Business Economics Group

MSc Thesis Business Economics

# Stochastic simulation model for investment decision making in a new beef cattle production system in Kazakhstan

Askhat Zhanibekov

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WAGENINGEN UNIVERSITY & RESEARCH

# Stochastic simulation model for investment decision making in a new beef cattle production system in Kazakhstan

Student name: Askhat Zhanibekov

Registration number: 840131987110

Programme: MSc. Management, Economics and Consumer Studies

Specialisation: Business Economics

Chair group: Business Economics

Emails: Askhat.zhanibekov@wur.nl

Supervisor: Dr. Jaap Sok

Examiner: Prof.dr.ir. AGJM (Alfons) Oude Lansink

Group: Business Economics

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Hollandseweg 1 (Building 201)

6706 KN Wageningen, The Netherlands

T: 0317-(4)84065

E: office.bec@wur.nl

WAGENINGEN UNIVERSITY & RESEARCH

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# Abstract

The primary objective of the thesis was to perform economic feasibility analysis of investing in a new beef cattle production system in Kazakhstan, specifically in cow-calf operations. To reach this goal, a stochastic simulation model of a cow-calf operation was developed and used as a research tool. First, a basic deterministic model of the cow-calf operation was constructed with the following major blocks: (i) reproduction, backgrounding and feed production enterprises, (ii) the whole-farm budget, and (iii) the cash flow budget. Second, several variables, such as price for cattle's live weight, calves' average weight and feed costs were turned into stochastic as major factors affecting the economic feasibility of the cow-calf operation. Finally, NPV was used as a measure of economic feasibility of investments. The analysis revealed that investments into the cow-calf operation could be economically feasible in a long term, that is above 10 years, on condition that governmental investment subsidies were reinvested into the project. The study in overall may help investors to understand risks and implications of investing into the beef cattle farming in Kazakhstan. Smallholder farmers may benefit by adopting the developed model as an economic decisions-making tool in their beef cattle farming operations.

Keywords: stochastic simulation, economic budgets analysis, enterprise budget, whole-farm budget, cash flow budget, net present value, beef cattle production system, cow-calf operation

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Askhat Zhanibekov

August 2019

*I would like to dedicate this work in memory of my Father. He would be happy to see me at this certain point of my life.*

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# Abbreviations

| | |
|---|---|
| BCPS | Beef Cattle Production System |
| KZT | Kazakhstan Tenge |
| MCS | Monte Carlo Simulation |
| NPV | Net Present Value |
| IRR | Internal Rate of Return |
| WACC | Weighted Average Cost of Capital |

# 1. Introduction

*This part introduces the background, then turns to the research problem, study objective and the theoretical framework. The research outline is presented at the end.*

## 1.1. Background

The agricultural sector in Kazakhstan has a high potential of growth and it is a strong diversification driver of the whole country's economy (World Bank, 2017). It is the best prospect industry sector for the country (The International Trade Administration of U.S. Department of Commerce, 2018). According to the recent report of the World Bank (2017): "Kazakhstan is well located geographically to serve growing traditional markets in the Central Asian region as well as new markets in China and the Middle East. This, along with the scale of agricultural resources available, makes Kazakhstan a potentially attractive investment for domestic and foreign investors".

The current beef cattle production industry in Kazakhstan is represented by small households, private smallholder farms, and agricultural enterprises. There is a big difference between these groups in production methods, feeding, animal care, veterinary, application of precision farming technologies, and support measures from the government. Conventional cattle growers in Kazakhstan raise cattle on pastures during summer and feed them in barns the rest of the year. The beef value chain consists of fragmented players that often have a weak resource base of production. The profitability of such operations appears to be questionable and is subject to significant risks. Schmitz and Meyers (2015) concluded that the current beef livestock production business model in Kazakhstan was unstructured and, therefore, the whole supply chain was non-transparent.

The current beef cattle production system (BCPS) in Kazakhstan is based mostly on an extensive pasture grazing approach inherited from the nomadic past. However, raising cattle at pastures is problematic nowadays due to several reasons. First, the country is faced with socio-economic, infrastructural constraints to restore its pasture-lands (Robinson et al., 2000, Brinkert, 2016). Second, livestock mobility is declining globally (Boone et al. 2005). "Kazakhstan is no exception to this pattern and has suffered from a particularly extreme contraction in livestock mobility" (Robinson, Kerven, Behnke, Kushenov & Milner-Gulland, 2017; Kerven et al., 2006). Third, the costs of moving livestock are not economically sustainable for individual households that predominate in the beef production farms and organisations. Kazakhstan uses only around 30% of its large grazing resources nowadays (Meat Union, 2018). According to Robinson et al. (2017), a distance that cattle needs to cover to reach the areas with the highest forage availability was the main determinant of moving livestock from the farm's surrounding pastures to new grazing lands. For abovementioned reasons, it is challenging to develop the industry within the existing extensive approach of cattle farming. Nevertheless, livestock breeding for the meat production is expected to be one of the top drivers of the country's agricultural development.

Kazakhstan's authorities are not satisfied with "the Status Quo" and have targeted to develop a new BCPS taking into consideration examples of some industry leaders like the USA and Canada. (Ministry of the agriculture of the Republic of Kazakhstan, n.d.). Three phases of the new BCPS according to Maclachlan & Stringham (2016) are as follows: "*cow-calf* operations that produce weaned calves, *stocker or backgrounding* operations that feed calves to maturity by grazing and/or on forage and *finishing or feedlot* operations that feed cattle intensively to reach slaughter weight". Advantages of Kazakhstan that can contribute to the development of a competitive business model comprise significant land resources for cattle grazing and fodder crop production, geographical location that is close to growing export markets, strong attention from the government, and its readiness to make changes. In view of the above, Kazakhstani cattle industry undergoes substantial structural changes.

## 1.2. Research Problem

The proposed Kazakhstani new BCPS is developed based on existing knowledge and experience of the main beef production industry-leader countries. Diversified and segmented BCPS operations are common in the US and Canada, however, it is questionable if existing structures are economically viable for Kazakhstan. The fundamentals of BCPS are similar worldwide, but specific management practices differ across the regions, cultures and markets (Herring, 2014). Numerous research studies related in BCPS (Pogue et al, 2018; Sheppard et al., 2015) and economic analysis of beef farming with stochastic simulations have been performed (Khakbazan, 2014; Evans, 2007). The majority of these studies were aimed at regions within developed industries of beef livestock production. Studies of such investments in developing markets are limited (Lanfranco et al., 2018; Evans et al., 2007).

According to the Organisation for Economic Co-operation and Development (2013), bottlenecks of further livestock sector development in Kazakhstan are: low land productivity, feeding quality, fodder supply management, underdeveloped infrastructure and logistics in rural areas. Obviously, the above-mentioned starter point conditions in the development of the new BCPS will result in an increase in the amount of required investments.

Kazakhstan has immense unutilised pastures and grazing land for inexpensive range-based livestock production (Hankerson et al., 2019). The availability of inexpensive feed sources is important because the largest part of beef cattle maintenance costs is associated with nutrition or feed (Herring, 2014). The economic profitability of the new BCPS in Kazakhstan has not been assessed yet by considering the variability of price for cattle's live weight (P), calves' average weight (W), and feed cost (FC). At the same time, critical analysis and assessment of the potential risks are essential to develop a detailed strategy of the new BCPS in Kazakhstan (Meat Union, 2018).

According to Alberta Agriculture and food (2008), cow-calf operation is a low profit and low rate-of-return business even in Canada with long traditions of beef cattle farming and an established supply-chain. One who decides to organize a cow-calf enterprise must expect return on investment only in the long run because of the modest economic profit of this type of an enterprise. Planning of a cow-calf farm requires a diligent concentration on calf harvest ratio or cost per kilogram of a calf weaned. However, new cow-calf-type farmers in Kazakhstan tend to take risks of feeding weaned calves at their farms, while necessary ration cannot be provided in most of the cases due to overgrazing of nearby settlements areas and absence of low-cost high-energy feed for cattle (Robinson, 2000). There are lots of uncertainties in sales prices of cattle in the market. It is also not clear what the costs and benefits of running a backgrounding enterprise at a cow-calf operator's farm are and whether backgrounding should be better performed on a feedlot's side within a new BCPS of Kazakhstan.

## 1.3. Objective of the Study

The primary objective of this research is to analyse the economic feasibility of investing in the new BCPS in Kazakhstan, specifically in cow-calf farming, by developing a stochastic simulation model of a cow-calf operation (Model) that can be further used as a decision-making tool. The uncertainty in price for cattle's live weight (P), calves' average weight (W) and feed costs (FC) will be taken into consideration as major factors that affect the economic feasibility of a cow-calf operation within a new BCPS. To reach the objective, the following research question must be answered:

*How do the changes of price for cattle's live weight, calves' average weight and feed costs affect the economic feasibility of investing in the cow-calf operation within the new BCPS in Kazakhstan?*

Specific research questions that will help to answer the main research question are as follows:

a) *How will price for cattle's live weight, calves' average weight and feed costs be formed within the new BCPS?*
b) *What is the Net Present Value of the expected cash flows within the new BCPS?*
c) *How will the variability in price for cattle's live weight, calves' average weight and feed costs affect the Net Present Value?*

## 1.4. Relevance of the Study

According to Hespos et al. (1965): "Investment decisions that are characterized by a high degree of uncertainty are probably the most significant and hard decisions that confront top management". It is expected that this work will contribute to a more thoughtful understanding of the economic feasibility of a cow-calf operation within the new Kazakhstani BCPS. First, the Model will help to identify risks that should be taken into consideration when making investment decisions into the cow-calf farming in Kazakhstan. Second, the developed Model can be used as a decision-making tool, that helps to understand the effect of uncertainty in price for cattle's live weight (P), calves' average weight (W) and feed costs (FC) on economic profitability of projected investments.

## 1.5. Theoretical framework

The underlying theory to be used to perform the economic feasibility study is cost-benefit analysis. The theory of cost-benefit analysis, as a part of micro-economic theory, is widely used in scientific studies. "It contributes to the understanding by giving a formal description of the subject and examining theoretical basis for some of the techniques that have become the accepted tools of decision-making around the world" (Drèze & Stern, 1987).

Budgeting is used to construct a deterministic model by bringing together all economic costs and benefits of a cow-calf operation. According to Kay, Edwards, and Duffy (2008), budgets are planning tools that help to estimate profitability and feasibility of an enterprise after which a decision on implementation will follow. Budgeting is an important step in the decision-making process. The problem is structured by means of different types of budgets: enterprise, whole-farm, and cash flow budgets.

The net present value (NPV) method is used to define how worthwhile capital investments in the new BCPS in Kazakhstan are. The NPV is one of the major tools for appraisal of long-term projects that takes into consideration the time value of money of future cash flows (Brealey, Myers, Allen & Mohanty, 2012). At the same time studying the feasibility of an investment by using NPV can lead to a misleading result if uncertainties are not considered. Hardaker, Lien, Anderson & Huirne (2015) defined uncertainty as imperfect knowledge that lead to risks as unfavorable consequences. Beef cattle farming is exposed to many risks due to influence of unpredictable factors including market risks and uncertainty in performance of crops and livestock. Because of aforementioned reasons, uncertainty associated with the cow-calf operation is considered in the Model.

The Monte Carlo simulation (MCS) is a technique used as a research tool to make stochastic simulations in complex decision models and understand the effect of uncertainty inherent in a project. Clemen & Reilly (2014) defined a simulation model as 'a mathematical model in which a probability distribution is used to represent the possible values of un uncertain variable'. Thus, MCS helps to include variability into a deterministic model for further NPV calculation taking into consideration the uncertainty. Both tools together make the modeling outcomes relevant for feasibility analysis and the results are closer to a real-life situation.

### 1.6. Methods of data collection.

Series of inputs were defined before starting of the modelling process. The structure of the beef production system in the Model was reconstructed using existing knowledge of beef cattle husbandry practice from industry specific literature. Available scientific works related to beef farming in Canada and the USA were studied. Inputs related to revenue and expenses of each enterprise were found from market sources and statistical databases. Secondary data sources were reviewed as literature, scientific articles, and statistical databases. In the process of model building, studies on animal nutrition specific to Kazakhstan were used in particular.

### 1.7. Research outlines

The research is structured as follows.

*Chapter 2 Methodology* is a central part of the research that introduces the general assumptions of the cow-calf operations model, explains how the cow-calf operation model was constructed and what main building blocks it consisted of. The first section of the Methodology chapter introduces general assumptions used in a model building process. The second section explains how revenues and costs were formed within the enterprise budgets. The third section presents the whole-farm budget as a result of merge of enterprise budgets. The fourth section presents the cash flow budget and explains general assumptions and steps performed for the cash flow budget construction. The last section shows how uncertainty was embedded in variables: price for cattle's live weight (P), calves' average weight (W) and feed costs (FC), and what inputs were used in NPV calculation.

*Chapter 3 Results* is another important part of the research that presents both the modeling and stochastic simulation outcomes. It is explained at the beginning of the chapter how variability of above mentioned input variables affects the economic profitability of the modeled cow-calf operation and what the distribution of NPV in 10-year and 15-year terms was. The chapter gives the summary of findings from the economic feasibility analysis performed.

*Chapter 4 Discussion* elaborates on the results of the study by answering how the researched results meet the research objective and explains findings. In this chapter the limitations of the modeling process are stated together with implications for further research.

Finally, the study is summarized, and *conclusion* is made in *Chapter 5*.

The Appendix section contains the print screens from the Model of the input variables module, enterprises budgets, a whole-farm budget, and a cash flow budget. The detailed calculation of feed costs by type of cattle included in to explain the feed costs numbers in the budgets. Lastly, the figures of stochastic distributions from NPV scenario analysis shown in this part to enlarge understanding of the research results by visual representation of the Model's parts and important findings from stochastic simulation.

# 2. Methodology

*Chapter 2 Methodology is a central part of the research that introduces the general assumptions used in the Model, explains how the Model was constructed and what main building blocks it consisted of. The section 2.1. General assumptions introduce the new beef cattle production system in Kazakhstan, gives overview of the Model's structure, the logic of its construction and states general parameters of the Model. The following sections of the Methodology chapter: 2.2. Revenue, 2.3. Cattle feed costs, 2.4. Other operating costs, 2.5. Ownership costs explicitly discuss how the integral parts of enterprises budgets and the whole-farm budget were built. Complete budgets are presented in Appendix 3. Finally, section 2.6 discusses the cash flow budget that is shown as a whole in Appendix 4.*

## 2.1. General assumptions

### 2.1.1. Beef cattle production system

According to the classification by Herring (2014), cattle producers can designate their operations to several beef cattle production stages like seedstock, commercial (market animal production) and combination of both seedstock and commercial. Thus, commercial cow-calf farmers are able to purchase high breed animals from one of the local seedstock operators or import from abroad. Production of market cattle involves several stages of beef cattle production like cow-calf, stocker or backgrounder and finishing or feedlot. Operations are separated in relation to different cattle development stages from birth until 20-months of age. Beef cattle production stages are highly segmented in countries with developed beef cattle production industries. Two types of commercial operators are likely to emerge according to Meat Union (2018) within a new BCPS in Kazakhstan while the whole supply chain is at the development phase yet. They are cow-calf operators and feedlots. The summary of beef cattle production stages within the new BCPS in Kazakhstan is shown in Table 1.

*Table 1. General description of beef cattle production stages in the new BCPS in Kazakhstan*

| Stages/ operations | Seedstock | Commercial (market cattle production) | | | |
|---|---|---|---|---|---|
| | | **Cow-calf** | **Backgrounding** | **Backgrounding** | **Finishing/ Feedlot** |
| **Operator (EN)** | Seedstock | Cow-calf | Cow-calf or Feedlot | | Feedlot |
| **Operator (QAZ)** | Asyl tukymdy mal sharuashylygy | Fermer | | Mal zhemdeu alany | |
| **Characteristic** | | Smallholder cattle farm | | Middle or large-scale farm | |
| **Ownership** | | family | | corporate or cooperative | |
| **Herd size, heads** | 100-5,000 | 50-200 | 50-200 | 1,000-10,000 | 1,000-10,000 |
| **Definition*** | Production of high breed animals for further sale to other seed stockers and cow-calf operators | Concentration on cows' reproductive performance with the goal to produce calves, growing them until weaning and selling at a commercial market. | Purchasing of weaned calves and rising on pastures with supplemental feed. | Purchasing of weaned calf and rising in small lots with supplemental feed. Developing eating habits from a feed bunk and preparation to live in feedlots. | Feeding with high grain concentrate diets with a final goal to produce commercial cattle that is ready to slaughter. |
| **Product** | Pure bred cattle (bulls and heifers) | Weaned calves, additional (breeding heifers, *culled cows) | Yearling calves | Steers | Fattened male cattle ready for slaughter |
| **Animal age** | | 7-8 months | 12 months | 15 months | 18-20 months |
| **Average calf weight (in), kg** | | 22 | 184-250 | | |
| **Average calf weight (out), kg** | | 184-250 | 295-390 | | |

*Note. *Based on description of beef cattle production stages by Herring (2014).*

***Culled cow means a cow or a heifer that was removed or expected to be removed from the herd because of factors as death, slaughter, or sale (Herring, 2014).*

The current study has been concentrated on economic performance of a cow-calf operation. A *cow-calf operation* is defined in this study as economic activities of a smallholder farm with an average herd size of 100 breeding cows. The cattle are kept by a farmer in order to produce calves. The permanent goal is rising newborn calves until weaning at 7-8 months of age with further sale. Alongside this, there is a possibility that a cow-calf operator can perform part of a backgrounding operation at his own cow-calf farm. *Backgrounding at a cow-calf farm* is an operation of rising calves from weaning until yearling age, namely from 8 until 12 months. Backgrounded calves after weaning experience fewer health problems than those transported after weaning directly to a feedlot with a shrill diet change. A cow-calf operator can be interested in performing backgrounding operations due to additional weight gain of calves at this life period. Thus, calves with more weight can be sold to a feedlot and revenues can be higher.

A cow-calf farm can simultaneously run different types of activities in order to supply calves for sale to the market. These activities can be seen as divisions of a farm's business, identified by a type of product they produce. Each of the activities can be analyzed as a single enterprise (Warren, 1986). Enterprise budgeting technique helps to identify economic profit (return to management) of each single enterprise by allocating revenue, operating and ownership costs to an enterprise.

Activities of the modeled cow-calf farm have been considered from the perspective of three enterprises. (i) A *reproduction enterprise* cares about breeding cows and production of calves weaned at 7-8 months. Then there is (ii) a *backgrounding enterprise* that aims to produce yearlings or 12-month old heifer and steer calves. And the last is (iii) a *feed production enterprise* that is usually run to decrease feed costs due to expectations that own feed is cheaper compared to purchased one. All together reproduction, backgrounding and feed production enterprises form a whole-farm enterprise (Figure 1).

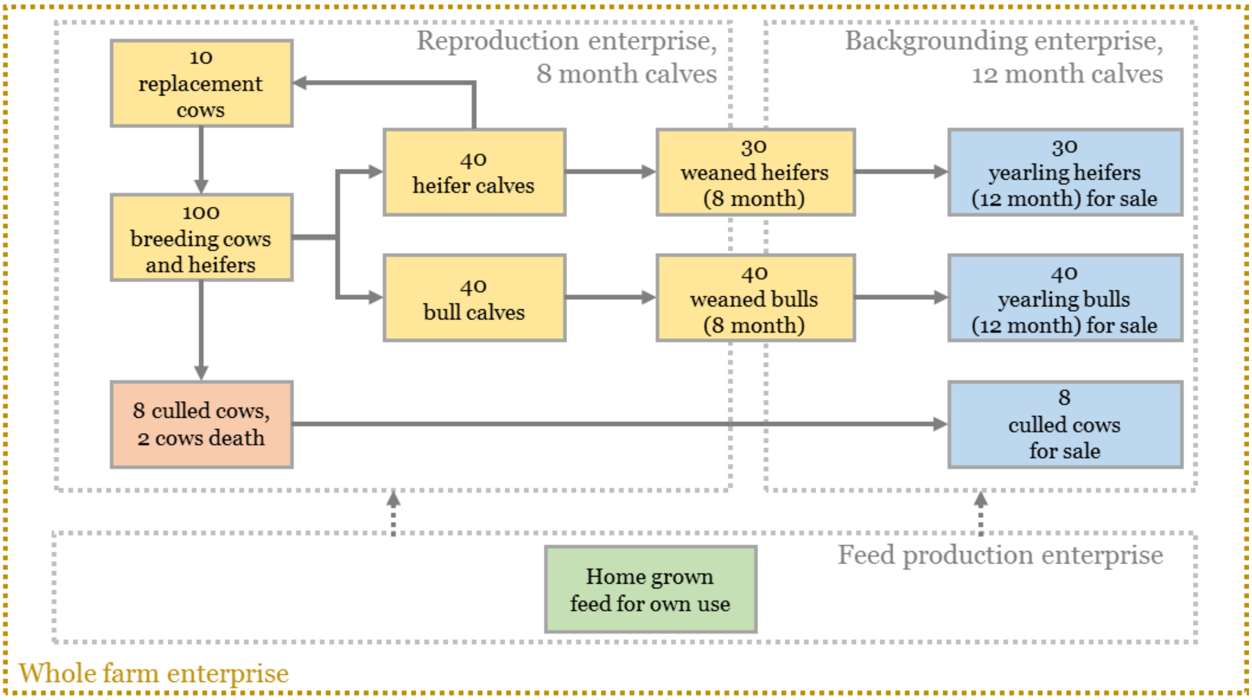



*Figure 1: Cow-calf operation's enterprises*

*Note. The figure illustrates the modeled cow-calf operation with three enterprises, where: reproduction enterprise + backgrounding enterprise + feed production enterprise = whole-farm enterprise.*

Enterprise budgets have been constructed to analyse revenues and costs of each of above-mentioned enterprise and to define how economic profit (return to management) is formed. Enterprise budgets serve as building blocks of a whole-farm budget. Kay, Edwards & Duffy (2008) defined a whole-farm budget as a detailed projection of costs and returns of enterprises that form together a picture of an organisation.

### 2.1.2. Model structure

The Model was structured from four main blocks (Figure 2). First, cow-calf operation budgets. These enterprises include: 1) reproduction enterprise's budget (production of calf weaned at 8 months of age); 2) backgrounding enterprise's budget (rising calves from 8 until 12 months of age); 3) feed production enterprise budget (own feed production). All information for enterprises budgets were taken from the linked 'input' spreadsheet. Second, based on the three enterprise budgets a whole-farm budget was built. Third, the cash-flow budget was constructed based on the whole-farm budget and the input data that is specific only to a cash flow enterprise (discount rate, debt repayment schedule, and inflation rate). The last fourth step was application of the Monte Carlo simulation to account the stochastic character of several input variables: price for cattle's live weight (P), calves' average weight (W), and feed costs (FC). The simulation helped to understand an effect of uncertainty in input variables to the NPV of the project in 10-year and 15-year terms and, as a result, evaluate the economic feasibility of investing in the new BCPS in Kazakhstan. The basic deterministic model was constructed in Microsoft Excel 2010 (Microsoft Corporation, Redmond, Washington, US), while @Risk add-in program (Palisade Corporation, Ithaca, New York, US) was utilised to deal with stochastic variables. The full production cycle was replicated to forecast a continuous operation of the system.

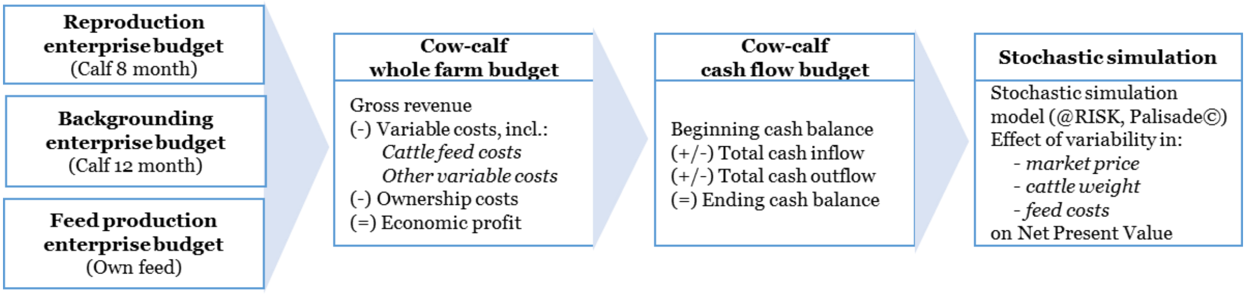



*Figure 2: The Model's structure*

### 2.1.3. General parameters of the Model

Input parameters of the Model were identified to start building enterprise budgets and the modeling process in general. Each enterprise was built from specific assumptions. First, the herd's performance characteristics were defined from the beef cattle management literature and several assumptions were made. Second, the information about market prices forming revenue streams and critical costs within the modeled cow-calf enterprises budgets were incorporated into the Model. The detailed information on parameters forming revenue and costs were presented in Table 2, Appendix 1 and in the subsequent parts of the Methodology chapter.

*Table 2: Defaults inputs to the Model*

| Parameter | Value | Unit | Reference |
|---|---|---|---|
| Herd size | 100 | cows | Author's assumption |
| Calving cows persenatage | 80 | % from total exposed cows | Beef Cow-Calf Manual (2008) |
| Bull-to-cow ratio | 1/25 | Head | Herring (2014) |
| # of culled cows | 8 | heads per year | Beef Cow-Calf Manual. (2008) |
| # of cow death | 2 | heads per year | Beef Cow-Calf Manual (2008) |
| # of weaned steer calves | 40 | heads per year | Author's assumption |
| # of weaned heifer calves | 40 | heads per year | Author's assumption |
| # of replacements (cull + death) | 10 | heads per year | Calculated |
| # of heifers retained to increase a herd size | 0 | head | Author's assumption |

| | | | |
|---|---|---|---|
| # of replacement heifers purchased | 0 | head | Author's assumption |
| Subsidies for a head of weaned or yearling calf that is sold to feedlot for fattening | 200 | KZT/ kg | Order of the Deputy Prime Minister (2018) |
| Subsidies to cover cost of keeping a breeding bull | 100 000 | KZT/ head in 1 mating season | Order of the Deputy Prime Minister (2018) |
| Subsidies to cover acquisition costs of imported breeding stock | 200 000 | KZT/ head | Order of the Deputy Prime Minister (2018) |

*Note. The currency used in Model building process is Kazakhstan Tenge (KZT). All monetary operations were conducted in local currency KZT.*

The unique characteristic of the Model lies in the possibility for a future user to track costs and benefits from different enterprises within one cow-calf operation. It might be a case that all specific input data are not available to investors. Therefore, the default data that were presented in the Model and constructed links between budgets and modules might be used to build a tailor made budget of a new cow-calf operation project. The income and costs can change considerably and vary across different farms based on a type of cattle breed, initial investments made into a farm, feeding practices, regions, climatic conditions, calf harvest ratio, and many other factors. Multiple cow-calf farming practices are used in the beef industry to produce and deliver one type of product with similar characteristics. However, the parameters of the Model simulate the specific behavior of a cow-calf farm and therefore the economics of this type of operation can be understood from the Model.

## 2.2. Revenue

*The following section explains how revenues were formed within the enterprise's budgets. Revenue estimations and expected range of stochastic variability of price for cattle's live weight (P), calves' average weight (W) are described below.*

### 2.2.1. Price for cattle's live weight

It is possible to calculate an average market price for live weight of cattle from commodity prices for carcass weight. The equations (1) and (2) show formulas of a minimum or maximum market price for live weight of cattle, where dressing percentage is meat and skeletal portion from a live weight of an animal. Dressing percentage varies from 56.5 to 59.8% due to several factors like a frame size of an animal, sex, and grades (Understanding dressing percentage, n.d.). For the modeling reason 59.8% was used since this percentage was applicable for beef purpose cattle on a finishing diet.

$$P(W)\ min = 0.598dp * HP(CW)\ min, \quad (1)$$

$$P(W)\ max = 0.598dp * HP(CW)\ max, \quad (2)$$

*Where,*

*P(W) min and P(W) max – minimum or maximum market price for live weight of a cattle,*

*HP(CW) min and HP(CW) max – minimum or maximum historical price for carcass weight of a cattle,*

*dp* **-** *average dressing percentage*

The Food and Agriculture Organization of the United Nation in its commodities overview (Commodity snapshots, 2019) had stated that "nominal meat prices are expected to start at levels similar to those registered in 2010, and in most cases, with the marginally upward trend. By 2025, prices for beef are projected to increase to around USD 4 497/ton carcass weight equivalent (c.w.e.)". The highest price was in 2014 reaching almost USD 5 600/ton carcass weight and the lowest was USD 2 900/ton carcass weight during the period between 2009 and 2019 (Commodity snapshots, 2019). By using equations (1) and (2) it was found that the minimum and maximum prices for cattle's live weight were 664 KZT/ kg and 1283 KZT/kg respectively (Table 3). The most likely value, 850 KZT/ kg, was the author's expert elicitation that took into account current market prices for high quality Angus breed calves grown according to industry standards (Calves, n.d.), (Bulls, n.d.).

*Table 3. Calculation of live weight of cattle*

| | Carcas weight price | Dressing coefficient | Price for live weight | | Data source |
|---|---|---|---|---|---|
| | USD/ ton | _ | USD/ ton | KZT/ kg | |
| Min | 2900 | 0,598 | 1734 | 664 | Calculated |
| Max | 5600 | 0,598 | 3349 | 1 283 | Calculated |
| Most likely | | | | 850 | Author's estimation |

Therefore, market price for the live weight of cattle was expected to be within the minimum, most likely, and maximum values (664, 850, 1283) in the triangular distribution that is skewed to the left (Figure 3)

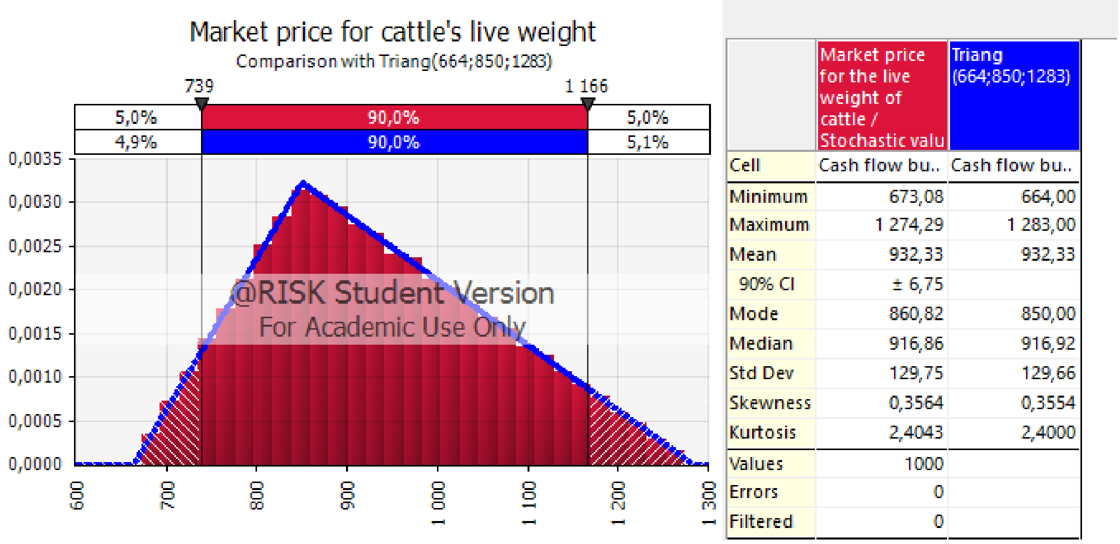



*Figure 3: Triangular distribution of market price for the cattle's live weight (KZT per kilogram)*

Sales price of one yearling heifer cattle was expected to be around 400 thousand KZT per head (Meat Union, 2018) High market price for heifer calves are explained with a growing internal demand for high breed animals that can be used by other farmers to replacements, increase of a herd population or even to startup a new cow-calf farm. Hence, the expected price was 1374 KZT/ kg of live weight of a heifer calf, taking into consideration that the average live weight of a heifer calf was 290 kg. And this value was kept as deterministic in the Model.

### 2.2.2. Calves' weight

One of the important factors that determines profitability of a cow-calf operator is animal performance from birth until sale to a feedlot. The new BCPS in Kazakhstan is an intensive beef production system, where calf's weight gaining ability in a certain period of time depends on breed type among other factors. One of the popular rears is Aberdeen-Angus cattle (further – Angus). Among other cattle breeds like Hereford, Simental, Kazakh Akbas, Auliekol, Angus is used to produce crossbreds with the local nondescript cattle (further – Crossbreed). Pure Angus breed cattle and crossbreeds of local nondescript and Angus breeds were used to model calves' weight. The average calf's weight in relation to breed type (an underbred, a crossbreed or pure Angus breed) and age is shown in Table 4.

*Table 4. Calf's weight*

| Average calf weight, kg | Underbred<br>Min | Crossbreed<br>Avg | Max | Min | Angus<br>Avg | Max |
|---|---|---|---|---|---|---|
| at birth | 25 | 28 | 35 | 25 | 28 | 35 |
| 7 months | 133 | 184 | 200 | 180 | 220 | 250 |
| 12 months | 205 | 295 | 320 | 275 | 340 | 390 |

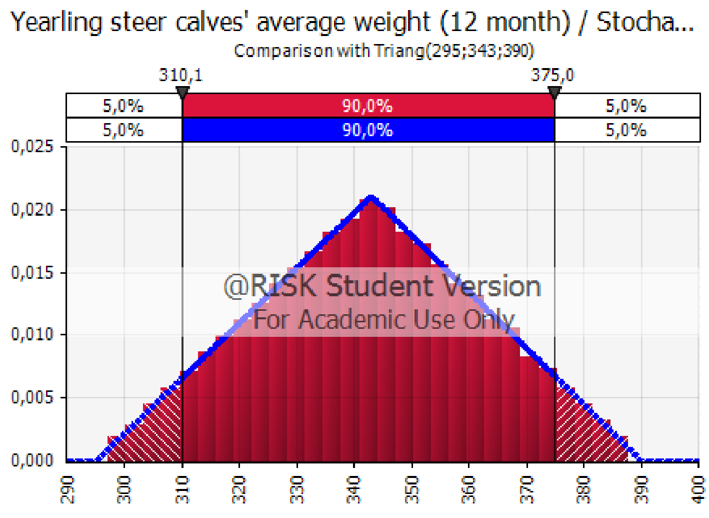
*Note. Assumptions are based on data from Republican Chamber of Kazakhstan Angus, 2018*

It was assumed that an average weight of a calf variated within a certain range. The reason for that could be inherited genetics of each individual animal, health issues, practice of using growth implants. The insufficiency of nutrients was not considered as a factor affecting cattle's weight gain in the Model. The expectations were that feed was assumed to be supplied in the required amount to maintain daily requirements of cattle. Therefore, a triangular statistical distribution was used to capture an inherent variability of animal weight.

According to information from the Republican Chamber of Angus of Kazakhstan on the advantages of angus breed in crossbreeding with other breeds of cattle (2019) and from Schiermiester et al (2015), the average weight of a yearling (12-month-old) steer calf is expected to be within the distribution of [295, 343, 390] (Figure 4) and for yearling (12-month-old) heifer calf between [250, 291, 331] (Figure 5). It is expected that steer calves are heavier in weight than heifer calves. For the modeling reason the average weight of 12-month-old steer calves was assumed to be 1.15 times from heifer calves' weight of the same age (Bock et al., 1991). The total weight of animals sold also affects significantly on the subsidy amount a farmer can get. According to the governmental decree 200 KZT subsidies can be granted for every kilogram of live weight sold to a feedlot. (Order of the Minister of Agriculture, 2019).

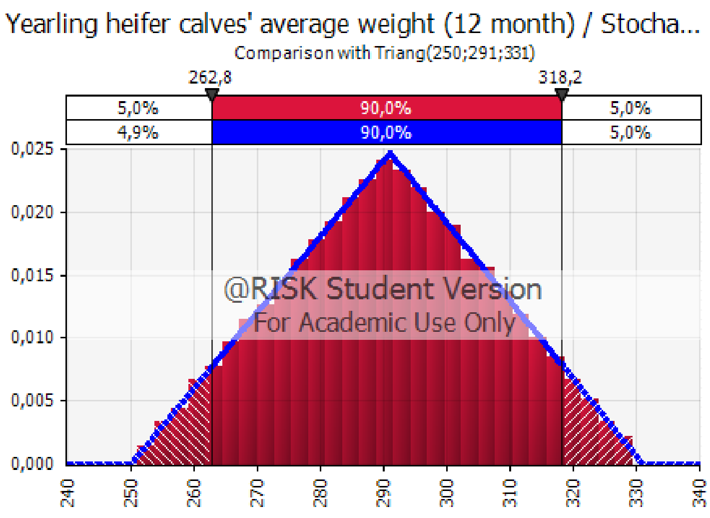
The variability in weight of weaned or 7-month-old calves was not included in the Model because it had been assumed that the revenue stream came from the sale of 12-month-old calves to the market. The revenue of the reproduction enterprise came from the sale of 7-month-old calves to the Backgrounding enterprise. Then at the backgrounding enterprise budget the purchased calves' costs were included as a variable cost. The reproduction and backgrounding enterprise budgets will complement at the whole-farm budget level. Therefore, the assumption about the static weight of 7-month-old calves does not affect farm's budget on the whole-farm level.

The weight of culled and non-fertile cows was assumed to be between the range of triangle distribution in pounds (1194, 1374, 1394) or kilograms (542, 623, 632). These data were taken from the American Angus Association's database (Genetic trend EDP, 2019) of registered Angus cows phenotypic cow weight during the expected lifetime of ten years.




| | Yearling steer calves' average weight (12 month) / | Triang (295;343;390) |
|---|---|---|
| Cell | Cash flow bu.. | |
| Minimum | 297,094 | 295,000 |
| Maximum | 387,892 | 390,000 |
| Mean | 342,667 | 342,667 |
| 90% CI | ± 1,01 | |
| Mode | 344,433 | 343,000 |
| Median | 342,724 | 342,749 |
| Std Dev | 19,400 | 19,392 |
| Skewness | -0,0102 | -0,0103 |
| Kurtosis | 2,4016 | 2,4000 |
| Values | 1000 | |
| Errors | 0 | |
| Filtered | 0 | |

*Figure 4: Triangular distribution of the yearling steer calves' average weight (12 months of age)*




| | Yearling heifer calves' average weight (12 month) / | Triang (250;291;331) |
|---|---|---|
| Cell | Cash flow bu.. | |
| Minimum | 251,094 | 250,000 |
| Maximum | 329,401 | 331,000 |
| Mean | 290,667 | 290,667 |
| 90% CI | ± 0,861 | |
| Mode | 290,546 | 291,000 |
| Median | 290,731 | 290,749 |
| Std Dev | 16,544 | 16,534 |
| Skewness | -0,0124 | -0,0121 |
| Kurtosis | 2,4031 | 2,4000 |
| Values | 1000 | |
| Errors | 0 | |
| Filtered | 0 | |

*Figure 5: Triangular distribution of a yearling heifer calves' average weight (12 months of age)*

## 2.3. Cattle feed costs

Operating costs (also: variable costs, direct costs) occur when operating activities are performed at a farm. The amount of operating costs is under control of a decision maker and can be reduced to zero if production is stopped (Kay, Edwards, and Duffy, 2008). Operating costs in the Model were grouped into two main parts: cattle feed costs and other operating costs. *Cattle feed costs* are one of the largest expenditures in cattle farming.

The following parts of the study introduce how cattle feed costs were defined in the Model. First, the herd's feed requirements for one budgeted year were calculated, based on cattle's daily nutritional needs and market prices for feed components. Second, feed components were separated into home-grown and purchased feed. The allocation of home-grown feed was made because the study aimed to calculate the budget for own feed production enterprise next to reproduction and backgrounding enterprise budgets. Finally, the effect of uncertainty of both total purchased feed costs and operating costs in own feed production enterprise budget were modeled.

### 2.3.1. Cattle's feed requirements and associated costs

Feeding formulas differentiate significantly and based on knowledge of cattle's nutritional needs and ability of a farmer to provide necessary feed components. A farmer has to obtain high-quality feed for the lowest possible cost to ensure a cost-effective beef cattle farming. It is essential to supply farm's cattle with a recommended amount of feed units all year around. The feed of high quality is also needed to reach the genetic potential of an animal in weight gain.

Kazakh beef cattle industry utilizes hay, hay-silo or hay-silage types of feeding. The forage and supplemented additives are provided during the period of cold days which is almost 185 days in a year. Peculiarities of local natural-climatic conditions, vegetation cover, composition and nutrition of local forage are important considerations. Therefore, feed rations of beef cattle in this study were based on the locally available feed components according to Kazakhstani researchers (Zhazylbekov et al., 2008). Costs were calculated based on local market prices for feed components. The detailed calculation of feed costs for bulls, breeding cows, calves before weaning, young stock cattle after weaning was implemented (Appendix 2).

The total cattle feed costs were calculated separately for *reproduction and backgrounding enterprises*, after that estimations of feed costs for different cattle in the herd were made. The reproduction enterprise included three types of diets: feed for bulls, feed for breeding cows including replacement heifers at the age above 12 months, and supplemental feed for calves before they reach the weaning age. At the same time, the backgrounding diets consist of feed for heifer and separately feed for steer calves between 9 months to 12 months of age. The total cattle feed costs were also divided into *home-grown feed and purchased feed* in order to calculate costs associated with the feed production enterprise. Home grown feed included hay, haylage, corn silo as well as naturally grown and seeded pastures. The total volume required was 1,002 thousand kg per year with the estimated cost of 4,918 thousand KZT for the reproduction enterprise and 168 thousand kg per year with the cost of 1,459 thousand KZT for the backgrounding enterprise respectively. It was anticipated that a farmer used naturally grown pastures and, therefore, had not carry any directly associated costs on pasture grass. Purchased feed included stock feed (cereals), straw, concentrates, protein-vitamin and mineral supplements, phosphate supplements and salt blocks. The total volume of purchased feed for the reproduction enterprise made 1,174 thousand kg per year with the total market cost of 9,893 thousand KZT per a farming year and 199 thousand kg per year with total costs of 1,688 thousand KZT for the backgrounding enterprise respectively. The total summary of necessary volume of cattle feeds and associated costs can be found in Table 5 where the feed costs are divided by the type of enterprises and by source, whether the feed is home-grown or purchased.

*Table 5. Cattle feed costs for reproduction and backgrounding enterprises*

| Feed type | Reproduction enterprise | | Backgrounding enterprise | |
|---|---|---|---|---|
| | KZT | ton/ year | KZT | ton/ year |
| Hay | 1,123,367 | 103 | 551,830 | 50 |
| Haylage | 1,275,000 | 85 | 362,400 | 43 |
| Corn silo | 2,520,000 | 168 | 544,800 | 74 |
| Pasture grass | - | 555 | - | - |
| Seeded grass | - | 92 | - | - |
| *Total home-grown feed* | 4,918,367 | 1,003 | 1,459,030 | 167 |
| Stock feed (cereals) | - | - | 180,000 | 12 |
| Straw | 990,000 | 90 | - | - |
| Concentrates | 3,069,360 | 73 | 6,384 | 18 |
| Protein-vitamin and mineral supplements | 609,600 | 6 | - | - |
| Phosphate supplements | 42,240 | 0.4 | 21,296 | 0.4 |
| Salt blocks | 263,824 | 2,3 | 21,296 | 0.4 |
| *Total purchased feed* | 4,975,024 | 172 | 228,976 | 31 |
| *Total cattle feed costs* | 9,893,391 | 1,175 | 1,688,006 | 198 |

### 2.3.2. Estimations of own feed production costs

It was defined above that in order to run a cow-calf farm with 100 breeding cows and produce 80 yearling (12-month-old) calves each year with 70 heads for sale, a farmer would need the calculated amount of feed over other farm's costs (Table 5). From all required types of feed there were several feed components that assumed to be grown at the modeled farm. Hence, the major activity of the feed production enterprise would be supply of hay, haylage, corn silo and maintaining of the pastures in the required amount for reproduction and backgrounding enterprises. An assumption was made for the Model simplification reasons that the amount of feed produced at the farm would be equal to the amount of the type of feed required by the farm's cattle. Therefore, under- or overproduction of home-grown feed was not expected. Another assumption was that the revenue of the feed production enterprise was equal to the sum of spending of reproduction and backgrounding enterprises for purchase of home-grown feed. The visual representation of this equality can be seen from the whole-farm budget's table in Appendix 3.

In order to produce the required amount of feed, it is important to determine the structure and the size of seeding areas with particular crop types. For this purpose, it was necessary to know not only the yield of a fodder crop, but also the conversion rate of green mass into hay, silage and/or haylage. The calculated yearly volume of the on-farm produced feed for 180 heads of cattle comprised 153 tons of hay, 128 tons of haylage, 242 tons of corn silage, and 647 ton of pasture and seeded grass. The size of the land used for cultivation by a cow-calf farmer was found by multiplication of the three following variables: the required feed amount, the conversion coefficient of green biomass to green feed, and the average crop yield from a hectare of land. It was found that the winter-feed from hay and haylage required cultivation of grass on 485 ha of land having yield of 2 ton/ ha (Isabekov, Nurmanov & Turganbekova, 2012) and noting conversion coefficient of biomass into feed as 4:1 (Zhazylbekov et al., 2008). The same type of calculation technique was applied to corn silage considering corn yield at the level of 8.0 ton/ ha (Lunik, 2015) and conversion coefficient of biomass into feed at 1:1,16 ratio (Zhazylbekov et al., 2008). The result showed that it was necessary to sow 35 ha of land to cover one-year requirement of cattle in corn silo. The total cultivated land should be around 926 ha to support own feed requirements of the reproduction and backgrounding enterprises (Table 6). However, the size of the land can variate significantly and depends on different factors, such as yield of cultivated plants, climate, soil potential, quantity of inputs, and applied variable costs. The size of a farm and access to cheap resources may have effect to variable cost per hectar of a cultivated land. Sustaining high yields from year to year while keeping the lowest possible cost of production is the main challenge of the feed production enterprise.

*Table 6. The calculation of land that needs to be cultivated for own feed production*

| | Total | Green biomass required per 1 ton of green feed* | Average yield** | Cultivated land |
|---|---|---|---|---|
| | ton/ year | conversion coefficient | ton/ Ha | Ha |
| Hay | 153 | 4,00 | 2,0 | 306 |
| Haylage | 128 | 2,80 | 2,0 | 179 |
| Corn silo | 242 | 1,16 | 8,0 | 35 |
| Pasture grass | 555 | 1,00 | 1,5 | 370 |
| Seeded grass | 92 | 1,00 | 2,6 | 36 |
| Total home grown feed | 1 170 | - | 16,1 | 926 |

*Note. *Conversion coefficients of biomass into feed for hay, haylage, corn silo was taken from the study of Zhazylbekov et al (2008). **The average yields of grass on lands dedicated to hay and haylage, pasture and seeded grass production in Kazakhstan are taken from the study of Isabekov, Nurmanov & Turganbekova (2012). Corn yields ranged from approximately 5 to 15 tons per hectare according to the study of Lunik & Langemeier (2015) and taken as 8 ton/Ha for Kazakhstan as in countries with similar crop management practice like Russia and Ukraine.*

Knowledge of the amount of land that needs to be cultivated at the modeled cow-calf farm allowed to estimate operating and ownership costs of the feed production enterprise budget. The ownership costs in the Model's enterprise budgets are costs associated to the machinery and equipment used at the farm, they are as follows: depreciation and amortization, interest expenses on capital expenditure loans, property taxes, housing, and repair costs. The details of the calculation are given in section 2.5 Ownership costs.

For simplification reason the operating costs of the feed production enterprise in deterministic model were assumed to be 30% from the total revenue value. This assumption was made due to several reasons given bellow:

1) The operating costs can differentiate significantly from a farm to a farm due to numerous factors, such as soil nutrient potential, type of soil, quality and quantity of inputs needed to be used to grow crops, climate conditions, costs of prepared feed storage, and grazing practices. Moreover, prices for inputs can change the operating costs in a short and long run (Plastina, 2018). Therefore, a deterministic value of variable operating costs in the feed production enterprise cannot give a precise estimation of the necessary spending.
2) The theoretical nature of the budgeting is that a whole-farm budget consists of enterprise budgets. The assumption was made that all feed produced within the feed production enterprise of the modeled farm was for the sole purpose to feed own cattle. By this reason, the Model does not presume any excess or deficit of production and sale of own feed: hay, haylage, corn silo, and pasture grass. As a result, economic profit of the feed production enterprise budget tends to zero, because profit is not a goal. Any change in revenue of the feed production enterprise will change a budget value of other two enterprises to the same amount. This value is named as "the total costs of home grown feed". It can be expected that the amount of operating costs will not affect the economic profit of the modeled cow-calf farm at the whole-farm level. Therefore, making assumption on the amount of operating costs of the feed production enterprise for simplification reasons can be a reasonable solution to achieve the study goals without distortion of the whole-farm budget.
3) The total operating cost of feed production enterprise used for NPV calculation is assumed to be a stochastic variable.

### 2.3.3. Variability in feed costs

Operating costs of a cow-calf farmer associated with animals feeding differentiate significantly and depend on many factors. One of the hardships is how to find an optimal balance between a high-quality diet and the lowest possible cost. And that is a difficult task to accomplish even for an experienced farmer. There are several factors that should be considered before a farmer decides to allocate budget on feeding. Feed costs are influenced by feed sources, feedstuff combinations, market prices for feed components, associated preparation and delivery costs, feeding strategies, climate zones, and seasons. Farmers can use different pasture management practices to improve natural hayfields and pastures and apply land rotation. In the regions where cattle grazing practice is new, a farmer is advised to care about creation of seeded hayfields. The land reclamation can be an issue if saline land is used for farming. Application of an intensive production of fodder might be required on floodplains, estuaries. Finally, the local climate conditions can differentiate significantly in different parts of the country (Isabekov, Nurmanov, and Turganbekova, 2012). On this account it is important to understand the effect of variability in feed costs. All the above mentioned factors made finding the average value of the feed costs quite challenging. Therefore, the values of the total purchased feed and the total operating expenses of the feed production enterprise were assigned to be stochastic. It helped to capture the uncertainty in feed costs in the Model.

A uniform distribution was applied both to total purchased feed and total operating costs of own feed production. In the uniform distribution a value can be distributed equally between minimum and maximum levels. It is hard to predict the value since a lot of factors affect formation of feed costs. This turns the discussion onto the necessity to define the range of uniform distribution. The assumption was made that minimum and maximum boundary parameters of distributions were 30% from the mean value. It can be an effect of, for example, different feed costs decreasing strategies or increase in prices for feed components. The total purchased feed costs equated to 6 005 thousand KZT per year and operating costs of own feed production enterprise made 2 170 thousand KZT per year, according to the whole-farm budget. Therefore, the stochastic distribution of values for the total purchased feed and total operating costs of own feed production fell between the range of maximum and minimum levels, as it is shown in Table 7.

*Table 7. Stochastic distribution of feed costs*

| Feed costs | Distribution from the mean | Min | Mean | Max | Type of the distribution | Source |
|---|---|---|---|---|---|---|
| Total purchased feed | 50% | 3 002 792 | 6 005 584 | 9 008 376 | Uniform | Author's assumption |
| Total cash operating expenses of own feed production | 50% | 1 085 130 | 2 170 259 | 3 255 389 | Uniform | Author's assumption |

## 2.4. Other operating costs

*Other operating costs specific to reproduction and backgrounding enterprises* include bedding costs, expenses associated with veterinary, medicine, and breeding. Additionally, there are costs for cattle insurance and fuel for equipment used by reproduction and backgrounding enterprises. The data on other operating costs specific to reproduction and backgrounding enterprises are shown in Table 8 in calculated value (KZT) and Figure 6 in percentage to the total operating costs.

*Table 8. Other operating costs specific to reproduction and backgrounding enterprises*

| Item, in thousands KZT | Total Annual Cost | Total annual costs per the enterprise | |
|---|---|---|---|
| | | reproduction | backgrounding |
| Grain stalks and straw for bedding | 658 | 470 | 188 |
| Total veterinary, medicine and breeding costs | 1,005 | 825 | 180 |
| Cattle insurance | 1,800 | 1,600 | 200 |
| Fuel (cattle machinery) | 839 | 587 | 252 |
| Total | 4,302 | 3,482 | 820 |

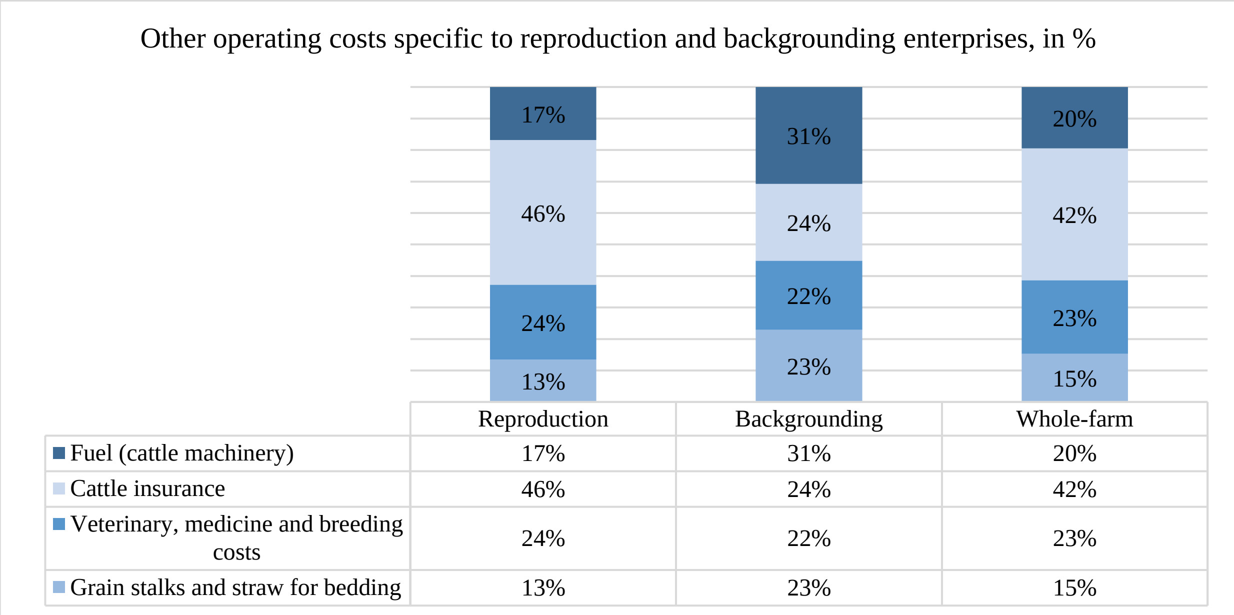



*Figure 6: Other operating costs specific to reproduction and backgrounding enterprises*

Cattle needs grain stalks and straw for bedding in a winter-stall housing period that lasts 185 days. The herd from 100 cows plus 80 heifer and steer calves require 1,000 kg/ year per head. With the price of 4,700 KZT/ ton, the total spending for bedding is 658 thousand KZT/ year. Veterinary, medicine and breeding expenses were taken from Angus Kazakhstan Association (Cost of production in breeding farm, 2014), corrected for the inflation rate and comprised in total 1,005 thousand KZT/ year for the modeled farm. Cattle insurance premiums are offered in the range of 1-5% from market price of an animal and cover loss of insured cattle as a result of a disease or an accidence (Republican Chamber of Kazakhstan Angus, 2019). An insurance premium of 10,000 KZT per head was taken for the modeling purposes. Fuel costs were calculated based on the assumption of spending 10 liters per day during the whole year with the average price of 230 KZT per liter.

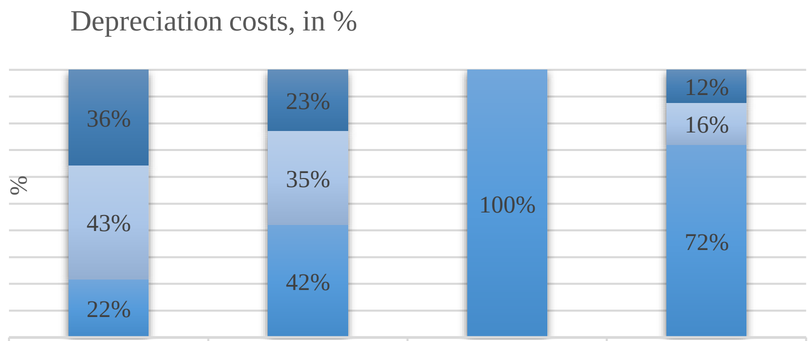
*Other operating costs specific to the feed production enterprise* are farmers' expenses to grow and prepare several feed types, such as hay, haylage, corn silo and pasture grass at the farm. The main operating costs include fuel, seeds, fertilizers, crop protection agents as well as pastures maintenance, harvest transportation and storage costs. The details of assumptions used to calculate the operating costs specific to the feed production enterprise is shown in the previous section 2.3 Cattle feed costs.

## 2.5. Ownership costs

According to Kay, Edwards, and Duffy (2008), ownership costs (also indirect costs, fixed costs) are associated with costs that cannot be avoided once a machinery or equipment is purchased. Ownership costs of the modeled cow-calf farm consisted of three main blocks: depreciation costs, other fixed costs and opportunity costs. The *depreciation costs* included the depreciation of machinery, equipment, and constructions on the farm's territory. O*ther fixed costs* included interests on loans, taxes, insurance, costs for equipment and machinery housing, repair and maintenance. *Opportunity costs* presented by estimations of own labor cost and alternative use of own capital. The calculation of the ownership costs in the Model can be found below.

### 2.5.1. Depreciation costs

Annual *depreciation costs* of fixed assets were calculated as the difference between market price and estimated salvage value with further dividing of useful life before replacement by years. The Salvage value is an estimate of the asset's market price that a farmer can receive at the end of an asset's useful life. The market prices were taken as those recommended by the Order of the Deputy Prime Minister (2018) as budgeting costs for machinery and equipment to run a beef cattle farm. The comparison with classifier marketplaces demonstrates a compatibility with the existing market prices for the commercial equipment and machinery. Edwards (2015) in his work on farm machinery costs proposed to use salvage value as a percentage of the new list's price calculated by American society of agricultural and biological engineers. Thus, by taking 15 years of useful life, the salvage values on average were as follows: 25% for a tractor with 600 hours of work per year, 17% for a forage harvester with 100 hours of work per year, 22% for a rake, 21% for a hay baler, 25% for a hay mover, 36% for a maize seeder, 21% for a maize shredder-haymaker. Salvage values of other machinery and equipment were assumed to be 15%. These percentages were used to calculate the depreciation costs of machinery and equipment of the modeled farm. As a result of calculations performed, the total annual depreciation costs made 2 301 thousand KZT while the total cost of assets amounted to 43 900 thousand KZT. The exhaustive information on the ownership costs can be found from the budgets in Appendix 3. And Figure 7 below visually represents how depreciation costs are allocated among enterprises and types of fixed assets. It should be noted that winter stables and shed together with the equipment for cattle check and water supply for grazing cattle were not allocated to Feed production enterprise. Therefore, its depreciation cost comprised 100% from machineries depreciation.




| | Reproduction | Backgrounding | Feed production | Whole-farm |
|---|---|---|---|---|
| Depreciation of wintering stables + winter shed | 36% | 23% | 0% | 12% |
| Equipment depreciation | 43% | 35% | 0% | 16% |
| Total Machinery depreciation | 22% | 42% | 100% | 72% |

*Figure 7: Annual depreciation costs distributed by enterprise budgets and the whole-farm*

### 2.5.2. Other fixed costs

Other fixed costs of the cow-calf production enterprise cover interest payments on capital investment loans, taxes, insurance premiums, housing and repair costs for machinery and equipment. The approach used in building of other fixed costs is described below:

1) *Interest payments on bank loans;* the assumptions made at this part of the study allowed to construct sources of project's finance and forecast later on the debt repayment schedule. Loans for beef farming development purpose in Kazakhstan are provided by a governmental financial organization JSC "KazAgro" (further – Kazagro) within the "Sybaga" beef purpose livestock lending program (n.d.). This program became very popular among small cattle farmers in Kazakhstan due to low interest rate and affordable collateral conditions. Therefore, it was assumed that the modeled cow-calf farm was funded partially by Kazagro, besides capital inflows from an investor or an owner. The modeled investments conditions of own and borrowed funds are presented in Table 9. The total required investment into a new cow-calf farm operation is 83 900 thousand KZT. 52% of investments is necessary to purchase an equipment, machinery, and winter stables with sheds. Another part or 48% from total required amount is dedicated to purchase of breeding cattle. It is important to note that an investor invested 15% from the total required amount, while 33% comes as reinvestment subsidies for machinery and cattle from the Kazakh government and remaining 52% comes as debt finance.

*Table 9. Funds investment conditions*

| | Unit measure | Investments into fixed assets | Investments into cattle |
|---|---|---|---|
| Total required investments | thousand KZT | 43 900 | 40 000 |
| Share from total required investments | % | 52% | 48% |
| Own capital investments | thousand KZT | 6 585 | 6 000 |
| *Loan amount, % from total value | % | 85,0% | 85,0% |
| Investment subsidies | thousand KZT | 12 025 | 15 400 |
| Loan amount, KZT from total necessary investments | thousand KZT | 25 290 | 18 600 |
| *Interest rate | % | 6,4% | 4,4% |
| *Loan maturity | month | 180 | 84 |
| *Grace period for principal's repayment | month | 24 | 24 |
| Principal repayment (equal distribution) | KZT/ year | 1 945 | 3 720 |
| Interest repayment in the first year | KZT/ year | 1 619 | 818 |
| Total repayment in the first year | KZT/ year | 3 564 | 4 538 |

*Note. *Loan financing conditions are taken from "Sybaga" beef purpose livestock lending program (n.d.).*

2) *Taxes;* basic tax rates on agricultural lands are established per one hectare and are differentiated by soil quality based on a soil fertility indicator. For the modeling purposes the Base tax rate of 166 KZT was taken for a soil with soil quality index around 45 points (Tax Code of the Republic of Kazakhstan, Article 503). The calculated land tax amount comprised 153 thousand KZT for 926 ha of land. Together with calculated machinery and property tax rates, the total payment to tax authorities amounted 417 thousand KZT.
3) *Insurance premiums;* insurance companies in Kazakhstan offer coverage of machinery and equipment damage or loss due to unforeseen events. Insurance premiums were taken from internet sources as 2.5% per year for machinery and 0.5% for equipment.
4) *Housing and repair costs for machinery and equipment;* housing is a sheltering cost for farm's equipment and tools available at a farm for machinery maintenance. These costs can vary significantly and for the modeling purposes were taken as 0.2% charge from average value of machinery and equipment. Repair costs made a significant portion of other fixed costs (29%) and total ownership costs (11%) and calculated based on operation and maintenance cost factors for agricultural machinery and equipment proposed by Kay, Edwards, and Duffy (2008)

### 2.5.3. Opportunity costs of investments

Opportunity costs of an investment is an important consideration when economic costs are calculated. Assessment of opportunity costs can be done by comparing two alternative investment opportunities or conducting a utility study to find the value of the second-best use of an investment. (Palmer & Raftery, 1999). Opportunity costs contain expenses that farmers do not usually bear because they don't pay for themselves. (Hughes et al., 1989) Therefore, opportunity costs include estimates of utilisation of these assets (Table 10). Two types of opportunity costs were considered in the Model and presented below: an opportunity cost of own labour and an opportunity cost of funds invested into assets, such as machinery, equipment and cattle.

1) *Opportunity cost of own labour* included in the Model is 4,700 thousand KZT per year or 391 thousand KZT per month. That is the expected earning of a cow-calf farmer according to Meat Union of Kazakhstan (2018) and 2.2 times of the average salary in Kazakhstan, which was 173 thousand KZT per month as of May 2019 (Average monthly salary, 2019). This amount can be an attractive income assuming that a farmer can use his own labor by performing a paid work as the best alternative to farming (Kay, Edwards, and Duffy, 2008).
2) *Opportunity cost of funds invested into assets, such as machinery, equipment and cattle* were calculated based on the cost of equity of 11.3%. The section 2.6. discusses explicitly the calculation method of the cost of equity rate. It appeared that the opportunity cost of investing own funds in the amount of 12 585 thousand KZT could potentially bring an income of up to 1 853 thousand KZT per year. After that the opportunity cost of equity of 11.3%, was compared with the interest rate on saving accounts in Kazakhstani banks. This second assessment was useful to understand the profitability of the alternative use of funds avoiding high-degree risks associated with investments. According to National Bank of Kazakhstan (2019) interest rates of Kazakh banks on attracted deposits in KZT currency for terms above 5 years were 10,9% as of May 2019. Therefore, opportunity cost of investing in the equity capital can be around 10.9 - 11.3%. However, the rate of 11.3% was remained for use in the Model following more conservative approach to costs formation.

*Table 10. Opportunity costs*

| Opportunity cost, in thousands KZT | Total | Allocation to | | |
|---|---|---|---|---|
| | | reproduction | backgrounding | feed production |
| Own labor | 4 700 | 2 350 | 1 175 | 1 175 |
| Assets (all), including: | 1 853 | 1 135 | 130 | 587 |
| - *machinery, equipment* | *969* | *251* | *130* | *587* |
| - *assets (cattle)* | *883* | *883* | - | - |
| Total | 6 552 | 3485 | 1 306 | 1 762 |

## 2.6. Cash flow budget

### 2.6.1. General assumptions of the cash flow budget

The next step in the budget's construction was the identification of cash and non-cash items for building a cash flow budget. This financial analysis tool is used to determine feasibility of planning, sufficiency of capital in certain time periods in the future, forecast financial gaps, and plan borrowings with respective repayments. In other terms, it is a summary of all cash flows and outflows with projection over certain periods in the future (Kay, Edwards, and Duffy, 2008). In comparison with the whole-farm budget the cash-flow budget is characterized by including, firstly, all farm's sources of cash income (from operational activities, subsidies, assets sale) and, secondly, timing of cash flows. The cash flow can be a useful management tool because it helps to foresee if a farm generates enough income to meet all cash obligations in upcoming periods and plan loan injection requirements and repayment opportunities. By using cash flow, a cow-calf farmer would be able to plan the proper use of invested capital.

All farm's activities are repetitive with a year-round cycle, therefore the estimates in the cash flow budget were made for the period up to ten years with one-year long cycle. A forecast based on more than ten years was expected to be unfeasible since many external and unforeseen factors could affect the financial planning. All cash flows were corrected to an inflation rate of 4% according to the National Bank (2019).

Since the Model constitutes three probability distributions (P, W, FC), there is a logical question about possible relationship between stochastic variables. The assumption was made that the explanatory variables were probabilistically independent. Literally it means that there was almost no causal relationship assumed between market price of calves, weight of animals on sale and feed costs. There might be some dependent relationship between a minimum price offer and feed costs of one particular cow-calf farm. However, it does not necessarily mean that changes in feed costs in one smallholder cow-calf farm cause an effect on the beef prices on the free commodities market.

### 2.6.2. Steps in cash flow construction

The whole-farm budget was a base to calculate all cash inflows and outflows. The construction of the cash-flow budget for the modeled cow-calf farm was performed in several steps recommended by the studies of Kay, Edwards, and Duffy (2008), Edwards W. (2014). The major steps are highlighted below.

1. *Drawing of a whole-farm plan including livestock and crop production plans.* By maintaining a constant herd size of 100 cows it is expected to produce 80 calves, where half of the calf crop is males and the other half is females respectively. Tentative plans are to produce each year for sale in average 30 heads of yearling heifer cattle; 30 heads of yearling steer cattle, and 8 cull cows open heifers as a result of the replacement. Crop production plan includes preparation of winter forage containing153 ton of hay, 128 ton of haylage, 242 ton of corn silo, and maintaining a pasture for summer grazing with the capacity of 667 ton of grass in total.
2. *Inventory planning*. Since the modeled cow-calf farm is a new startup farm, the livestock inventory consists of 100 cows in a late gestation period. They are to be purchased and delivered to the farm close to the expected calving period in spring. Feed is purchased for the first year before own crop is grown to cover partially the feed requirements. The amount of the purchased feed is as follows: 12 ton of cereals, 90 ton of straw, 90 ton of concentrates, 6 ton of protein-vitamin and mineral supplements, 2.7 ton of salt blocks and phosphorus supplements.
3. *Estimation of feed requirements was* performed and described in part 2.3. Cattle feed costs of Methodology chapter.
4. *Estimation of a cash flow income* is based on Revenue figures of the whole-farm budget and described in the part 2.2 Revenue. Some variables, such as price for cattle's live weight and animal

weight are taken as stochastic. They formed a base of cash flow income calculation. The uncertainty is assigned to these values in the cash flow in order to capture the variability.

5. The model and specifically the cash flow budget do not take into consideration any additional income from *sales of nonfeed crops and feed excess.*
6. *Estimation of a cash flow income from other sources*. The Model includes assumption that a cow-calf farmer will get an additional income in the form of subsidies paid by the government for yearling calves sold to a feedlot and subsidies for maintenance of rented bulls (Order of the Minister of Agriculture, 2019). A new farm can also benefit from investment subsidies from the government in the amount of 35% from the initial investments made (Order of the Deputy Prime Minister, 2019). Sale of the machinery and equipment is expected after 15 years from the purchase date as a result of replacement. However, the income for the salvage value is not a part of the 15 years planning horizon of the projected cash flow. The same goes for the purchase of new machinery and equipment because substitution is not projected in the last year of planned time horizon.
7. *Projection of farm's operating expenses is* performed and described in the part 2.4 Other operating costs.
8. *Estimation of Capital purchases is* performed and described in the part 2.5 Ownership costs.
9. *Summary of debts payment.* It is assumed that the modeled cow-calf farm will be financed partially from debt sources, investment subsidies and own sources (Table 9 *Funds investment conditions).* The loan allocated for the equipment and machinery purchasing purpose has 6.4% of the interest rate and it is expected to be repaid in 180 months with a grace period of 24 months. The second investment is allocated to the purchase of breeding cattle. It can be taken for 84 months with a grace period of 24 months and with the interest rate of 4.4%. Among debt sources of finance, the farmer assumed to invest own capital and cover part of the investments with the governmental subsidies. All these assumptions formed a base to build financing activities of the cash flows.
10. *Estimation of non-farm expenditures*. It is assumed that a farmer will not spend cash from farms resources, unless it is non-farm expenditures covered by family living expenses included in the cash outflows.
11. *Estimation of net cash flow*. It is possible to find net cash flow by simply netting cash inflows and cash outflows. Since certain variables of the cash flow projection are stochastic the net cash flow also variates. The net cash flows from the ending cash balance for each projected period and serve as a starting balance for the next period.

The summary of the completed cash flow budget of the modeled cow-calf farm is shown in Appendix 4. The cash flow budget is a base to the Economic Feasibility Analysis based on the Net Present Value calculation.

### 2.6.3. Net Present Value with uncertainty

The purpose of constructing the cash flow budget was to come to calculation of the Net Present Value (NPV). NPV is a metric used to assess the feasibility of investing in the cow-calf operation within the new BCPS in Kazakhstan. The NPV is defined as the sum of the expected future discounted cash flows from a project less the initially invested amount of capital. The calculation formula is taken from Damodaran (2012) and can be expressed in the following general equation (3):

$$NPV = (-)II + PV\ FCF \tag{3}$$

*Where:*

*II – Initial investments*

*PV FCF -Present value of future cash flows*

The present value of future cash flow is found by discounting each future year's cash flow to the discount rate. The discount rate has been estimated by using the Weighted Average Cost of Capital (WACC) method.

WACC is the sum of cost of equity and cost of debt weighted against shares in the total amount of investments. (Kumar, 2015). According to Brealey, et al., (2012), WACC is a blended measure of the company's cost of capital that can be found by using the equation (4)

$$WACC = \frac{(1-T)R\mathfrak{d}D}{V} + \frac{R\mathfrak{e}E}{V} \quad (4)$$

*Where:*
*T – marginal tax rate,*
*$R\mathfrak{d}$ – cost of debt,*
*$R\mathfrak{e}$ – cost of equity,*
*D – debt amount*
*E – equity amount,*
*V – total amount of capital (debt and equity)*

The WACC for the modeled cow-calf can be found by using the equation (4) and by application of the appropriate data specific to the studied case (Table 11). First, the cost of debt was calculated in a straightforward way by adjusting weighted average of interest rates of loans 5.6% (Sybaga beef purpose livestock lending program., n.d.) to the marginal tax rate of 3.0% (Tax Code of the Republic of Kazakhstan, article 313., n.d.). The cost of debt after tax shield was 5.4%. Secondly, the cost of equity was compounded from the Risk-free rate which is the US treasury 10 years bonds with the yield of 2.12% (US Generic Govt 10 Year Yield, USGG10YR., 2019) and the Market risk premium of 9.0% for Kazakhstan (Estimating Country Risk Premiums, 2019). The sum of risk free rate and the market risk premium gives 11.1% cost of equity rate. And finally, WACC of 8.3% is found by weighting cost of equity and cost of debt against share of debt or equity in total investments amount and finally adding these two values. Afterwards the WACC of 8.3% was used as the discount rate in NPV calculation.

*Table 11. Calculation of the WACC*

| Cost of debt | Rate | Source |
|---|---|---|
| Cost of debt ($R\mathfrak{d}$) | 5,6% | Sybaga beef purpose livestock lending program (n.d.) |
| Marginal tax rate (T) | 3,0% | Tax Code of the Republic of Kazakhstan, article 313 (n.d.) |
| Cost of debt after tax shield ($(1-T)R\mathfrak{d}$) | 5,4% | Calculated |
| Cost of equity | Rate | Source |
| Risk free rate | 2,1% | US Generic Govt 10 Year Yield, USGG10YR (2019) |
| Market risk premium (Kazakhstan) | 9,0% | Estimating Country Risk Premiums (2019). |
| Cost of equity ($R\mathfrak{e}$) | 11,1% | Calculated |
| Capital structure | % Weight | Market value (in thousand KZT) |
| Net debt (D) | 49,5% | 43 890 |
| Equity (E) | 50,5% | 44 710 |
| Total (V) | | 88 600 |
| Weighted average cost of capital (WACC): | 8,3% | Calculated |

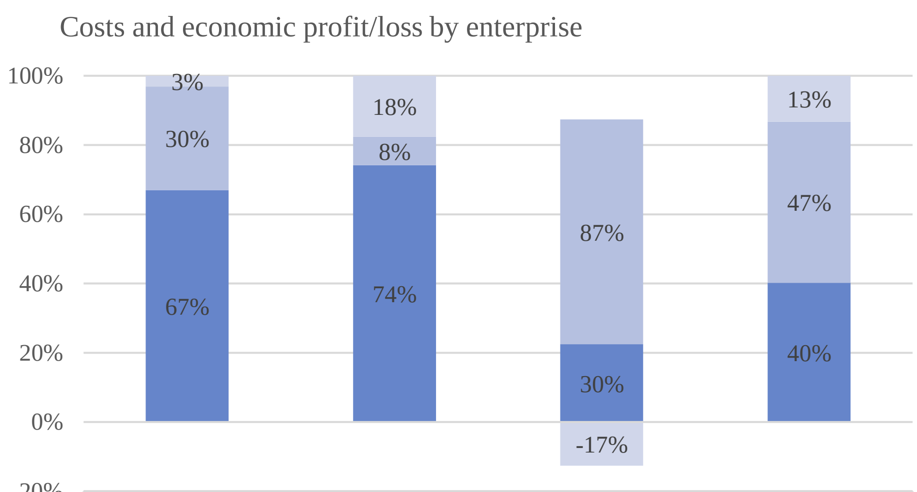
It is worthwhile to calculate the Internal Rate of Return (IRR) for a scenario analysis in order to understand better the NPV. IRR is widely used in addition to NPV in investments analysis. According to Brealey, et al (2012), IRR is a discount rate that gives a zero NPV. It is a profitability measure that is calculated based on a projected cash flow. The NPV value is zero when the discount rate is equal to IRR. Thus, the investment into the cow-calf operation is considered as profitable if IRR is higher than the discount rate of 8.3%. Another situation is when an investor is expected to return the invested amount, but the project cannot be as attractive as alternative investments at the market. This situation occurs when IRR is less than 8.3%, but at the same time NPV is positive. For example, an alternative investment can be into a saving account at a Bank. NPV and IRR are used in scenario analysis and results are presented in the following chapter.

# 3. Results

*In this chapter the results of the modeling and stochastic simulation are presented. The Model output gives a measure of the profitability of investing in a cow-calf operation through the NPV calculated for 10 year and 15 year terms.*

## 3.1. Deterministic model's results

The budgeting technique gave the opportunity to look "inside" of the cow-calf operation by modeling economic budgets for every enterprise. Thus, by comparing revenues and costs of the enterprises it became possible to find out lines of operations where a farmer should pay attention to improve economic profitability. The comparison of economic budgets of reproduction, backgrounding, and feed production enterprises and the whole-farm budget is presented in Appendix 3 and summarized in Figure 8.




| | Reproduction enterprise | Backgrounding enterprise | Feed production enterprise | Whole farm budget |
|---|---|---|---|---|
| Economic profit (return to management) | 3% | 18% | -17% | 13% |
| Total Ownership (fixed) costs | 30% | 8% | 87% | 47% |
| Total Operating (variable) costs | 67% | 74% | 30% | 40% |

*Figure 8: Comparison of enterprises budgets and whole-farm budget's structure*

From Appendix 3 and Figure 8 it is evident how revenue of every enterprise is distributed between economic profit, ownership costs and operating costs. The cumulative result of the cow-calf operation can be seen from the whole-farm budget's bar. However, it should be noted that the values show a snapshot of a cow-calf firm based on the deterministic model. For this very reason variables of price for cattle's life weight (P) and calves' average weight (W) are fixed on their most likely value and the feed costs (FC) variable is taken as a mean value of their stochastic distribution range as it is shown in Table 12. From the results of economic budgets construction it is evident that:

1) *At the whole-farm level* the cow-calf operation has economic profit of 13% or 4 117 thousand KZT from 31 037 thousand KZT of revenue. Almost 14% of revenue comes from sale of culled cows and open heifers as a result of replacement, 76% comes from sale of yearling steers with heifers and 10% comes in form of subsidies for calves sold to a feedlot and subsidies paid for maintenance of invited bulls during mating periods. Operating and ownership costs comprise 40% and 47% of the budget respectively.

2) *Feed production enterprise* has the economic loss of (-) 17%. This fact can be explained by several factors that influence the feed production enterprises budget. First, the assumption is made that operating costs are 30% of revenue. At the same time the ownership costs and revenue are calculated figures. The revenue of the feed production enterprise is formed from theoretical sale of the feed produced at the feed production enterprise to reproduction and backgrounding enterprises. Another specificity of the feed production enterprise is high ownership costs. Almost 87% of the funds coming from the feed's sale are spent to cover depreciation costs and other fixed costs associated mostly with operation and maintenance of the feed production equipment. From the total value of farm's machinery and equipment over 60% are allocated to the feed production enterprise. The feed production enterprise is the most intensive user of machinery and equipment at the cow-calf farm.
3) *Backgrounding enterprise* has the highest economic return of 18% or 4 727 thousand KZT from 26 801 thousand KZT of revenue to management in comparison with other enterprises. At the same time the backgrounding enterprise has the uppermost operating costs of 74% and the smallest ownership expenses of 8% from the revenue.
4) *Reproduction enterprise* has a very small economic profit of 3% or 610 thousand KZT from the revenue of 19 960 thousand KZT. It is quite low in comparison with the backgrounding enterprise.

To conclude, the deterministic model revealed the results of the budgets construction, where cow-calf operation is economically profitable at the whole-farm level. At the same time the backgrounding enterprise generates the biggest revenue and economic profit, whereas the reproduction enterprise is balancing on a low economic profitability level. Regarding the feed production enterprise, it has an economic loss in the modeled conditions.

## 3.2. Results of the stochastic simulation

The problem with economic feasibility analysis by using a deterministic model is that the result represents a snapshot of the farm's economic activities without consideration of changes that always take place in real life. Therefore, judging the cow-calf investment project based on a single-output result might bring investors to unfavorable decisions. In reality, investors estimate their return based on different scenarios of market prices, animal's performance characteristics, costs associated with running a farm and many others. Although an accurate result cannot be predicted the stochastic simulation indicates how uncertainty in input variables changes the economic profitability and feasibility of the investment in general.

Several steps were taken before stochastic simulation of the Model was possible. Studies of Kay, Edwards & Duffy (2008) were used in order to build the enterprise, whole-farm and cash flow budgets, while methods described in the work of Clemen & Reilly (2014) were followed to run Monte Carlo simulation and to see how variability of price for cattle's live weight (P), calves' average weight (W) and feed costs (FC), affect the NPV. The following three consecutive major blocks were constructed to build the deterministic model of the cow-calf operation with 100 breeding cows: (i) reproduction, backgrounding and feed production enterprises, (ii) the whole-farm budget (Appendix 3), and, finally, (iii) the cash flow budget (Appendix 4). After that the probability distributions to input and output variables were assigned. The stochastic input variables include market price for life weight of cattle (P), calves' average weight (W), and feed costs (FC): the total purchased feed and operating costs of own feed production enterprise. The following step was sequential simulation of the Model with 1000 iterations. Finally, the feasibility of investing into the cow-calf operation within the new BCPS in Kazakhstan was examined. The output variable, that is NPV served as an indicator of feasibility of investments. The stochastic variables used for simulation are shown in Table 12.

*Table 12. Summary of all stochastic variables in the Model*

| Stochastic variables: | Value | Parameters of distribution | | | Type of the distribution |
|---|---|---|---|---|---|
| | | Min | Most likely | Max | |
| Price for live animal weight of 1) cull cows/ open heifers and 2) steer calves | 968 | 664 | 850 | 1283 | Triangular |
| Steer calf average yearling weight (12 months) | 298 | 295 | 343 | 390 | Triangular |
| Heifer calf average yearling weight (12 months) | 306 | 250 | 291 | 331 | Triangular |
| Cull cows' and open heifers' weight | 622 | 542 | 623 | 632 | Triangular |
| | | Min | Mean | Max | |
| Total purchased feed, in KZT | | 3 002 792 | 6 005 584 | 9 008 376 | Uniform |
| Total cash operating expenses of own feed production, in KZT | | 1 085 130 | 2 170 259 | 3 255 389 | Uniform |

*Note. Methodology chapter shows how parameters of distributions are formed.*

The analysis shows how variability of above mentioned values affects the economic profitability and the Net Present Value calculated for 10 year and 15 year terms. The stochastic simulation demonstrates the following distribution of economic profit of the whole-farm budget (Figure 9) and the Net Present Value for 10 years and 15 years (Appendix 5 and Table 13). It should be noted that the results might be slightly different each time when the simulation runs. The reason behind this is that in each simulation values from a given range are chosen randomly by the program (@RISK).

### 3.2.1. The effect of stochastic simulation on economic profit (return to management)

The distribution of the economic profit/loss at the whole-farm budget's level in the histogram demonstrates that possible outcomes can be between the range of 102 thousand KZT and 11 072 thousand KZT (5% and 95% confidence interval). The mean of the distribution is 5 449 thousand KZT with the standard deviation from the mean of 3 257 thousand KZT. There is a 95.7% chance that the economic profit of the modeled cow-calf enterprise is above zero (Figure 9).

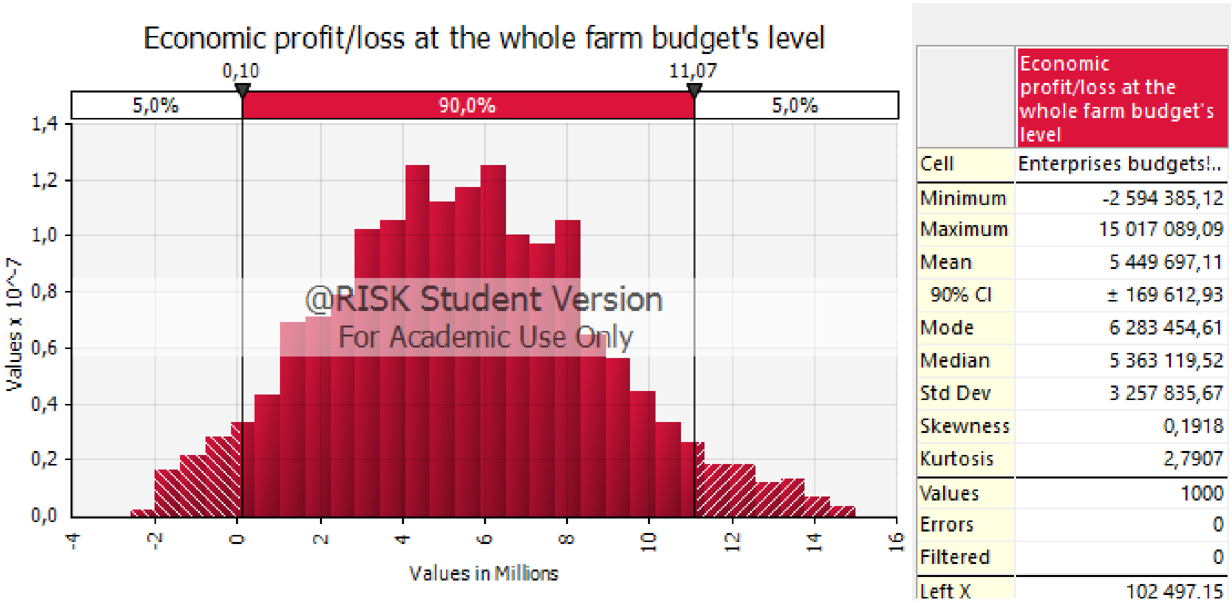



*Figure 9: The cumulative graph and statistics output of the whole-farm's economic profit distribution*

### 3.2.2. The effect of the stochastic simulation on NPV under the different scenarios

However, the enterprises and whole-farm budgets do not consider several important factors for investment decision making. These factors include time value of money, principal debt repayments, benefits and costs over projected period on a cumulative basis and availability of investment subsidies from the government. Therefore, the cash flow budget is used to define the Net Present Value of future cash flows from operation of the Modeled cow-calf farm. The Stochastic simulation of the NPV was performed with the following scenarios:

- Scenario 1: investment period 15 years, with subsidies;
- Scenario 2: investment period 15 years, without subsidies;
- Scenario 3: investment period 10 years, with subsidies;
- Scenario 4: investment period 10 years, without subsidies;

The assumptions made for scenario analysis are as follows:

1) *Projected investment periods: 10 years and 15 years.* 10 year period is chosen because it is the most common and convenient middle point used to summarize results of investments. At the same time another period of 15 years is chosen because at this future time point useful life period of most of the machinery and equipment will expire and maturity of the investment loan will finish.
2) Subsidies in the current study are type of financial support from Kazakhstani government to new cattle farmers in form of incentives and/or financial aids aimed to develop the new BCPS. According to the Order of the Deputy Prime Minister (2019) two types of investment subsidies for beef cattle farmers are considered. The first one is subsidies in the amount of 154 thousand KZT per head of cattle paid when pedigree breeding cattle is acquired. A cow-calf farmer gets 15 400 thousand KZT for 100 cattle purchased. The second type of investment subsidies is a refund of money spent by a cow-calf farmer for purchase of machinery and equipment. According to the estimate in the Model, from 43 900 thousand KZT invested in fixed assets the return in form of subsidies comprises 12 025 thousand KZT. Therefore, a cow-calf farmer gets refund of 27 425 thousand KZT all together. This amount is assumed to be invested into the project and covered part of the required own capital investments, which is 44 710 thousand KZT.
3) *The required own capital investments* amount is 44 710 thousand KZT. However, only 17 285 thousand KZT can be invested into the project if subsidies are reinvested. It is uncertain if the investment subsidies in the calculated amount of 27 425 thousand KZT can be received and reinvested into the project. Therefore, if the larger amount of the initial investment is made it means that the farmer does not get subsidies and he is reluctant to invest more from his own sources of finance.
4) *The discount rate* is 8.3% according to calculations performed and presented in the previous chapter and summarized in Table 11.

The results of the stochastic simulation of NPV in four different scenarios are shown in Table 13.

*Table 13. NPV scenario analysis*

| Scenarios* | 5% CI | Mean | 95% CI | SD |
|---|---|---|---|---|
| Scenario 1, NPV 15 years, with subsidies, thousands KZT | 35 949 | 47 367 | 59 090 | 7 301 |
| Scenario 2, NPV 15 years, without subsidies, thousands KZT | 8 524 | 19 942 | 31 665 | 7 301 |
| Scenario 3, NPV 10 years, with subsidies, thousands KZT | 14 894 | 26 267 | 37 979 | 69 |
| Scenario 4, NPV 10 years, without subsidies, thousands KZT | -12 530 | -1 157 | 10 554 | 69 |
| Scenario 1, IRR, % | 18,3% | 29,5% | 43,1% | 7,6% |
| Scenario 2 IRR, % | 2,0% | 5,4% | 9,0% | 2,1% |
| Scneario 3, IRR, % | 14,2% | 27,3% | 42,1% | 8,6% |
| Scenario 4, IRR, % | -5,9% | -0,6% | 4,6% | 3,2% |

*Note. *The cumulative graphs showing the range of possible outcomes of NPV and IRR simulations are in the Appendix 5*

The results of NPV scenario analysis can be summarized out several patterns from the Table 13. Thus, the longer period of cash flow projection is taken the higher NPV and IRR are.  According to Scenarios 1, 2 and 3 the NPV is between two positive values. This means that with 90% probability the investor will return his investments. The project is less attractive according to Scenario 4 because the mean value of the NPV distribution is negative. The picture of investment's feasibility is more complete if IRR is considered along with NPV. It has been discussed earlier in the section 2.6.3 that the investment into the cow-calf operation is worthwhile investment if IRR is higher than the discount rate of 8.3%. The distribution of the IRR in Scenarios 2 is between -5.9% and 4.6% and in Scenario 4 the IRR value falls into the range between 2.0% and 9.0%. In both scenarios 1 and 3 the calculated IRR exceeds the value of the opportunity cost of capital. In overall, the results of the scenario analysis suggest that subsidies are crucial factor affecting the feasibility of investments into the cow-calf operation. Scenario 3 and 4 with NPV of 10 years and 15 years respectively can be suggested as the most feasible options to consider on condition that subsidies are available to reinvest into the project.

# 4. Discussion

*This chapter aims to discuss and critically elaborate the results of the study by giving summary of the main findings, limitations of the model building and the analysis process and by suggestion of implications for further research.*

## 4.1. Summary

There are several important outcomes for those investors who consider investing into the cow-calf operation within the new BCPS in Kazakhstan. The economic profitability of a cow-calf farm can vary considerably due to inherited uncertainty in factors as market price, calves' live weight and feed costs. The feasibility analysis using stochastic simulation revealed that reinvesting of the investment subsidies was an important factor to run a profitable cow-calf operation. The biggest part of this work was the construction of the stochastic simulation model. Scenario analysis was performed, and conclusions were made based on the modeling results.

*Summary on the model construction;* the Model considers a cow-calf farmer who kept 100 breeding cows, gets yearly calves, and rise them until yearling (12-month-old) age. The cattle breeding activities are supported by producing partially own feed at the modeled farm. Enterprise budgets were used as "building blocks" for the whole-farm and further cash flow budgets development. The benefit of the whole-farm budget analysis was that changes in feed costs of reproduction and backgrounding enterprises offset the same changes in the revenue of the feed production enterprise at the whole-farm level. Therefore, the economic profit (return to management) at a whole-farm level increases or decreases to the amount of operating costs of the own feed production enterprise while the ownership costs are constant. In overall, constructing budgets requires a large amount of appropriate data. The research was performed by using combination of methods from cost benefit analysis, budgeting, excel modeling, and economic feasibility analysis by application of stochastic simulation using @RISK (Palisade). The stochastic simulation model was designed to examine the research question on how several factors like market price for cattle's life weight, calves' average weight and feed cost would affect the economic feasibility of investing in a cow-calf operation within the new BCPS in Kazakhstan. The Net Present Value of the expected cash flows was used as an indicator of profitability of investments that included not only economic profit but also return of investments. Finally, the stochastic simulation model of the cow-calf farm was constructed that could be used further by industry stakeholders for investment decision making into the beef cattle farming in Kazakhstan.

*Control of production costs;* the cost of rising feed for livestock should be clear for a farmer to understand true cost of production. It is easy to be trapped with high cost of production, therefore diligent cost benefit analysis is required. At the same time a farmer might not have control over revenue as it was found out during the analysis that animal weight and market price had a big effect on profitability of cow-calf farm's operations.

*High ownership costs;* the ownership costs can be in average 10-15 % annually from the cost of machinery and equipment (Kay, Edwards, and Duffy, 2008). The total ownership costs in the Model, excluding the opportunity costs, made up 7 918 thousand KZT or 18% from the initial investment in the amount of 43 900 thousand KZT into machinery and equipment. Therefore, the Model might be conservative in comparison with recommended industry norms. Another expectation is that the calculated ownership costs might be higher than competitors' who specialized in feed production, has a fleet of machinery and can produce feed in big amounts and sale it to the market. The economy of scale can play a certain role making the production of the same type of feed more efficient in terms of costs. It brings another assumption that a cow-calf farmer might consider concentration solely on cattle farming, having pastures only if a feed producer is located nearby. Thus, forage can be purchased for a reasonable market price.

*Low profitability of cow-calf operation*; traditional cow-calf farms usually are low profitable businesses organized in abundant lands where other economic activities do not take place in Canada (Sheppard et al., 2015). Beef production industry is characterized with low economic profitability of cow-calf operations. Thus, for example, study of Pendel & Herbel (2018) stated that over 42 years between 1975 and 2016 average return over total costs were positive only 14% times with the average of -96.5 USD per cow for a farm that are a part of Kansas Farm Management Association. The average cow-calf producer operating in Iowa, Illinois, the US during 1996-1999 had a negative return to labor and management. And the feed cost was a major factor affecting profitability (more than 50% in profit variation) followed by depreciation and operating costs (Miller, 2002). Cow-calf producers' income is very vulnerable to the output and input prices and is not stable. Most of cow-calf farmers in the US have additional income from off-farm sources like salaries, retirement income or from other farming activities (McBride & Mathews, 2011).

The stochastic simulation of the economic profit (return to management) demonstrated that possible outcomes could be between the range of 102 thousand KZT and 11 072 thousand KZT (5% and 95% confidence interval) for a cow-calf farm operation based in Kazakhstan. This earning might be sustainable for a Kazakh cow-calf farmer, but rather low for a North American cow-calf farmer. The budgeting results based on the deterministic figures suggests that the reproduction is low profitable enterprise in comparison with backgrounding. The calculated economic profit of the reproduction enterprise was 3% against 18% profit of the backgrounding enterprise. However, feed production might be expensive to a small cow-calf farmer in Kazakhstan due to many associated risks to run a profitable feed production enterprise. However, feeding weaned calves until yearling age might bring additional income if the problem with feed is solved. It is expected that cow-calf farms will tend to apply any possible practices to decrease cost while preserving high yield of crops in their feed production enterprises. Then the backgrounding operation until yearling age can be profitable at the cow-calf farm level. In general, the results of the analysis are in line with the expectations about low profitability and cost intensive character of cow-calf farming.

*The results of the stochastic simulation* on NPV under the different scenarios revealed that investments into the cow-calf farming within the new BCPS in Kazakhstan without support from the government might be not feasible even in a 15 year term. It might be an important consideration for an investor to place his funds into the profitable business. Due to this reason opportunity cost of investment should be considered along with NPV. Thus, IRR can be compared with the discount rate that is also a measure of the opportunity cost of investment. Following these criteria, a good investment has positive NPV with IRR more than 8.3%. An investor is suggested to invest into the modeled type of the cow-calf farm operation considering that return of funds is expected after 10 years and the governmental subsidies are paid and reinvested into the project at the time when the project is started. This recommendation is consistent with the scenario 3 where 90% confidence interval of NPV is between 14 897 thousand KZT and 37 979 thousand KZT and IRR with 90% confidence interval falls between 14.2% and 42.1%. The Scenario 1 has a 15 year investment period with subsidies and by default it is another feasible option to consider.

## 4.2. Limitations

The constructed budgets and stochastic simulation tool helped to understand the level of economic profitability and return on investment based on the Net Present Value of future cash flows supplemented with internal rate of return. The model included stochastic factors, such as price for cattle's life weight (P), calves' average weight (W) and feed costs (FC) to better understand their effect on the NPV. However, methods used for the analysis have a number of limitations that are observed in the current section. They include limitations of the model building process, validation of the Model's results, variables that affect the NPV, lack of local scientific researches.

*The limitations of the model building process* were as follows:

1) The calculation of variable costs of own feed production was optimized in the deterministic model by making assumptions on total variable cost as a percentage from total revenue. This simplification was expected to have minor effect on prediction power of the final model since this value was assumed to be stochastic.
2) All together the total opportunity cost was 6 523 thousand KZT or 45% from the value of the total ownership costs and 24% from all budgeted costs of the modeled cow-calf operation farm. Therefore, opportunity cost made a considerable portion of the budgeted costs and influenced highly on the economic profit estimates of the whole-farm.
3) Different farmers have different machinery and equipment. Thus, the total value of fixed assets might change from case to case as all related expenses.
4) Miscellaneous and overhead expenses were not included in other fixed costs to simplify the Model and to avoid a conservative approach. However, unexpected extra costs can run a farm out of cash if occurred and therefore by planning this budget line a financial cushion can be made.
5) One of the problems with budgets construction is that they require lots of data and time investments.
6) The majority of the information used in the Model has a deterministic character. However, inserting a lot of stochastic variables added complexity into the model building process. The results can be vague and therefore useful for practical use in investment decision making.

*Validation of the model's results*; another limitation of the analysis is that validation of the modeling results was not performed. The beef cattle production system is a complex continuous process with simultaneous change of many factors in a real life situation. The study analyzed one type of operation (cow-calf farming) within the new BCPS in Kazakhstan. Validation of results requires testing on many farms of the same type. Since the new BCPS is an innovative way of traditional beef cattle farming in Kazakhstan it might be difficult to find the necessary number of cow-calf farms rising calves until yearling age with own feed production for validation reasons.

*The study revealed how the stochastic input variables affected the NPV, but not which input variable affected most.* The common variability effect on the Net Present Value of the stochastic variables was studied. However, it has not been defined what factors from price for cattle's life weight (P), calves' average weight (W) and feed costs (FC) had more effect on the NPV. However further research might investigate how different variables specifically affect the economic profit and NPV of the cow-calf operation. It would be also interesting to investigate how the above mentioned stochastic variables affect cash flow's output variables of every enterprise.

*Lack of the local scientific researches;* another problem was a limited number of scientific researches related to the economics of cattle farming in Kazakhstan. The available information is limited mainly to the sources that cannot be considered as scientific and therefore can be biased.

To sum up, it has been found how several input variables all together affect the profitability of a cow-calf operation within the new BCPS in Kazakhstan by constructing the stochastic simulation model. Whereas the answer to the research question has been given, the Model itself and the methods used for its construction have several limitations presented above. The majority of these limitations are common to chosen analysis methods while others are specific to the performed analysis. However, further research might take into consideration the limitations stated above, adjust the Model to specific needs and to improve the prediction power of the Model. The results of the study might not be summarized to the whole cow-calf production in Kazakhstan within the new BCPS. The conclusion is rather a demonstration of how the stochastic simulation model works and an attempt to point out where attention of investors should be paid if they consider making investments into the new BCPS in Kazakhstan.

## 4.3. Implications for further research

The final goal of the Model was to define how uncertainty of several variables affected the feasibility of investments into the cow-calf operation within the new BCPS in Kazakhstan. The constructed enterprises budgets, whole-farm and cash-flow budgets can be used in further research and by farmers, investors and other beef production industry stakeholders in numerous ways.

The results of this cow-calf operation's feasibility analysis cannot be applied to all cow-calf operations in Kazakhstan. Firstly, the assumptions made in the model are not equal for all farms within the new BCPS. Industry stakeholders interested in evaluation of economic feasibility of investing into a cow-calf operation within the new BCPS in Kazakhstan by using this model should apply their own data specific to every situation, considering besides economic also climatic and biological factors. Secondly, the Model can be used as a starting point and a tool for further calculations and applied research rather than a source of direct reference for summaries about economic feasibility of cow-calf operations within the new BCPS in Kazakhstan.

It is advisable to conduct future economic researches on similar type of cow-calf operators in Kazakhstan and regions with the same cattle management practice and conditions. These types of research scope can reveal very practical primary data on cattle farming practice in Kazakhstan that is not present in statistical databases and scientific literature yet.

The investors might be interested to compare the economic profitability and the NPV of investing in a cow-calf farm with production and sale of weaned calves against the cow-calf farm with additional backgrounding and selling at yearling age. Partial budgets might be a useful tool to measure necessary adjustments to the Model and conduct an appropriate research and analysis. Real options approach might be used because it allows to count the value of flexibility of an investment. It is of great interest to investors to understand what conditions should be set to meet profitable operations in every enterprise before investing and establishing a cow-calf operation.

Another point for further research is feed cost formation. There is a certain dilemma that needs to be studied on how to provide animals with required energy, protein sources from local feedstuff sources while maintaining the lowest possible costs. The analysis has shown that a big portion of spending goes to the purchase of protein concentrates and preparation of own feed, such as corn silage and haylage. Potential decrease in feed production cost might be reached by using by-products of cash crops production rather than feeding with more expensive own produced feed and protein concentrates.

The relationship among several phenomena needs to be studied in order to make more accurate predictions. It is required to understand how stochastic variables, such as price for cattle's life weight (P), calves' average weight (W) and feed costs (FC) will affect the NPV of the Modeled cow-calf farm.

Turning specifically to the constructed model, the correlation between market prices for beef and production cost factors was not considered in the Model. That might lead to a scenario when the market price for cattle's live weight soared while cost of production remained considerably low. Such situation might have a place. Therefore, the relationship between these two variables needs to be understood and the correlation effect to be introduced into any further research based on the developed Model.

Several strategies can be considered to increase farm's income and to decrease costs. These strategies might be different and can include increase of income from additional farm activities and adding another non-farm income to reduce spending on family leaving expenses. It is thought-provoking to consider reduction of external financing from debt sources, restructure a debt by amortization of payments of principal and interest; reduce feed costs as the main source of cash outflows and at the same time without affecting quality and quantity of necessary feed; sharing with other neighboring farmers the ownership and investments into capital assets like machinery and equipment. Therefore, further research might concentrate on cattle management practices in Kazakhstani conditions that will increase profitability of cow-calf operators and BCPS in general. As a result, valuable practical recommendations can be made to cattle farmers on how to sustain a profitable operation and avoid risks.

# 5. Conclusion

This study has been aimed to analyse the economic feasibility of investing into the new beef cattle production system in Kazakhstan. Economic budgets of a cow-calf operation were developed to construct the model and the stochastic simulation technique was applied to understand the effect of uncertainty in variables, such as price for cattle's life weight, calves' average weight and feed costs on the Net Present Value. The results of the study suggest that the backgrounding can be a profitable enterprise and can be supplementary fit to reproduction enterprise. Investments into the cow-calf operation can be economically efficient in a long run above 10 years on condition that the governmental subsidies are reinvested.

Expectations of the study have been partially met. The stochastic simulation model was developed and used to measure economic feasibility of investments. The total effect of uncertain variables to NPV has been measured but not each separately.

The developed stochastic simulation model can be used in future researches and for commercial purposes as a decision support tool in a new beef cattle production system in Kazakhstan. The study in overall may bring benefits to smallholder cattle farmers in Kazakhstan if results are adopted to every specific case.

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# Appendix 1. Input data

| INPUT DATA | | | | | |
|---|---|---|---|---|---|
| **Item** | **Unit** | **Value** | **%** | **Benchmark** | **Source** |
| **Breeding cattle** | | | | | |
| # of breeding cows & heifers at the farm (herd size) | cows | 100 | 100% | | Author's assumption |
| Av. market value of breeding cows | KZT/ head | 450 000 | | | MeatUnion (2018) |
| Cow herd total value (all breeding cows & heifers at the farm) | | 45 000 000 | | | Calculated |
| Calving cows persenatage | # from total expos | 80 | 80,0% | 85% | Orey, D., & King, C. (Eds.) (2008) |
| Bull-to-cow ratio | head | 4 | 1/25 | | Herring (2014) |
| # of culled cows | # per year | 8 | 8,0% | | Beef Cow-Calf Manual. (2008) |
| # of cow death | # per year | 2 | 2,0% | max 4% | Orey, D., & King, C. (Eds.) (2008) |
| # of weaned steer calves | # per year | 40 | 50,0% | | Author's assumption |
| # of weaned heifer calves | # per year | 40 | 50,0% | | Author's assumption |
| # of replacements (cull + death) | # per year | 10 | 10,0% | | Beef Cow-Calf Manual. (2008) |
| # of heifers retained to increase a herd size | head | 0 | | | Author's assumption |
| # of replacement heifers purchased | head | 0 | | | Author's assumption |
| Cull cow price for kg of live weight | KZT/ Kg | 850 | 664, 850, 1283 | 850 | Stochastic variable |
| Cull cow average weight | Kg | 623 | 542, 623, 632 | 623 | Genetic trend EDP (2019) |
| **Calves** | | **Crossbreed** | **Distribution range** | **Deterministic** | **Type of the distribution** |
| Calves average birth weight (BW), kg | Kg | 28 | | | Republican Chamber of Kazakhstan Angus (2018) |
| Steer calf average weaning weight (SWW) (7 month) | Kg | 220 | | | Republican Chamber of Kazakhstan Angus (2018) |
| Heifer calf average weaning weight (HWW) (7 month) | Kg | 200 | | | Republican Chamber of Kazakhstan Angus (2018), Bock at al (1991) |
| Steer calf average yearling weight (SYW) (12 month) | Kg | 343 | 295, 343, 390 | 343 | Trangular |
| Heifer calf average yearling weight (HYW) (12 month) | Kg | 291 | 250, 291, 331 | 291 | Trangular |
| Weaned steer calf price for kg of live weight | KZT/ Kg | 850 | 664, 850, 1283 | 850 | Calculated |
| Weaned heifer calf price for kg of live weight | KZT/ Kg | 1374 | | | Calculated |
| Yearling steer cattle price for kg of live weight | KZT/ Kg | 850 | 664, 850, 1283 | 850 | Calculated |
| Yearling heifer cattle price for kg of live weight | KZT/ Kg | 1374 | | | Calculated |
| **Subsidies** | | | | | https://moa.gov.kz/ru/documents/529 |
| paid for a head of weaned and yearling calf sold to feedlot for fattening | KZT/ Kg | 200 | | | Order of the Deputy Prime Minister (2018) |
| to cover cost of keeping a breeding bull (beef purpose farms) in mating season | KZT/ head | 100 000 | | | Order of the Deputy Prime Minister (2018) |
| to cover costs of acquisition of imported breeding stock | KZT/ head | 200 000 | | | Order of the Deputy Prime Minister (2018) |
| **# of days cattle is on feed** | **# of animals on feed per year** | **# of days cattle is on feed** | | | |
| Bulls | 4 | 60 | | | Author's assumption |
| Cows in dry period | 10 | 185 | | | Author's assumption |
| Cows in first half of lactation period (up to 4 month after giving birth) | 80 | 0 | | | Author's assumption |
| Cows in second half of lactation period & after weaning | 80 | 185 | | | Author's assumption |
| Calf (1-8 month) | 80 | 150 | | | Author's assumption |
| Steer calf (9-12 month) | 40 | 120 | | | Author's assumption |
| Heifer calf (9-12 month) | 40 | 120 | | | Author's assumption |
| All breeding cows (including replacing heifers <12 month) | 100 | 365 | | | Author's assumption |

To change model add 1 or 2 in the cell:

| | |
|---|---|
| Model | 1 |
| Deterministic | 1 |
| Stochastic | 2 |

*Note. The outline of the stochastic simulation model. Input data module*

# Appendix 2. Feed costs calculation

## A2.1. Nutrition costs of bulls

It is assumed that bulls are rented from feedlots to a maximum of 60 days between the end of spring and the end of summer. The bulls feed ration contains green fodder, hay, and concentrates. Bulls graze on pastures and additional supplementation of hay and concentrates will be provided. a farmer with 100 cows needs about 4 bulls given the 1: 25 ratio (Herring, 2014). It is assumed that in a summer grazing period a bull's diet structure in average consists of 38-40% of green fodder, 25-28% of hay, and 35-40% of concentrates. According to Zhazylbekov et al (2008, p. 161), average feed requirements per bull per day are 12kg of green fodder, 4.5 kg of hay, 4.5 kg of concentrates, 0.4 kg of protein-vitamin and mineral supplements and 0.06 kg of mineral salt (Table A.2.1) Prices for feed items are calculated based on actual market data. Green fodder is available from farmland and therefore comes for free. Market price for hay is taken as 10,949 KZT per ton based on statistical data (Prices and indices for agricultural products in the Republic of Kazakhstan (2019), prices for concentrates taken as 42 KZT/kg and for protein-vitamin and mineral additives as 100 KZT/ kg (Kormovik.kz feed additives., n.d.).

*Table A.2. 1. Nutrition costs of bulls*

| Item | Quantity used per day per head | | Cost per item, KZT | Cost per one bull, KZT | | Cost, KZT | | |
|---|---|---|---|---|---|---|---|---|
| | Kg | % | | per day | per season | Total | per cow | per cwt of calf sold |
| Green fodder | 12 | 56% | 0 | 0 | 0 | 0 | 0 | 0 |
| Hay | 4.5 | 21% | 11 | 49 | 2,956 | 11,825 | 118 | 1 |
| Concentrates | 4.5 | 21% | 20 | 90 | 5,400 | 21,600 | 216 | 1 |
| Protein-vitamin and minerals | 0.4 | 2% | 100 | 40 | 2,400 | 9,600 | 96 | 1 |
| Salt blocks | 0.06 | 0% | 110 | 7 | 396 | 1,584 | 16 | 0 |
| Total | 21 | 100% | | 186 | 11,152 | 44,609 | 446 | 3 |

*Note.*
*Quantity used per day per head is according to Zhazylbekov et al (2008)*
*Information on cost of Protein-vitamin and minerals and salt blocks according to the source: Kormovik.kz feed additives. (n.d.). Retrieved from http://www.kormovik.kz, information on green fodder, hay according to market data, on hay cost according to Prices and indices for agricultural products in the Republic of Kazakhstan. (04.2019)*

## A2.2. Nutrition costs of breeding cows

More than half of the feed costs can be associated to breeding cows since breeding cows constitute the majority of the herd's population at a cow-calf farm. Cow's ration depends on different factors, such as : current state of a cow (live weight, age, period of pregnancy and lactation, body condition score), management practice (free grazing or keeping in a stable), and external factors (season, region of a country, nutrition quality and structure in pastures). An assumption has been made that there are 100 breeding cows on feed during a year. According to Zhazylbekov et al (2008, p. 171), an average feed requirement for one cow per day is 2.5 kg of hay, 2.5 kg. of straw, 3.8 kg of silo, 2.3kg. of haylage (grainage), 1.6 kg of concentrates, 0.2 kg of protein-vitamin and mineral supplements and 0.05 kg of mineral salt. Also, cows consume pasture grass and seeded grass with the average daily intake of 13.2 kg and 2.2 kg respectively. Feed cost calculations have been made for 100 dairy cows for one year. Prices for feed items are calculated based on actual market data. Green fodder is available on farmlands and therefore comes free of costs. (Table A.2.2).

*Table A.2. 2. Nutrition costs of breeding cows*

| Item | Quantity used per year per head | | Cost per an item, KZT | Cost per one cow, KZT | | Cost, KZT | | |
|---|---|---|---|---|---|---|---|---|
| | Kg | % | | per year | per day | Total | per cow | Kg of calf sold |
| Hay (miscellaneous) | 900 | 9% | 11 | 9,854 | 27 | 985,410 | 9,854 | 77 |
| Straw | 900 | 9% | 11 | 9,900 | 27 | 990,000 | 9,900 | 77 |
| Silo | 1,400 | 14% | 15 | 21,000 | 58 | 2,100,000 | 21,000 | 163 |
| Haylage (grainage) | 850 | 8% | 15 | 12,750 | 35 | 1,275,000 | 12,750 | 99 |
| Concentrates | 600 | 6% | 20 | 12,000 | 33 | 1,200,000 | 12,000 | 93 |
| Protein-vitamin and mineral supplements | 60 | 1% | 100 | 6,000 | 16 | 600,000 | 6,000 | 47 |
| Salt blocks | 20 | 0% | 110 | 2,200 | 6 | 220,000 | 2,200 | 17 |
| Pasture grass | 4,800 | 46% | 0 | 0 | 0 | 0 | 0 | 0 |
| Seeded grass | 800 | 8% | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 10,330 | 100% | | 73,704 | 202 | 7,370,410 | 73,704 | 572 |

*Note.*
*Data on quantity of feed per year per head is according to Zhazylbekov et al (2008). Information on cost of Protein-vitamin and minerals and salt blocks according to the source: Kormovik.kz feed additives. (n.d.). Retrieved from http://www.kormovik.kz, information on green fodder, hay according to market data, on hay cost according to Prices and indices for agricultural products in the Republic of Kazakhstan. (04.2019)*

Calving cows' percentage at the level of 80% was used. Therefore 80 newborn calves are under care on a modeled farm each year. For the purpose of the analysis calves are divided into two groups: sucking calves before weaning at 7-8 months of age and backgrounded calves between 8-12 months that require a specially balanced diet.

### A2.3. Nutrition costs of calves before weaning

During the period from birth until 7-8 months of age a calf is grown near a mother on a free suckling. So, the growth and development of a calf depend on the cow's milk productivity in addition to other factors like month of birth, weight at birth, size and quantity of supplementary feeding. The optimal calving time for Kazakhstan is an early spring, that is also used as an assumption for the model. Therefore, a calf can benefit from a summer grazing period when consumption of large quantities of green fodder stimulates the increase of cow's milk by 15-20%. A calf, who is suckling milk in combination with good pasture grazing, gives a gain between 0.6-1.4 kg per day (Beef Cow-Calf Manual, 2008). For the purpose of the analysis feed requirements for a calf are used from the study of Zhazylbekov et al (2008, p. 176). Feed composition differentiates every two months of a calf during the first 9 months of life. According to the estimation, a calf gaining 0.9 kg of live weight per day consumes on average 1.0 kg of hay, 2.3 kg of silo, 1.0 kg of concentrates, 0.06 kg of phosphate supplements with mineral salt, and 1.0 kg of concentrates. During free grazing days a calf consumes regularly 6.0 kg of pasture grass, 1.0kg of seeded grass together with suckling mother's milk in the amount of 5.4 kg per day. (Table A.2.3).

*Table A.2. 3. Nutrition costs of calves until weaning (8 months of age)*

| Item | Quantity of feed consumed until 8 months | | Cost per an item | Cost per one animal, KZT | | Cost, KZT | | |
|---|---|---|---|---|---|---|---|---|
| | Kg | % | KZT | Total in 8 months | per day | Total | per cow | Kg of calf sold |
| Hay | 144 | 5% | 11 | 1,577 | 11 | 126,132 | 1,261 | 10 |
| Silo | 350 | 12% | 15 | 5,250 | 35 | 420,000 | 4,200 | 33 |
| Concentrates | 150 | 5% | 20 | 3,000 | 20 | 240,000 | 2,400 | 19 |
| Phosphate supplements | 5 | 0% | 110 | 528 | 4 | 42,240 | 422 | 3 |
| Salt blocks | 5 | 0% | 110 | 528 | 4 | 42,240 | 422 | 3 |
| Pasture grass | 900 | 30% | 0 | 0 | 0 | 0 | 0 | 0 |
| Seeded grass | 150 | 5% | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Milk | 1,300 | 43% | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 3,004 | 100% | 266 | 10,883 | 73 | 870,612 | 8,706 | 68 |

*Note.*
*Quantity of feed consumed until 8 months of age is according to Zhazylbekov et al (2008)*
*Information on cost of Protein-vitamin and minerals and salt blocks according to the source: Kormovik.kz feed additives. (n.d.). Retrieved from http://www.kormovik.kz, information on green fodder, hay according to market data, on hay cost according to Prices and indices for agricultural products in the Republic of Kazakhstan. (04.2019)*

In practice many stallholder farms do not consider additional feeding of suckling calves during the period until weaning. While in intensive beef production systems, calves require feeding with supplementary nutrition in order to meet additional protein and energy requirements and grow to their genetic potential. In these circumstances mother's milk alone is not sufficient and creep feed can be economically advantageous because it gives 10-15% of additional calf's live weight (Beef Cow-Calf Manual, 2008). However, the costs and benefits of creep feed should be taken into consideration in order to ensure that gains from additional weight will cover the costs of supplementary feed and administrative expenses.

### A2.4. Nutrition costs of youngstock cattle after weaning

Calves' reaching 7-8 months of age coincides with the beginning of a stall period. After weaning, animals enter a post-weaning development period that lasts 40-45 days. It is characterized by restructuring of a young cattle's organism due to the transition from milk-pasture grass to hay-silo-concentrates type of feeding. In case of inadequate feeding and maintenance during this time, animals significantly reduce their growth intensity that ultimately affects their development and future productivity.

The model calculates costs of feed for 9-12 months of age heifer calves (Table A.2.4) and steer calves (Table A.2.5). The assumptions have been made that after weaning a modeled farm has 40 heifer calves and 40 steer bulls on a special diet for 120 days before being sold to feedlots or retaining of some heifer calves for herd replacement. The diet of heifer calves and steer calves differentiate. Therefore, two different feeding schemes are considered. They are appropriate for winter feeding and target weight gain of cattle up to 1.0 kg per day.  The diet is formatted according to the data from Zhazykbayev et al (2008).

*Table A.2. 4. Average feed requirements for one heifer calf between 9-12 months of age*

| Item | Quantity of feed per day per head | | Cost per an item, KZT | Cost per one animal, KZT | | Cost, KZT | | |
|---|---|---|---|---|---|---|---|---|
| | Kg | % | | per season | % | Total | per cow | Kg of calf sold |
| Hay (cereals) | 5,50 | 27% | 11 | 7 226 | 20% | 289 054 | 2 891 | 22 |
| Haylage | 5,00 | 24% | 15 | 9 000 | 26% | 360 000 | 3 600 | 28 |
| Corn silo | 7,50 | 36% | 15 | 13 500 | 38% | 540 000 | 5 400 | 42 |
| Stock feed (cereals) | 2,50 | 12% | 15 | 4 500 | 13% | 180 000 | 1 800 | 14 |
| Phospate supplements | 0,04 | 0% | 110 | 528 | 1% | 21 120 | 211 | 2 |
| Salt blocks | 0,04 | 0% | 110 | 528 | 1% | 21 120 | 211 | 2 |
| Total | 20,58 | 100% | 276 | 35 282 | 100% | 1 411 294 | 14 113 | 110 |

*Notes.*
*Quantity used per day per head is according to Zhazykbayev et al (2008)*
*Information on cost of minerals and salt blocks according to the source: Kormovik.kz feed additives. (n.d.). Retrieved from http://www.kormovik.kz, information on green fodder, hay according to market data, on hay cost according to Prices and indices for agricultural products in the Republic of Kazakhstan. (04.2019)*

According to the estimation, a heifer calf consumes on average 5.5 kg of cereals hay, 5.0 kg of haylage, 7.5 kg of corn silo, 2.5 kg of stock feed, and 0.08 kg of phosphate supplements with mineral salt. Feeding of one heifer calf between 9-12 months of age requires spending of 14 113 KZT per cow or 110 KZT per kg. of calf sold.

*Table A.2. 5. Average feed requirements for one steer calf between 9-12 months of age*

| Item | Quantity of feed per day per head | | Cost per an item, KZT | Cost per one animal, KZT | | Cost, KZT | | |
|---|---|---|---|---|---|---|---|---|
| | Kg | % | | per season | % | Total | per cow | Kg of calf sold |
| Hay (legume and cereals) | 5,00 | 24% | 11 | 6 569 | 14% | 262 776 | 2 628 | 20 |
| Haylage | 4,00 | 19% | 15 | 7 200 | 15% | 288 000 | 2 880 | 22 |
| Corn silo | 8,00 | 38% | 15 | 14 400 | 30% | 576 000 | 5 760 | 45 |
| Concentrates | 3,80 | 18% | 42 | 19 152 | 40% | 766 080 | 7 661 | 59 |
| Phospate supplements | 0,04 | 0% | 110 | 528 | 1% | 21 120 | 211 | 2 |
| Salt blocks | 0,04 | 0% | 110 | 528 | 1% | 21 120 | 211 | 2 |
| Total | 20,88 | 100% | 303 | 48 377 | 100% | 1 935 096 | 19 351 | 150 |

*Notes.*
*Quantity used per day per head is according to Zhazykbayev et al (2008)*
*Information on cost of Protein-vitamin and minerals and salt blocks according to the source: Kormovik.kz feed additives. (n.d.). Retrieved from http://www.kormovik.kz, information on green fodder, hay according to market data, on hay cost according to Prices and indices for agricultural products in the Republic of Kazakhstan. (04.2019)*

The average feed requirements for steer calves between 9-12 months of age are calculated. Assumptions have been made that one steer calf consumes on average 5.0 kg of legume and cereals hay, 4.0 kg of haylage, 8.0 kg of corn silo, 3.8 kg of concentrates, 0.08 kg of phosphate supplements with mineral salt. Feeding of one steer calf between 9-12 months of age requires spending of 19 351 KZT per cow or 150 KZT per kg. of calf sold.

# Appendix 3: Whole-farm budget

### Whole farm budget

Income

1 EUR= 428 KZT

| | Reproduction enterprise, KZT | Backgrounding enterprise, KZT | Feed production enterprise, KZT | Whole farm budget, KZT | Per one cow unit, KZT | Per one kg of calf sold, KZT | Whole farm budget, EUR | Per one cow unit, EUR | Per one kg of calf sold, EUR |
|---|---|---|---|---|---|---|---|---|---|
| **Weaned heifers (8 month calf)** | 8 244 000 | - | - | - | | | - | - | - |
| **Weaned steers (8 month calf)** | 7 578 472 | - | - | - | | | - | - | - |
| **Cull cows/ open heifers (= # of repl-ts by weaned heifers)** | 4 150 526 | - | - | 4 150 526 | 41 505 | 190 | 9 697 | 97 | 0,44 |
| **Yearling heifer cattle (12 month)** | - | 13 027 631 | - | 13 027 631 | 130 276 | 598 | 30 438 | 304 | 1,40 |
| **Yearling steer cattle (12 month)** | - | 10 608 202 | - | 10 608 202 | 106 082 | 487 | 24 786 | 248 | 1,14 |
| **Subsidies for bulls maintenance** | - | 400 000 | - | 400 000 | 4 000 | 18 | 935 | 9 | 0,04 |
| **Subsidies for yearling calf sold to feedlot** | - | 2 463 615 | - | 2 463 615 | 24 636 | 113 | 5 756 | 58 | 0,26 |
| **Home grown feed** | - | - | - | - | | | - | - | - |
| Hay (cereals) | - | - | 1 675 197 | - | | | - | - | - |
| Heylage | - | - | 1 923 000 | - | | | - | - | - |
| Corn silo | - | - | 3 636 000 | - | | | - | - | - |
| Pasture grass | - | - | - | - | | | - | - | - |
| Seeded grass | - | - | - | - | | | - | - | - |
| **Total Revenue** | 19 972 998 | 26 499 448 | 7 234 197 | 30 649 974 | 306 500 | 1 406 | 71 612 | 716 | 3,29 |
| | | | | | | | - | - | - |
| ***Expenses*** | | | | | | | - | - | - |
| ***Operating (variable) costs*** | - | - | - | - | | | - | - | - |
| ***Calves costs*** | - | - | - | - | | | - | - | - |
| Weaned heifers (8 month calf) | - | 8 244 000 | - | - | | | - | - | - |
| Weaned steers (8 month calf) | - | 7 578 472 | - | - | | | - | - | - |
| **Total calves costs** | - | 15 822 472 | - | - | | | - | - | - |
| ***Cattle feed costs*** | - | - | - | - | | | - | - | - |
| Hay (cereals) | 1 123 367 | 551 830 | - | - | - | - | - | - | - |
| Heylage | 1 275 000 | 648 000 | - | - | - | - | - | - | - |
| Corn silo | 2 520 000 | 1 116 000 | - | - | - | - | - | - | - |
| Pasture grass | - | - | - | - | - | - | - | - | - |
| Seeded grass | - | - | - | - | - | - | - | - | - |
| **Total home grown feed** | **4 918 367** | **2 315 830** | - | - | - | - | - | - | - |
| Stock feed (cereals) | - | 180 000 | - | 180 000 | 1 800 | 8 | 421 | 4 | 0,02 |
| **Straw** | 990 000 | - | - | 720 119 | 7 201 | 33 | 1 683 | 17 | 0,08 |
| **Concentrates** | 3 069 360 | 766 080 | - | 2 276 048 | 22 760 | 104 | 5 318 | 53 | 0,24 |
| **Protein-vitamin and mineral supplements** | 609 600 | - | - | 519 771 | 5 198 | 24 | 1 214 | 12 | 0,06 |
| Phospate supplements | 42 240 | 42 240 | - | 84 480 | 845 | 4 | 197 | 2 | 0,01 |
| Salt blocks | 263 824 | 42 240 | - | 306 064 | 3 061 | 14 | 715 | 7 | 0,03 |
| **Total purchased Feed** | **4 975 024** | **1 030 560** | - | **4 086 482** | **40 865** | **187** | **9 548** | **95** | **0,44** |
| **Total cattle feed costs** | **9 893 391** | **3 346 390** | - | **4 086 482** | **40 865** | **187** | **9 548** | **95** | **0,44** |
| | | | | | | | - | - | - |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | - | - | - |
| ***Other operating costs*** | - | - | - | - | | | - | - | - |
| **Grain stalks and straw for bedding** | **470 000** | **188 000** | **-** | **658 000** | **6 580** | 29 | **1 537** | **15** | 0,07 |
| Vaccines- calves | 12 000 | - | - | 12 000 | 120 | 1 | 28 | 0 | 0,00 |
| Vaccines- cows | 15 000 | - | - | 15 000 | 150 | 1 | 35 | 0 | 0,00 |
| Dewormer | 81 000 | - | - | 81 000 | 810 | 4 | 189 | 2 | 0,01 |
| Medicine | 225 000 | 180 000 | - | 405 000 | 4 050 | 18 | 946 | 9 | 0,04 |
| Veternary service cost | 432 000 | - | - | 432 000 | 4 320 | 19 | 1 009 | 10 | 0,05 |
| Ear tags | 60 000 | - | - | 60 000 | 600 | 3 | 140 | 1 | 0,01 |
| **Total veterinary, medicine and breeding costs** | **825 000** | **180 000** | **-** | **1 005 000** | **10 050** | **45** | **2 348** | **23** | **0,11** |
| **Cattle insurance** | **1 600 000** | **200 000** | **-** | **1 800 000** | **18 000** | **81** | **4 206** | **42** | **0,19** |
| **Fuel (cattle machinery)** | **587 650** | **251 850** | **-** | **839 500** | **8 395** | **38** | **1 961** | **20** | **0,09** |
| **Total operating costs of cattle management** | **3 482 650** | **819 850** | **-** | **4 302 500** | **43 025** | **192** | **10 053** | **101** | **0,45** |
| **Fuel (feed)** | - | - | - | - | | | - | - | - |
| **Seeds** | - | - | - | - | - | - | - | - | - |
| Nitrogen | - | - | - | - | - | - | - | - | - |
| Phosporus | - | - | - | - | - | - | - | - | - |
| Potash | - | - | - | - | - | - | - | - | - |
| **Total fertilizers costs** | - | - | - | - | - | - | - | - | - |
| **Crop protection agents (CPA)** | - | - | - | - | - | - | - | - | - |
| **Pasture maintanance** | - | - | - | - | - | - | - | - | - |
| **Harvest transportation and storage** | - | - | - | - | - | - | - | - | - |
| **Operating costs of own feed production** | - | - | **1 803 505** | **1 803 505** | 18 035 | 81 | **4 214** | 42 | 0,19 |
| **Total other operating costs** | 3 482 650 | 819 850 | 2 170 259 | 6 106 005 | 61 060 | 273 | 14 266 | 143 | 0,64 |
| **Interest expenses on Working capital loans** | - | - | - | - | - | - | - | - | - |
| **Total Operating (variable) costs** | **13 376 041** | **20 046 749** | **2 170 259** | **11 486 118** | **114 861** | **514** | **26 837** | **268** | **1,20** |
| | | | | | | | - | - | - |
| INCOME ABOVE OPERATING COSTS BEFORE INTEREST | 6 628 759 | 6 949 796 | 5 063 938 | 19 634 718 | 196 347 | 878 | 45 876 | 459 | 2,05 |
| INCOME ABOVE OPERATING COSTS AFTER INTEREST | 6 628 759 | 6 949 796 | 5 063 938 | 19 634 718 | 196 347 | 878 | 45 876 | 459 | 2,05 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Ownership (fixed) costs*** | | | | | | | - | - | - |
| Autonomus mobile house | 28 333 | 28 333 | 56 667 | 113 333 | 1 133 | 5 | 265 | 3 | 0,01 |
| Tractor+loader+trailer | 102 000 | 102 000 | 476 000 | 680 000 | 6 800 | 30 | 1 589 | 16 | 0,07 |
| Rake/hipper for hay | - | - | 10 400 | 10 400 | 104 | 0 | 24 | 0 | 0,00 |
| Feeder wagon | - | - | 198 333 | 198 333 | 1 983 | 9 | 463 | 5 | 0,02 |
| Hay baler | - | - | 131 667 | 131 667 | 1 317 | 6 | 308 | 3 | 0,01 |
| Hay mower | - | - | 35 000 | 35 000 | 350 | 2 | 82 | 1 | 0,00 |
| Pneumatic precision air seeder (maize) | - | - | 170 667 | 170 667 | 1 707 | 8 | 399 | 4 | 0,02 |
| Trailed shredder, for maize and haymaking | - | - | 316 000 | 316 000 | 3 160 | 14 | 738 | 7 | 0,03 |
| **Total Machinery depreciation** | **130 333** | **130 333** | **1 394 733** | **1 655 400** | **16 554** | **74** | **3 868** | **39** | **0,17** |
| Mobile equipment for cattle check | 55 533 | 23 800 | - | 79 333 | 793 | 4 | 185 | 2 | 0,01 |
| Wells at a pasture (50m) | 39 667 | 17 000 | - | 56 667 | 567 | 3 | 132 | 1 | 0,01 |
| Wind water pump | 138 833 | 59 500 | - | 198 333 | 1 983 | 9 | 463 | 5 | 0,02 |
| Storage tank | 19 833 | 8 500 | - | 28 333 | 283 | 1 | 66 | 1 | 0,00 |
| **Equipment depreciation** | **253 867** | **108 800** | **-** | **362 667** | **3 627** | **16** | **847** | **8** | **0,04** |
| Depreciation of wintering stables + winter shed | 212 500 | 70 833 | - | 283 333 | 2 833 | 13 | 662 | 7 | 0,03 |
| Land (grazing pastures, feed grow) depreciation | - | - | - | - | - | - | - | - | - |
| **Total Depreciation Costs** | **596 700** | **309 967** | **1 394 733** | **2 301 400** | **23 014** | **103** | **5 377** | **54** | **0,24** |
| Interest expense on CAPEX loan | 1 238 055 | 217 998 | 980 907 | 2 436 960 | 24 370 | 109 | 5 694 | 57 | 0,25 |
| Taxes | 108 772 | 56 504 | 254 246 | 419 522 | 4 195 | 19 | 980 | 10 | 0,04 |
| Insurance | 65 505 | 58 145 | 898 663 | 1 022 313 | 10 223 | 46 | 2 389 | 24 | 0,11 |
| Housing | 20 693 | 13 333 | 84 798 | 118 823 | 1 188 | 5 | 278 | 3 | 0,01 |
| Repair costs | 477 300 | 224 300 | 917 600 | 1 619 200 | 16 192 | 72 | 3 783 | 38 | 0,17 |
| Miscellaneous Overhead expenses | - | - | - | - | - | - | - | - | - |
| **Total other fixed costs** | **1 910 325** | **570 279** | **3 136 213** | **5 616 817** | **148 755** | **665** | **13 123** | **348** | **1,55** |
| Pasture grass feed | - | - | 2 705 852 | 2 705 852 | 27 059 | 121 | 6 322 | 63 | 0,28 |
| Own labor | 2 350 000 | 1 175 000 | 1 175 000 | 4 700 000 | 47 000 | 210 | 10 981 | 110 | 0,49 |
| Cost of equity | 1 134 737 | 130 578 | 587 551 | 1 852 866 | 18 529 | 83 | 4 329 | 43 | 0,19 |
| **Total opportunity costs** | 3 484 737 | 1 305 578 | 4 468 403 | 9 258 718 | 92 587 | 414 | 21 633 | 216 | 0,97 |
| **Total Ownership (fixed) costs** | **5 991 762** | **2 185 823** | **8 999 349** | **17 176 935** | **171 769** | **768** | **40 133** | **401** | **1,80** |
| | - | - | - | - | | | - | - | - |
| **Total Operating & Ownership costs** | **19 367 804** | **22 232 572** | **11 169 608** | **28 663 053** | **286 631** | **1 282** | **66 970** | **670** | **3,00** |
| | - | - | - | | | | - | - | - |
| **Economic profit (return to management)** | **636 997** | **4 763 973** | **(3 935 411)** | **2 457 783** | **24 578** | **110** | **5 742** | **57** | **0,26** |
| | - | - | - | - | | | - | - | - |
| | - | - | - | - | | | - | - | - |
| **Statement of profit or loss (P&L)** | - | - | - | - | | | - | - | - |
| Total Revenues | 20 004 801 | 26 996 545 | 7 234 197 | 31 120 837 | 311 208 | 1 392 | 72 712 | 727 | 3,25 |
| COGS (Cost of goods sold) | 13 376 041 | 20 046 749 | 2 170 259 | 11 486 118 | 114 861 | 514 | 26 837 | 268 | 1,20 |
| SG&A and Other | 672 270 | 352 281 | 2 155 306 | 3 179 857 | 31 799 | 142 | 7 430 | 74 | 0,33 |
| **Operating profit - EBIT** | 5 956 489 | 6 597 515 | 2 908 632 | 16 454 862 | 164 549 | 736 | 38 446 | 384 | 1,72 |
| Interest expense | 1 238 055 | 217 998 | 980 907 | 2 436 960 | 24 370 | 109 | 5 694 | 57 | 0,25 |
| **Pretax income - EBT** | 4 718 434 | 6 379 517 | 1 927 725 | 14 017 902 | 140 179 | 627 | 32 752 | 328 | 1,46 |
| Income tax rate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0,00 |
| Taxes | 141 553 | 191 386 | 57 832 | 420 537 | 4 205 | 19 | 983 | 10 | 0,04 |
| **Net INCOME (Accounting profit)** | 4 576 881 | 6 188 132 | 1 869 893 | 13 597 365 | 135 974 | 608 | 31 770 | 318 | 1,42 |
| | | | | | | | - | - | - |
| **EBITDA Reconciliation** | | | | | | | - | - | - |
| EBIT | 4 718 434 | 6 379 517 | 1 927 725 | 14 017 902 | 140 179 | 627 | 32 752 | 328 | 1,46 |
| Depreciation & amortization | 596 700 | 309 967 | 1 394 733 | 2 301 400 | 23 014 | 103 | 5 377 | 54 | 0,24 |
| **EBITDA** | 5 315 134 | 6 689 484 | 3 322 459 | 16 319 302 | 163 193 | 730 | 38 129 | 381 | 1,71 |

# Appendix 4: Cash flow budget

Cow-calf farm's enterprises budgets

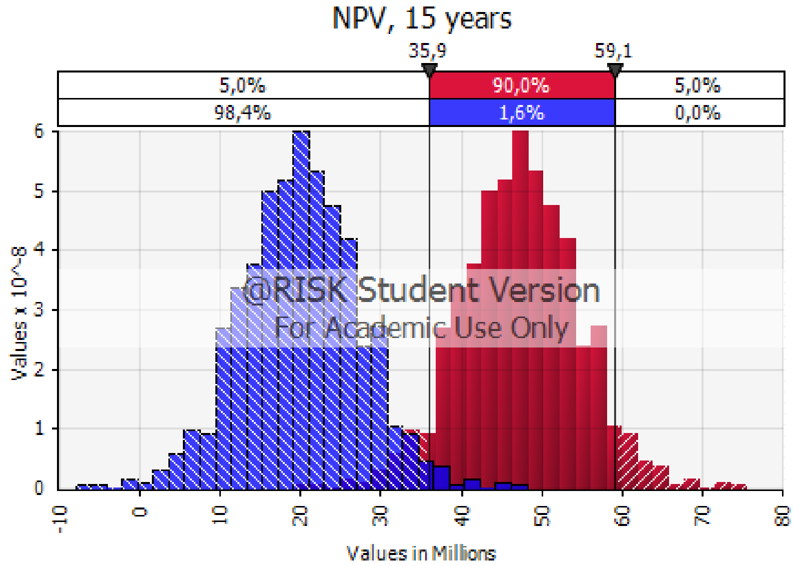
| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflation rate, % | | | 4,0% | 4,0% | 4,0% | 4,0% | 4,0% | 4,0% | 4,0% | 4,0% | 4,0% | 4,0% | 4,0% | 4,0% | 4,0% | 4,0% | 4,0% |
| **Cash flow budgeting** | | **Projected Annual Forecast** | | | | | | | | | | | | | | | |
| Year | | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** | **2034** | **2035** |
| Year # | | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| **BEGINING CASH BALANCE** | A | 0 | 4 700 000 | 3 177 435 | 9 995 455 | 19 740 715 | 23 255 591 | 28 867 255 | 32 971 172 | 41 222 448 | 50 092 144 | 62 795 676 | 68 457 985 | 78 959 324 | 91 382 572 | 104 511 285 | 117 962 651 |
| **# of heads for sale:** | | | | | | | | | | | | | | | | | |
| Yearling heifer cattle (12 month) | | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| Yearling steer cattle (12 month) | | | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Subsidies for yearling calf sold to feedlot | | | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Cull cows/ open heifers (= # of repl-ts by weaned heifers) | | | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| **Average weight:** | | | | | | | | | | | | | | | | | |
| **Yearling heifer cattle (12 month)** | | | **315** | **297** | **281** | **274** | **289** | **277** | **297** | **286** | **272** | **266** | **318** | **296** | **268** | **266** | **296** |
| min | | | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 |
| most likely | | | 291 | 291 | 291 | 291 | 291 | 291 | 291 | 291 | 291 | 291 | 291 | 291 | 291 | 291 | 291 |
| max | | | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 |
| **Yearling steer cattle (12 month)** | | | **348** | **324** | **364** | **360** | **333** | **325** | **360** | **335** | **361** | **341** | **354** | **339** | **353** | **370** | **346** |
| min | | | 295 | 295 | 295 | 295 | 295 | 295 | 295 | 295 | 295 | 295 | 295 | 295 | 295 | 295 | 295 |
| most likely | | | 343 | 343 | 343 | 343 | 343 | 343 | 343 | 343 | 343 | 343 | 343 | 343 | 343 | 343 | 343 |
| max | | | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 |
| Subsidies for yearling calf sold to a feedlot | | | 314 | 314 | 314 | 314 | 314 | 314 | 314 | 314 | 314 | 314 | 314 | 314 | 314 | 314 | 314 |
| **Cull cows/ open heifers (= # of repl-ts by weaned heifers)** | | | **600** | **601** | **623** | **621** | **627** | **580** | **616** | **623** | **618** | **621** | **586** | **590** | **557** | **599** | **615** |
| min | | | 542 | 542 | 542 | 542 | 542 | 542 | 542 | 542 | 542 | 542 | 542 | 542 | 542 | 542 | 542 |
| most likely | | | 623 | 623 | 623 | 623 | 623 | 623 | 623 | 623 | 623 | 623 | 623 | 623 | 623 | 623 | 623 |
| max | | | 632 | 632 | 632 | 632 | 632 | 632 | 632 | 632 | 632 | 632 | 632 | 632 | 632 | 632 | 632 |
| **Price per (KZT/ kg of live weight):** | | | | | | | | | | | | | | | | | |
| Yearling heifer cattle (12 month) | | | 1 374 | 1 429 | 1 486 | 1 546 | 1 607 | 1 672 | 1 739 | 1 808 | 1 880 | 1 956 | 2 034 | 2 115 | 2 200 | 2 288 | 2 379 |
| Yearling steer cattle (12 month) & Cull cows/ open heifers | | | **738** | **721** | **1 155** | **845** | **934** | **873** | **928** | **834** | **1 090** | **771** | **778** | **1 006** | **1 058** | **1 062** | **947** |
| min | | | 664 | 664 | 664 | 664 | 664 | 664 | 664 | 664 | 664 | 664 | 664 | 664 | 664 | 664 | 664 |
| most likely | | | 850 | 850 | 850 | 850 | 850 | 850 | 850 | 850 | 850 | 850 | 850 | 850 | 850 | 850 | 850 |
| max | | | 1 283 | 1 283 | 1 283 | 1 283 | 1 283 | 1 283 | 1 283 | 1 283 | 1 283 | 1 283 | 1 283 | 1 283 | 1 283 | 1 283 | 1 283 |
| Subsidies for yearling calf sold to feedlot | | | 200 | 208 | 216 | 225 | 234 | 243 | 253 | 263 | 274 | 285 | 296 | 308 | 320 | 333 | 346 |
| **CASH INFLOW CALCULATION:** | | | | | | | | | | | | | | | | | |
| Yearling heifer cattle (12 month) | | | 12 991 914 | 12 711 920 | 12 515 761 | 12 714 179 | 13 951 063 | 13 907 278 | 15 494 263 | 15 503 316 | 15 337 578 | 15 576 698 | 19 398 852 | 18 777 414 | 17 654 024 | 18 225 459 | 21 120 599 |
| Yearling steer cattle (12 month) | | | 10 262 183 | 9 339 147 | 16 790 985 | 12 159 878 | 12 455 298 | 11 352 234 | 13 371 936 | 11 184 804 | 15 728 347 | 10 527 966 | 11 005 510 | 13 630 591 | 14 929 260 | 15 739 987 | 13 118 674 |
| Subsidies for yearling calf sold to feedlot | | | 2 511 702 | 2 612 170 | 2 716 657 | 2 825 323 | 2 938 336 | 3 055 869 | 3 178 104 | 3 305 228 | 3 437 437 | 3 574 935 | 3 717 932 | 3 866 649 | 4 021 315 | 4 182 168 | 4 349 455 |
| **Total operating receipts:** | B1 | **-** | **25 765 799** | **24 663 237** | **32 023 402** | **27 699 380** | **29 344 697** | **28 315 381** | **32 044 303** | **29 993 348** | **34 503 363** | **29 679 598** | **34 122 294** | **36 274 655** | **36 604 599** | **38 147 614** | **38 588 728** |
| Cull cows/ open heifers (= # of repl-ts by weaned heifers) | | | 3 540 298 | 3 466 430 | 5 754 941 | 4 200 313 | 4 681 320 | 4 048 449 | 4 567 826 | 4 155 045 | 5 385 121 | 3 833 275 | 3 645 782 | 4 743 204 | 4 711 906 | 5 095 668 | 4 658 724 |
| Machinery and equipment sale | | | | | | | | | | | | | | | | | 9 379 000 |
| **Total capital receipts:** | B2 | **-** | **3 540 298** | **3 466 430** | **5 754 941** | **4 200 313** | **4 681 320** | **4 048 449** | **4 567 826** | **4 155 045** | **5 385 121** | **3 833 275** | **3 645 782** | **4 743 204** | **4 711 906** | **5 095 668** | **14 037 724** |
| Investment subsidies | | 27 425 000 | | | | | | | | | | | | | | | |
| Equity capital investments | | 17 285 000 | | | | | | | | | | | | | | | |
| *Debt capital investments: CAPEX loan* | | 43 890 000 | | | | | | | | | | | | | | | |
| *Debt capital investments: WC loan* | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total non-farm (financial) receipts:** | B3 | **88 600 000** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** |
| **TOTAL CASH INFLOW** | B | **88 600 000** | **29 306 097** | **28 129 668** | **37 778 344** | **31 899 693** | **34 026 017** | **32 363 829** | **36 612 128** | **34 148 394** | **39 888 483** | **33 512 874** | **37 768 076** | **41 017 858** | **41 316 505** | **43 243 282** | **52 626 452** |
| **TOTAL CASH INFLOW (including BEGINNING CASH BALANCE)** | C=A+B | **88 600 000** | **34 006 097** | **31 307 103** | **47 773 799** | **51 640 408** | **57 281 607** | **61 231 085** | **69 583 300** | **75 370 842** | **89 980 627** | **96 308 550** | **106 226 060** | **119 977 182** | **132 699 077** | **147 754 566** | **170 589 103** |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operating expenses (OPEX):** | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| **Cattle feed expenses** | D | | | | | | | | | | | | | | | | |
| Hay (cereals) | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Heylage | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Corn silo | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pasture grass | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Seeded grass | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total home grown feed** | D1 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| Stock feed (cereals) | | | 180 000 | 187 200 | 194 688 | 202 476 | 210 575 | 218 998 | 227 757 | 236 868 | 246 342 | 256 196 | 266 444 | 277 102 | 288 186 | 299 713 | 311 702 |
| **Straw** | | | **973 036** | **789 205** | **541 834** | **542 659** | **946 785** | **740 937** | **630 340** | **636 632** | **960 781** | **914 699** | **733 259** | **877 308** | **554 002** | **988 660** | **899 152** |
| **Concentrates** | | | **3 728 644** | **2 545 470** | **3 449 432** | **3 581 386** | **3 365 819** | **2 536 790** | **1 949 373** | **2 701 425** | **3 263 796** | **3 248 551** | **2 441 531** | **3 323 613** | **1 959 702** | **3 313 378** | **2 094 528** |
| **Protein-vitamin and mineral supplements** | | | **554 953** | **305 311** | **452 488** | **565 874** | **342 924** | **444 795** | **551 995** | **559 925** | **379 689** | **595 502** | **337 702** | **422 613** | **465 385** | **414 380** | **369 800** |
| Phospate supplements | | | 84 480 | 87 859 | 91 374 | 95 029 | 98 830 | 102 783 | 106 894 | 111 170 | 115 617 | 120 241 | 125 051 | 130 053 | 135 255 | 140 665 | 146 292 |
| Salt blocks | | | 306 064 | 318 307 | 331 039 | 344 280 | 358 052 | 372 374 | 387 269 | 402 759 | 418 870 | 435 625 | 453 049 | 471 171 | 490 018 | 509 619 | 530 004 |
| **Total purchased Feed** | D2 | **0** | **13 979 737** | **4 233 352** | **5 060 854** | **5 331 702** | **5 322 984** | **4 416 676** | **3 853 628** | **4 648 779** | **5 385 095** | **5 570 814** | **4 357 036** | **5 501 860** | **3 892 550** | **5 666 416** | **4 351 478** |
| **Total cattle feed expenses:** | D | **0** | **13 979 737** | **4 233 352** | **5 060 854** | **5 331 702** | **5 322 984** | **4 416 676** | **3 853 628** | **4 648 779** | **5 385 095** | **5 570 814** | **4 357 036** | **5 501 860** | **3 892 550** | **5 666 416** | **4 351 478** |
| **Other cash operating expenses** | | | | | | | | | | | | | | | | | |
| **Grain stalks and straw for bedding** | **E1** | | **658 000** | **684 320** | **711 693** | **740 161** | **769 767** | **800 558** | **832 580** | **865 883** | **900 518** | **936 539** | **974 001** | **1 012 961** | **1 053 479** | **1 095 618** | **1 139 443** |
| Vaccines- calves | | | 12 000 | 12 480 | 12 979 | 13 498 | 14 038 | 14 600 | 15 184 | 15 791 | 16 423 | 17 080 | 17 763 | 18 473 | 19 212 | 19 981 | 20 780 |
| Vaccines- cows | | | 15 000 | 15 600 | 16 224 | 16 873 | 17 548 | 18 250 | 18 980 | 19 739 | 20 529 | 21 350 | 22 204 | 23 092 | 24 015 | 24 976 | 25 975 |
| Dewormer | | | 81 000 | 84 240 | 87 610 | 91 114 | 94 759 | 98 549 | 102 491 | 106 590 | 110 854 | 115 288 | 119 900 | 124 696 | 129 684 | 134 871 | 140 266 |
| Medicine | | | 405 000 | 421 200 | 438 048 | 455 570 | 473 793 | 492 744 | 512 454 | 532 952 | 554 270 | 576 441 | 599 499 | 623 479 | 648 418 | 674 355 | 701 329 |
| Veternary service cost | | | 432 000 | 449 280 | 467 251 | 485 941 | 505 379 | 525 594 | 546 618 | 568 483 | 591 222 | 614 871 | 639 466 | 665 044 | 691 646 | 719 312 | 748 084 |
| Ear tags | | | 60 000 | 62 400 | 64 896 | 67 492 | 70 192 | 72 999 | 75 919 | 78 956 | 82 114 | 85 399 | 88 815 | 92 367 | 96 062 | 99 904 | 103 901 |
| **Total veterinary, medicine and breeding costs** | E2 | | **1 005 000** | **1 045 200** | **1 087 008** | **1 130 488** | **1 175 708** | **1 222 736** | **1 271 646** | **1 322 511** | **1 375 412** | **1 430 428** | **1 487 646** | **1 547 151** | **1 609 037** | **1 673 399** | **1 740 335** |
| **Cattle insurance** | E3 | | 1 800 000 | 1 872 000 | 1 946 880 | 2 024 755 | 2 105 745 | 2 189 975 | 2 277 574 | 2 368 677 | 2 463 424 | 2 561 961 | 2 664 440 | 2 771 017 | 2 881 858 | 2 997 132 | 3 117 018 |
| **Fuel (cattle machinery)** | E4 | | 839 500 | 873 080 | 908 003 | 944 323 | 982 096 | 1 021 380 | 1 062 235 | 1 104 725 | 1 148 914 | 1 194 870 | 1 242 665 | 1 292 372 | 1 344 067 | 1 397 829 | 1 453 742 |
| **Total cash operating expenses of cattle management** | E | | **4 302 500** | **4 474 600** | **4 653 584** | **4 839 727** | **5 033 316** | **5 234 649** | **5 444 035** | **5 661 796** | **5 888 268** | **6 123 799** | **6 368 751** | **6 623 501** | **6 888 441** | **7 163 979** | **7 450 538** |
| **Fuel (feed)** | F1 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Seeds** | F2 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Nitrogen | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phosporus | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Potash | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total fertilizers costs** | F3 | | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** |
| **Crop protection agents (CPA)** | F4 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Pasture maintanance** | F5 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Harvest transportation and storage** | F6 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total cash operating expences of own feed production | F | | 1 883 321 | 1 611 546 | 1 607 089 | 1 434 119 | 1 196 837 | 1 650 620 | 1 993 071 | 1 326 162 | 1 961 130 | 1 879 677 | 1 920 844 | 1 486 581 | 2 042 086 | 1 194 497 | 1 897 342 |
| **Total other operating expenses** | G=E+F | **0** | **6 185 821** | **6 086 146** | **6 260 673** | **6 273 847** | **6 230 153** | **6 885 269** | **7 437 106** | **6 987 958** | **7 849 399** | **8 003 476** | **8 289 595** | **8 110 082** | **8 930 528** | **8 358 476** | **9 347 880** |
| **Total cash OPERATING EXPENCES** | H=D+G | **0** | **20 165 558** | **10 319 498** | **11 321 527** | **11 605 549** | **11 553 137** | **11 301 945** | **11 290 734** | **11 636 737** | **13 234 493** | **13 574 290** | **12 646 631** | **13 611 942** | **12 823 077** | **14 024 892** | **13 699 358** |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Capital expenditures (CAPEX)** | | | | | | | | | | | | | | | | | |
| Autonomus mobile house | | 2 000 000 | | | | | | | | | | | | | | | |
| Tractor+loader+trailer | | 13 600 000 | | | | | | | | | | | | | | | |
| Rake/hipper for hay | | 200 000 | | | | | | | | | | | | | | | |
| Feeder wagon | | 3 500 000 | | | | | | | | | | | | | | | |
| Hay baler | | 2 500 000 | | | | | | | | | | | | | | | |
| Hay mower | | 700 000 | | | | | | | | | | | | | | | |
| Pneumatic precision air seeder (maize) | | 4 000 000 | | | | | | | | | | | | | | | |
| Trailed shredder, for maize and haymaking | | 6 000 000 | | | | | | | | | | | | | | | |
| **Total CAPEX on Machinery** | I1 | **32 500 000** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| Mobile equipment for cattle check | | 1 400 000 | | | | | | | | | | | | | | | |
| Wells at a pasture (50m) | | 1 000 000 | | | | | | | | | | | | | | | |
| Wind water pump | | 3 500 000 | | | | | | | | | | | | | | | |
| Storage tank | | 500 000 | | | | | | | | | | | | | | | |
| **Total CAPEX on Equipment** | I2 | **6 400 000** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **Wintering stables + winter shed** | I3 | **5 000 000** | | | | | | | | | | | | | | | |
| **Land (grazing pastures, feed grow)** | I4 | **-** | | | | | | | | | | | | | | | |
| Breeding cows | | 40 000 000 | | | | | | | | | | | | | | | |
| Bulls | | - | | | | | | | | | | | | | | | |
| **Total CAPEX on cattle** | I5 | **40 000 000** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **Total cash CAPEX** | I | **83 900 000** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **Other fixed cost and other cash expenditures** | | | | | | | | | | | | | | | | | |
| Taxes | | | 419 522 | 436 302 | 453 755 | 471 905 | 490 781 | 510 412 | 530 829 | 552 062 | 574 144 | 597 110 | 620 994 | 645 834 | 671 668 | 698 534 | 726 476 |
| Insurance | | | 1 022 313 | 1 063 205 | 1 105 733 | 1 149 963 | 1 195 961 | 1 243 799 | 1 293 551 | 1 345 294 | 1 399 105 | 1 455 069 | 1 513 272 | 1 573 803 | 1 636 755 | 1 702 225 | 1 770 314 |
| Housing | | | 118 823 | 123 575 | 128 518 | 133 659 | 139 006 | 144 566 | 150 348 | 156 362 | 162 617 | 169 121 | 175 886 | 182 922 | 190 239 | 197 848 | 205 762 |
| Repair costs | | | 1 619 200 | 1 683 968 | 1 751 327 | 1 821 380 | 1 894 235 | 1 970 004 | 2 048 805 | 2 130 757 | 2 215 987 | 2 304 626 | 2 396 812 | 2 492 684 | 2 592 391 | 2 696 087 | 2 803 931 |
| Miscellaneous Overhead expenses | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total other fixed costs** | | | **3 179 857** | **3 307 051** | **3 439 333** | **3 576 906** | **3 719 982** | **3 868 782** | **4 023 533** | **4 184 474** | **4 351 853** | **4 525 927** | **4 706 965** | **4 895 243** | **5 091 053** | **5 294 695** | **5 506 483** |
| Family living expenses | | | 4 700 000 | 4 888 000 | 5 083 520 | 5 286 861 | 5 498 335 | 5 718 269 | 5 946 999 | 6 184 879 | 6 432 275 | 6 689 566 | 6 957 148 | 7 235 434 | 7 524 851 | 7 825 845 | 8 138 879 |
| Income tax | | | 346 287 | 360 139 | 374 544 | 389 526 | 405 107 | 421 311 | 438 164 | 455 690 | 473 918 | 492 874 | 512 589 | 533 093 | 554 417 | 576 593 | 599 657 |
| Other non farm expenses | | | | | | | | | | | | | | | | | |
| Other non farm expenses | | | | | | | | | | | | | | | | | |
| **Total other cash expenditures** | J | **0** | **5 046 287** | **5 248 139** | **5 458 064** | **5 676 387** | **5 903 442** | **6 139 580** | **6 385 163** | **6 640 570** | **6 906 192** | **7 182 440** | **7 469 738** | **7 768 527** | **8 079 268** | **8 402 439** | **8 738 536** |
| **Scheduled debt payments** | | | | | | | | | | | | | | | | | |
| Current debt - principal | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Current debt - interest | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Noncurrent debt principal | | - | - | - | 5 665 385 | 5 665 385 | 5 665 385 | 5 665 385 | 5 665 385 | 1 945 385 | 1 945 385 | 1 945 385 | 1 945 385 | 1 945 385 | 1 945 385 | 1 945 385 | 1 945 385 |
| Noncurrent debt interest | | - | 2 436 960 | 2 436 960 | 2 148 775 | 1 860 591 | 1 572 406 | 1 284 222 | 996 037 | 871 532 | 747 028 | 622 523 | 498 018 | 373 514 | 249 009 | 124 505 | (0) |
| **Scheduled debt payments** | K | **0** | **2 436 960** | **2 436 960** | **7 814 160** | **7 525 975** | **7 237 791** | **6 949 606** | **6 661 422** | **2 816 917** | **2 692 412** | **2 567 908** | **2 443 403** | **2 318 898** | **2 194 394** | **2 069 889** | **1 945 385** |
| **TOTAL CASH OUTFLOW** | L=H+I+J+K | **83 900 000** | **30 828 662** | **21 311 647** | **28 033 084** | **28 384 817** | **28 414 352** | **28 259 913** | **28 360 852** | **25 278 698** | **27 184 951** | **27 850 566** | **27 266 736** | **28 594 610** | **28 187 792** | **29 791 915** | **29 889 761** |
| **TOTAL CASH AVAILABLE** | M=C-L | **4 700 000** | **3 177 435** | **9 995 455** | **19 740 715** | **23 255 591** | **28 867 255** | **32 971 172** | **41 222 448** | **50 092 144** | **62 795 676** | **68 457 985** | **78 959 324** | **91 382 572** | **104 511 285** | **117 962 651** | **140 699 342** |
| **New borrowings** | | | | | | | | | | | | | | | | | |
| Current | | | | | | | | | | | | | | | | | |
| Noncurrent | | | | | | | | | | | | | | | | | |
| **Total new borrowings:** | N | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **Payment on new current debt** | | | | | | | | | | | | | | | | | |
| Principal | | | | | | | | | | | | | | | | | |
| Interest | | | | | | | | | | | | | | | | | |
| **Total payment on new current debt** | O | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **ENDING CASH BALANCE** | P=M+N-O | **4 700 000** | **3 177 435** | **9 995 455** | **19 740 715** | **23 255 591** | **28 867 255** | **32 971 172** | **41 222 448** | **50 092 144** | **62 795 676** | **68 457 985** | **78 959 324** | **91 382 572** | **104 511 285** | **117 962 651** | **140 699 342** |
| **Summary of debt outstanding** | | | | | | | | | | | | | | | | | |
| Current | | | | | | | | | | | | | | | | | |
| Non current | | | | | | | | | | | | | | | | | |
| **Total debt outstanding** | | | | | | | | | | | | | | | | | |

# Appendix 5: NPV scenario analysis

*Figure A.5. 1: Scenarios 1 and 2, NPV in a 15 year planning period with and without subsidies*

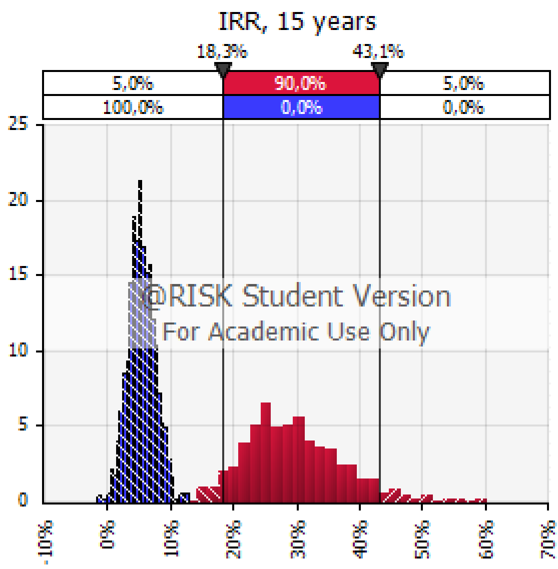



| | NPV1 | NPV1 |
|---|---|---|
| Cell | Cash flow bu.. | Cash flow bu.. |
| Minimum | 19 385 922,34 | -8 039 077,66 |
| Maximum | 75 592 127,04 | 48 167 127,04 |
| Mean | 47 367 253,77 | 19 942 253,77 |
| 90% CI | ± 380 132,28 | ± 380 132,28 |
| Mode | 43 307 956,74 | 15 882 956,74 |
| Median | 47 466 456,64 | 20 041 456,64 |
| Std Dev | 7 301 380,55 | 7 301 380,55 |
| Skewness | 0,0469 | 0,0469 |
| Kurtosis | 3,5062 | 3,5062 |
| Values | 1000 | 1000 |
| Errors | 0 | 0 |
| Filtered | 0 | 0 |
| Left X | 35 949 349,61 | 35 949 349,61 |
| Left P | 5,0% | 98,4% |
| Right X | 59 090 302,97 | 59 090 302,97 |

*Where,*

*NPV1 (left side cumulative curve) – is the Net Present Value for a 15 year period, with subsidies*
*NPV1 (right side cumulative curve) – is the Net Present Value for a 15 year period, without subsidies.*

*Figure A.5. 2: Scenarios 1 and 2, IRR in a 15 year planning period with and without subsidies*

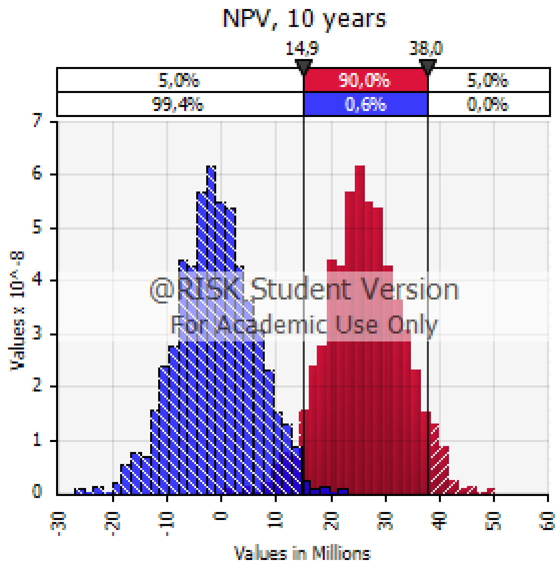



| | IRR1 | IRR1 |
|---|---|---|
| Cell | Cash flow bu.. | Cash flow bu.. |
| Minimum | 10,785% | -1,611% |
| Maximum | 60,330% | 12,973% |
| Mean | 29,564% | 5,402% |
| 90% CI | ± 0,394% | ± 0,1119% |
| Mode | 24,045% | 5,224% |
| Median | 28,844% | 5,280% |
| Std Dev | 7,560% | 2,149% |
| Skewness | 0,6103 | 0,1704 |
| Kurtosis | 3,5467 | 3,1907 |
| Values | 1000 | 1000 |
| Errors | 0 | 0 |
| Filtered | 0 | 0 |
| Left X | 18,3% | 18,3% |

*Where,*

*IRR1 (left side cumulative curve) – is the Internal Rate of Return for a 15 year period, with subsidies*
*IRR1 (right side cumulative curve) – is the Internal Rate of Return for a 15 year period, without subsidies.*

*Figure A.5. 3: Scenarios 3 and 4, NPV in a 10 year planning period with and without subsidies*

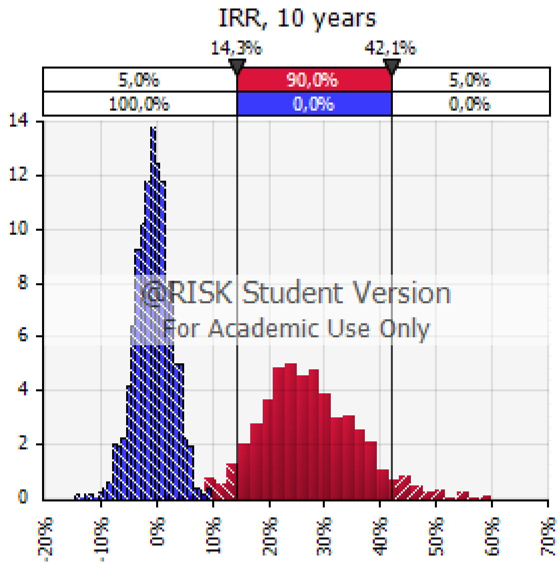



| | NPV1 | NPV1 |
|---|---|---|
| Cell | Cash flow bu.. | Cash flow bu.. |
| Minimum | 365 798,44 | -27 059 201,56 |
| Maximum | 50 588 261,61 | 23 163 261,61 |
| Mean | 26 267 376,43 | -1 157 623,57 |
| 90% CI | ± 362 313,67 | ± 362 313,67 |
| Mode | 22 013 885,21 | -5 411 114,79 |
| Median | 26 170 319,20 | -1 254 680,80 |
| Std Dev | 6 959 129,94 | 6 959 129,94 |
| Skewness | -0,0181 | -0,0181 |
| Kurtosis | 3,0710 | 3,0710 |
| Values | 1000 | 1000 |
| Errors | 0 | 0 |
| Filtered | 0 | 0 |
| Left X | 14 894 021,93 | 14 894 021,93 |

*Where,*

*NPV1 (left side cumulative curve) – is the Net Present Value for a 10 year period, without subsidies*
*NPV1 (right side cumulative curve) – is the Net Present Value for a 10 year period, with subsidies.*

*Figure A.5. 4: Scenarios 3 and 4, IRR in a 10 year planning period with and without subsidies*




| | IRR1 | IRR1 |
|---|---|---|
| Cell | Cash flow bu.. | Cash flow bu.. |
| Minimum | 0,442% | -14,637% |
| Maximum | 60,097% | 9,792% |
| Mean | 27,316% | -0,567% |
| 90% CI | ± 0,446% | ± 0,16813% |
| Mode | 23,197% | 0,563% |
| Median | 26,687% | -0,578% |
| Std Dev | 8,567% | 3,229% |
| Skewness | 0,4175 | -0,1593 |
| Kurtosis | 3,3602 | 3,4693 |
| Values | 1000 | 1000 |
| Errors | 0 | 0 |
| Filtered | 0 | 0 |
| Left X | 14,3% | 14,3% |

*Where,*

*IRR1 (left side cumulative curve) – is the Internal Rate of Return for a 10 year period, without subsidies*
*IRR1 (right side cumulative curve) – is the Internal Rate of Return for a 10 year period, with subsidies.*