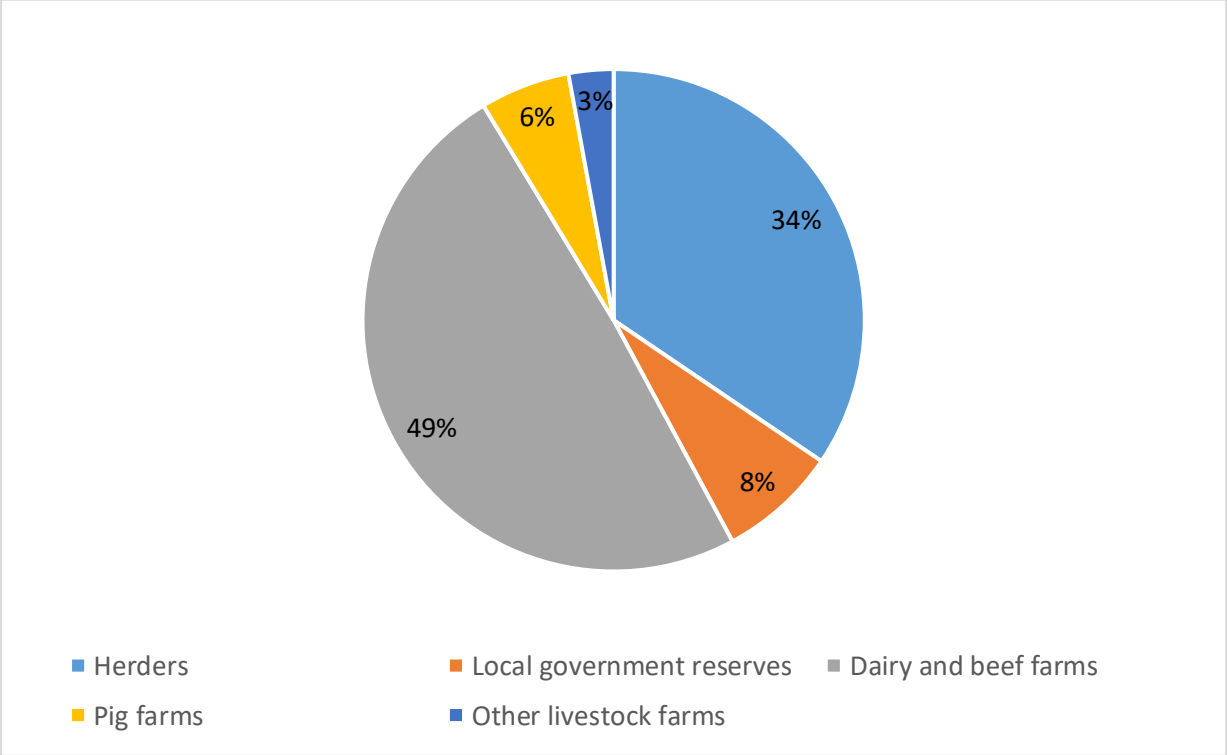

Figure 4.5: Structure of bran consumption measured in monetary value (2016 data)

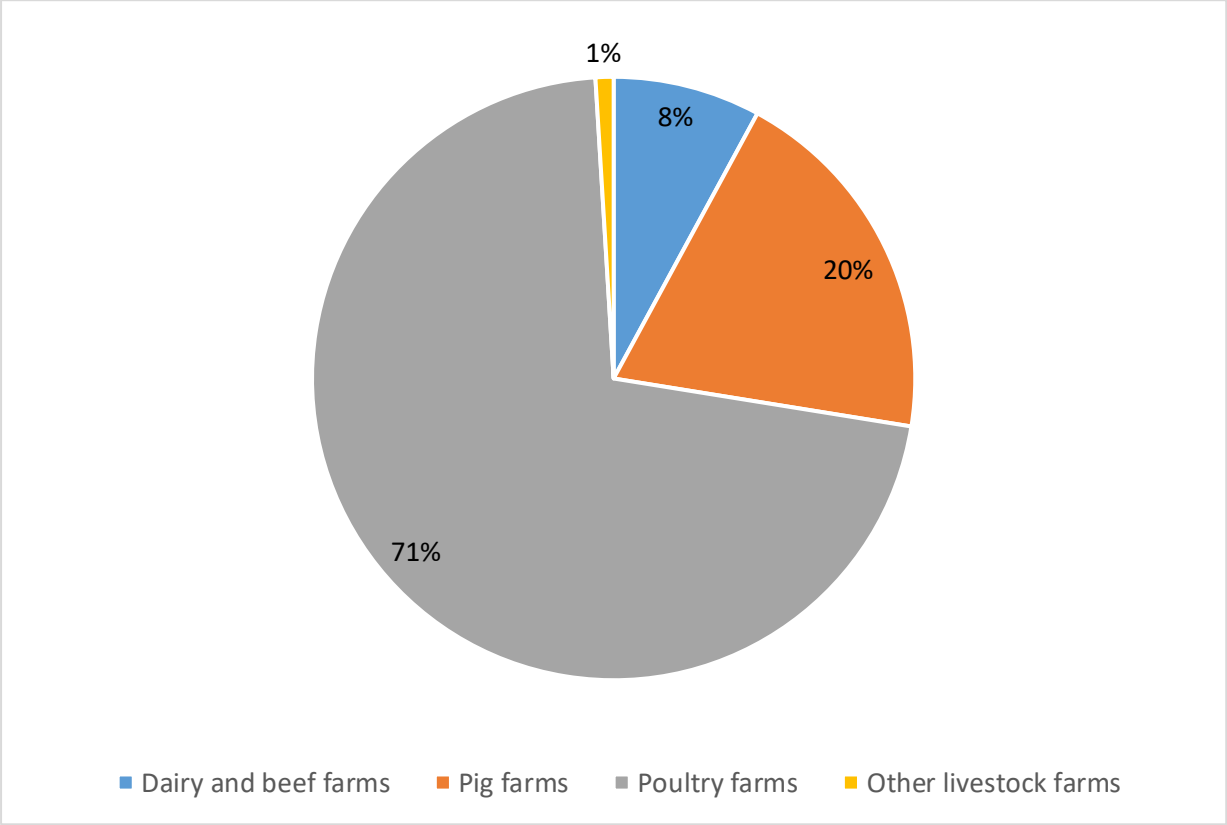

Figure 4.6: Structure of compound feed consumption measured in monetary value (2016 data)

5. Potential for additional fodder consumption

5.1 Potential fodder demand in intensified livestock farming

Due to the relatively neglectable role of goat and racehorse farms and sheep fattening operations in the fodder market the analysis in this section is focused on fodder balancing in dairy, beef, poultry and pig farming. Also, hand-made fodder and natural saline are excluded from the analysis since hand-made fodder is not used by intensified livestock farms and the consumption of natural saline is not relevant for energy-based fodder balancing in section 5.1.2.

5.1.1 Current pattern of fodder consumption

Gross amounts of fodder consumption by intensified livestock farms were estimated in section 4.3, Table 4.3. Considering transportation and storage losses, varying from 5 percent for packaged fodder to 15 percent for unpackaged fodder that are supplied in large amounts such as hay, straw and green fodder, the net amount of consumption is approx. 216.6 thousand tons in total, consisting of 145 thousand tons of roughages and 71.6 thousand tons of concentrates (Table 5.1).

Table 5.1: Net total amounts of fodder consumed by intensified livestock farms in 2016

Fodder	Gross amounts consumed, t	Transportation and storage losses, %	Net amounts consumed, t
Roughages			
Hay, domestic	83,927	15%	71,338
Hay imported	20	15%	17
Straw, domestic	35,700	15%	30,345
Green fodder, domestic	28,710	15%	24,404
Green fodder, imported	10,913	15%	9,276
Silage, domestic	7,900	10%	7,110
Waste potato and vegetables, domestic	3,000	15%	2,550
Roughages subtotal	**170,171**		**145,040**
Concentrates			
Waste grain, domestic	7,200	15%	6,120
Waste grain, imported	5,893	15%	5,009
Bran, domestic	34,711	5%	32,975
Compound feed, domestic	27,100	5%	25,745
Compound feed, imported	1,815	5%	1,724
Concentrates subtotal	**76,718**		**71,573**
Total	**246,889**		**216,613**

The net amounts of fodder consumption by dairy and beef, pig and poultry farms in 2016 were determined using estimated percental shares of these farms in the total fodder consumption in the intensified livestock farming sector (cf. section 4.2, Table 4.2). Accordingly, dairy and beef cattle were consumed approx. 129 thousand tons of roughages and 32.4 thousand tons of concentrates. Pigs consumed 2550 tons of roughages and 11.2 thousand tons of concentrates. Poultry feeding involves the consumption of 25.8 thousand tons of concentrates. Total net amounts of roughages and concentrates consumed by dairy, beef, pig and poultry farms were approx. 131.5 thousand tons and 69.3 thousand tons, respectively (Table 5.2).

Table 5.2: Net amounts of fodder consumption by dairy, beef, pig and poultry farms in 2016

Fodder	Estimated net amounts of fodder consumption, t			
	Dairy and beef farms	Pig farms	Poultry farms	Total
Roughages				
Hay, domestic	64,204			64,204
Hay imported	15			15
Straw, domestic	27,311			27,311
Green fodder, domestic	21,963			21,963
Green fodder, imported	8,349			8,349
Silage, domestic	7,110			7,110
Waste potato and vegetables, domestic		2,550		2,550
Roughages subtotal	**128,952**	**2,550**	**-**	**131,502**
Concentrates				
Waste grain, domestic	1,224	918	3,672	5,814
Waste grain, imported	250	751	4,007	5,009
Bran, domestic	28,029	3,298		31,326
Compound feed, domestic	2,832	6,179	16,477	25,488
Compound feed, imported	17	52	1,638	1,707
Concentrates subtotal	**32,353**	**11,197**	**25,794**	**69,343**
Total	**161,305**	**13,747**	**25,794**	**200,846***

* The balance between the totals in Table 5.1 and 5.2 is the net amount of fodder consumption by goat and racehorse farms and sheep fattening operations.

For analysing the patterns of fodder consumption in each segment of intensified livestock farming (dairy and beef farms, pig farms and poultry farms) as well as for comparative fodder balancing we used metabolizable energy (ME) as the common denominator[9]. Metabolizable energy is broadly defined as the amount of energy that is left from the total digestible amount of energy intake after deducting energy losses through defecation and urination, and in the case of ruminants, also through methane emission (Kirchgessner, 2004). While metabolizable energy can be expressed in both Joules and calories the unit used in this study is Megajoule (MJ).

The combined energy supply from fodder for dairy and beef cattle, pig and poultry at intensified farms 2016 was approx. 1.3 billion MJ ME. Energy supply from roughages[10] and concentrates accounted for 48 and 52 percent, respectively, whereas hay as the major roughage accounted for 61% of the total energy supply from roughages and 29% of the total supply from roughages and concentrates. Dairy and beef cattle accounted for 68%, and pigs and poultry for 12% and 20% of the total energy supply, respectively (Table 5.3).

Roughage feeding of dairy and beef cattle (excluding grazing) provided 605.2 million MJ ME in 2016. This equalled 67% of the total energy intake from fodder of the nearly 76 thousand dairy and beef cattle. Energy intake of pigs from roughages (mainly waste potato and vegetables) was approx. 31 million MJ ME (Figure 5.1).

[9] ME supply from the same fodder is different for cattle, pigs and poultry. This is considered in the calculations using the ME sheet in Appendix 9.1.

[10] The term „Roughages“ in this analysis only refers to roughages fed to animals, and excludes the roughage intake through grazing.

Table 5.3: Total energy intake of dairy and beef cattle, pigs and poultry in 2016

Fodder	Estimated total energy intake, MJ ME			
	Dairy and beef cattle	Pigs	Poultry	Total
Roughages				
Hay, domestic	385,225,464			385,225,464
Hay imported	91,800			91,800
Straw, domestic	133,821,450			133,821,450
Green fodder, domestic	50,516,020			50,516,020
Green fodder, imported	19,201,663			19,201,663
Silage, domestic	16,353,000			16,353,000
Waste potato and vegetables, domestic		31,008,000		31,008,000
Roughages subtotal	**605,209,398**	**31,008,000**	**-**	**636,217,398**
Concentrates				
Waste grain, domestic	12,240,000	9,180,000	29,376,000	50,796,000
Waste grain, imported	2,504,372	7,513,116	32,055,960	42,073,448
Bran, domestic	249,457,075	30,666,898		280,123,973
Compound feed, domestic	28,456,340	77,608,200	186,259,679	292,324,218
Compound feed, imported	173,235	649,633	18,514,542	19,337,410
Concentrates subtotal	**292,831,022**	**125,617,846**	**266,206,181**	**684,655,049**
Total	**898,040,420**	**156,625,846**	**266,206,181**	**1,320,872,447**

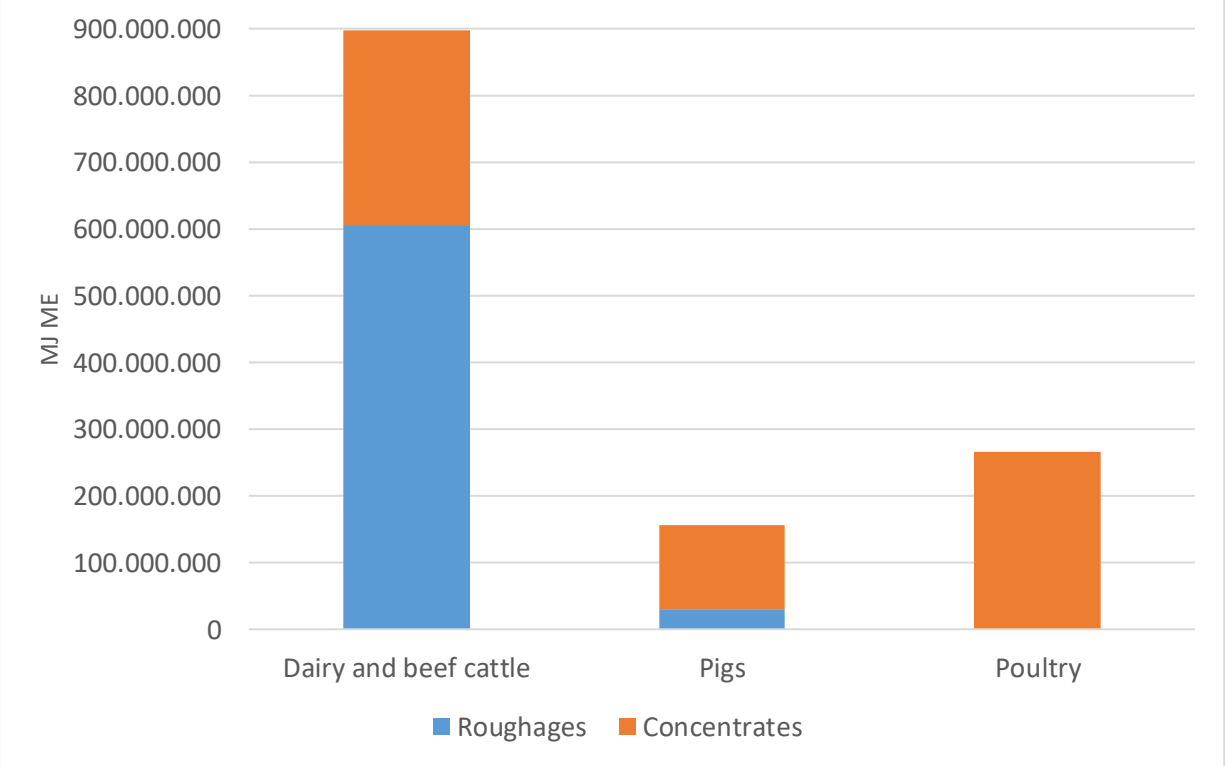

Figure 5.1: Structure of fodder consumption of dairy and beef cattle, pigs and poultry, measured in ME supply, by type of fodder (2016 data)

Roughage rations of dairy and beef cattle are basically hay rations, partly supplemented by small amounts of straw and/or green fodder. Silage is made by a few large farms with integrated cropping, and only contributes 3% of the total energy intake of dairy and beef cattle (Figure 5.2).

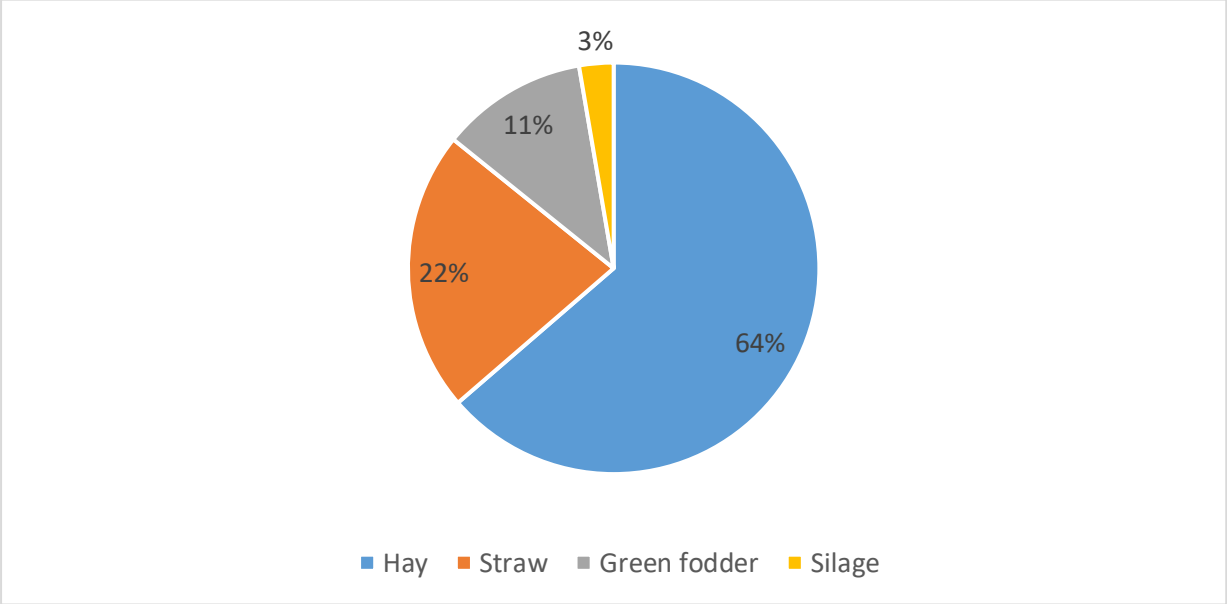

Figure 5.2: Structure of roughage consumption of dairy and beef cattle, measured in ME supply, by type of fodder (2016 data)

Concentrates supplied 33% of the total energy intake of dairy and beef cattle in 2016. The main concentrate fed to cattle is bran. At many small- and medium-sized dairy and beef farms bran is the only concentrate used. Larger dairy and beef farms, on the other hand, enrich bran rations with waste grain and compound feed. Waste grain as a concentrate is primarily used by farms with fodder cropping and crop farms with integrated dairy and beef farming operations. The combined amount of waste grain and compound feed fed to dairy and beef cattle in 2016 contributed 14.8% of the total energy intake from concentrates (Figure 5.3).

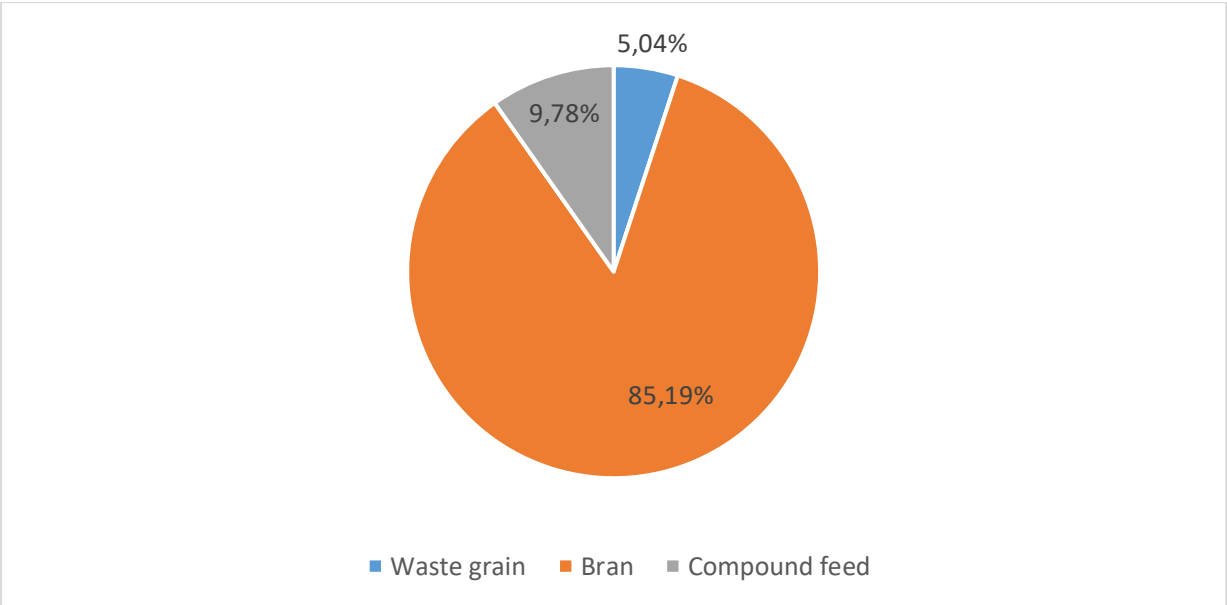

Figure 5.3: Structure of concentrates consumption of dairy and beef cattle, measured in ME supply (2016 data)

For pigs, concentrate consumption provided 80% of the total energy intake in 2016. The composition of concentrate rations primarily depends on the financial capacity of pig farms. While the rations at smaller farms tend to be dominated by bran and waste grain larger farms rather use compound feed. Overall, compound feed accounted for 62.3% of the total energy intake from concentrates, bran for 24.4% and waste grain for 13.3% (Figure 5.4).

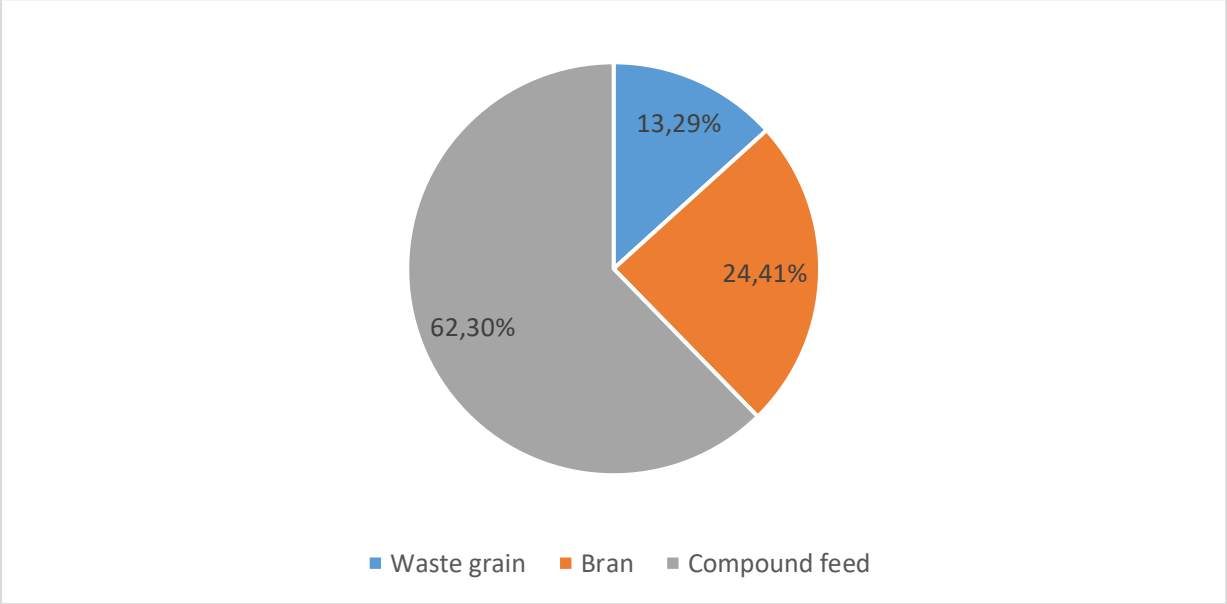

Figure 5.4: Structure of concentrates consumption of pigs, measured in ME supply (2016 data)

Poultry farms are the main consumers of imported concentrates. Also, an estimated 64% of compound feeds from domestic production is used in poultry feeding. Waste grain is widely used as a supplementary concentrate. In 2016, compound feed and waste grain accounted for 77% and 23% of the total energy intake of poultry, respectively % (Figure 5.5).

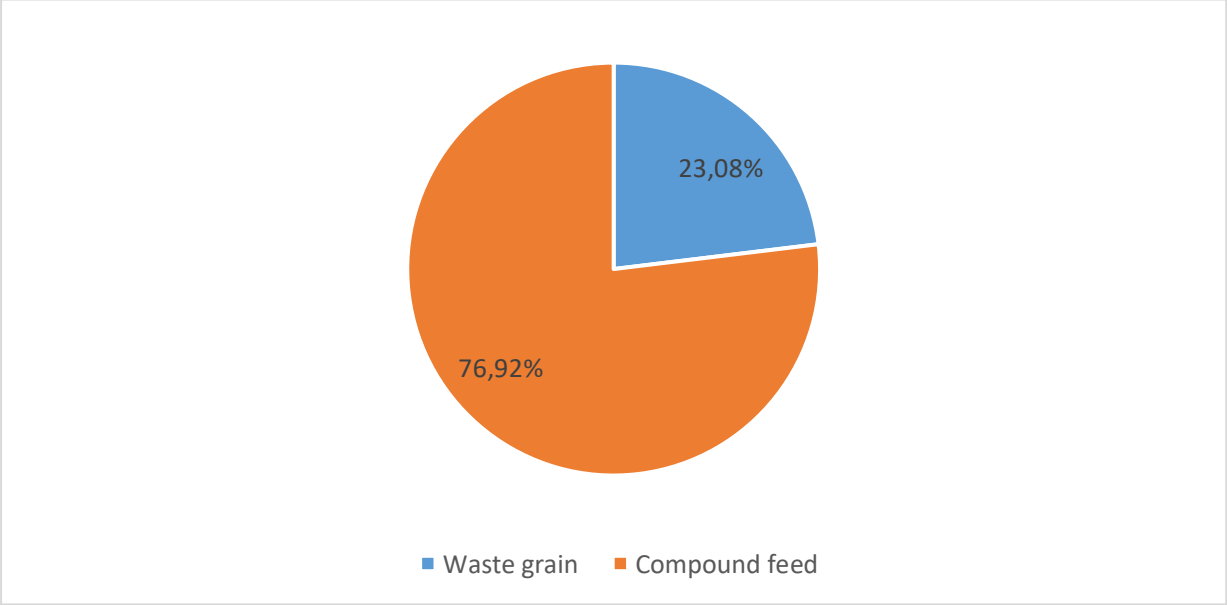

Figure 5.5: Structure of concentrates consumption of poultry, measured in ME supply (2016 data)

5.1.2 Current fodder balance

Fodder balancing in this section is based on balancing of ME requirements and supply of fodder consumption at dairy and beef cattle, pigs and poultry farms as these farms constitute 93% of total fodder consumption in the intensified livestock farming sector, hence presenting the main segments in the intensified livestock farming sector for the domestic fodder market (cf. section 5.1.1). Hence the term “intensified farms” in this section and following sections will refer to these four types of farms.

Energy (ME) requirements on fodder consumption of intensified livestock farms, as determined in Appendix 9.3 and summarized in Table 5.4, totalled approx. 1.94 billion MJ ME in 2016.

Table 5.4: Energy requirements on fodder consumption of intensified livestock farms, MJ ME

MJ ME requirements	Dairy farms	Beef farms	Pig farms	Poultry farms	Total
Requirements on roughage consumption	576,207,843	94,248,865	47,723,919		718,180,627
Requirements on concentrate consumption	521,275,218	67,422,772	245,378,114	390,847,355	1,224,923,460
Total requirements on fodder consumption	**1,097,483,061**	**161,671,637**	**293,102,032**	**390,847,355**	**1,943,104,087**

Dairy and beef farms accounted for 65% of the total ME requirements on fodder consumption, and poultry and pig farms for 35 percent. Energy requirements on roughage consumption mainly depends on the requirements of dairy farms. In contrast, the ME requirements on the consumption of concentrated fodder can be divided into comparable combined shares dairy and beef farms (48%) on the one side and poultry and pig farms (52%) on the other (Figure 5.6).

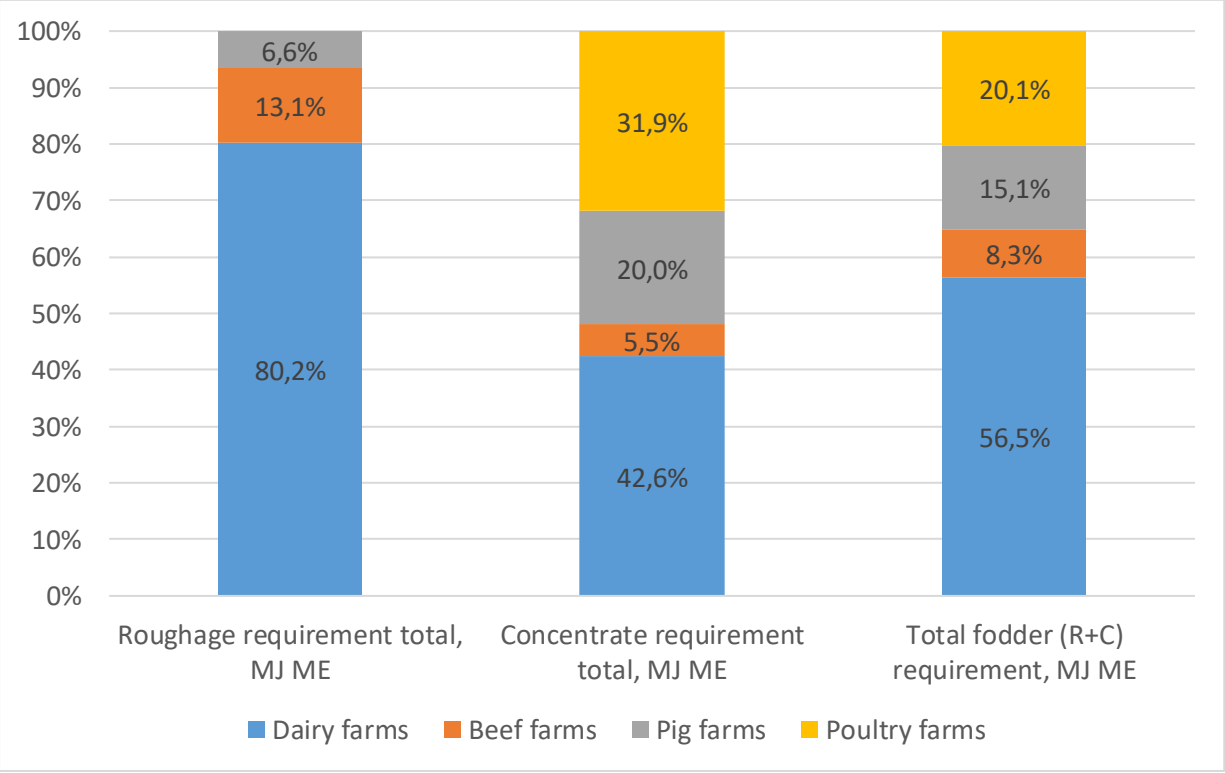

Figure 5.6: Relative shares of dairy, beef, poultry and pig farms in combined energy requirements measured in MJ ME (2016 data)

The relative shares of ME requirements on concentrate consumption in the total ME requirements range from 42% for beef farms to 100% for poultry farms. Across all farms, the ME requirements on concentrates account for 63% of the combined ME requirement on fodder consumption (Figure 5.7).

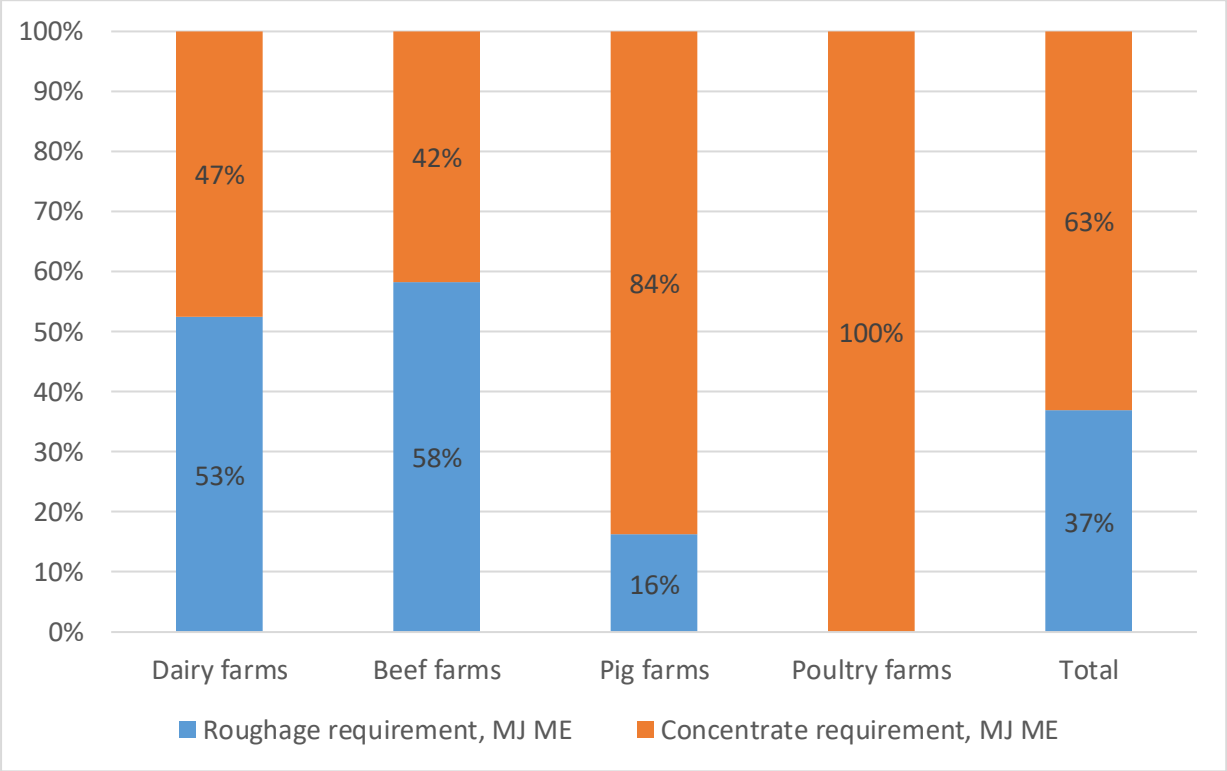

Figure 5.7: Overall structures of ME requirements of dairy, beef, poultry and pig farms on fodder consumption (2016 data)

The overall rate of fodder sufficiency (i.e. rate of supply in relation to requirements) of dairy, beef, pig and poultry farms in 2016, measured in ME values, was 68%. Highest fodder sufficiency rates of 71 and 68 percent were attained by dairy and beef farms and poultry farms, respectively. In contrast to dairy and beef farms, however, poultry farms only achieved a relatively high fodder sufficiency through consumption of a substantial amount of imported fodder. This is indicated by the domestic sufficiency rate of 55% for poultry farms in contrast to 70% for dairy and beef farms. Pig farms only reached a 53% overall fodder sufficiency (Table 5.5).

Table 5.5: Total fodder balance of dairy, beef, pig and poultry farms in 2016, expressed in MJ ME

Key figures	Dairy and beef farms	Pig farms	Poultry farms	Total
Energy supply, MJ ME				
Supply from domestic fodder	876,069,350	148,463,097	215,635,679	1,240,168,126
Supply from imported fodder	21,971,071	8,162,749	50,570,502	80,704,321
Total supply	**898,040,420**	**156,625,846**	**266,206,181**	**1,320,872,447**
Total energy requirements on fodder consumption, MJ ME	**1,259,154,699**	**293,102,032**	**390,847,355**	**1,943,104,087**
Energy balance in relation to total fodder consumption, MJ ME	-361,114,279	-136,476,187	-124,641,174	-622,231,640
Total sufficiency rate	71%	53%	68%	68%
Energy balance in relation to consumption of domestically supplied fodder, MJ ME	-383,085,349	-144,638,935	-175,211,677	-702,935,961
Domestic sufficiency rate	70%	51%	55%	64%

The energy balance for roughage consumption by dairy, beef and pig farms was approx. -82 million MJ ME. Dairy and beef farms were able to cover approx. 90% of their roughage requirements: 87% from

domestic supply (mostly hay) and 3% from imported hay and green fodder. Pig farms only consumed domestically supplied roughages and reached a 65% roughage sufficiency. The total sufficiency rate for roughage consumption across dairy, beef and pig farms was 89% and the domestic sufficiency rate was 86% (Table 5.6).

Table 5.6: Roughage balance of dairy, beef, pig and poultry farms in 2016, expressed in MJ ME

Key figures	Dairy and beef farms	Pig farms	Total
Energy supply from roughage consumption, MJ ME			
Hay, domestic	385,225,464		385,225,464
Hay imported	91,800		91,800
Straw, domestic	133,821,450		133,821,450
Green fodder, domestic	50,516,020		50,516,020
Green fodder, imported	19,201,663		19,201,663
Silage, domestic	16,353,000		16,353,000
Waste potato and vegetables, domestic		31,008,000	31,008,000
Total supply	**605,209,398**	**31,008,000**	**636,217,398**
Domestic supply	**585,915,935**	**31,008,000**	**616,923,935**
Energy requirements on roughage consumption, MJ ME	**670,456,708**	**47,723,919**	**718,180,627**
Energy balance in relation to total supply of roughages, MJ ME	-65,247,311	-16,715,919	-81,963,229
Total sufficiency rate, %	90%	65%	89%
Energy balance to in relation to domestic supply of roughages, MJ ME	-84,540,774	-16,715,919	-101,256,692
Domestic sufficiency rate, %	87%	65%	86%

In contrast to the relatively high rate of roughage sufficiency, the rate of concentrate sufficiency was only 56% in 2016. Poultry farms reached the highest concentrate sufficiency of 68%, in comparison to 50% for dairy and beef farms and 51% for pig farms. The relatively high concentrate sufficiency of poultry farms is explained by their use of a considerable amount of imported concentrates. If poultry farms had only consumed domestic concentrates, their concentrate sufficiency would have been 55%. For dairy and beef farms, on the other hand, consumption of imported concentrates only made a difference of 1% in the total concentrate sufficiency. Pig farms covered 48% of their concentrate requirements from domestic supply and another 3% from imported concentrates (Table 5.7).

In summary, fodder consumption is most balanced for dairy and beef farms. This is mainly due to the fact that approx. 60% of their roughage requirements are covered through grazing, hence deducted from the total fodder requirements. The 71% fodder sufficiency itself is essentially constituted by the consumption of hay as a cheap roughage and bran as a cheap concentrate, both available in relatively sufficient amounts.

Poultry farms have a higher fodder sufficiency compared to pig farms. This can be explained by better financial capacities of poultry farms[11] and the relatively high fodder utilization potential of poultry[12] that justifies the use of expensive imported concentrates for balancing consumption of domestically supplied concentrates in both quantitative and qualitative terms.

[11] The majority of poultry is in possession of a few large companies while pigs are equally distributed to companies and family farms (cf. section 2.1).

[12] Large poultry farms prefer importing laying hens from specialized breeding farms rather than raising own breeding herds in order to maintain a high genetic potential of poultry to utilize fodder (cf. Appendix 9.2).

Table 5.7: Concentrate balance of dairy, beef pig and poultry farms in 2016, expressed in MJ ME

Key figures	Dairy and beef farms	Pig farms	Poultry farms	Total
Energy supply from concentrate consumption, MJ ME				
Waste grain, domestic	12,240,000	9,180,000	29,376,000	50,796,000
Waste grain, imported	2,504,372	7,513,116	32,055,960	42,073,448
Bran, domestic	249,457,075	30,666,898		280,123,973
Compound feed, domestic	28,456,340	77,608,200	186,259,679	292,324,218
Compound feed, imported	173,235	649,633	18,514,542	19,337,410
Total supply	**292,831,022**	**125,617,846**	**266,206,181**	**684,655,049**
Domestic supply	**290,153,415**	**177,455,097**	**215,635,679**	**623,244,191**
Energy requirements on concentrate consumption, MJ ME	**588,697,990**	**245,378,114**	**390,847,355**	**1,224,923,460**
Energy balance in relation to total supply of concentrates, MJ ME	-295,866,968	-119,760,268	-124,641,174	-540,268,410
Total sufficiency rate	50%	51%	68%	56%
Energy balance in relation to domestic supply of concentrates, MJ ME	-298,544,575	-127,923,017	-175,211,677	-601,679,269
Domestic sufficiency rate	49%	48%	55%	51%

5.1.3 Potential for increased consumption of domestically supplied fodder

The figures presented in section 5.1.2 revealed that current fodder supply of intensified livestock farms is not sufficient. In order to meet the energy requirements of the animals the supply of roughages and concentrates, measured in ME amounts, need to be increased by approx. 14% and 49%, respectively. The goal of Mongolia's policy on fodder production, however, is to support domestic production of fodder in sufficient amounts rather than balancing fodder needs through imports. Hence, a more relevant question is how much domestically produced fodder could be absorbed by intensified livestock farms as to meet their requirements. This question is approached in this section in two different scenarios. The first scenario is that the farms retain the current compositions of their roughage and concentrate consumptions. This means, the same roughages and concentrates will be used in the same percental shares as in 2016 (cf. section 5.1.1) but in increased amounts as to exactly meet the fodder requirements of the farms (measured in MJ ME). The second scenario is that the farms use roughages and concentrates in improved rations i.e. the total supply of roughages and concentrates will increase to the level as to meet the fodder requirements of the farms but the proportions of individual roughages and concentrates are slightly modified for better nutritional quality of fodder rations.

Potential for increased consumption of domestically supplied roughages

Scenario 1: The current roughage consumption of dairy and beef farms consists of hay, straw, green fodder and silage accounting for 63.7%, 22.1%, 11.5% and 2.7% of the total energy supply from roughages, respectively. In order to fully meet their roughage requirements at this composition dairy and beef farms need approx. 167.5 thousand tons of roughages. The potential additional demand in relation to the gross amounts of roughages domestically supplied in 2016 totals 26.1 thousand tons, and consists of 8.2 thousand tons of hay, 3.5 thousand tons of straw, 13.7 thousand tons of green fodder and 852 tons of silage (Table 5.8, first part). The total requirement of pig farms for waste potato and vegetables is approx. 4617 tons. In relation to 3000 tons supplied in 2016, this involves a potential additional demand of 1617 tons (Table 5.9).

Scenario 2: Since the use of waste potatoes and vegetables in pig feeding is justified by relatively high cost-effectiveness and nutritional quality compared with possible alternatives such as silage or green fodder there is no recognizable reason to modify roughage consumption of pig farms.

As for dairy and beef farms, the goal is to balance roughage rations dominated by hay with increased green fodder and silage consumption. The problem with hay in Mongolia is its usually negative rumen nitrogen balance (RNB). Hay is mostly made in September when the crude fibre contents of pasture grass have increased in relation to protein contents, reducing the digestibility of grass and causing its RNB to turn negative. A negative RNB indicates that the actual amount of nitrogen available for rumen bacteria is less than the nitrogen amount that is theoretically available in the concerning feedstuff due to lack of digestibility of the fodder (Wiedenmann et al. 1999). This is most critical for dairy cattle as lack of protein supply caused by non-balanced hay rations is a major limitation for lactation yields of dairy cows during non-grazing seasons (Erdenebolor, 2007). In summary, supplementing hay rations with other roughages with positive RNBs such as green fodder or silage will lead to higher digestibility of the rations and increased fodder utilization, hence better growth and productivity of cattle.

Based on the above argument, yet taking into account that hay is the cheapest and most accessible roughage, we assume that the percental share of hay in the total roughage consumption of dairy and beef farms could be slightly reduced (from 63.7% to 57%) for allowing shares of green fodder and silage to increase to 16 and 5 percent, respectively. The share of straw as a common supplementary roughage, esp. in beef cattle feeding, shall stay unchanged at 22.1%. In this scenario, the total roughage requirement would be 181 thousand tons and, in relation to 2016 domestic supply amounts, the total additional demand for roughages would be approx. 40 thousand tons. This will involve additional demands for 29 thousand tons of green fodder and 7.9 thousand tons of silage (Table 5.8, second part).

Potential for increased consumption of domestically supplied concentrates

Scenario 1: In order to meet their concentrate requirements at current compositions of concentrate consumption, dairy, beef, pig and poultry farms need 133.5 thousand tons of concentrates in total. In comparison with the gross amounts domestically supplied in 2016, 13.7 thousand tons of waste grain, 33.1 thousand tons of bran and 20 thousand tons of compound feeds are additionally required.

Additional supply of waste grain and compound feed is required by all intensified livestock farms, but most relevantly by poultry farms, which currently are the main consumers of imported concentrates. Potential additional demands of poultry farms for waste grain and compound feed, shall they be fully met by domestic supply, are estimated at 8.9 thousand and 10.7 thousand tons, respectively. In comparison, the additional requirements of dairy, beef and pig farms for these concentrates total 4.8 thousand and 9.3 thousand tons, respectively.

Increased supply of bran is required by dairy, beef and pig farms, whereas dairy and beef farms account for 90% of the additional requirements (Table 5.10).

Scenario 2: Since there is no justifiable reason to modify the quantitative composition of concentrate feeding of poultry (23.1% waste grain and 76.9% compound feed) we adopt it in scenario 2.

In the case of dairy and beef farms, a major recognizable weakness in the current composition of concentrate consumption is the lack of protein-rich concentrates for balancing the negative RNB caused by overuse of hay as well as grazing in spring or late autumn that is practiced by many small and medium dairy farms and nearly all beef farms. The current overuse of bran is rather worsening the problem with the negative RNB since bran itself is also rich in crude fibre, causing a laxative effect that reduces overall fodder utilization potential of cattle (Göhl, 1982). Hence, our main assumption is that the current 85% share of bran in concentrate feeding could be reduced to 60%. Another assumption is that, given the current tendency in Mongolian crop sector to reach oversupply of wheat, availability of waste grain will increase and its price will, if not be reduced, stay constantly. Hence, the share of waste grain in concentrate feeding could be realistically increased from currently 5 percent to 15 percent.

Furthermore, the share of compound feed in concentrate feeding of dairy and beef cattle could be increased from currently 9.8% to 20% as to reduce the use of bran and to balance the negative RNB in winter feeding. In fact, compound feeds for dairy and beef cattle are the cheapest among domestically supplied compound feeds and some dairy farms have already replaced bran with compound feed. The final assumption is that protein-rich crops could be introduced in concentrate feeding of dairy and beef cattle. This assumption is supported by the fact that most farmers are actually aware of the benefits of using protein-rich crops in cattle feeding. Some larger farms have already been attempting to grow protein-rich crops. The problem, however, is that they seem to be focused on growing alfalfa, which is a protein-rich legume but does not qualify as a concentrate[13]. Hence, we assume that protein-rich crops such as rape pea or soy could take a 5% share in the overall concentrate consumption of dairy and beef farms.

As for concentrate feeding of pigs, the simplest and most reasonable goals of improving concentrate rations should be to reduce the consumption of bran, of which negative effect on fodder utilization is even stronger on monogastric animals such as pigs than on ruminants, and to introduce protein-rich crops for a balanced nutrition and enhanced gain weight of pigs. Hence, we assume that protein-rich crops could be introduced at a 5% share in overall concentrate consumption of pig farms while the shares of waste grain and compound feeds could be slightly increased from currently 13.3 and 62.3 percent to 15 and 65 percent, respectively, for reducing the current 24.4% share of bran to 15 percent.

In a final conclusion, this scenario leaves concentrate consumption at poultry farms at its current composition and involves slightly improved compositions at dairy, beef and pig farms. The total amount of concentrates required in this scenario is 131 thousand tons. Additional concentrate requirements in relation to 2016 domestic supply of concentrates total 64.4 thousand tons, and consist of 21.1 thousand tons of waste grain, 3.4 thousand tons of protein-rich crops (such as pea, rape or soy), 13 thousand tons of bran and 26.9 thousand tons of compound feed (Table 5.11).

Summary

Potential total and additional demands for roughages: Total roughage requirements of dairy, beef and pig farms are estimated between 172 thousand tons and 186 thousand tons. The potential demand of the farms for additional domestic supply of roughages, in relation to 2016 supply amounts, is anywhere between 28 and 41 thousand tons in total, and consists of up to 8.1 thousand tons of hay, up to 7.9 thousand tons of silage and 14 to 29 thousand tons of green fodder, in addition to 1617 tons of waste potato and vegetables.

Potential total and additional demands for concentrates: Total concentrate requirements of dairy, beef, pig and poultry farms are estimated between 131 and 133.5 thousand tons. The potential demand of the farms for additional domestic supply of concentrates, in relation to 2016 supply amount, is between 64 and 67 thousand tons in total, consisting of 14 to 21 thousand tons of waste grain, up to 3.4 thousand tons of protein-rich crops such as pea, soy or rape, 13 to 33 thousand tons of bran and 20 to 27 thousand tons of compound feed (Table 5.12).

Total monetary value of additional fodder requirements: At current compositions of roughage and concentrate consumption, the total additional requirements of dairy, beef, pig and poultry farms are 28 thousand tons of roughages with a combined market value of MNT 5.9 billion and 67 thousand tons of concentrates with a combined market value of MNT 41.3 billion. The total value of the additional fodder requirements is MNT 47.3 billion (Table 5.13).

[13] As an example, alfalfa hay contains approx. 101 g digestible protein for cattle per kg, compared to 192 g per kg of soy, 281 g per kg of pea and 346 per kg of rape (Kalashnikov et al. 2007).

Table 5.8: Potential for increased consumption of domestically supplied roughages by dairy and beef farms

Key figures	Composition of roughages used	MJ ME required	Gross amount required*, t	Gross amount domestically supplied, t	Potential additional demand for domestic supply
At current composition of overall roughage consumption					
Hay	63.7%	426,858,118	83,698	75,534	8,163
Straw	22.1%	148,248,671	35,594	32,130	3,464
Green fodder	11.5%	77,233,911	39,506	25,839	13,666
Silage	2.7%	18,116,008	8,752	7,900	852
Domestic supply	100%	**670,456,708**	**167,549**	**141,404**	**26,145**
At improved composition of roughage consumption					
Hay	57.0%	382,160,324	74,933	75,534	-601
Straw	22.1%	148,248,671	35,594	32,130	3,464
Green fodder	16.0%	107,273,073	54,871	25,839	29,032
Silage	4.9%	32,774,640	15,833	7,900	7,933
Domestic supply		**670,456,708**	**181,232**	**141,404**	**39,828**

* Gross amount required/supplied equals net amount plus transportation and storage losses (cf. section 5.1.1, Table 5.1).

Table 5.9: Potential for increased consumption of domestically supplied roughages by pig farms

Key figures	Composition of roughages used	Required energy supply, MJ ME	Gross amount required, t	Gross amount domestically supplied, t	Potential additional demand for domestic supply
Waste potato and vegetables	100%	47,723,919	4,617	3,000	1,617

Table 5.10: Potential for increased consumption of domestically supplied concentrates by intensified livestock farms at current compositions of concentrates used

Key figures	Composition of concentrates used	Required energy supply, MJ ME	Gross amount required, t	Gross amount domestically supplied, t	Potential additional demand for domestic supply, t
Dairy and beef farms					
Waste grain	5.0%	29,641,607	3,487	1440	2,047
Bran	85.2%	501,500,414	59,314	29504	29,810
Mixed concentrates	9.8%	57,555,970	6,029	2981	3,048
Subtotal		**588,697,990**	**68,831**	**33,925**	**34,906**
Pig farms					
Waste grain	13.3%	32,607,829	3,836	1080	2,756
Bran	24.4%	59,903,793	6,780	3,471	3,309
Compound feed	62.3%	152,866,491	12,811	6,504	6,307
Subtotal		**245,378,114**	**23,428**	**11,055**	**12,372**
Poultry farms					
Waste grain	23.1%	90,195,198	13,264	4320	8,944
Compound feed	76.9%	300,652,157	27,996	17,344	10,652
Subtotal		**390,847,355**	**41,260**	**21,664**	**19,596**
Total amounts					
Waste grain			20,587	6840	13,747
Bran			66,094	32975	33,119
Compound feed			46,836	26829	20,007
Total			**133,518**	**66,644**	**66,874**

Table 5.11: Potential for increased consumption of domestically supplied concentrates by intensified livestock farms at improved compositions of concentrates used by dairy, beef and pig farms

Key figures	Composition of concentrates used	Required energy supply, MJ ME	Gross amount required, t	Gross amount domestically supplied, t	Potential additional demand for domestic supply, t
Dairy and beef farms					
Waste grain	15%	88,304,699	10,389	1,440	8,949
Protein-rich crops	5%	29,434,900	2,567		2,567
Bran	60%	353,218,794	41,776	29,504	12,272
Compound feed	20%	117,739,598	12,334	2,981	9,353
Subtotal		**588,697,990**	**67,066**	**33,925**	**33,141**
Pig farms					
Waste grain	15%	36,806,717	4,330	1,080	3,250
Protein-rich crops	5%	12,268,906	864		864
Bran	15%	36,806,717	4,166	3,471	695
Compound feed	65%	159,495,774	13,367	6,504	6,863
Subtotal		**245,378,114**	**22,727**	**11,055**	**11,672**
Poultry farms					
Waste grain	23.1%	90,195,198	13,264	4320	8,944
Compound feed	76.9%	300,652,157	27,996	17,344	10,652
Subtotal		**390,847,355**	**41,260**	**21,664**	**19,596**
Total amounts					
Waste grain			27,983	6840	21,143
Bran			3,431		3,431
Bran			45,942	32975	12,967
Compound feed			53,697	26829	26,868
Total			**131,053**	**66,644**	**64,409**

Table 5.12: Summary of additional fodder requirements of intensified livestock farms

Key figures	At current compositions of fodder consumption, t	At improved compositions of fodder consumption, t
Roughages		
Hay	8,163	-601
Straw	3,464	3,464
Green fodder	13,666	29,032
Silage	852	7,933
Waste potato and vegetables	1,617	1,617
Roughages supply	**27,763**	**41,445**
Concentrates		
Waste grain	13,747	21,143
Protein-rich crops		3,431
Bran	33,119	12,967
Compound feed	20,007	26,868
Concentrates subtotal	**66,874**	**64,409**
Total	**94,637**	**105,854**

If the compositions of roughage and concentrate consumptions would be slightly modified/improved the combined additional roughage requirement of the farms would be 41.4 thousand tons with a market value of MNT 9.8 billion and the additional concentrate requirement would be 64.4 thousand tons with combined market value of MNT 39.8 billion. The total value of additional fodder requirements of dairy, beef, pig and poultry farms would be MNT 49.6 billion (Table 5.13).

Table 5.13: Monetary value of additional fodder requirements of intensified livestock farms

Key figures	At current compositions of fodder consumption, MNT million	At improved compositions of fodder consumption, MNT million
Roughages		
Hay	1,633	-120
Straw	346	346
Green fodder	3,417	7,258
Silage	213	1,983
Waste potato and vegetables	323	323
Roughages supply	**5,932**	**9,791**
Concentrates		
Waste grain	4,812	7,400
Protein-rich crops		1,811
Bran	18,216	7,132
Compound feed	18,299	23,500
Concentrates subtotal	**41,326**	**39,842**
Total	**47,258**	**49,633**

Additional fodder requirements of dairy and beef farms sum up to a monetary value of MNT 25 billion at current fodder rations and MNT 28 billion at improved/optimized rations. For pig farms, improvement of fodder rations would actually reduce fodder costs: the total value of additional fodder requirements would be MNT 8.1 billion compared to MNT 8.5 billion at current fodder rations. Finally, the value of additional fodder requirements of poultry farms is approx. MNT 14 billion.

5.2 Potential fodder demand in pastoral livestock production

There are various estimations and recommendations on how much fodder is needed by herders. A manual published by the Emergency Committee for Organizing Wintering of Livestock in 1978 recommends supplementary feeding of animals for 150 to 210 days in winter, and lists daily fodder rations ranging from 0.2 kg FU (see section 2.3.1 for explanation of FU) for a lamb to 6.4 kg FU for crossbred bulls. Namjim (2004) recalls the ambition of the government during the 1980s to increase domestic annual fodder production to 4 million FU in order to secure an annual supply of 80 to 90 kg FU per sheep head unit (SHU)[14]. The goal was never achieved. The highest level of domestic fodder supply ever achieved in Mongolia was 22 FU per SHU in 1985. By 1990, fodder supply per SHU dropped to 12.6 FU. During the period 1990 to 2016, according to NSO, it ranged between 5 and 11.3 FU.

Togtokhbayar et al. (2017) define 45 kg hay per animal as the mid-term goal of reaching fodder sufficiency for herders while Nyambat and Gerelkhuu (2017) estimate the total need for fodder at 1.3 million tons FU, based on a model ration of 21.6 kg FU per animal, consisting of approx. 17.35 kg FU dry hay and green fodder, 0.63 kg FU succulent fodder and 3.59 kg FU concentrates.

The underlying assumption of these recommendations for increasing fodder supply for herders is that increased supply and consumption of fodder were essential for animal survival and this was recognized by herders. Statistical figures, however, depict a different reality. In 1985, when domestic fodder supply was 22 FU per SHU, the total livestock population was 22.5 million heads, equalling 48.2 million SHU. By 2016, domestic fodder supply has dropped to 6.8 FU per SHU but the number of animals has increased to 102.8 million SHU. If we compare recent statistics (1999 to 2016), we can recognize a significant increase in the number of animals that was not affected by changes in fodder supply (Figure 5.8).

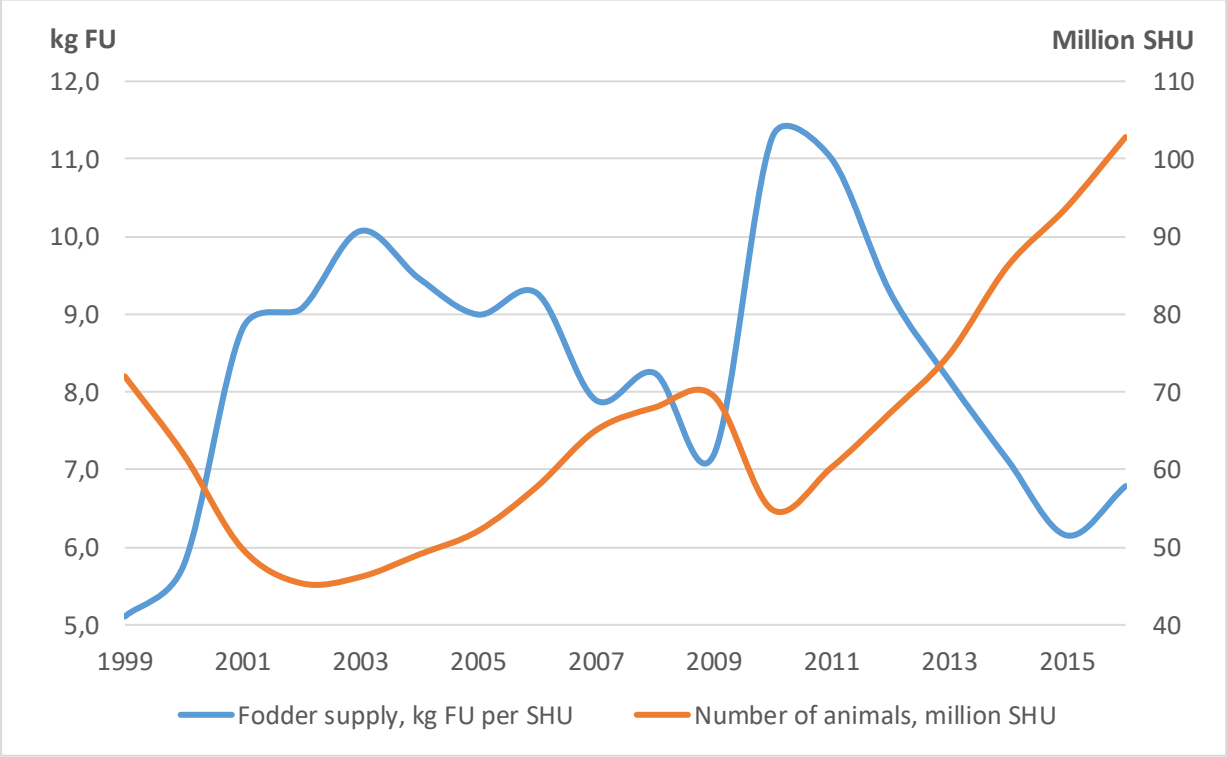

Figure 5.8: Trends in domestic fodder supply and the number of animals in the period 1999 to 2016

Source: NSO.

Rasmussen and Dorlig (2011, pp. 5) also concluded that the dzuds in 1999, 2000 and 2001 occurred because insufficient amounts of fodder were available. This conclusion, however, is not backed by

[14] Sheep head unit (SHU) conversions: 1 sheep=1 SHU, 1 goat=0.9 SHU, 1 cattle=6 SHU, 1 horse=7 SHU and 1 camel=5 SHU.

evidence. In fact, the springs 2000, 2001 and 2002 caused losses of 3.5 million, 4.8 million and 2.9 million animals, respectively. The levels of fodder supply in the preceding years 1999 and 2000 and 2001 were 5.1 FU per SHU, 5.8 FU per SHU, and 8.8 FU per SHU. The facts beg the question why in 2001 more animals died than in 2000 despite slightly increased fodder supply and why the 2002 animal losses occurred at all when there was sufficient fodder (8.8 FU per SHU is even higher than the 2016 level of fodder supply).

This is not to neglect the importance of fodder supply for animal survival of winter and spring, as confirmed by the 2010 dzud, which was far more devastating than the 2000-2002 dzud (Figure 5.9). But the fact is that a dzud is not only caused by insufficient fodder but it is the combined effect of extremely cold and stormy weather, thick snow and lack of fodder. The argument that herders need more fodder in order to avoid animal losses is correct but it will probably not suffice for making herders actually buy more fodder.

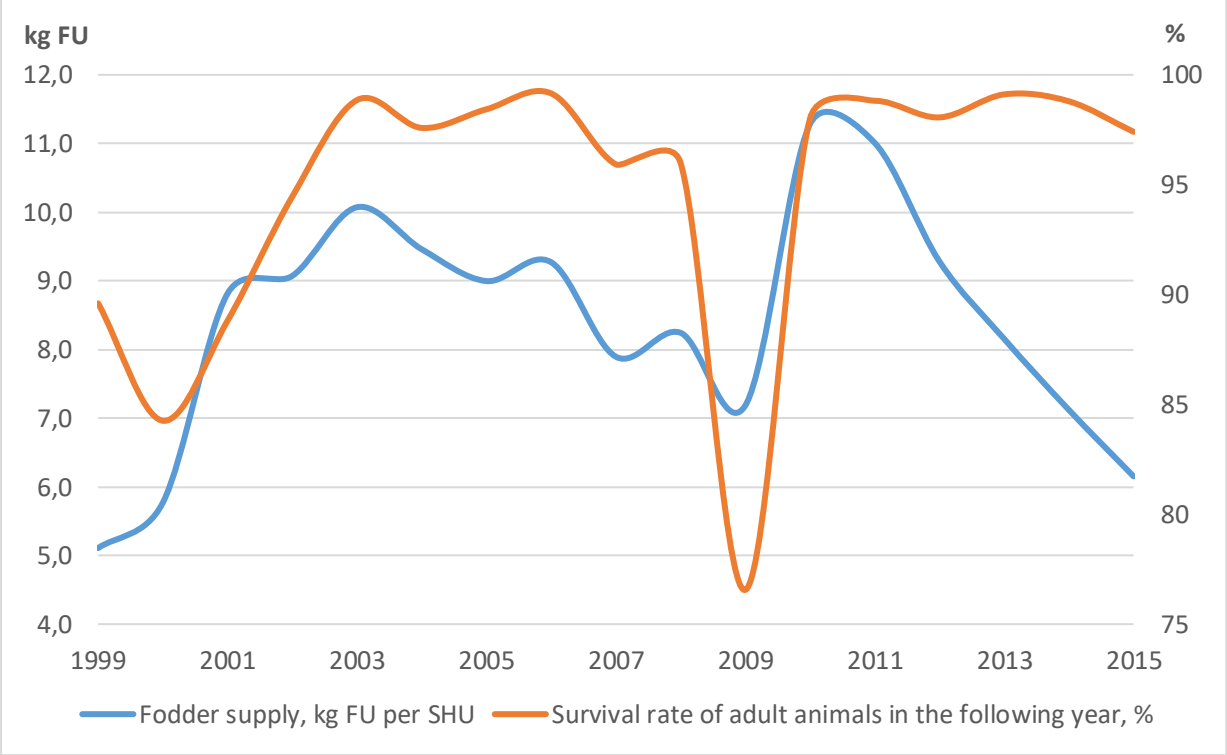

Figure 5.9: Trends in domestic fodder supply and survival of adult animals in the period 1999 to 2016

Source: NSO.

Our interviews with herders indicated that they usually prepare certain amounts of hay, hand-made fodder and natural saline as preparation for wintering. Additional fodder is only bought on a case-by-case basis when a herder recognizes the immediate danger of losing animals. When grazing in winter and spring allows the animals to survive then there is no reason for herders to buy more fodder. Overall, the function of fodder in pastoral livestock production is merely comparable with that of veterinary drugs.

At their current level of fodder consumption herders already achieved an 87% increase in the number of animals and 97 to 99 percent survival of adult animals since the 2010 dzud. Hence, it is difficult to impossible to assume that herders are willing to pay for more fodder, unless policy makers and fodder suppliers facilitate increase herders' demand through financial incentives, allocation of purebred or crossbred animals, and product promotion or similar measures. In a final conclusion, herders' fodder consumption per animal or per SHU will most likely not increase. However, as the total number of animals has been increasing at an average rate of 10% per year during the last 7 years, and will probably proceed to do so, herders' requirements can be expected to increase by approx. 20% for hay, and 10 to 15% for green fodder, and 15 to 20 percent for bran until 2020.

6. Discussion: Opportunities and challenges for domestic fodder production

6.1 Opportunities for domestic fodder production

Fodder consumption in pastoral livestock production is not likely to increase in amounts per animal, given the constant increase in number of animals and survival rates of nearly 100% of adult animals at the current level of fodder consumption. Additional demand for fodder will arise from further increase of the number of animals. Since this is likely to occur herders' total demand for hay, green fodder and bran will, in relation to fodder consumption in 2016, increase by an estimated 5 to 10 percent per year. Approximate additional demands in pastoral livestock production are 50 to 100 thousand of hay, 1 to 2.5 thousand tons of bran and 300 to 600 tons of green fodder per year. The monetary value of additional demands of herders for fodder is between MNT 7 billion and MNT 14 billion per year.

In the case of intensified livestock farms, domestic fodder supply only meets 86% of the roughage requirements and 51% of the concentrate requirements as of 2016. The total roughage requirements are estimated between 172 and 185 thousand tons and the total concentrate requirements between 131 and 133.5 thousand tons per year. Additional requirements in relation to domestic supply in 2016 are approx. 28 to 41 thousand tons of roughages and 64 to 67 thousand tons of concentrates. Total worth of fodder additionally required in intensified livestock farming is between MNT 47 and 50 billion. This involves a potential market capacity of MNT 30 to 35 billion for industrial fodder production.

Hence, the key opportunity for increasing domestic fodder production is the unsatisfied fodder requirements of intensified livestock farms. In order to actually consume more fodder as to meet their requirements, however, the intensified livestock farms will need to improve/increase their fodder rations (cf. section 6.2).

Another major opportunity for increasing domestic fodder production lies in the livestock sector policies targeting increased domestic supply of fodder. This target is expressed in policy documents such as the SAPF and the MLP, but most relevantly in the GAP 2017-2020. Government interventions planned for the period 2017 to 2020 are expected to increase industrial fodder production as well as small-scale fodder production and haymaking by herders and intensified livestock farms. Furthermore, the GAP 2017-2020 includes measures for supporting intensified livestock farms, and these measures can be seen as indirect promotion of domestic fodder production as they are expected to increase fodder consumption of existing livestock farms as well as to facilitate the establishment of new livestock farms.

Last but not least, the need to increase fodder cropping is increasingly gaining attention in crop sector policies and also among crop farms. Introduction of fodder crops incl. legumes as rotational crops in the current wheat monoculture system is planned in both the SPFA and the GAP 2017-2020, and crop farmers we interviewed confirmed that they are aware of the benefits of crop rotations in general and growing legumes in wheat rotation in particular. Partly also motivated by the meanwhile nearly satisfied domestic demand for wheat, crop farms are willing to grow fodder crops such as rape, soy, pea and white mustard but the key requirement hereby is that they should be able to sell these crops. Crop farmers are not sure whether and to whom they could sell fodder crops, and whether fodder cropping will be profitable at all.

The market capacity for fodder cropping can be estimated at different levels:

1. The 1st level is to replace imports. As of 2016, Mongolia imports approx. 11 thousand tons of oat (green fodder), 6 thousand tons of maize (grain), 12 thousand tons of waste grain (wheat and barley) and 3 thousand tons of soy expeller in addition to 26 tons of soy to a total value of MNT 14.5 billion. Hence, fodder crop growers could attain a MNT 14.5 billion additional turnover by simply supplying the amounts of green fodder, and grain and legumes for industrial fodder production that are currently imported.
2. The 2nd level is the level at which the fodder requirements of intensified livestock farms are fully met at current pattern of their fodder consumption. At this level, approx. 3.5 thousand tons of

straw, 14 thousand tons of green fodder, 852 tons of silage crops and 14 thousand tons of waste grain besides the amounts of imported soy, maize and soy expeller are additionally required. In this case, the market value of additional supply of fodder crops would be MNT 17 billion.

3. The 3rd level would be the level at which the fodder requirements of intensified livestock farms are fully met but the farms use improved fodder rations targeting balanced protein and crude fibre supply, thus better fodder utilization of animals. At this level, approx. 3.5 thousand tons of straw, 29 thousand tons green fodder, 7.9 thousand tons of silage crops, 21 thousand tons of waste grain and 3.4 thousand tons of protein-rich crops such soy, pea or rape are additionally needed. Combined with the value of imported fodder crops used in industrial fodder production the market volume for additional domestic supply of fodder crops in this case would be MNT 27 billion.

In summary, the market capacity for additional supply of fodder crops is currently MNT 14.5 billion (USD 5.8 million) but it can grow to MNT 17 to 27 billion (USD 6.8 to 10.8 million) if the fodder consumption of intensified livestock farms would increase to match their fodder requirements.

6.2 Challenges for domestic fodder production

6.2.1 Challenges for roughage supply

Mongolian roughage market is MNT 239 billion (USD 96 million), with domestic supply accounting for 98 percent. Eighty-six percent of the roughages supplied are consumed by herders and the remaining 14% by intensified livestock farms. The rate of total roughage sufficiency for intensified livestock farms in 2016 was 89% and the domestic sufficiency was 86 percent, which is relatively satisfying compared to 51% for concentrates. Intensified dairy and beef farms require up to 40 thousand tons of additional roughages, and pig farms require 1.6 thousand tons of waste potato and vegetables in order to fully meet their requirements for roughages. In addition, herders will require an additional supply of approx. 50 to 100 thousand tons of hay and 300 to 600 tons of green fodder per year in accordance with the anticipated trend of 5 to 10 percent annual increase in the number of animals in the coming years.

The most significant challenge for domestic supply of roughages is Mongolia's limited capacity for hay production in contrast to the increasing demand for hay. In this regard, the amount of hay additionally required by dairy and beef farms for their 76 thousand cattle is quite insignificant to the amount required by herders for over 61 million animals. Herders consumed 1 million tons of hay in 2016, compared to 75.5 thousand tons consumed by dairy and beef farms. As projected above, herders' hay consumption is likely to increase by up to 100 thousand tons per year. The question is whether Mongolia has the capacity to annually increase its hay production by 100 thousand tons. While empirical research is needed to provide an evidence-based answer to this question the fact that at least 65% of Mongolia's pasture land is overgrazed suggests that Mongolia's capacity for hay production from pastures is nearly exhausted. Increase in haymaking will cause additional pressure on already overgrazed pastures.

A similar conclusion can be made for use of straw in animal feeding too. One of the priorities in the crop sector, as manifested in the SPFA and the GAP 2017-2020, is to increase mulching of wheat fields in order to prevent wind erosion and reduce humus deficiencies. In fact, soil erosion, in combination with an overall shortage of humus, is a serious threat to the future of Mongolia's crop sector[15]. Hence, the need for using straw in mulching crop fields limits the possibility for increased use of straw (approx. 3.5 thousand tons) in animal feeding.

Given the above constraints in increasing the use of hay and straw in animal feeding, additional roughage requirements in the livestock sector in general and in intensified livestock farming in particular should preferably be addressed through increased domestic production of green fodder and silage.

[15] About a half of arable land is humus-poor (humus content below 2%) and 96.3% is moderately or strongly eroded (Choijamts et al. 2015).

Total supply of green fodder in 2016 was 45.3 thousand tons, including 34.4 thousand tons of domestic supply. Major consumers are dairy and beef farms (35.7 thousand tons). Herders' green fodder consumption is estimated at nearly 6 thousand tons per year. Unsatisfied green fodder requirements of dairy and beef farms as well as the anticipated increase in herders' demand by up to 600 tons per year involve market opportunities for increasing domestic supply of green fodder. Dairy and beef farms alone could absorb an additional supply of up to 29 thousand tons of green fodder. At the very least, domestic production can grow by 11 thousand tons in order to replace imports (cf. section 6.1).

As to why the existing market potential for increased domestic supply of green fodder is not utilized yet, our interviews with crop farms indicated that they are hesitant to include typical green fodder crops such as oat and barley in wheat rotation since they are not sure how beneficial a wheat-green fodder crop rotation would be, both in economic terms and for soil fertility.

On the other hand, green fodder cropping by herders and livestock farms for their own consumption has been continuously increasing. As of 2016, green fodder is grown in 20 out of 21 aimags in total. Overall, sown areas of green fodder crops increased by 105% between 2012 and 2016. All herders and farmers we interviewed confirmed that they consider green fodder as a better roughage than hay, and are willing to start growing or expand current scope of growing green fodder if they had sufficient crop land, equipment and funds.

In a final conclusion, domestic production of green fodder by herders and livestock farms is likely to increase. The main challenge in this regard is the lack of arable land and insufficient financial capacity of the latter. Yet, this is not to neglect the realistic possibility of increased green fodder production by mechanized crop farms. However, this will require that the concerns of crop farmers relating to insecure profitability and marketing of green fodder are adequately addressed e.g. through information and advice on profitability of green fodder production and facilitation of green fodder sales.

Silage production in 2016 was 7.9 thousand tons. Larger dairy and beef farms with integrated fodder cropping in the Central region (Tuv and Selenge aimag) account for 86% of silage production and consumption. Nevertheless, silage crops were also grown by smaller livestock farms in 6 other aimags on plots between 0.3 and 20 hectares. Typical silage crops include maize and sunflower, but mixed silages containing green fodder crops and perennial grasses are also common.

As of 2016, silage takes a 2.7% share in the total roughage consumption of dairy and beef farms, measured in energy supply. At this percental share, additional silage requirements dairy and beef farms are estimated at 852 tons. This is a rather insignificant amount if compared to 14 thousand tons of green fodder additionally required, for instance. In relation to the amount of 2016 silage production, however, this figure implies a potential increase of 11%. If dairy and beef farms would slightly increase their silage consumption, e.g. as a result of or reaction to the limitations of increasing hay and straw supply but also as to ensure better digestibility of roughage rations, silage production could be increased by up to 8000 tons at the current numbers of farms and animals (cf. section 5.1.3).

Insufficient silage consumption in dairy and beef farming largely results from their lack of arable land, equipment and funds. Another reason is the lack of knowledge and motivation. Most dairy and beef farmers are not trained in or informed on fodder cropping, silage making and designing of fodder rations in accordance with the nutrient requirements of cattle. The basic farm management approach of most small and medium-sized dairy and beef farms is to imitate farming methods applied by other farms nearby that they consider advanced and successful. Silage is used in cattle feeding by more or less 10 farms countrywide while most dairy and beef farmers have never fed silage to their cattle, nor have they been informed why they should use silage (instead of hay, for instance) in animal feeding. Most dairy and beef farmers simply lack the opportunity to learn silage making or experience silage feeding.

In conclusion, the challenge to provide dairy and beef farmers with know-how and motivation is as relevant as the challenge to provide them with access to land, seeds and equipment for silage production. In fact, once the majority of dairy and beef farms are willing to use silage in animal feeding they could do so even without growing silage crops by themselves. Those crops could be grown by crop farms as well, if the sales could be facilitated.

Silage can also be made and used by herders. There are a few examples of herders and herder groups preparing grass silage from pasture grasses. This practice should be supported as a strategy for improving supplementary feeding in winter. However, the relevance of silage making from pasture grasses for overall improvement of domestic fodder production is quite limited since this is merely an additional method of pasture use within the existing capacities and will not increase domestic fodder supply. Domestic fodder supply can only be increased if the amount of biomass available for animal feeding is increased.

Pig farms currently use approx. 3000 tons of waste potato and vegetables per year. An additional 1617 tons are required for balancing the roughage requirements of 35.7 thousand pigs at current level of productivity (5% mortality of sows, 30% mortality of piglets, 100 kg slaughter weight at 8 months of age). The main reason for underconsumption of roughages among pig farms is their lack of financial capacity resulting from low productivity of animals and poor farm management. Approximately a half of the pigs are raised by family farms with 253 pigs per farm on average. While incomes and expenditures of those family farms cannot be estimated without an in-depth economic analysis, which is beyond the scope of this study, MoFALI (2017) indicates that pig farms with less than 300 pigs are not likely to maintain an economically efficient and profitable operation. Hence, the major challenge for increasing roughage consumption at pig farms seems to be to increase the production capacity and profitability of family-owned pig farms with less than 300 pigs. Whereas, the 300-pig threshold refers to the currently rather poor level of productivity: if the overall productivity of pig farms would increase, e.g. animal mortality is lowered, breeding cycle and fattening period are shortened and slaughter weight is increased, a family farm with 250 pigs could be equally or even more profitable as low-productivity farm with 300 pigs.

6.2.2 Challenges for concentrate supply

The main problem regarding the supply of concentrated feed is underconsumption. Except for waste grain, the concentrates supplied (bran and compound feeds) are industrial products. Basically, as much concentrates as demanded are supplied by industrial fodder producers. The requirements are 150 to 160 thousand in total but the actual demand/consumption in 2016 was only about 100 thousand tons whereas the production capacity is of industrial production is approx. 266 thousand tons. The total market potential for additional domestic supply of concentrates is estimated between MNT 40 billion and MNT 41 billion (USD 16 to 16.5 million) but this potential will only be utilized if the consumption of intensified livestock farms and herders will increase.

The main reasons for underconsumption of concentrates, as identified through our interviews with farmers and herders in this study, include:

- Low productivity of animals, which does not justify increase in concentrate feeding;
- High prices of concentrates;
- Lack of financial capacity to increase concentrate feeding, resulting from low productivity of animals and low prices of animal products; and
- Lack of know-how.

In the case of pastoral livestock production, the issue concerning concentrate prices in relation to herder incomes actually is a minor reason for underconsumption of concentrates, compared to the overall lack in herders' motivation to use more concentrates than the amount of bran that they currently use in livestock feeding. As explained in section 5.2, herders' view of fodder is different than the view of intensified livestock farmers. For farmers, fodder is an essential input required for producing outputs. In this sense, there is no question whether they should use fodder but the question is about how much fodder they should use and how to optimize fodder rations. As for herders, fodder is merely a mean for avoiding animal losses. Fodder is only used when the immediate threat of losing animals is recognized. The argument that herders have limited funds to purchase concentrates is a half-truth. In fact, 43% of herders who have less than 200 animals in addition to about a half or even a majority of herders with

201 to 500 animals do not have any funds beyond covering their household consumption and investing a minimal amount in livestock production, incl. feeding. On the other hand, at least 30% of herders actually attain excess funds that they spend for non-agricultural purposes such as buying vehicles, mobile phones, building a house at the soum centre or buying an apartment at the aimag centre. For 22% of herders who have more than 500 animals, alone, the total amount of cash that is left after covering consumption expenses and current amounts of their agricultural expenses is approx. MNT 500 to 600 billion (cf. section 4.1). The conclusion is that herders do have money that they could spend on purchasing more fodder incl. concentrates but they prefer to spend their money on other things. They do so because they do not see reason to increase their fodder consumption after they have been able to constantly increase their animals at a 98% survival rate of adult animals since the 2010 dzud (cf. section 5.2).

This is not to neglect the importance of increasing supply and consumption of concentrated fodder in pastoral livestock production. However, this will be a long-term process requiring controlled pasture use, introduction of animal breeding services throughout the country, some level of specialization in pastoral livestock production as well as improved know-how of herders. The immediate focus of policy makers and fodder suppliers is better placed on improving roughage supply in pastoral livestock production, given the contrast of substantial hay production from pastures with the critical trend of overgrazing.

In the case of intensified livestock farming, concentrate consumption urgently needs to be increased, given the current sufficiency rates of 50% for dairy and beef cattle, 51% for pigs and 68% for poultry. The main obstacles in increasing concentrate consumption, as listed above, are briefly explored below.

Low productivity of animals at intensified livestock farms results from a range of factors. These factors include, besides insufficient breeding services[16] and limited availability and high prices of purebred breeding animals, suboptimal farming methods such as excessive grazing, and inappropriate animal housing and health care. The major reason for poor farm management is lack of know-how. Improvement of animal productivity will require increased access to breeding services such as AI and embryo transfer, imports of purebred animals leading to reduced prices of breeding animals and information and advisory services for intensified livestock farms, preferably performed on a regular basis. These challenges are partly addressed in current livestock sector policies. The most relevant progress being made is the establishment of a new National Livestock Gene Bank in Darkhan-Uul aimag, which is expected to commence its operation in 2018. The NLGB will provide livestock farms, herders and AI technicians with frozen semen, and perform embryo transfer. According to the GAP 2017-2020, the total collection of frozen semen at the NLGB will reach 30 thousand doses in 2018 and 50 thousand doses by the end of 2020. In addition, the GAP 2017-2020 allocates a MNT 1.6 billion budget for supporting AI services. Building of structural and technical capacities for improving animal genetics at intensified livestock farms, in fact, is a major priority of both the SPAF and MLP, this priority finds a proper position in the GAP 2017-2020. What is not addressed in the GAP, however, is the lack of farmers' know-how: no concrete measures are defined for improving farmers' access to information, training and advisory services.

The issue regarding limited purchasing power of intensified livestock farms cannot be generalized since the purchasing power of each farm is different. Our study suggests that, overall, poultry farms have higher purchasing power than dairy, beef and pig farms (cf. section 5.1.2). This is, among others, confirmed by the fact that compound feeds imported in 2016 were almost exclusively used in poultry feeding, whereas they were much more expensive than domestic compound feeds. For comparison, one kg compound feed of Altan Taria for poultry costs MNT 950 to 1100 while the average price of imported compound feeds was MNT 1829 per kg. Yet, the fact is that different poultry farms have different levels of purchasing power, as it is the case for dairy, beef and pig farms as well. Compared to larger farms

[16] As an example, out of nearly 40 thousand dairy and beef cows only 2100 were inseminated artificially in 2016 (MoFALI, 2017).

operated by companies (usually running other businesses at the same time) family farms are more exposed to shortage of funds and less able to cover such shortages due to limited credit security.

The need for strengthening the financial capacity of intensified livestock farms is well recognized in livestock sector policies. After having provided MNT 71 billion soft loans to intensified livestock farms between 2012 and 2016, the government intends to provide an additional MNT 9 billion between 2017 and 2020. In addition, pastoral beef and mutton production will be supported with MNT 4 billion soft credit. Moreover, a MNT 14.8 billion budget is separately planned for implementation of the SPFA and the MLP as well as a new program for supporting intensified livestock farming, and we can assume that a part of this budget will be provided as soft loans or used in facilitating soft loans from commercial banks.

Supply of soft credits to intensified livestock farms seems to be a preferred policy instrument to support the sector's development and is, in fact, essentially required, especially for family farms with limited production capacity and turnover. A part of the credits supplied to the farms is most certainly used in carrying out measures for improving animal nutrition such as haymaking, fodder cropping or purchase of commercially supplied roughages and concentrates. A certain percentage of the credits might be used in improving animal genetics and productivity as well. Yet, there is justified concern about the effectiveness of the use of those funds by farmers, given the overall lack of know-how and poor farm management. A well-informed farmer will produce much better economic outcomes out of a given amount of funds than a farmer lacking know-how and experience. This illustration directly relates to the use of concentrates in intensified livestock farming. More money spent on concentrate feeding does not necessarily result in better nutrition and productivity of animals. Concentrate rations must provide sufficient and balanced amounts of energy, protein, vitamins, minerals and microelements in accordance with the animals' requirements. Moreover, in Mongolian context, concentrate rations fed to dairy and beef cattle must balance the negative RNB caused by overuse of hay in roughage rations as well as grazing in spring or late autumn that is practiced by many small and medium dairy farms and nearly all beef farms. Hence, it is essential for farmers to be able to design appropriate fodder rations, and especially concentrate rations.

A major issue with current concentrate feeding at intensified livestock farms concerns bran feeding. Given the relative high crude fibre content of bran causing low digestibility and a laxative effect, the current 85% share of bran in concentrate feeding of dairy and beef cattle needs to be reduced as it is worsening the problem with the negative RNB. Also in pig feeding, the 24.4% share of bran in concentrate rations needs to reduced since the negative effect of bran on fodder utilization is even stronger on pigs than on cattle. Hence, this study strongly recommends reducing bran consumption in cattle and pig feeding, and increasing the use concentrates with better digestibility such as crushed grain, legumes and compound feeds, which will also provide essentially required minerals, vitamins and microelements, instead. As demonstrated in model calculations in section 5.1.3, improved concentrate rations of dairy and beef cattle and pigs will actually be less expensive than the current concentrate rations. The monetary value of additional requirements of dairy, beef and pig farms for concentrates will be approx. MNT 27.5 billion if the current rations of concentrate feeding are maintained, but it can be reduced to MNT 26 billion if the concentrate rations are slightly improved as to include small amounts of protein-rich crops and proportions of compound feeds in relation to reduced use of bran.

In a final conclusion, sufficient purchasing power of farms is an essential requirement for improving concentrate feeding of farm animals, but its effects will be limited unless the farmers are enabled to design and use appropriate concentrate rations in animal feeding. Optimization of concentrate feeding within the capacities available is as important as an overall increase in the consumption of concentrates. Policies facilitating provision of soft credits to intensified livestock farms will have a much better impact on improving animal feeding if they are accompanied with measures facilitating access of farmers to information, training, demonstrations and advisory services. Unfortunately, this is not recognized in current livestock sector policies of Mongolia. Overall, the policies are targeting individual elements influencing animal feeding, but they fail to address those elements in a context, thus ultimately missing the big picture.

The issue regarding the high prices of domestically produced concentrates is more or less subjective, given the comparably high prices of imported concentrates. Yet, it deserves political attention and a brief analysis in this study. The political issue related to this is the taxation of imported raw materials of industrial fodder production. Fodder producers who participated in our interviews requested policy makers to reduce the import taxes in order to reduce the prices of concentrates, especially against the (assumed) limited purchasing power of herders and small livestock farm.

Import taxes being a cost factor in industrial fodder production, the other side of the issue the inability of the domestic crop sector to supply those raw materials, which include maize, soy, barley and soy and rape expeller, in addition to premixes. As mentioned in section 6.1, crop farms could supply those raw materials if they could be sure that they could sell them for a profit. Also, some fodder producers indicated that they had already attempted to grow the crops required for industrial fodder production themselves, but stopped to do so because the costs of growing those crops exceeded costs of importing them instead. A good practice established by Mind Tech, which mainly uses rape expeller in concentrate production, on the other hand, is to import rape seeds and contract crop farms for growing them, instead of importing rape.

The question whether and to what extent a slight reduction in the prices of concentrates would boost sales cannot be answered without a large-scale consumer survey that is beyond the scope of this study. What the findings of this study suggest is that domestic production of fodder crops used in industrial fodder production is limited because the costs of growing those crops in Mongolia are higher than the prices that the industrial fodder producers are willing to pay, except for rape. While in-depth analysis is needed to find out what factors cause in-country production costs to be higher than import prices we assume that this issue results from the generally unfavourable agro-ecological conditions (low precipitation, low soil fertility and short vegetation period), which in combination with poor seed quality and inappropriate cropping technologies, lead to relatively low yields of fodder crops. Farmer interviews conducted in this study indicated that maize grown in Mongolia does not fully ripen and is poor in cobs. Growing of soy, which is another major raw material for industrial fodder production, is commented as generally difficult but feasible.

The need to increase fodder cropping as to supply roughages and concentrates to the herders and livestock farms as well as raw materials to industrial fodder production is well recognized at the policy level. The policy goal of including fodder crops in general and fodder legumes in particular in wheat rotations is declared in the SPFA and indicated by the target of “increasing the share of secondary crops grown in (wheat) rotations to 20% of total sown areas” that is budgeted with MNT 2 billion in the GAP 2017-2020. Additional measures defined in the GAP 2017-2020 to support fodder cropping include allocation of pesticides and fertilizers at subsidized prices (MNT 14.7 billion), utilization of abandoned arable land and acclimatization and seed multiplication of 5 fodder crop varieties (MNT 2.3 billion).

We can assume that, effective implementation required, the implementation of the above measures in the GAP 2017-2020 will have an overall positive impact on domestic fodder cropping, especially with regard to the need to replace imports of fodder crops used in industrial fodder production. What is missing in the current policy framework is an overall context. The policies seem to support fodder cropping but do not provide a clear perspective on who should buy the crops once they are grown. In fact, growing a crop is the easier part, given the modern equipment and advanced technologies applied by many crop farms. The actual challenge is to sell the crop for a profit. Hence, the policy measures targeting an increase in domestic fodder cropping will have limited impact unless they are supplemented by measures that facilitate increased demand for fodder crops. Experiences in industrialized countries demonstrate that a significant amount of biomass for industrial fodder production results from the food processing industry. Even in Mongolia, we already have a value chain model that resembles international experiences: Mind Tech contracts crop farms for rape cropping, buys the rape and produces rape oil, and then utilizes the rape expeller resulting from oil production in producing concentrated fodder. Similar value chains should be established for other fodder crops such as soy, pea and white mustard. What is critically needed is policy support for food processors that use those crops and provide the waste biomass to the fodder industry.

7. Implications

7.1 Policy implications

The following policy implications are derived from the analysis of market constraints and gaps in the policy framework of domestic supply and consumption of fodder.

1. Limit the use of hay and straw in animal feeding and promote green fodder and silage production

Increase in hay production should not be supported since it will further increase overgrazing. In intensified dairy and beef farming, the current overuse of hay also causes a negative rumen nitrogen balance, hence reducing overall digestibility of fodder rations. Straw, on the other hand, is primarily needed for mulching the crop fields. Hence, use of hay and straw in animal feeding should be repressed by increased use of green fodder in pastoral and intensified livestock production, and increased use of silage in intensified livestock farming. The key recommendations are:

- Establish emergency reserves of green fodder instead of hay at local governments (GAP 2017-2020, measure 2.34.2);
- Establish soum-level green fodder production units as public-private-partnerships (PPPs) between soum governments and herders in areas where green fodder cropping is possible, and supply a part of the yields to the emergency reserves of local governments. Test this model in selected areas in Central, Western and Eastern regions before upscaling it in other areas.
- Discontinue distribution of subsidized haymaking equipment to herders and farmers (GAP 2.25.2). Instead, distribute seeds of green fodder crops and allocate equipment and crop land for green fodder cropping to soum governments, herder cooperatives, the suggested soum-level PPPs and intensified livestock farms;
- Allocate crop land, seeds and equipment at subsidized prices to intensified livestock farms for green fodder and silage production.

2. Reward fodder cropping by crop farms

Increase in domestic fodder supply will require sustainable production and increased availability of biomass that can be used in animal feeding. Crop farms have land, equipment, know-how that can be utilized in fodder cropping. Policies should make use of this existing capacity and create incentives for crop farms to grow fodder crops in rotation with the main crop (which is usually wheat). The related recommendations are:

- Introduce different levels in subsidization of pesticides and fertilizers; reward crop farms growing fodder crops with a higher subsidization than other crop farms (GAP, 2.42.3);
- Link wheat subsidization to fodder cropping; reward wheat growers growing fodder crops in rotation with higher subsidy on wheat (GAP, 2.39.2).

3. Establish value chains of fodder crops

The goal of increasing fodder cropping is only effective if there is actual demand for fodder crops so that the crops grown can be sold at prices that allow the crop farms to make a profit. Hence, policies should aim for establishment of strong value chains of fodder crops involving multiple marketing channels. The following is recommended:

- Provide support e.g. soft credits and tax benefits to food processors that utilize nutritious fodder crops such as rape, soy and white mustard as raw materials and produce wastes that can be used in animal feeding;
- Encourage exports of the nutritious fodder crops specified above 1in the event that the amount produced exceeds the demand of domestic food processing sector, e.g. through tax benefits, but with the condition that the wastes are imported back to Mongolia for use in animal feeding;

- When providing soft credits to intensified livestock farms that do not have integrated fodder cropping, specify that a certain share (e.g. 5%) of the credit shall be spent on purchase of fodder crops from domestic crop farms. Consequently, plan the fodder purchase annually, and contract crop farms for supplying the planned amounts of crops (preferably through the MoFALI-based Fund for Supporting Crop Production);
- In the event that the suggested soum-level PPPs for green fodder production cannot be established, facilitate supply of green fodder by crop farms to the emergency fodder reserves of local governments.

4. Support existing fodder producers before creating additional production capacities

The fact that only 23 out of 53 small-scale fodder production units registered at MoFALI, most of which were subsidized, are actually used and that the industrial fodder producers are only utilizing 38% of their production capacity does not justify the plan of establishing new fodder factories and distributing more crushers, mixers and pelleting machines to herders and farmers for small-scale fodder production. Establishment of new fodder factories will not improve but rather reduce overall performance of the fodder industry since it will cause unnecessary competition among fodder producers, and possibly bankrupt some of them. The recommendations in this regard are:

- Delay the plan of establishing new fodder factories (GAP 2.34.1) until at least 50% of the existing fodder production capacity is utilized;
- Discontinue distribution of subsidized equipment for small-scale fodder production to herders and intensified livestock farms (GAP 2.25.2);
- Provide support e.g. soft credits and tax benefits to fodder producers;
- Reduce import taxes on raw materials of industrial fodder production (this should be considered as a short-term option for reducing prices of industrially produced fodder, in the long term the imports should be replaced by domestic supply).

5. Establish a functioning extension service structure

A critical target missing in the policies for increasing domestic supply and consumption of fodder is establishment of extension services to facilitate increased consumption of fodder and improved fodder rations among herders and livestock farms. The GAP 2017-2020 includes the approval of a "Law on Agricultural Extension Services" by 2019 (GAP, 3.2.36.4). This law will probably become effective in 2020. Other than, no measures with immediate impacts in the livestock sector, and on animal feeding in particular, are planned in the GAP. In view of the importance of increased access of herders and farmers to information, training and extension services as well as the urgent need to improve animal feeding as a response to the threat of overgrazing in pastoral livestock production and to the underperformance and poor management of intensified livestock farms, this study recommends the following:

- Train the livestock specialists at Animal Health and Breeding Units in all soums in providing information and advice on improving animal feeding to herders;
- Provide the AHBUs with information materials, illustrated brochures and training videos on fodder preparation and use in pastoral livestock production for use in informing and advising herders (a proven method to reach a large number of herders with information at minimal costs is to use a wandering information bag that each herder keeps for a few days before passing it to the next herder);
- Restore the former Extension Centres at the aimag Departments of Food and Agriculture, at least in crop and intensified livestock farming regions, and provide each Extension Centre with demonstration plots, small-scale equipment for fodder cropping and a training room as well as operational budget;
- Create a position at the MoFALI in charge of agricultural extension services;

- Facilitate regular training of intensified livestock farmers on fodder production and livestock feeding.
- Attest qualified and experienced specialists in fodder production, animal nutrition, animal breeding and farm management and mechanization as certified farm advisors (for intensified livestock farming);
- When providing soft credits to intensified livestock farms, specify that a certain share (e.g. 5%) of the credit shall be spent on advisory services, preferably provided by certified farm advisors;

6. Strengthen the overall institutional framework around fodder production

The issue of livestock feeding has a somewhat hybrid character in that it is relevant for both livestock and crop sectors. This involves the disadvantage that the political attention on the subject is divided between the two sectors and overshadowed by other priorities in each sector. In addition, statistics on fodder production are limitedly available and not reliable, and the policy documents such as the MLP still use the outdated and confusing Fodder Unit scale in measuring fodder production. In response to these obstacles, the following is recommended:

- Elaborate and implement a subprogram on "Livestock Fodder" within the broader framework of the SPFA;
- Promote applied research on fodder production and animal feeding through facilitation of research grants;
- Support herder and farmer cooperatives producing fodder for own consumption or contracting crop farms for growing fodder crops through soft credits and other means available;
- Collect and publish reliable statistics on fodder production;
- Discontinue using the Fodder Unit scale, and introduce energy- and protein-based fodder valuation scales at both academic and policy levels instead.

7.2 Recommendations to the German-Mongolian cooperation project „Sustainable Agriculture"

In accordance with its mandate to support sustainable agriculture in Mongolia through professional dialogue and delivery of professional advice, the German-Mongolian cooperation project "Sustainable Agriculture" (2016 to 2018) is advised to make contributions to improvement of domestic fodder production and fodder consumption in the livestock sector of Mongolia in accordance with the following recommendations:

- ***Consult MoFALI***: While the GAP 2017-2020 provides an overview of government interventions planned in the field of livestock fodder the project is advised to consult MoFALI on possible technical assistance from the project within its mandate and focal areas;
- ***Follow-up this study***: The project is advised to address selected issues from the study, which require more information and knowledge, through follow-up studies, expert consultations and related activities. Issues to be primarily addressed include the concerns of crop farms relating to insecure yield potential and economic profitability of fodder cropping, the lack of knowledge of the impacts of current overuse of hay on the humus balance of pastures, and the lack of a value chain perspective in agricultural policies aiming to promote fodder cropping.
- ***Facilitate a multi-stakeholder dialogue***: The nature of the subject of livestock fodder is such that it requires involvement of different stakeholders for an overall improvement of the current situation. The project is advised to bring together the stakeholders, such as policy makers, livestock farmers, herder cooperatives, crop farmers, local governments and industrial fodder producers to discuss challenges faced by the stakeholders, and identify options for collaboration and collective actions, possibly making use of the findings of this study. Such an effort could

provide the needed impulse for initiating a subprogram focused on livestock fodder within the broader framework of SPFA.

- ***Facilitate knowledge transfer***: Given the overall lack of know-how on the subject in the agricultural sector, the project is strongly advised to publish a reference book following the example of the KTBL-Datensammlung that is annually published in Germany in order to provide crop and livestock farmers, researchers and policy makers with relevant norms, reference values (such as energy and protein contents of different feedstuffs) and model calculations (such as gross margin calculations for crop rotations and exemplary fodder rations for different animals) for fodder cropping and animal feeding. The suggested reference book could be also published in electronic form, readable on computers, tablets and smart phones as to allow farmers to access it on their smart phones at any time and place. Further practical activities for knowledge transfer may include farmer training, training of trainers and field demonstration.
- ***Demonstrate practical steps towards improvement***: While the primary function of the project is to facilitate professional dialogue and knowledge transfer at the policy level it is advised to examine the possibility of conducting field activities with practical relevance and immediate outcomes. The issue that is currently not gaining proper political attention in the agricultural sector despite its substantial relevance for increasing domestic fodder production and improving animal feeding is the lack of agricultural extension services. The project could, for example in collaboration with the Department of Agriculture of Ulaanbaatar city or with a Farmer Association such as the Association of Milk Producers, pilot an extension service model in a selected area with concentration of intensified livestock farms. The suggested pilot will require careful designing and preparation along with a certain amount of project funds. If successfully implemented, however, it could be very useful in establishing extension as an integral part of government interventions targeting critical issues such as underconsumption of fodder among intensified livestock farms. Another pilot could be establishment of a soum-level green fodder production unit in the form of a PPP, as suggested in section 7.1. This is most feasible in cropping areas such as Selenge aimag, where the soum governments are able to use abandoned crop fields. The collaboration model is that the soum government provides the land and facilitates the sales of green fodder (primarily to local herders) while local herder cooperatives or intensified livestock farmers provide the equipment and work forces. The project, on the other hand, can facilitate the collaboration and provide the necessary know-how, possibly along with some inputs such as seeds and fertilizers. The pilot could also be implemented in collaboration with a Farmers' Association instead of a soum government. In that case, the pilot would demonstrate how small farmers could provide green fodder for themselves through collective actions. The final suggestion for a pilot is to assist IPAS in acclimatization of fodder crop varieties and seed multiplication. This activity is already planned and budgeted in the GAP 2017-2020, but IPAS might still need technical assistance from the project. Details of such a pilot and scope of type of the project's contribution need to be discussed with both IPAS and MoFALI.

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Policy documents used:

State Policy on Food and Agriculture (2015)

Mongolian Livestock Program (2010)

Action Plan for Implementation of the Government Program 2016 to 2020 (2016)

9. Appendices

9.1 Metabolizable energy contents of fodder consumed by intensified livestock farms

Table 9.1: Estimated amounts of metabolizable energy (ME) supply from roughages and concentrates consumed by intensified livestock farms in Mongolia, MJ per kg fresh mass

Fodder	ME supply for cattle	ME supply for pigs	ME supply for poultry
Pastures in forest-steppe regions (average between mid-May and mid-September)	3.20		
Hay	6.00		
Straw (wheat)	4.90	3.70	
Green fodder (oat)	2.30	1.90	
Silage (maize)	2.30	2.60	
Potato	13.08	12.16	
Waste grain (wheat)	10.00	10.00	8.00
Wheat bran	8.90	9.30	8.00
Maize grain	13.29	16.01	15.60
Barley grain	12.93	14.09	12.60
Pea	11.10	15.72	12.60
Bran pellets	9.21		
Mixed concentrates for dairy cattle*	10.47		
Mixed concentrates for beef cattle	9.63		
Mixed concentrates for pigs		12.56	
Mixed concentrates for chicken			11.30

Sources: Durst and Wittmann, 2001; Togtokhbayar et al., 2005; Kalashnikov et al., 2007; www.altantaria.mn.

* Due to lack of verifiable data on the MJ ME values of mixed concentrates imported and produced by smaller domestic manufacturers, the MJ ME values of mixed concentrates produced by Altan Taria JSC, as stated on the company's website reference values.

9.2 Estimation of population structures for dairy and beef cattle, pigs and poultry

Introduction

We conducted model calculations to simulate herd dynamics resulting from rotational delivery of offspring for each population (dairy cattle, beef cattle, pigs and poultry) in order to determine the periods, after which herd structures i.e. percental shares of sex and age classes of animals within each herd stabilize. The model calculations demonstrated that herd structures stabilize after 3 years for a given pig or poultry herd, after 5 years for a given beef cattle herd and after 6 years for a given dairy cattle herd. Hence, we assume that the herd structures in Year 4 for pigs and poultry, in Year 6 for beef cattle in Year 7 for dairy and beef cattle resulting from model calculations broadly reflect the structures of the actual populations of these animals in Mongolia as of 2016 (except for poultry, see below).

Estimated structure of dairy cattle population

The model calculations for dairy herd dynamics presented in Tables 9.6 to 9.8 are based on the following assumptions:

- The herd starts with 1000 dairy cows and 20 bulls in Year 1,
- The number of cows grows each year by the balance of annual heifer sales specified below,
- The number of bulls equals 2% of the number of cows (one bull per 50 cows)[17],
- Rates of cow and calf mortality are 5% and 10%, respectively, per year,
- Calf losses occur during the first 4 months after birth,
- New-born calves are 50% male and 50% female,
- Male calves are sold out after birth,
- Twenty percent of heifers are sold each year (10% during pregnancy and 10% after first delivery),
- Cows are culled six years after first delivery,
- Bull replacement occurs through purchase,
- Heifers deliver at the age of 30 months[18].

According to the model calculations (leading to a stabilized herd structure in Year 7), 49.34% of pure- and crossbred dairy cattle in Mongolia are cows, 0.99% are breeding bulls, 28.27% are heifers and 21.4% are calves on average in any given month. Accordingly, the average numbers of cows, bulls, heifers and calves per month were 30098; 13054; 602; 17246 and 13054, respectively, in 2016. In accordance with MoFALI's estimation (2017), 80% of these animals are crossbreeds and the remaining 20% are crossbreeds. The estimated numbers of animals in each category within the total populations of 15,250 purebred dairy cattle and 45,750 crossbred dairy cattle as of 2016 are shown in Table 9.2.

Estimated structure of beef cattle population

The model calculations for herd dynamics of beef cattle presented in Tables 9.9 to 9.11 are based on the following assumptions:

- The herd starts with 1000 breeding cows and 50 bulls in Year 1,
- The number of cows stays 1000 (as the preference of most beef farms is to quickly fatten and cull the offspring rather than keeping them for expanding the breeding herd),
- The number of bulls equals 5% of the number of cows (one bull per 20 cows),

[17] Many small and medium-sized dairy farms do not keep bulls since they make use of AI services.

[18] While purebred heifers at larger dairy farms usually deliver at the age between 24 and 28 months we used the age of 30 months as the average for the total dairy population, considering that 80% of dairy cattle are crossbreeds with relatively slow growth of heifers to reaching the body height and weight required for first insemination.

- Rates of cow and calve mortality are 5% and 80%,
- Calf losses occur during the first 12 months,
- Fattening starts at the age of 12 months,
- Male cattle are fattened for 6 months i.e. sold/culled at the age of 18 months,
- Female cattle are fattened for 8 months i.e. sold/culled at the age of 20 months,
- Cows are culled seven years after first delivery),
- Bull replacement occurs through purchase,
- Heifers for breeding herd replacement deliver at the age of 36 months.

According to the model calculations (leading to a stabilized herd structure in Year 6), 46% of (mainly crossbred) beef cattle in Mongolia are cows, 2.3% are breeding bulls, 11.83% are heifers, 21.47% are young cattle for fattening and 18.4% are calves on average in any given month. The estimated numbers of animals in each category within the total population of 14,974 beef dairy cattle as of 2016 are shown in Table 9.3.

Table 9.2: Estimated structure of dairy cattle population in 2016

Animal categories (by sex and age)	Percental share in population	Number of animals (average per month)
Purebred dairy cattle		
Cows	49.340%	7,524
Bulls	0.987%	150
Heifers in 19th to 30th month	18.178%	2,772
Heifers in 13th to 18th month	10.094%	1,539
Calves in 5th to 12th month	14.074%	2,146
Calves in first 4 months	7.326%	1,117
Purebreds subtotal		**15,250**
Crossbred dairy cattle		
Cows	49.340%	22,573
Bulls	0.987%	451
Heifers in 19th to 30th month	18.178%	8,316
Heifers in 13th to 18th month	10.094%	4,618
Calves in 5th to 12th month	14.074%	6,439
Calves in first 4 months	7.326%	3,352
Crossbreeds subtotal		**45,750**
Total		**61,000**

Table 9.3: Estimated structure of beef cattle population in 2016

Animal categories	Percental share in population	Number of animals (average per month)
Bulls	2.300%	344
Cows	46.002%	6,888
Heifers (for replacing culled cows)	11.829%	1,771
Male young cattle (for fattening)	9.200%	1,378
Female young cattle (for fattening)	12.267%	1,837
Calves	18.401%	2,755
Total		**14,974**

Estimated structure of pig population

The model calculations for pig herd dynamics presented in Tables 9.12 to 9.13 are based on the following assumptions:

- The herd starts with 1000 sows and 20 boars in Year 1,
- The number of sows stays 1000 (as the preference of pig farms is to quickly fatten and cull the offspring rather than keeping them for expanding the breeding herd),
- The number of boars equals 5% of the number of sows (one sow per 50 boars),
- Rate of sow mortality is 5% per year,
- First delivery of young sows occurs at the age of 13 months,
- One sow delivers twice a year and 14 piglets in total (7 piglets per delivery),
- Rates of piglet mortality are 10% in the first month, 10% in the second month, 5% in the third month and 5% in the fourth month after birth,
- Fattening starts at the age 4 months and an average weight of 40 kg,
- Weight gain is 0.5 kg per day on average,
- Fattening continues for 4 months and ends at the age of 8 months with a slaughter weight of 100 kg;
- Sows are culled 2 years from first delivery (after 4 deliveries in total),
- Sows died or culled are replaced by gilts from the herd while boar replacement occurs through purchase.

According to the model calculations (leading to a stabilized herd structure in Year 4), 11.52% of pigs in Mongolia are sows, 0.23% are boars, 4.75% are gilts, 44.22% are piglets and the remaining 39.27% are fattening pigs, usually between 4 and 8 months of age, on average in any given month. The estimated numbers of animals in each category within the total population of 35,704 pigs as of 2016 are shown in Table 9.4.

Table 9.4: Estimated structure of pig population in 2016

Animals categories	Percental share in population	Number of animals (average per month)
Boars	0.230%	82
Sows	11.524%	4,114
Gilts for breeding (above 4 months of age)	4.753%	1,697
Fattening pigs (above 4 months of age)	39.268%	14,020
Piglets in 4th month	10.345%	3,694
Piglets in 3rd month	10.890%	3,888
Piglets in 2nd month	10.890%	3,888
Piglets in 1st month	12.100%	4,320
Total		**35,704**

Estimated structure of poultry population

The model calculations for poultry herd dynamics presented in Tables 9.14 to 9.15 are based on the following assumptions:

- The herd starts with 1000 hens and 100 roosters in Year 1,
- The number of hens constantly grows, but the growth is limited by hen mortality and culling rates specified below,
- The number of roosters equals 10% of the number of hens (one rooster per 100 hens),

- The rate of hen mortality is 5% per year,
- Hens start laying eggs at the age of 6 months,
- The rate of culling hens per year is 100% i.e. each hen lives for one year after reaching the age of 180 days,
- Rates of chick mortality are 10% in the first month and 5% in the second month after birth,
- Hens are replaced from the herd while rooster replacement occurs through purchase.

According to the model calculations (leading to a stabilized herd structure in Year 4), 51% of the total poultry population in Mongolia should be hens, 5% roosters and the remaining 44% chicks of different ages. However, NSO statistics (2017) indicate that 80% of the poultry population are hens. Our interviews with poultry farmers also indicated that this relatively share of hens is caused by imports of live hens and chicks of advanced age, which in turn results from the high mortality and low fertility rates of domestically raised chicks in relation to the need of poultry farms for maximal utilization of production capacity. Hence, we adopted the 80% share of hens in poultry population in our overall estimation and used the model calculations for estimating the numbers of chicks in each age category. Accordingly, the estimated population structure consists hens accounting for 80%, roosters for 8%, and chicks of various ages accounting for 12 percent. The estimated numbers of animals in each category within the total population of 880,114 as of 2016 are shown in Table 9.5.

Table 9.5: Estimated structure of poultry population in 2016

Animal categories	**Percental share in population**	**Number of animals (average per month)**
Roosters	8.000%	70,409
Laying hens	80.000%	704,091
Chicks: 151st to 180th day of age	1.956%	17,214
Chicks: 121st to 150th day of age	1.966%	17,306
Chicks on 91st to 120th day of age	1.977%	17,400
Chicks on 61st to 90th day of age	1.988%	17,493
Chicks on 31st to 90th day of age	1.998%	17,588
Chicks in first 30 days	2.115%	18,613
Total		**880,114**

Table 9.6: Model calculation of herd structure of dairy cattle: Year 1

Animal categories	Key figures	Months											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Bulls	# per month	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**
Cows	# at the beginning of month	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
	Died	4	4	4	4	4	4	4	4	4	4	4	4
	Culled	14	14	14	14	14	14	14	14	14	14	14	14
	Purchased	18	18	18	18	18	18	18	18	18	18	18	18
	# at the end of month	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**
Reproduction	Cows delivered	83	83	83	83	83	83	83	83	83	83	83	83
Calves below the age of 4 months	# at the beginning of month		38	75	113	150	150	150	150	150	150	150	150
	New-born female calves	38	38	38	38	38	38	38	38	38	38	38	38
	Shifted to next age category					38	38	38	38	38	38	38	38
	# at the end of month	**38**	**75**	**113**	**150**	**150**	**150**	**150**	**150**	**150**	**150**	**150**	**150**
Calves between 5th and 12th month	# at the beginning of month						38	75	113	150	188	225	263
	Added from previous age category					38	38	38	38	38	38	38	38
	Shifted to next age category												
	# at the end of month					**38**	**75**	**113**	**150**	**188**	**225**	**263**	**300**

Table 9.7: Model calculation of herd structure of dairy cattle: Year 3

Animal categories	Key figures	Months											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Bulls	# per month	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**21**	**21**	**21**	**21**
Cows	# at the beginning of month	1000	1000	1000	1000	1000	1000	1000	1012	1024	1035	1046	1058
	Died	4	4	4	4	4	4	4	4	4	4	4	4
	Culled	14	14	14	14	14	14	14	14	14	14	15	15
	Purchased	18	18	18	18	18	18						
	Added from heifers							30	30	30	30	30	30
	# at the end of month	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1012**	**1024**	**1035**	**1046**	**1058**	**1069**
Reproduction	Cows delivered	83	83	83	83	83	83	84	85	86	87	88	89
Calves below the age of 4 months	# at the beginning of month	150	150	150	150	150	150	150	150	151	153	154	156
	New-born female calves	38	38	38	38	38	38	38	38	39	39	40	40
	Shifted to next age category	38	38	38	38	38	38	38	38	38	38	38	38
	# at the end of month	**150**	**150**	**150**	**150**	**150**	**150**	**150**	**151**	**153**	**154**	**156**	**158**
Calves between 5th and 12th month	# at the beginning of month	300	300	300	300	300	300	300	300	300	300	300	300
	Added from previous age category	38	38	38	38	38	38	38	38	38	38	38	38
	Shifted to next age category	38	38	38	38	38	38	38	38	38	38	38	38
	# at the end of month	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**301**
Heifers between 13th and 18th month	# at the beginning of month	225	225	225	225	225	225	225	225	225	225	225	225
	Added from previous age category	38	38	38	38	38	38	38	38	38	38	38	38
	Shifted to next age category	38	38	38	38	38	38	38	38	38	38	38	38
	# at the end of month	**225**	**225**	**225**	**225**	**225**	**225**	**225**	**225**	**225**	**225**	**225**	**225**
Heifers between 19th and 30th month	# at the beginning of month	225	259	293	326	360	394	428	428	428	428	428	428
	Added from previous age category	38	38	38	38	38	38	38	38	38	38	38	38
	Sold during pregnancy	4	4	4	4	4	4	4	4	4	4	4	4
	Delivered, total							34	34	34	34	34	34
	Sold after delivery							4	4	4	4	4	4
	Kept at farm after delivery							30	30	30	30	30	30
	# at the end of month	**259**	**293**	**326**	**360**	**394**	**428**	**428**	**428**	**428**	**428**	**428**	**428**

Table 9.8: Model calculation for herd structure of dairy cattle: Year 7

Animal categories	Key figures	Months											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Bulls	# per month	**28**	**28**	**28**	**28**	**29**	**29**	**29**	**29**	**29**	**30**	**30**	**30**
Cows	# at the beginning of month	1378	1388	1397	1407	1416	1426	1436	1446	1456	1466	1476	1486
	Died	6	6	6	6	6	6	6	6	6	6	6	6
	Culled	19	19	19	20	20	20	20	20	20	20	20	21
	Purchased												
	Added from heifers	34	34	35	35	35	36	36	36	36	37	37	37
	# at the end of month	**1388**	**1397**	**1407**	**1416**	**1426**	**1436**	**1446**	**1456**	**1466**	**1476**	**1486**	**1496**
Reproduction	Cows delivered	116	116	117	118	119	120	120	121	122	123	124	125
Calves below the age of 4 months	# at the beginning of month	205	206	207	209	210	212	213	215	216	218	219	221
	New-born female calves	52	52	53	53	53	54	54	55	55	55	56	56
	Shifted to next age category	51	51	51	52	52	52	53	53	53	54	54	55
	# at the end of month	**206**	**207**	**209**	**210**	**212**	**213**	**215**	**216**	**218**	**219**	**221**	**222**
Calves between 5th and 12th month	# at the beginning of month	394	396	399	402	404	407	409	412	415	418	421	423
	Added from previous age category	51	51	51	52	52	52	53	53	53	54	54	55
	Shifted to next age class	48	49	49	49	49	50	50	50	51	51	51	52
	# at the end of month	**396**	**399**	**402**	**404**	**407**	**409**	**412**	**415**	**418**	**421**	**423**	**426**
Heifers between 13th and 18th month	# at the beginning of month	284	285	287	289	290	292	294	295	297	299	301	303
	Added from calves	48	49	49	49	49	50	50	50	51	51	51	52
	Shifted to next age category	47	47	47	47	48	48	48	49	49	49	49	50
	# at the end of month	**285**	**287**	**289**	**290**	**292**	**294**	**295**	**297**	**299**	**301**	**303**	**305**
Heifers between 19th and 30th month	# at the beginning of month	509	512	516	519	523	526	529	533	536	539	542	546
	Added from previous age category	47	47	47	47	48	48	48	49	49	49	49	50
	Sold during pregnancy	4	5	5	5	5	5	5	5	5	5	5	5
	Delivered, total	38	39	39	39	40	40	40	41	41	41	41	42
	Sold after delivery	4	4	4	4	4	4	4	5	5	5	5	5
	Kept at farm after delivery	34	34	35	35	35	36	36	36	36	37	37	37
	# at the end of month	**512**	**516**	**519**	**523**	**526**	**529**	**533**	**536**	**539**	**542**	**546**	**549**

Table 9.9: Model calculation for herd structure of beef cattle: Year 1

Animal categories	Key figures	Months											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Bulls	# per month	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**
Cows	# at the beginning of month	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
	Died	4	4	4	4	4	4	4	4	4	4	4	4
	Culled	12	12	12	12	12	12	12	12	12	12	12	12
	Purchased	16	16	16	16	16	16	16	16	16	16	16	16
	Added from heifers												
	# at the end of month	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**
Reproduction	Cows delivered	83	83	83	83	83	83	83	83	83	83	83	83
Calves below 12 months (of age)	# at the beginning of month		33	67	100	133	167	200	233	267	300	333	367
	New-born males	33	33	33	33	33	33	33	33	33	33	33	33
	New-born females	33	33	33	33	33	33	33	33	33	33	33	33
	Males shifted to next age category												
	Females shifted to next age category												
	# at the end of month	**33**	**67**	**100**	**133**	**167**	**200**	**233**	**267**	**300**	**333**	**367**	**400**

Table 9.10: Model calculation for herd structure of beef cattle: Year 3

Animal categories	Key figures	Months											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Bulls	# per month	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**
Cows	# at the beginning of month	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
	Died	4	4	4	4	4	4	4	4	4	4	4	4
	Culled	12	12	12	12	12	12	12	12	12	12	12	12
	Purchased	16	16	16	16	16	16	16	16	16	16	16	16
	Added from heifers												
	# at the end of month	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**
Reproduction	Cows delivered	83	83	83	83	83	83	83	83	83	83	83	83
Calves below 12 months (of age)	# at the beginning of month	400	400	400	400	400	400	400	400	400	400	400	400
	New-born males	33	33	33	33	33	33	33	33	33	33	33	33
	New-born females	33	33	33	33	33	33	33	33	33	33	33	33
	Males shifted to next age category	33	33	33	33	33	33	33	33	33	33	33	33
	Females shifted to next age category	33	33	33	33	33	33	33	33	33	33	33	33
	# at the end of month	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**
Male cattle between 12 18 months	# at the beginning of month	200	200	200	200	200	200	200	200	200	200	200	200
	Added from calves	33	33	33	33	33	33	33	33	33	33	33	33
	Culled	33	33	33	33	33	33	33	33	33	33	33	33
	# at the end of month	**200**	**200**	**200**	**200**	**200**	**200**	**200**	**200**	**200**	**200**	**200**	**200**
Female cattle between 12 and 20 months	# at the beginning of month	267	267	267	267	267	267	267	267	267	267	267	267
	Added from calves	33	33	33	33	33	33	33	33	33	33	33	33
	Shifted to heifers	16	16	16	16	16	16	16	16	16	16	16	16
	Culled	17	17	17	17	17	17	17	17	17	17	17	17
	# at the end of month	**267**	**267**	**267**	**267**	**267**	**267**	**267**	**267**	**267**	**267**	**267**	**267**
Heifers between 20 and 36 months	# at the beginning of month	64	80	96	113	129	145	161	177	193	209	225	241
	Added from previous age category	16	16	16	16	16	16	16	16	16	16	16	16
	Delivered and shifted to cows												
	# at the end of month	**80**	**96**	**113**	**129**	**145**	**161**	**177**	**193**	**209**	**225**	**241**	**257**

Table 9.11: Model calculation for herd structure of beef cattle: Year 6

Animal categories	Key figures	Months											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Bulls	# per month	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**
Cows	# at the beginning of month	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
	Died	4	4	4	4	4	4	4	4	4	4	4	4
	Culled	12	12	12	12	12	12	12	12	12	12	12	12
	Purchased												
	Added from heifers	16	16	16	16	16	16	16	16	16	16	16	16
	# at the end of month	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**
Reproduction	Cows delivered	83	83	83	83	83	83	83	83	83	83	83	83
Calves below 12 months (of age)	# at the beginning of month	400	400	400	400	400	400	400	400	400	400	400	400
	New-born males	33	33	33	33	33	33	33	33	33	33	33	33
	New-born females	33	33	33	33	33	33	33	33	33	33	33	33
	Males shifted to next age category	33	33	33	33	33	33	33	33	33	33	33	33
	Females shifted to next age category	33	33	33	33	33	33	33	33	33	33	33	33
	# at the end of month	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**
Male cattle between 12 18 months	# at the beginning of month	200	200	200	200	200	200	200	200	200	200	200	200
	Added from calves	33	33	33	33	33	33	33	33	33	33	33	33
	Culled	33	33	33	33	33	33	33	33	33	33	33	33
	# at the end of month	**200**	**200**	**200**	**200**	**200**	**200**	**200**	**200**	**200**	**200**	**200**	**200**
Female cattle between 12 and 20 months	# at the beginning of month	267	267	267	267	267	267	267	267	267	267	267	267
	Added from calves	33	33	33	33	33	33	33	33	33	33	33	33
	Shifted to heifers	16	16	16	16	16	16	16	16	16	16	16	16
	Culled	17	17	17	17	17	17	17	17	17	17	17	17
	# at the end of month	**267**	**267**	**267**	**267**	**267**	**267**	**267**	**267**	**267**	**267**	**267**	**267**
Heifers between 20 and 36 months	# at the beginning of month	257	257	257	257	257	257	257	257	257	257	257	257
	Added from previous age category	16	16	16	16	16	16	16	16	16	16	16	16
	Delivered and shifted to cows	16	16	16	16	16	16	16	16	16	16	16	16
	# at the end of month	**257**	**257**	**257**	**257**	**257**	**257**	**257**	**257**	**257**	**257**	**257**	**257**

Table 9.12: Model calculation for pig herd structure: Year 1

Animal categories	Key figures	Months											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Boars	# per month	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**
Sows	# at the beginning of month	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
	Died	4	4	4	4	4	4	4	4	4	4	4	4
	Culled	42	42	42	42	42	42	42	42	42	42	42	42
	Purchased	46	46	46	46	46	46	46	46	46	46	46	46
	Added from gilts												
	# at the end of month	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**
Reproduction	Sows delivered	167	167	167	167	167	167	167	167	167	167	167	167
Piglets in 1st month	# at the beginning of month		1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050
	New-born piglets	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050
	Shifted to next age category		1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050
	# at the end of month	**1050**	**1050**	**1050**	**1050**	**1050**	**1050**	**1050**	**1050**	**1050**	**1050**	**1050**	**1050**
Piglets in 2nd month	# at the beginning of month			945	945	945	945	945	945	945	945	945	945
	Added from previous age category		945	945	945	945	945	945	945	945	945	945	945
	Shifted to next age category			945	945	945	945	945	945	945	945	945	945
	# at the end of month		**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**
Piglets in 3rd month	# at the beginning of month				898	945	945	945	945	945	945	945	945
	Added from previous age category			898	945	945	945	945	945	945	945	945	945
	Shifted to next age category				898	945	945	945	945	945	945	945	945
	# at the end of month			**898**	**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**
Piglets in 4th month	# at the beginning of month					853	898	898	898	898	898	898	898
	Added from previous age category				853	898	898	898	898	898	898	898	898
	Shifted to next age category					853	898	898	898	898	898	898	898
	To gilts					*46*	*46*	*46*	*46*	*46*	*46*	*46*	*46*
	To fattening pigs					*807*	*852*	*852*	*852*	*852*	*852*	*852*	*852*
	# at the end of month				**853**	**898**	**898**	**898**	**898**	**898**	**898**	**898**	**898**
Gilts between 4th and 13th month	# at the beginning of month						46	92	138	183	229	275	321
	Added from previous age category					46	46	46	46	46	46	46	46
	Shifted to next age category												
	# at the end of month					**46**	**92**	**138**	**183**	**229**	**275**	**321**	**367**
Fattening pigs in 5th to 8th month	# at the beginning of month						807	1659	2511	3363	3408	3408	3408
	Added from previous age category					807	852	852	852	852	852	852	852
	Shifted to next age category									807	852	852	852
	# at the end of month					**807**	**1659**	**2511**	**3363**	**3408**	**3408**	**3408**	**3408**

Table 9.13: Model calculation for pig herd structure: Year 4

Animal categories	Key figures	Months											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Boars	# per month	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**
Sows	# at the beginning of month	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
	Died	4	4	4	4	4	4	4	4	4	4	4	4
	Culled	42	42	42	42	42	42	42	42	42	42	42	42
	Purchased												
	Added from gilts	46	46	46	46	46	46	46	46	46	46	46	46
	# at the end of month	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**
Reproduction	Sows delivered	167	167	167	167	167	167	167	167	167	167	167	167
Piglets in 1st month	# at the beginning of month	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050
	New-born piglets	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050
	Shifted to next age category	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050
	# at the end of month	**1050**	**1050**	**1050**	**1050**	**1050**	**1050**	**1050**	**1050**	**1050**	**1050**	**1050**	**1050**
Piglets in 2nd month	# at the beginning of month	945	945	945	945	945	945	945	945	945	945	945	945
	Added from previous age category	945	945	945	945	945	945	945	945	945	945	945	945
	Shifted to next age category	945	945	945	945	945	945	945	945	945	945	945	945
	# at the end of month	**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**
Piglets in 3rd month	# at the beginning of month	945	945	945	945	945	945	945	945	945	945	945	945
	Added from previous age category	945	945	945	945	945	945	945	945	945	945	945	945
	Shifted to next age category	945	945	945	945	945	945	945	945	945	945	945	945
	# at the end of month	**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**	**945**
Piglets in 4th month	# at the beginning of month	898	898	898	898	898	898	898	898	898	898	898	898
	Added from previous age category	898	898	898	898	898	898	898	898	898	898	898	898
	Shifted to next age category	898	898	898	898	898	898	898	898	898	898	898	898
	To gilts	*46*	*46*	*46*	*46*	*46*	*46*	*46*	*46*	*46*	*46*	*46*	*46*
	To fattening pigs	*852*	*852*	*852*	*852*	*852*	*852*	*852*	*852*	*852*	*852*	*852*	*852*
	# at the end of month	**898**	**898**	**898**	**898**	**898**	**898**	**898**	**898**	**898**	**898**	**898**	**898**
Gilts between 4th and 13th month	# at the beginning of month	413	413	413	413	413	413	413	413	413	413	413	413
	Added from previous age category	46	46	46	46	46	46	46	46	46	46	46	46
	Shifted to next age category	46	46	46	46	46	46	46	46	46	46	46	46
	# at the end of month	**413**	**413**	**413**	**413**	**413**	**413**	**413**	**413**	**413**	**413**	**413**	**413**
Fattening pigs in 5th to 8th month	# at the beginning of month	3408	3408	3408	3408	3408	3408	3408	3408	3408	3408	3408	3408
	Added from previous age category	852	852	852	852	852	852	852	852	852	852	852	852
	Shifted to next age category	852	852	852	852	852	852	852	852	852	852	852	852
	# at the end of month	**3408**	**3408**	**3408**	**3408**	**3408**	**3408**	**3408**	**3408**	**3408**	**3408**	**3408**	**3408**

Table 9.14: Model calculation for poultry herd structure: Year 1

Animal categories	Key figures	Months											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Roosters	# per month	**100**	**100**	**100**	**100**	**100**	**100**	**101**	**102**	**102**	**103**	**104**	**104**
Laying hens	# at the beginning of month	1000	1000	1000	1000	1000	1000	1000	1009	1017	1024	1030	1035
	Died	50	50	50	50	50	50	50	50	51	51	51	52
	Culled	83	83	83	83	83	83	83	84	85	85	86	86
	Purchased	133	133	133	133	133	133						
	Added from chicks							143	143	143	143	143	143
	# at the end of month	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1009**	**1017**	**1024**	**1030**	**1035**	**1040**
Reproduction	Hens delivered	167	167	167	167	167	167	168	170	171	172	173	173
Chicks in 1st month	# at the beginning of month		150	150	150	150	150	150	151	153	154	154	155
	New-born chicks	150	150	150	150	150	150	151	153	154	154	155	156
	Shifted to next age category		150	150	150	150	150	150	151	153	154	154	155
	# at the end of month	**150**	**150**	**150**	**150**	**150**	**150**	**151**	**153**	**154**	**154**	**155**	**156**
Chicks in 2nd month	# at the beginning of month			143	143	143	143	143	143	144	145	146	147
	Added from previous age category		143	143	143	143	143	143	144	145	146	147	148
	Shifted to next age category			143	143	143	143	143	143	144	145	146	147
	# at the end of month		**143**	**143**	**143**	**143**	**143**	**143**	**144**	**145**	**146**	**147**	**148**
Chicks in 3rd month	# at the beginning of month				143	143	143	143	143	143	144	145	146
	Added from previous age category			143	143	143	143	143	143	144	145	146	147
	Shifted to next age category				143	143	143	143	143	143	144	145	146
	# at the end of month			**143**	**143**	**143**	**143**	**143**	**143**	**144**	**145**	**146**	**147**
Chicks in 4th month	# at the beginning of month					143	143	143	143	143	143	144	145
	Added from previous age category				143	143	143	143	143	143	144	145	146
	Shifted to next age category					143	143	143	143	143	143	144	145
	# at the end of month				**143**	**143**	**143**	**143**	**143**	**143**	**144**	**145**	**146**
Chicks in 5th month	# at the beginning of month						143	143	143	143	143	143	144
	Added from previous age category					143	143	143	143	143	143	144	145
	Shifted to next age category						143	143	143	143	143	143	144
	# at the end of month					**143**	**143**	**143**	**143**	**143**	**143**	**144**	**145**
Chicks in 6th month	# at the beginning of month							143	143	143	143	143	143
	Added from previous age category						143	143	143	143	143	143	144
	Shifted to next age category							143	143	143	143	143	143
	# at the end of month						**143**	**143**	**143**	**143**	**143**	**143**	**144**

Table 9.15: Model calculation for poultry herd structure: Year 4

Animal category	Key figures	Months											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Roosters	# per month	**119**	**120**	**120**	**121**	**121**	**122**	**123**	**123**	**124**	**125**	**125**	**126**
Laying hens	# at the beginning of month	1183	1189	1196	1202	1208	1215	1222	1228	1235	1241	1248	1255
	Died	59	59	60	60	60	61	61	61	62	62	62	63
	Culled	99	99	100	100	101	101	102	102	103	103	104	105
	Purchased												
	Added from chicks	164	165	166	167	168	169	169	170	171	172	173	174
	# at the end of month	**1189**	**1196**	**1202**	**1208**	**1215**	**1222**	**1228**	**1235**	**1241**	**1248**	**1255**	**1262**
Reproduction	Hens delivered	198	199	200	201	202	204	205	206	207	208	209	210
Chicks in 1st month	# at the beginning of month	177	178	179	180	181	182	183	184	185	186	187	188
	New-born chicks	178	179	180	181	182	183	184	185	186	187	188	189
	Shifted to next age category	177	178	179	180	181	182	183	184	185	186	187	188
	# at the end of month	**178**	**179**	**180**	**181**	**182**	**183**	**184**	**185**	**186**	**187**	**188**	**189**
Chicks in 2nd month	# at the beginning of month	168	169	169	170	171	172	173	174	175	176	177	178
	Added from previous age category	169	169	170	171	172	173	174	175	176	177	178	179
	Shifted to next age category	168	169	169	170	171	172	173	174	175	176	177	178
	# at the end of month	**169**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**	**179**
Chicks in 3rd month	# at the beginning of month	167	168	169	169	170	171	172	173	174	175	176	177
	Added from previous age category	168	169	169	170	171	172	173	174	175	176	177	178
	Shifted to next age category	167	168	169	169	170	171	172	173	174	175	176	177
	# at the end of month	**168**	**169**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**
Chicks in 4th month	# at the beginning of month	166	167	168	169	169	170	171	172	173	174	175	176
	Added from previous age category	167	168	169	169	170	171	172	173	174	175	176	177
	Shifted to next age category	166	167	168	169	169	170	171	172	173	174	175	176
	# at the end of month	**167**	**168**	**169**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**
Chicks in 5th month	# at the beginning of month	165	166	167	168	169	169	170	171	172	173	174	175
	Added from previous age category	166	167	168	169	169	170	171	172	173	174	175	176
	Shifted to next age category	165	166	167	168	169	169	170	171	172	173	174	175
	# at the end of month	**166**	**167**	**168**	**169**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**
Chicks in 6th month	# at the beginning of month	164	165	166	167	168	169	169	170	171	172	173	174
	Added from previous age category	165	166	167	168	169	169	170	171	172	173	174	175
	Shifted to next age category	164	165	166	167	168	169	169	170	171	172	173	174
	# at the end of month	**165**	**166**	**167**	**168**	**169**	**169**	**170**	**171**	**172**	**173**	**174**	**175**

9.3 Estimation of energy requirements of animals at intensified livestock farms on feeding[19]

Dairy and beef cattle

Total energy requirements of dairy cattle were estimated in MJ NEL (Net Energy Lactation) in accordance with Kirchgessner's reference values (2004) and converted to approximate amounts of metabolizable energy (MJ ME), as shown in Table 9.16. The calculation is based on the following assumptions:

- Average body weight of pure- and crossbred cows are 600 kg and 450 kg, respectively,
- Average lactation period is 305 days and average dry period is 60 days;
- Average milk yields per day are 18 litres for purebred cows and 8 litres for crossbred cows,
- Average fat content of milk is 4% for purebred cows and 3.8% for crossbreeds,
- Average protein content of milk is 3.5% for purebred cows and 3.2% for crossbreeds,
- Average length of the grazing period is 107 days (from 1 June to 15 September) for purebred cattle and 132 days (from 21 May to 30 September) for crossbreeds[20];
- Energy requirements of cows increase by 15% during grazing period.

Table 9.16: Total energy requirements of dairy cows, MJ NEL and MJ ME per cow and year

Structure of energy requirement	Requirement per day, MJ NEL*	# of days	Requirement per year, MJ NEL	Requirement per year in MJ ME (approximate)
Purebred dairy cow				
Maintenance requirement	35.5	323	11,467	
Additional requirement during grazing period	5.3	107	570	
Requirement during pregnancy	52.8	42	2,218	
Requirement for milk production	57.0	305	17,376	
Total energy requirements			**31,630**	**52,189**
Crossbred dairy cow				
Maintenance requirement	28.6	323	9,238	
Additional requirement during grazing period	4.3	132	566	
Requirement during pregnancy	42.5	42	1,787	
Requirement for milk production	24.2	305	7,388	
Total energy requirements			**18,979**	**31,315**

Energy requirements of bulls, heifers and calves over four months of age in dairy herds were estimated using reference values determined by Kirchgessner (2004) and DLG (2009).

Table 9.17: Total energy requirements of breeding bulls, heifers and calves over four months of age in dairy herds, MJ ME per animal and year

Animal category	Requirement per day		Requirement per year	
	Purebred	Crossbred	Purebred	Crossbred
Breeding bull	100	36,500	81	29,406
Heifer, between 19th and 30th month	80	29,200	64	23,525
Heifer, between 13th and 18th month	61	22,083	49	17,790
Calf, between 5th and 12th month	44	16,197	36	13,049

[19] This means "Total energy requirements minis energy supplied through grazing".

[20] In accordance with Erdenebolor (2007 and 2009) and farmer interviews conducted in this study.

In order to determine the energy requirements on feeding, energy supply from grazing needs to be deducted from the total requirements. This is done using estimated values for grass intakes and reference values for energy supply of pasture grass (Appendix 9.1), as summarized in Table 9.18.

Table 9.18: Total energy requirements of cows, bulls, heifers and female calves over four months of age in dairy herds, MJ ME per animal and year

Animal categories	Grass intake per day, kg FM	Energy supply per day, MJ ME	# of grazing days	Energy supply per year, MJ ME
Purebred dairy cattle				
Cow	35	112	107	11,984
Breeding bull	40	128	107	13,696
Heifer, between 19th and 30th month	25	80	107	8,560
Heifer, between 13th and 18th month	20	64	107	6,848
Calf, between 5th and 12th month	12	38	107	4,109
Crossbred dairy cattle				
Cow	28	90	132	11,910
Bull	32	103	132	13,612
Heifer, between 19th and 30th month	20	64	132	8,507
Heifer, between 13th and 18th month	16	52	132	6,806
Calf, between 5th and 12th month	10	31	132	4,084

Energy requirements of calves below four months of age that are to be covered through supplementary feeding (in addition to suckling or feeding with milk substitutes) were estimated as to equal the energy supply from exemplary fodder rations for the total feeding period of 4 months, which were designed in accordance with Kirchgessner (2004). The energy requirements are summarized in Table 9.19.

Table 9.19: Energy requirements of calves of pure- and crossbred dairy cows below four months of age on supplementary feeding, MJ ME per calf

Animal categories	Fodder ration, kg		MJ ME supply/requirement	
	Purebred	Crossbred	Purebred	Crossbred
Hay	30	180	24.2	145
Alfalfa hay (or comparable dry forage)	30	210	24.2	169
Maize silage (or comparable succulent fodder)	30	69	24.2	80
Concentrated fodder	120	1,200	96.7	967
Total energy supply/requirement, MJ ME		**1,659**		**1,361**
Share of energy requirement from roughages		**27.7%**		**29.0%**

In order to not only estimate total MJ ME requirements of dairy cattle on feeding, but also differentiate between MJ ME requirements on roughage and concentrate supply, we used, except for calves below four months of age (as the percental for this category, estimated percental shares of energy supply from roughage feeding in total energy supply from feeding. This estimation was based on Erdenebolor (2007 and 2009), Kirchgessner (2004), GEA (2008), Nyamgerel (2010) and findings of interviews conducted with dairy farmers in this study. Total MJ ME requirements of dairy cattle on feeding as well as MJ ME requirements to be covered by roughages and concentrates are summarized in Table 9.20.

Table 9.20: Energy requirements of dairy cattle on feeding, per animal and year

Animal categories	Total energy requirement; MJ ME	Estimated share of roughages in total energy supply	Energy requirement for total roughage intake, MJ ME	Energy supply from grazing, MJ ME	Total energy requirement on feeding, MJ ME	Energy requirement on roughage feeding, MJ ME	Energy requirement on concentrate feeding, MJ ME
Purebred dairy cattle							
Cow	52,189	65%	33923	11,984	**40,205**	21,939	18,266
Bull	36,500	75%	27375	13,696	**22,804**	13,679	9,125
Heifer, between 19th and 30th month	29,200	75%	21900	8,560	**20,640**	13,340	7,300
Heifer, between 13th and 18th month	22,083	75%	16562	6,848	**15,235**	9,714	5,521
Calf, between 5th and 12th month	16,197	75%	12148	4,109	**12,088**	8,039	4,049
Calf, below 4 months*	1,659	40%	664	-	**1,659**	664	995
Crossbred dairy cattle							
Cow	31,315	65%	20,355	11,910	**19,405**	8,444	10,960
Bull	29,406	75%	22,054	13,612	**15,794**	8,442	7,351
Heifer, between 19th and 30th month	23,525	75%	17,643	8,507	**15,017**	9,136	5,881
Heifer, between 13th and 18th month	17,790	75%	13,343	6,806	**10,984**	6,537	4,448
Calf, between 5th and 12th month	13,049	75%	9,787	4,084	**8,965**	5,703	3,262
Calf, below 4 months	1,361	40%	544	-	1,361	544	816

* Energy supply of calves below four months of age from grazing is neglected in the calculation as 1) the aim of the calculation is to estimate energy requirements on feeding and not grazing, and 2) it is very to difficult to estimate pasture grass intake of calves' grazing among dairy farms.

Energy requirements of beef cattle on feeding were estimated using reference values estimated by Javzmaa and Badarch (2004), Byamba (2005), Kalashnikov et al. (2007) and Enkhtuya (2010), and cross-checked through interviews with beef farmers in this study (Table 9.21).

Table 9.21: Energy requirements of beef cattle on feeding, per animal and year

Animal categories	Total energy requirement on feeding, MJ ME	Estimated share of roughages in total energy supply from feeding	Energy requirement on roughage feeding, MJ ME	Energy requirement on concentrate feeding, MJ ME
Bull	15,500	65%	10,075	5,425
Cow	14,000	65%	9,100	4,900
Heifer	11,000	65%	7,150	3,850
Male cattle between 12 and 18 months (of age)	8,000	30%	2,400	5,600
Female cattle between 12 and 18 months	7,000	30%	2,100	4,900
Calves	6,000	50%	3,000	3,000

Pigs and poultry

Energy requirements of pigs and poultry on feeding were estimated using reference values estimated by KTBL (1999) and Kalashnikov et al. (2007), and cross-checked through farmers interviews conducted in this study (Tables 9.22 and 9.23).

Table 9.22: Energy requirements of pigs on feeding, per animal and year

Animal categories	Total energy requirement on feeding, MJ ME	Estimated share of roughages in total energy supply from feeding	Energy requirement on roughage feeding, MJ ME	Energy requirement on concentrate feeding, MJ ME
Boar	14,564	15%	2,185	12,379
Sow	14,000	20%	2,800	11,200
Gilt (between 4th and 13th month)	10,768	15%	1,615	9,152
Fattening pig in 5th to 8th month	10,846	15%	1,627	9,219
Piglet in 4th month	7,300	15%	1,095	6,205
Piglet in 3th month	4,998	15%	750	4,248
Piglet in 2nd month	3,275	20%	650	2,620
Piglet in 1st month	1,120	20%	224	896

Table 9.23: Energy requirements of poultry on (concentrate) feeding, per animal and year

Animal categories	Energy requirement per day, MJ ME	Energy requirement per year, MJ ME
Rooster	1.408	513.9
Laying hen	1.275	465.4
Chick in 6th month	1.023	373.4
Chick in 5th month	0.922	336.5
Chick in 4th month	0.816	297.8
Chick in 3th month	0.710	259.2
Chick in 2nd month	0.559	203.9
Chick in 1st month	0.213	77.6

The energy requirements on feeding per animal estimated above are converted into total energy requirements of dairy, beef, poultry and pig populations on feeding i.e. total energy requirements fodder consumption of dairy, beef, pig and poultry farms on in Mongolia in Tables 9.24 to 9.26.

Table 9.24: Total energy requirements on fodder consumption of dairy farms

Animal categories	Energy requirements on feeding per animal, MJ ME			Number of animals	Total energy requirements on fodder consumption of all dairy farms		
	Total requirement on feeding, MJ ME	Requirement on roughage feeding, MJ ME	Requirement on concentrate feeding, MJ ME		Total requirement on fodder consumption, MJ ME	Requirement on roughage consumption, MJ ME	Requirement on concentrate consumption, MJ ME
Purebred dairy cattle							
Cows	40,205	21,939	18,266	7,524	302,519,761	165,077,406	137,442,355
Bulls	22,804	13,679	9,125	150	3,431,739	2,058,532	1,373,207
Heifers, between 19th and 30th month	20,640	13,340	7,300	2,772	57,217,378	36,980,612	20,236,766
Heifers, between 13th and 18th month	15,235	9,714	5,521	1,539	23,451,391	14,953,158	8,498,233
Calf, between 5th and 12th month	12,088	8,039	4,049	2,146	25,945,368	17,254,284	8,691,084
Calf, below 4 months*	1,659	664	995	1,117	1,853,448	741,379	1,112,069
Purebreds subtotal				**15,250**	**414,419,085**	**237,065,371**	**177,353,714**
Crossbred dairy cattle							
Cows	19,405	8,444	10,960	22,573	438,030,116	190,619,035	247,411,081
Bulls	15,794	8,442	7,351	451	7,130,284	3,811,377	3,318,906
Heifers, between 19th and 30th month	15,017	9,136	5,881	8,316	124,888,688	75,978,418	48,910,269
Heifers, between 13th and 18th month	10,984	6,537	4,448	4,618	50,726,928	30,187,535	20,539,392
Calves, between 5th and 12th month	8,965	5,703	3,262	6,439	57,727,356	36,721,864	21,005,492
Calves, below 4 months	1,361	544	816	3,352	4,560,606	1,824,242	2,736,363
Crossbreeds subtotal					**683,063,976**	**339,142,472**	**343,921,504**
Total					**1,097,483,061**	**576,207,843**	**521,275,218**

Table 9.25: Total energy requirements on fodder consumption of beef and pig farms

Animal categories	Energy requirements on feeding per animal			Number of animals	Total energy requirements on fodder consumption of all dairy farms		
	Total requirement on feeding, MJ ME	Requirement on roughage feeding, MJ ME	Requirement on concentrate feeding, MJ ME		Total requirement on fodder consumption, MJ ME	Requirement on roughage consumption, MJ ME	Requirement on concentrate consumption, MJ ME
Bulls	15,500	10,075	5,425	344	5,338,485	3,470,015	1,868,470
Cows	14,000	9,100	4,900	6,888	96,437,152	62,684,149	33,753,003
Heifers	11,000	7,150	3,850	1,771	19,484,241	12,664,757	6,819,484
Male cattle between 12 and 18 months of age	8,000	2,400	5,600	1,378	11,021,389	3,306,417	7,714,972
Female cattle between 12 and 20 months of age	7,000	2,100	4,900	1,837	12,858,287	3,857,486	9,000,801
Calves	6,000	3,000	3,000	2,755	16,532,083	8,266,042	8,266,042
Beef cattle total				**14,974**	**161,671,637**	**94,248,865**	**67,422,772**
Pigs							
Boars	14,564	2,185	12,379	82	1,198,387	179,758	1,018,629
Sows	14,000	2,800	11,200	4,114	57,600,922	11,520,184	46,080,738
Gilt	10,768	1,615	9,152	1,697	18,274,278	2,741,142	15,533,136
Fattening pigs	10,846	1,627	9,219	14,020	152,060,587	22,809,088	129,251,499
Piglets in 4th month	7,300	1,095	6,205	3,694	26,963,712	4,044,557	22,919,155
Piglets in 3th month	4,998	750	4,248	3,888	19,432,794	2,914,919	16,517,875
Piglets in 2nd month	3,275	650	2,620	3,888	12,734,441	2,546,888	10,187,552
Piglets in 1st month	1,120	224	896	4,320	4,836,911	967,382	3,869,529
Pigs total				**35,704**	**293,102,032**	**47,723,919**	**245,378,114**

Table 9.26: Total energy requirements on concentrated fodder consumption of poultry farms

Animal categories	Energy requirement on feeding per animal, MJ ME	Number of animals	Energy requirement per year, MJ ME
Rooster	513.9	70,409	36,184,655
Laying hen	465.4	704,091	327,666,442
Chick in 6th month	373.4	17,214	6,427,475
Chick in 5th month	336.5	17,306	5,824,111
Chick in 4th month	297.8	17,400	5,182,303
Chick in 3th month	259.2	17,493	4,533,409
Chick in 2nd month	203.9	17,588	3,585,285
Chick in 1st month	77.6	18,613	1,443,676
Total			**390,847,355**

9.4 Guiding questions for stakeholder interviews

Expert interviews

- What is your role in the fodder market?
- What is your assessment of the current fodder market situation? Could the domestic fodder production and fodder use be increased?
- What do you see as the driving and inhibiting forces (promoting and impeding factors) for domestic fodder production?
- What do you see as the driving and inhibiting forces for increasing fodder use by livestock farmers and herders?
- Do you know any good practices of boosting fodder production at national/local levels?
- Do you know any good practices of crop farmers producing animal fodder? If so, what were the driving forces/enabling conditions?
- What solutions would you suggest for:
    - improving domestic fodder production
    - increasing fodder use by livestock farmers and herders, and
    - regulating fodder production and fodder trade?
    - Do you have or know any information/publication that is useful to the study?

Producer interviews

- Name and address of enterprise, year of founding
- Fodder types produced
- Production capacity and amounts in 2014-2016 (by type of fodder)
- Raw materials used for fodder production
- Sources of raw materials (self-produced, purchased in-country or imported)
- Fodder prices
- Distribution: wholesale, retail, intermediate trade, contract supply etc.
- Main target groups/buyers
- Main competitors
- What are the strategic goals of the company? (increasing production, diversifying product types etc.)
- What internal strategies and external factors have contributed to the success of your fodder production business so far?
- What problems and external challenges do you encounter in fodder production and marketing?
- Have you received any external support? Please specify.
- How would you estimate the total capacity of the domestic fodder market?
- What do you see as the driving and inhibiting forces (promoting and impeding factors) for domestic fodder production in general?
- What do you see as the driving and inhibiting forces for increasing fodder use by livestock farmers and herders?
- What solutions would you suggest for:
    - improving domestic fodder production,
    - increasing fodder use by livestock farmers and herders,
    - supporting domestic fodder production, and
    - regulating fodder trade?

Trader interview

- Name and address of the company, year of founding
- Fodder types sold
- Sold amounts in 2014-2016 (by type of fodder)
- Sources of products
- Fodder prices
- Distribution: wholesale, retail, intermediate trade, contract supply etc.
- Main target groups/buyers
- Main competitors
- What internal strategies and external factors have contributed to the success of your fodder trade so far?
- What problems and external challenges do you encounter in your fodder trade?
- Have you received any external support? Please specify.
- How would you estimate the total capacity of the domestic fodder market?
- What do you see as the driving and inhibiting forces (promoting and impeding factors) for domestic fodder production in general?
- What do you see as the driving and inhibiting forces for increasing fodder use by livestock farmers and herders?
- What solutions would you suggest for:
    - improving domestic fodder production,
    - increasing fodder use by livestock farmers and herders, and
    - supporting/regulating domestic fodder production and fodder trade?

Interviews with farmers growing fodder crops

- Name and address of enterprise, year of founding
- Field size and crop rotation
- Types and amounts of crops grown in 2014-2016
- Sources of seeds of fodder crops
- Distribution of fodder crops: wholesale, retail, intermediate trade, contract supply
- Prices and buyers of fodder crops
- What made you start growing fodder plants? Are you satisfied with growing fodder crops?
- Has growing fodder crops caused additional investments and production costs? Do the revenues from growing fodder crops cover the costs?
- Have you received any external support for growing fodder crops? Please specify.
- Are you planning to expand/diversify production of fodder crops?
- Are you planning to run industrial fodder production?
- What do you see as the driving and inhibiting forces (promoting and impeding factors) for domestic fodder production in general?
- What do you see as the driving and inhibiting forces for increasing fodder use by livestock farmers and herders?
- What types of external support would you like to receive for increasing/improving your production of fodder crops?
- What solutions would you suggest for:
    - improving domestic fodder production,
    - increasing fodder use by livestock farmers and herders, and
    - supporting/regulating domestic fodder production and fodder trade?

Interviews with crop farmers not growing fodder crops

- Name and address of enterprise, year of founding
- Field size and crop rotation
- Types and amounts of crops grown in 2014-2016
- Are you planning to grow/interested in growing fodder crops? If so, why? If not so, why? Have you ever thought about it?
- Would you say that you could earn additional incomes through production of fodder crops? Can you think of any other benefits of growing fodder crops?
- What would make you interested in growing fodder crops?
- What do you see as the driving and inhibiting forces (promoting and impeding factors) for domestic fodder production in general?
- What do you see as the driving and inhibiting forces for increasing fodder use by livestock farmers and herders?
- What solutions would you suggest for:
    - improving domestic fodder production,
    - increasing fodder use by livestock farmers and herders, and
    - supporting/regulating domestic fodder production and fodder trade?

Interviews with dairy and beef farmers growing fodder crops

- Name and address of enterprise, year of founding
- Number of animals and types and average amounts of outputs per year
- Field size and crop rotation
- Types and amounts of fodder crops grown
- Sources of seeds of fodder crops
- Utilization of fodder crops: use at farm (processed, unprocessed), sales in processed/unprocessed form
- Distribution structure, prices and buyers of fodder crops, if those are sold
- When did you start growing fodder crops? Are you satisfied with growing fodder crops?
- Does your production of fodder crops maintain a positive economic balance with regards to investment and production costs? Are there any concerns?
- Do you have any specific strengths or opportunities for growing fodder crops that other dairy/beef farms in the region may not have?
- Have you received any external support for growing fodder crops? Please specify.
- Are you planning to expand/diversify your production of fodder crops?
- Are there any fodder crops that you need but have not been able to grow on your fields? Why?
- How much of your demand for fodder is covered by on-farm production? Do you still purchase additional fodders? If so, what types of fodder do you buy and where and in what amounts do you buy them?
- Are you running or planning to run industrial fodder production?
- Do you wish to see other dairy/beef farms following your example? What are the main issues that dairy/beef farms should take in consideration when they plan to grow fodder crops?
- What do you see as the driving and inhibiting forces (promoting and impeding factors) for domestic fodder production in general?
- What do you see as the driving and inhibiting forces for increasing fodder use by livestock farmers and herders?

- What types of external support would you like to receive for strengthening/improving your production of fodder crops?
- What solutions would you suggest for:
    - improving domestic fodder production,
    - increasing fodder use by livestock farmers and herders, and
    - supporting/regulating domestic fodder production and fodder trade?

Interviews with poultry and pig farmers growing fodder crops or with industrial fodder production

- Name and address of enterprise, year of founding
- Number of animals and types and average amounts of outputs per year
- Fodder types and amounts produced
- Sources of seeds of fodder crops
- Utilization of fodder: use at farm (processed, unprocessed), sales in processed/unprocessed form
- Distribution structure, prices and buyers of fodders, by type, if sold
- When did you start producing fodders? Are you satisfied with your fodder production?
- Does your fodder production maintain a positive economic balance with regards to investment and production costs? Are there any concerns?
- Do you have any specific strengths or opportunities for fodder production that other poultry/pig farms in the region may not have?
- Have you received any external support for fodder production? Please specify.
- Are you planning to expand/diversify your fodder production?
- Are there any fodder types that you need but have not been able to produce? Why?
- How much of your demand for fodder is covered by on-farm production? Do you still purchase additional fodders? If so, what types of fodder do you buy and where and in what amounts do you buy them?
- Are you running or planning to run industrial fodder production?
- Do you wish to see other poultry/pig farms following your example? What are the main issues that poultry/pig farms should take in consideration when they plan to produce fodders?
- What do you see as the driving and inhibiting forces (promoting and impeding factors) for domestic fodder production in general?
- What do you see as the driving and inhibiting forces for increasing fodder use by livestock farmers and herders?
- What types of external support would you like to receive for strengthening/improving your fodder production?
- What solutions would you suggest for:
    - improving domestic fodder production,
    - increasing fodder use by livestock farmers and herders, and
    - supporting/regulating domestic fodder production and fodder trade?

Interviews with livestock farmers and herders without on-farm fodder production

- Name and address of enterprise, year of founding
- Number of animals and types and average amounts of outputs per year
- Fodder use per year, total and specified by type

- How much would you estimate your fodder need per year is? How much of that amount is covered by your fodder purchases?
- Where and how do you buy the fodders? Fodder prices, specified by type of fodder.
- When do you buy fodders? Do your buy regularly or only when needed?
- Do you have contractual or non-contractual regular fodder suppliers?
- How much fodder can you store?
- Do you think the fodder prices are affordable and justified? Please specify by fodder type.
- Are there any seasonal fluctuations in the prices and availability of the fodders you regularly buy?
- Are you satisfied with the fodder types available for purchase? Are you satisfied with the quality of the fodders you buy?
- Are there any fodder types that you wish to buy but are not available or affordable?
- What are the difficulties that make you not fully meet your demands for fodder?
- What changes would enable you to fully meet your demands for fodder? What kinds of external support would you like to receive.
- Are you aware of any examples of livestock farmers/herders in your region fully covering their demands for fodder?
- Are you planning to grow/interested in growing fodder crops or run industrial fodder production? If so, why? If not so, why? Have you ever thought about it?
- What do you see as the driving and inhibiting forces (promoting and impeding factors) for domestic fodder production in general?
- What do you see as the driving and inhibiting forces for increasing fodder use by livestock farmers and herders?
- What solutions would you suggest for:
    - improving fodder production,
    - increasing fodder use by livestock farmers and herders, and
    - supporting/regulating domestic fodder production and fodder trade?