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The economic impact of diversification into agritourism

RESEARCH ARTICLE

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Abstract

Livestock production often has a crucial role in the overall farm system, especially under unpredictable conditions. In the Czech Republic, cattle farming is stagnating and farmers have to search for additional and alternative sources of income. Diversification strategies often mean that farmers have to find new uses for existing resources (farm buildings, equipment, labor), stepping into the meat processing sector and farm-to-table system or into agritourism. In this paper, we simulate the scenarios representing the potential benefit of diversification into agritourism. The paper adopts the system dynamics approach to model three different sized farms, calibrated with official data. In addition, a management flight simulator is used in an applied case study. In both cases, we evaluate the impact of the agritourism on the economic performance of the farm. In the case study, we also test the scenarios of the impact of coronavirus lockdown. From the long-term perspective, the diversification into agritourism brings the benefit even under the conditions of one season lockdown and improves the economic output of the beef cattle farm more than the farm-to-table strategy.

Keywords: agritourism, computer simulation, farm management, scenarios testing, system dynamics
JEL code: Q12, Q13, C53

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1. Introduction

Primary agricultural production is the basic pillar of the national economy (Odnorog *et al.*, 2019). Small farms are the oldest and most widespread model of a rural business model (Khalil *et al.,* 2017; Standing Committee on Agricultural Research, 2013). An international definition of a small farm remains unclear (Thomson and Davidova, 2014). Small farms play an indispensable role in the stability of local economies, food self-sufficiency and living standards (Pesch and Tuck, 2019). The majority of the EU-28 farms can be characterized as small (Eurostat, 2018b; Neuenfeldt *et al.,* 2019), two-thirds being less than 5 ha in size (EC, 2018b). On average, farms were the biggest in the Czech Republic (133 ha/farm in the year 2016) and the smallest in Romania (3.7 ha/farm) (Eurostat, 2018a). Due to the high percentage of farms held by a single natural person, the corresponding holdings can be considered as family farms, therefore, in most cases, the owner is also a farm manager but also the major workforce (EC, 2018b). Calling for a deeper understanding of how the family influences the strategic management of family-owned farms is a common topic in literature on family business management (Chua *et al.*, 2003; Westhead and Howorth, 2006). Nevertheless, the small size of the farms also reflects their weaker position on the market and their inability to influence the prices of their outputs (Winter *et al.,* 2016).

It is important to realize that the farmers are facing problems in the context of dynamic complex systems (Kopainsky *et al.*, 2015; Salmon *et al.,* 2018; Turner *et al.,* 2017). Such systems have many strong and diverse interconnections between elements and actors, the interconnections create feedbacks. Moreover, the systems are characterized by delays between cause and effect and trade-offs between short and long benefits (Meadows, 2008; Sterman, 2000). Therefore, the problems under these conditions are counterintuitive and the obvious solutions often focus only on symptoms and do not affect the core problem, which could result in the deepening of the problem in a long term (Forrester, 1971).

The system approach to problem-solving has been increasingly promoted, including strategies for agricultural intensification (Garnett *et al.,* 2013), manipulation of multiple leverage points (West *et al.,* 2014), and improving systems and resources integration (Liu *et al.,* 2015). The computer simulation proved to be an appropriate support tool for decision making in complex dynamic agricultural systems (Jones and Benjelloun, 2017; Loewer *et al.,* 1980; Plà, 2007; Sørensen, 1990).

Agricultural and especially livestock production often have a pivotal role in the overall farm system (Steinfeld and Mack, 1995). Livestock production tends to be even more complex than crop production from the perspective of the specific timing of production and the length of delays between decision and impact on production (Behzadi *et al.,* 2018; Krejčí *et al.,* 2019), especially cattle production (Mayberry *et al.,* 2018). Production cycles are seasonally influenced, but the most significant characteristics are the long-term processes. Livestock turnover is crucial for the farm's total income and also provides year-round employment, could affect the risk dispersion and plays a key role in a European sustainable circular bio-economy (EC, 2018a). Meat consumption belongs to the European diet tradition and the EU itself is the third largest producer of beef, which contributes to the economy, rural development, social life, culture and gastronomy of Europe (EC, 2004; Hocquette *et al.,* 2018).

In the Czech Republic, the cattle farming went through a radical fall from 3,359,976 heads in 1991 to the bottom of 1,343,686 heads in 2011. Currently, the livestock reaches 1,418,106 heads (Czech Statistical Office, 2020a). Due to the very low profitability of suckler cows (Syrůček *et al.,* 2017), the production of cattle for slaughter fell to 168,162 heads in 2019, i.e. 88.3% of 2018 production (Czech Statistical Office, 2020b). Beef production is driven by the demand of the domestic market, by the export options and also depends on the economics of rearing bovine animals, and on the amount of EU and national subsidy measures. Since 2015, the production has been stagnating, the beef production has risen slightly over the long term, but the consumption has slightly fallen (Eurostat, 2020b; Josrová, 2018; Ministry of Agriculture of the Czech Republic, 2018). There are supports for beef production on the EU but also national level, but the support of production through specialization and extensification is not always a solution (Ihle *et al.,* 2017). Diversification is considered as a

growth strategy for the rural economy, employment and migration (Barbieri and Mahoney, 2009; Brandth and Haugen, 2010; McNally, 2001; Vik and McElwee, 2011), therefore, the diversification of the rural economy is becoming the highly prioritized theme in the rural development policy (Augère-Granier, 2016).

Diversification activities are improving rural areas from the economic and unemployment point of view, the main idea behind the rural economy diversification is for farmers to find a use for the existing resources and commercialize them differently than in the conventional agriculture (Hansson *et al.,* 2013). Hence, the additional income can be generated also from the agritourism, which can be a very effective way of stimulating the farm's economy (Schilling *et al.*, 2014). The implementation of tourism activities on the farm is considered an important form of farms' diversification – especially for small and medium-sized farms (Giaccio *et al.,* 2018; Sharpley and Vass, 2006).

The success of farms often depends on many factors, such as the cultural values of the region, availability of animals, environment, etc. (Brodt *et al.,* 2001; Thornton, 2010). Various EU policies support farms diversification outside the scope of conventional agriculture. Remodeling of the farm's business model with the aim of finding new resources of income is considered as a strategy to lower the risks (Tangermann, 2011; Thomson and Davidova, 2014). The need to generate further income constitutes the main motivation for implementing the diversification of farms (Daskalopoulou and Petrou, 2002; Maye *et al.*, 2009; Meert *et al.,* 2005; Pfeifer *et al.,* 2009). Therefore, it is necessary to monitor the impact of diversification of small farms on their performance. Diversified farms are often combining farming, agritourism, food processing and direct marketing activities and therefore are showing also the positive impact on the multifunctionality of agriculture (Renting *et al.,* 2008; Schilling *et al.*, 2014; Wilson, 2007).

The food industry is currently undergoing a massive shift. As a result of pressure from customers who, as with most consumer goods, test individual producers' offers, companies are forced to adapt increasingly quickly to changing products and shopping preferences (Souiden *et al.*, 2019). Producers are then forced to reflect emerging visions, strategic business plans, which it is possible to formalize through new business management systems, which are currently referred to as Business Models (Bocken *et al.*, 2019).

The implementation of short distribution channels is considered an alternative food business model. These channels, which have been introduced in parallel with conventional food chains, play a key role in fast developing food networks and are an alternative to the globalized agrifood model. Short distribution chains can take a wide variety of forms, from farmers' markets to farm sales, consumer cooperatives, or online sales (Govindan, 2018). For example, in the Czech Republic, the development of alternative food networks is the result of finding new sales channels for their goods on the part of producers and dissatisfaction with the quality of food in the conventional network on the part of consumers (Syrovátková *et al.*, 2015).

Like some other sectors of the national economy, primary production cannot currently survive without subsidies and support (Anderson *et al.*, 2006; Sihem, 2019). The development of primary production at the regional level and the subsequent diversification of agricultural activities considering the local specification and production of unique regional products can become one of the cornerstones of agritourism (Liang, 2017; Sgroi *et al.*, 2018). Agritourism is commonly recognized as another successful diversification strategy (Pölling and Mergenthaler, 2017) and it has an impact on farmer's food sales as well (Kim *et al.,* 2019). As a result, this synergy between agritourism and primary production sales through short distribution channels could lead to the creation of a competitive and stable alternative business model. In this area, the analysis of managerial competencies crucial for the food sector is becoming increasingly important (Wesselink *et al.,* 2015).

In the EU, the support of rural economy diversification is set up in the Rural Development Program of the Common Agricultural Policy in the 2014-2020 CAP (Stolze *et al.,* 2016). Subsidies for investment into agritourism diversification are at the local (Czech) level focused on diversification leading to income diversification, job creation (even for unqualified workers), promotion of wider use of farms and utilization of rural brownfields (Ministry of Agriculture of the Czech Republic, 2019). Support is provided for the renovation

(reconstruction, modernization, static security) or new construction of small-capacity accommodation facilities (including catering and other buildings and areas within the tourist infrastructure, sports grounds and relevant background). According to the Czech farm structure survey, the total number of agritourism farms is estimated to be about 351 from 26,525 agricultural holdings (Czech Statistical Office, 2017).

In this paper, we simulate the potential benefits of diversification into agritourism. Application of the systems dynamics approach provided us with the tool to analyze and understand the system of individual cattle farming. The created model allows us to add the additional structure of agritourism and analyze the impact of such diversification on the economic performance of the beef cattle small scale farm.

2. Materials and methods

The research follows the system dynamics process (Forrester, 1994: 245; Pruyt, 2013: 46):

- description of the system;
- conversion of the description to level and rate equations;
- simulation of the model;
- design of alternative policies;
- education and debate;
- implementation of changes in policies and structure.

System dynamics combines both qualitative and quantitative research (Walters *et al.,* 2016). In the first phase, the dynamic hypothesis on the sources of the system's behavior is developed in the form of a causal loop diagram (Sterman, 2000). For the understanding of the interconnections and feedback, the system dynamist must focus on the mental database of the problem owners (Forrester, 1987: 143-144), therefore, the whole research started with the Focus Group (Kidd and Parshall, 2000) and individual interviews with Czech small-scale farmers (Koláčková *et al.*, 2017). The original research with farmers was conducted as a group interview as a part of the Association of Private Farming of the Czech Republic meeting. A total number of 28 farmers were participating, all of them representing the small or family farm with employees (usually 2-4) represented by family members. From the research results, we determined the assumption leading to diversification strategies and indicators to measure the success of diversification on the farm (e.g. fixed asset turnover) and verified these indicators on data obtained from the farmers (Poláková *et al.,* 2016).

Figure 1 represents the high-level causal loop diagram (CLD), which summarizes the main drivers of the behavior dynamics in beef cattle farming with agritourism diversification. The CLD shows the main feedbacks, however, the model assumptions must also take into consideration the very weak position of the farmer in inputs and outputs prices negotiation. Moreover, the loop that represents the land acquisition is highly limited by the land supply (available land for sale or rent at the relevant distance), which is a naturally exogenous variable for the farmer (and model) and works as a strong limit to growth. Similarly, the investment into agritourism is usually timed according to the subsidy programs, not to the current budget of the farm. The grey links and feedback loops represent the part of the system that was deeply analyses by Krejčí *et al.* (2019), which showed the optimal purchasing of heavily pregnant heifers under conditions of growing capacity and the impact of own beef processing.

The structure of the system is the main driver of the system's behavior (Bertalanffy, 1969; Meadows, 2008). The CLD expresses the structure in the form of links and feedbacks. The mathematical representation of the link depends on the polarity (+ or –). The positive link is defined by:

$$\delta y / \delta x > 0 \quad (1)$$

the negative link by:

$$\delta y / \delta x < 0 \quad (2)$$

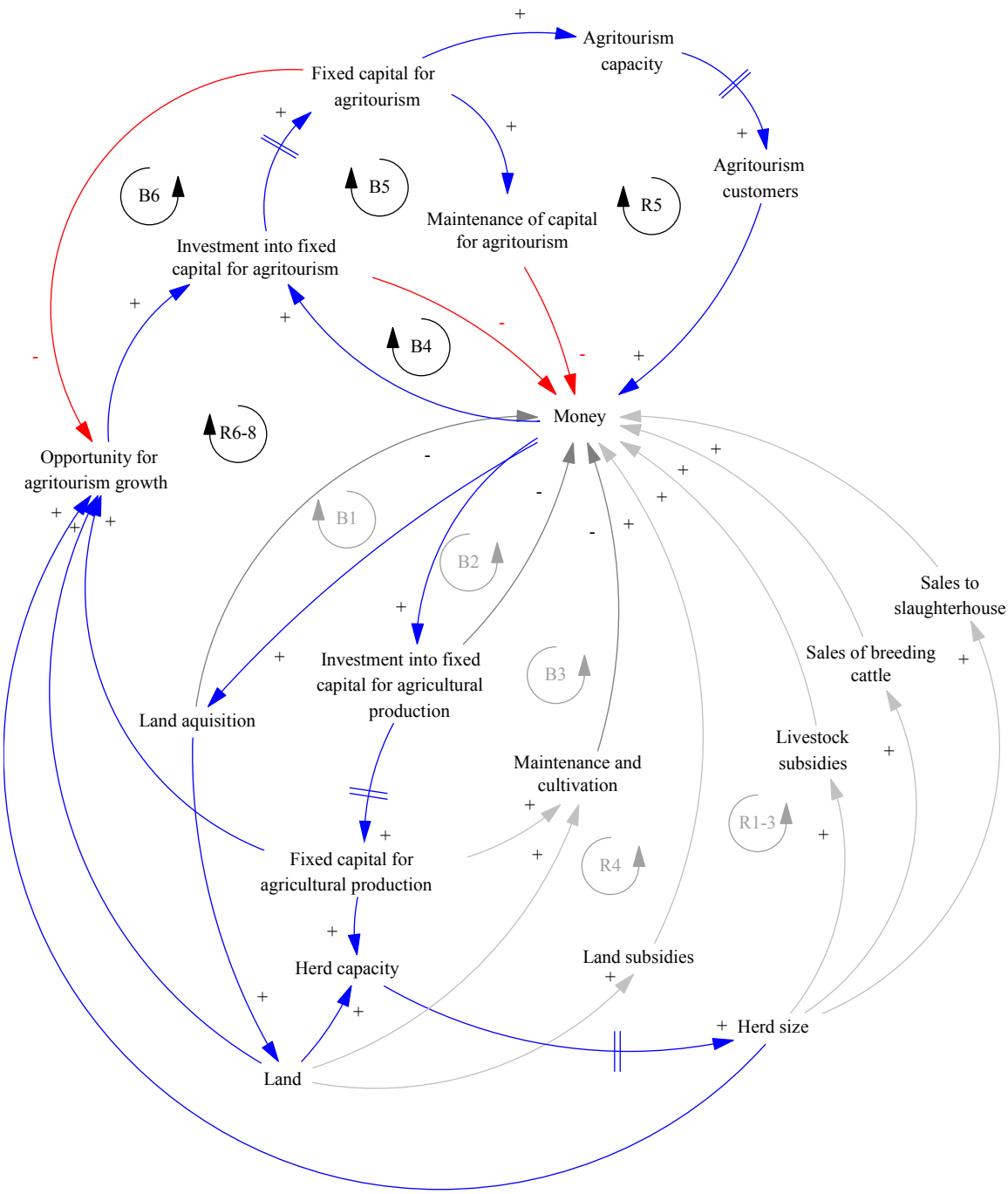

Figure 1. Causal loop diagram – feedbacks in the beef cattle production system with agritourism diversification.

Where *x* represents the independent variable (beginning of the arrow) and *y* is the dependent variable (variable at the arrowhead) (Richardson, 1997). Feedbacks are of two types – the reinforcing (R) and balancing (B). The reinforcing loops R1-4 represent the main growth driver of the livestock farm and B1-3 counteract the growth as the growth is interconnected with the increase of expenditures for maintenance of existing fixed capital. Similar dynamics is represented by the loops R5 and B4-5 for the agritourism. The R6-8 represent the fact that the budget growth through agritourism positively affects the agriculture production of the farm that could lead to new opportunities. One must understand that the CLD still represents small farms, which are considered more suitable for agritourism in comparison with the bigger ones. Moreover, the capital adequacy limits the possible size of the agritourism capacity and investment into agritourism (B6). Double

dash across the causal links denote significant delays in the system. The delays from investments represents the construction times. The delay between the increase of herd capacity and herd size represents the length of the natural reproduction process and herd turnover. The delay between tourism capacity and customers stands for time to attract the agritourism customers. Table 1 describes the model boundary (Pierson and Sterman, 2013), in other words, it lists the main variables included into the model as endogenous, variables that are in exogenous form and important excluded variables.

The core of the next stage of the process was the creation of the stock and flow diagram and its transformation into the system of first-order differential equations (System Dynamics Society, 2019). Figure 2 shows the accommodation subsystem to the core model of agriculture production (Krejčí *et al.*, 2019) for more details on livestock management subsystems. The revenues and expenditures related to accommodation are integrated with the whole farm budget, i.e. the main business decision-making variable of the farm management.

The interpretation of the links' polarity is the same as for the CLD, however, the stock and flow diagram distinguishes between two special types of variables – flows (depicted as pipes with faucets) and stock variables (depicted as boxes). In terms of the system of equations, the box variables are represented by definite integrals (Equation 3):

$$s = \int_{T_0}^{T} (i - o)dt + s_{T_0}, \tag{3}$$

where stock s integrates the inflows i and outflows o and t is any time between the initial time T_0 and current time T. The simple structure in Figure 2 allows us to estimate the value of the fixed capital, construction of the fixed capital and the continuous growth of occupancy in case of capacity extension. The estimation of goal-seeking loop's characteristics that represent the gradual growth of occupancy was based on the interviews and Powell optimization to minimize the differences between real and simulated data (Dangerfield and Roberts, 1999; Press *et al.,* 1992).

The livestock subsystem is parametrized on data from the Institute of Agricultural Economics and Information – Costs of Agricultural Products (Institute of Agricultural Economics and Information, 2018) and the Czech Statistical Office – Agriculture – time series and price index for revaluation of the data on a single year (Supplementary Table S1) (Czech Statistical Office, 2019a, 2020a). Since in the case of small farmers, the family members often replace the paid staff (Koláčková *et al.*, 2017; Poláková *et al.*, 2015) we reduced the

Table 1. The model boundary of beef cattle farming problem under conditions of diversification to agritourism.

Endogenous variables	Exogenous variables	Excluded variables
Fixed capital stocks for livestock production	Acquisition of land	Interest from savings
Fixed capital stocks for agritourism	Prices of sold cattle	Weather impact
Capital consumption	Prices of purchased cattle	Insurance
Cash flow	Land subsidies	Taxes
Livestock	Price level	Greenhouse gas emissions
Livestock capacity	Interest rates of bank loans	Advertisement
Slaughtering	Land rent	Accommodation quality
Calving	Expenditures on land cultivation per ha	Building permit processes
Cattle ageing	Decisions to start agritourism	Labor supply
Land cultivation expenses	Subsidies on agritourism	Labor qualification
Maintenance expenses		
Real occupancy of bed		
Bed places		
Agritourism capacity under construction		

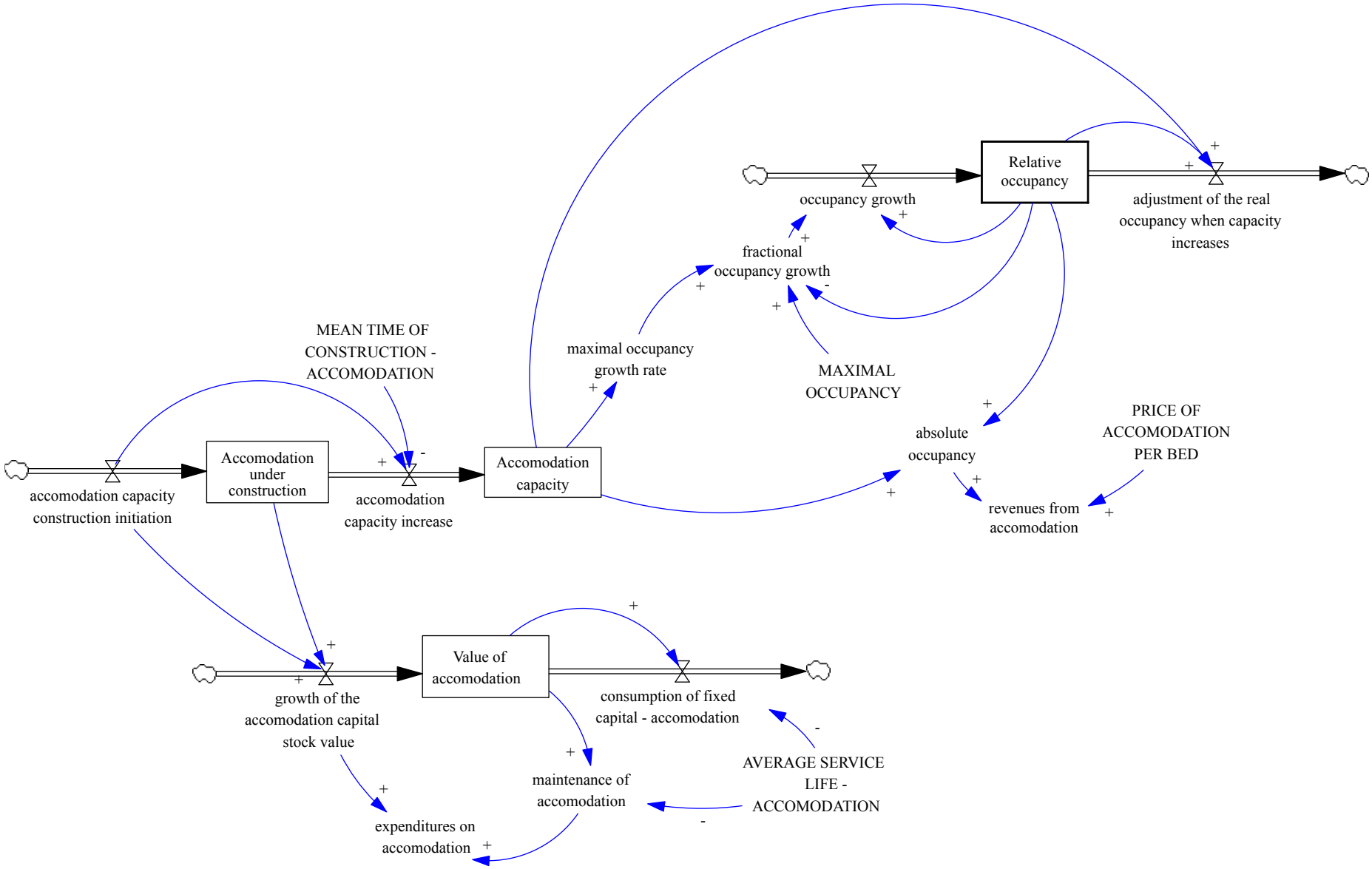

Figure 2. Stock and flow diagram – agritourism subsystem.

costs of production by labor and personal costs. That reduction is for the analysis because the need to secure the specific process by employing the external (non-family member) work force differs from farm to farm. The model could include the labor costs in the form of fixed and variable expenditures, however, according to Table 1, it does not deal with the qualification or availability of workers. In small-scale production, this part of the costs could be mostly considered the part of the farmers' profit. The model was designed and tested according to the Correctness Checklist (Lai and Wahba, 2001). The equilibrium herd structure is taken from 1000 simulations with random starting structure – we take the average structure after stabilization of these scenarios. The equilibrium structure of the herd and model testing are fully described in Krejčí *et al.* (2019).

Table 2 lists the parameters of the relative occupancy balancing loop and Figure 3 shows the comparison of the development between the real and simulated data. The simulated occupancy when the agritourism reaches its potential is 40.99% (maximal occupancy in Table 2). For comparison, the net occupancy of bed places in the Czech regions in 2018 is between 32.4% and 51.5% with an average 41.4% (with the exception of Prague where the occupancy reached 66.3% but one could hardly expect agritourism in the Capital) (Czech Statistical Office, 2019b).

Table 2. Characteristics of the occupancy loop.

Parameter	Value/formula
Maximal occupancy (*MO*)	40.9858
Maximal occupancy growth (*MOG*)	0.0479
Initial relative occupancy (RO_{T_0})	3.0953
Adjustment of relative occupancy when capacity increase (*AO*)	Sets the relative occupancy on the level that the absolute occupancy remains stable despite the change of capacity
Relative occupancy (*RO*)	$\int (OG - AO)dt + RO_{T_0}$
Fractional occupancy growth (*FOG*)	$MOG \times (1 - \frac{RO}{MO})$
Occupancy growth (*OG*)	*RO*×*FOG*

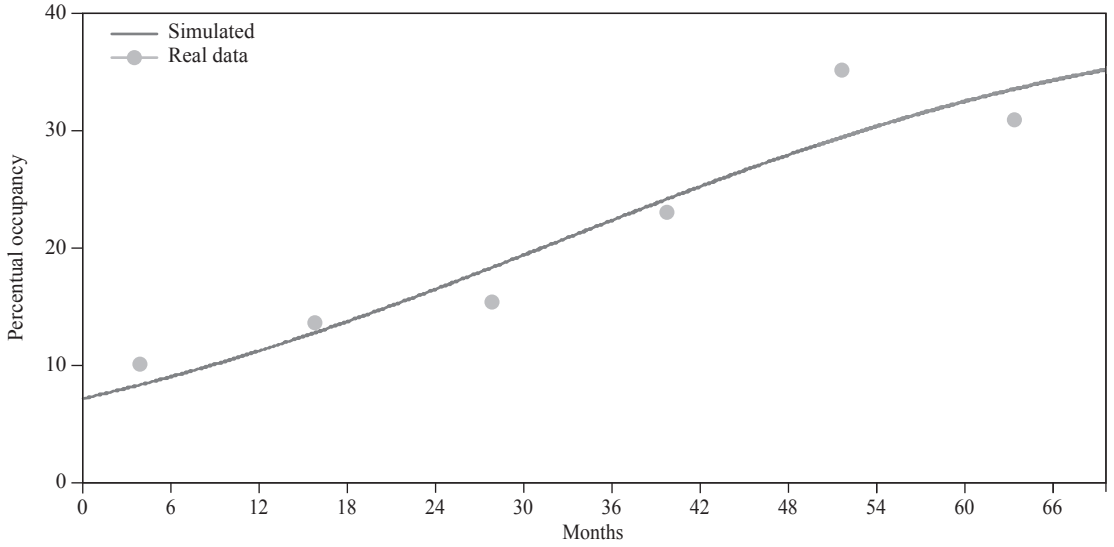

Figure 3. Relative occupancy.

According to the Czech Association of agritourism, the data that would fully describe the agritourism in the Czech Republic are missing (Svaz venkovské turistiky a agroturistiky, 2019), therefore for the scenarios we take the data from tourism statistics from the Czech statistical office and interviews. The core parameters are shown in Supplementary Table S1.

For the simulation runs, we use three hypothetical farms with the herd size equal to the average in the Czech Republic for natural persons and the average for the groups of 11-50 and 51-100 cattle (Supplementary Table S1) because these sizes represent the focus research (small scale producers with the main activity in livestock). We also simulate the beginning of the agritourism activity for these farms. It is not possible to expect to start the business activity with the Czech average capacity, therefore, we set the capacity of the accommodation to 10 in these scenarios accordingly to the real case experiences of the farmers interviews.

The last step in this paper illustrates stage 5 and possibly 6 (since the application of changes is the responsibility of the farmer) from the system dynamics process and is represented by the case study of the farmer from the Pilsen region. From our previous research (Koláčková *et al.*, 2017), we believe that using the average data and working with hypothetical average farmer lacks the value-added for the problem owners. Moreover, the average farmer could be represented by very different parameters, e.g. the Czech Statistical office and Institute of Agricultural Economics and Information provide different data with the same titles because of different thresholds for data collection and survey. The case studies could also represent the solution to the gap between knowing and doing, which is well-known problem across multiple science disciplines (Bero *et al.,* 1998; Graham *et al.*, 2018; Randers 2019).

3. Results and discussion

Figure 4 shows the three scenarios when the agritourism reached the maximal capacity. The scenario Average represents the case with the average herd size for agricultural subjects of natural persons in the Czech Republic. The scenarios called 11-50 and 51-100 use the average herd size for the farms' group size. When the scenario title contains +tourism, the farm utilizes the agritourism subsystem with the above described characteristics. Since the scenario simulates the agritourism with constant occupancy and the herd is in equilibrium, the monthly difference between the cash flow of farm with and without agritourism is constant (3,616 EUR under given circumstances). In all cases, the costs do not contain personal expenditures. The aggregated cash flow shows the increasing difference and stresses how the advantage of diversification grows in time. Therefore, the early act leads to a bigger profit in the long-term.

Since tourism represents the new sector for most farmers and the maximal capacity nearly 41 beds require a lot of service work, we can assume the need of employees. The average monthly wage in the Czech Republic is the lowest for accommodation and food service activities – 571 EUR (Czech Statistical Office, 2020c). The average number of bed places per one employee is 12.83 in full time equivalent (Czech Statistical Office, 2019b). Therefore, the maximal monthly employee expenditures are 2,487 EUR (we added mandatory health (9%) and social (25%) insurance, which is paid by the employer and in not counted in the gross wage the Czech Republic). As a result, the minimal average difference of the cash flow of farm with and without agritourism is constant 1,129. When compared to the cash flow of farms without agritourism, such amount represents 3.13 times average cash flow of the smallest farm (cow herd of 11-50 heads), 2.02 times the cash flow of the average (11-100) and 1.02 times the cash flow of the average from the category 51-100. In other words, the cash flow of the beef production starts to be comparable with the cash flow from the fully developed average agritourism from 70.53 heads (average of 51-100 size group). The theoretical maximal ratio between the average of the farms from size category 11-50 and the agritourism without employees is 10.03.

Figure 5 compares the development of the extreme scenarios from Figure 4. The group size 11-50 without agritourism (Figure 5A) produces the lowest cash flow, the group 51-100 with agritourism (Figure 5B) the highest. The graphs contain the results of a sensitivity analysis, which depicts the situation under conditions of uncertainty of the parameters (Clemson *et al.,* 1995; Eker *et al.,* 2014). For these purposes, we used Monte Carlo simulation with uniform random distribution of parameters from Supplementary Table S1. 5,000

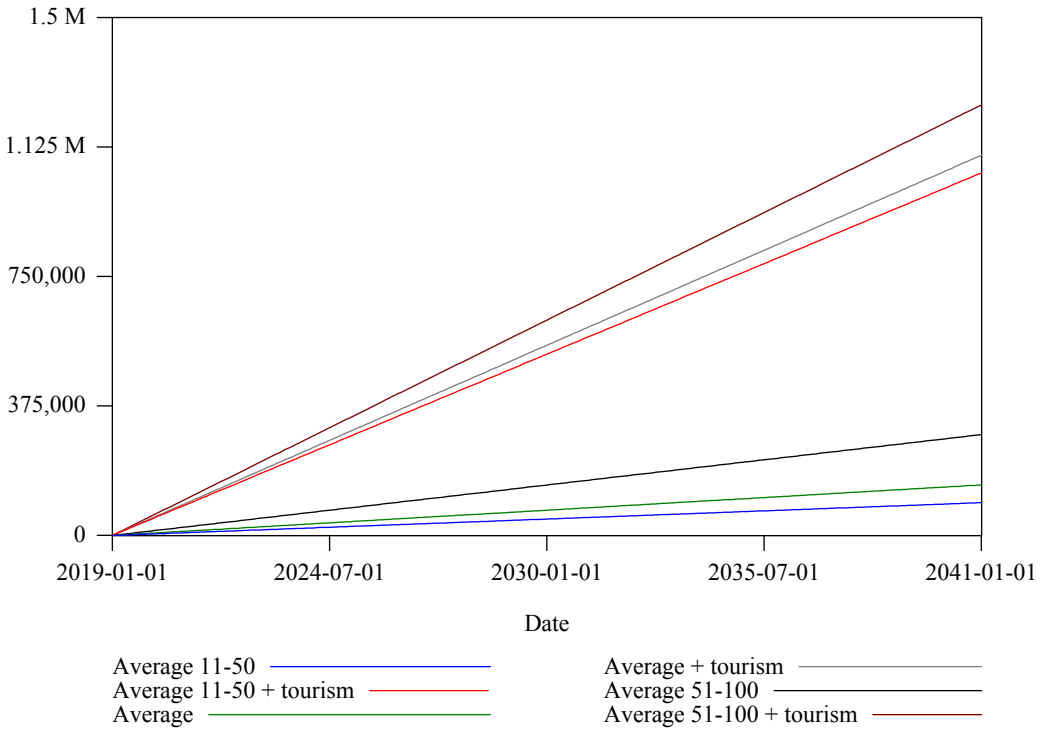

Figure 4. Farms' aggregated cash flow under conditions of fully developed agritourism and without it.

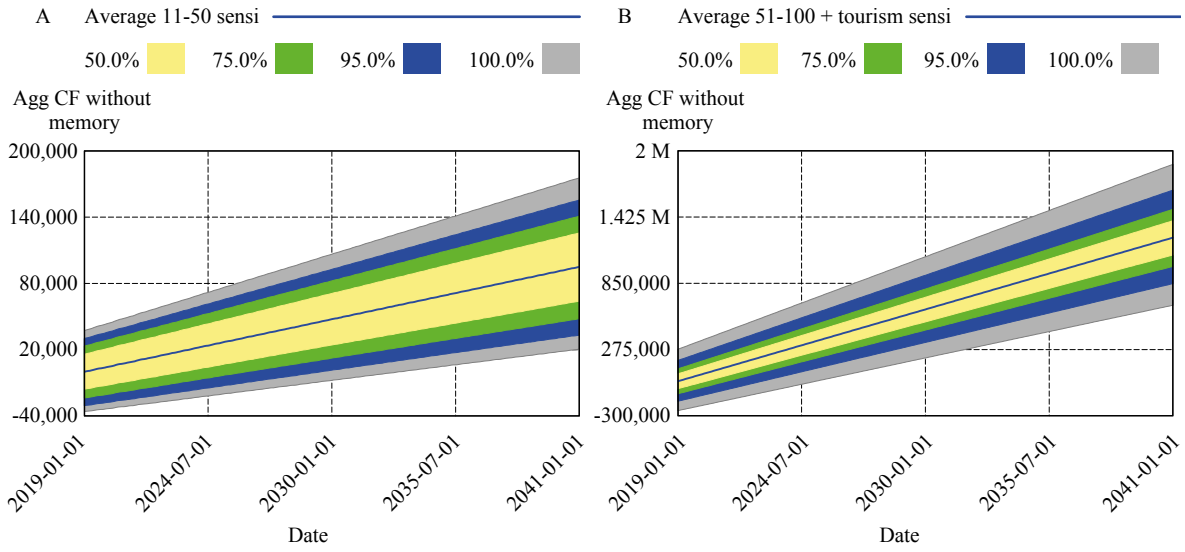

Figure 5. Sensitivity comparison of extreme scenarios, (A) without; and (B) with agritourism.

simulations were performed for every group size, the parameters were in the interval of ±10% of their basic values. None of the parameter changes has a significant impact on the results of the comparison.

Figure 6 depicts the development of the cash flow after the opening of the accommodation (with capacity 10). The scenarios with the 'nos' at the end of the title represent the situation when the subsidies are equal to zero but the prices of output remain at the current level. The figure does not contain the period between the beginning of the investment and the opening, which is dependent on the starting conditions of the farm and the form of accommodation (e.g. construction of the new building vs reconstruction of the existing one). The average period between a building permit and building approval is 2.75 years for the industry NACE I:

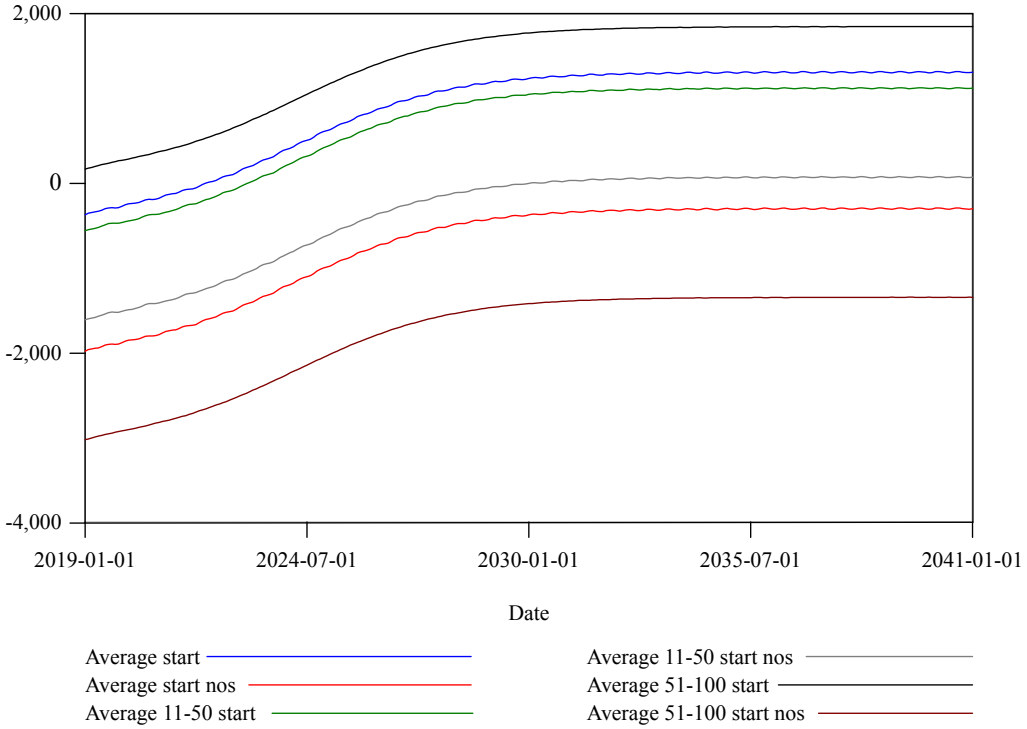

Figure 6. Farms cash flow under conditions of starting the agritourism.

accommodation and food service activities (Krejčí *et al.*, 2016). The start of the investment is typical for average maintenance expenditures exceeding the revenue from the accommodation services.

The negative cash flow without subsidies is in accordance with Syrůček *et al.* (2017) findings that beef production under current market conditions in the Czech Republic is unprofitable without subsidies. In such situation, the bigger herd leads to a bigger loss. The situation would be temporary, since the market would react and the growth of the prices would follow, nevertheless, that would result in a lower quantity purchased. Although the tradition and satisfaction of the farmer is often more important than profit (Poláková *et al.*, 2015), the loss could be covered only temporarily. The period with the negative economic result that could be survived is even shorter for low profitable businesses such as small-scale beef production, which could have only limited reserves. In this crisis scenario, the developed agritourism could serve as a buffer prolonging the time the farmer could survive before leaving the market.

The same methodology was used for the real case of the farm for describing the practical usage of the management flight simulator. Real data from a selected farm in the Pilsen region were used to compile and test the dynamic model, as described above. The farm represents an ideal example, the farmer makes use of the opportunity to improve his business model and his position on the market. In 2009, the farm walked the path of capacity growth – the farmer purchased and rented the land and acquired the cattle stable buildings to reach the maximal herd capacity equal 174 heads (the maximal capacity before that step was 54). A necessary reconstruction of the stables in 2016 followed this significant expansion, supported by investment subsidies. However, it also led to a loan of almost 68,400 EUR due in 20 years.

The farmer started diversification into agritourism in 2003. He rebuilt the not used brownfields into the guesthouse with the total capacity of 5 beds. The total cost of this diversification was 76,800 EUR covered with 50% subsidy. In 2010, the farmer extended the capacity to 25 beds with the cost of 197,800 EUR covered by 45% subsidy. For the development of occupancy, we apply the structure described above. Besides that, the farmer utilizes the farm-to-table strategy and sells the meat directly to final customers since 2011. That means

that the farmer started to process his own beef production in organic quality and to sell the vacuum-packed beef to the final customers with the delivery to their homes. Approximately once in the month, the newsletter to registered customers informs that the e-shop is open and they could order specific portions of meat.

The synergy of agritourism and farm-to-table diversification strategies (Kim *et al.,* 2019) is very obvious. The farmer does not need to participate in the farmers' markets, nor he needs to invest in the advertisement. Because the agritourism tourists could taste the meat produced on the farm during their stay, the tourists that spend time at the farm represent the future demand for the meat.

Figure 7 compares the farm's cash flow under the conditions of the four scenarios. In all these scenarios, we use the current prices and price index 1.9 for evaluation of the future prices, which is the 10-years average (Czech Statistical Office, 2019a). The cash flow is before personal expenditures. In all scenarios, the farmer purchases five heavily pregnant heifers every year between 2018 and 2022, which was identified as the proper and achievable strategy to maximize the farm's output as soon as possible (Krejčí *et al.,* 2019). The scenario called 'real settings', depicts the development of the cash flow based on the real data from the farmer, the remaining three scenarios show the development under circumstances of limited diversification (the case when the farmer does not run own meat processing, the case when the farmer does not diverse to agritourism and the case where the farmer depends only on the common production and sales to the slaughterhouse).

The agritourism shows to be more important for cash flow growth than meat processing. Moreover, the change in the scenario called 'without agritourism' would be even higher as the synergy mentioned above would not occur and the farmer would have to invest in distribution chains and advertisements. The fixed assets turnover (FAT) with the real settings diversification reaches 12.6%, without own meat processing it falls to 11.4%, without agritourism, the FAT is only 10.8% and without any of the diversification strategies, FAT does not exceed 9.6%. Figure 8 shows the aggregated cash flow under the same conditions to stress the impact of timely diversification and the cost of opportunity loss. For the estimation of the development, we assume the proportional cost of assets maintenance (service life of the equipment and machinery equal to 14.5 years, 30 years for agricultural buildings and 60 years of buildings for accommodation), however, the real development would not be as smooth and would perform deviations in both directions. See gross national income inventory (Czech Statistical Office, 2012) for service lives in the Czech republic and the manual of OECD (2009) for international comparison of service lives.

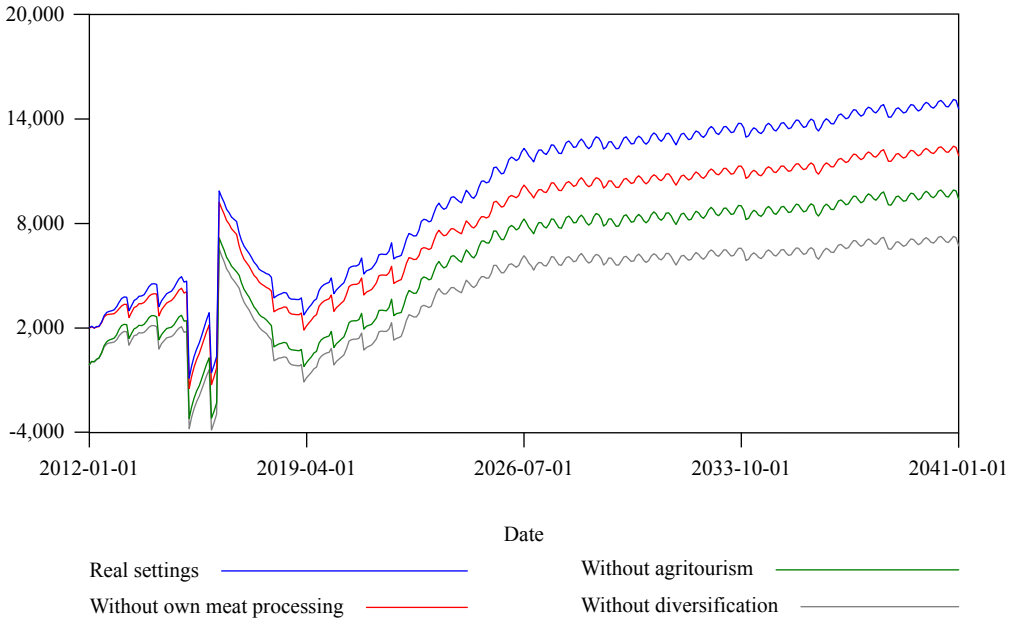

Figure 7. Case study – farm's cash flow under conditions of various scenarios.

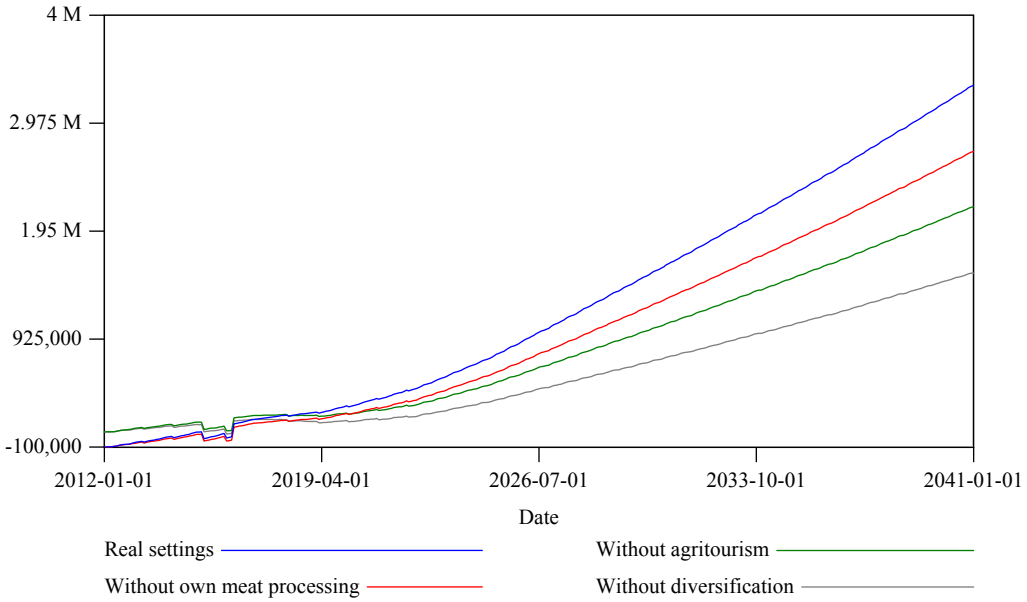

Figure 8. Case study – farm's aggregated cash flow under conditions of various scenarios.

The management flight simulator that we developed is supposed to help the understanding of the farms' behavior and to support decision-making. As a result, we simulate the current situation of lockdown and complete stop of tourism due to the Covid-19 situation depicts the risk part of agritourism diversification.

Figure 9 shows the possible development with the lockdown from March 2020 with theoretical reopening in October 2020. We consider the scenario of lockdown to be pessimistic as the reopening is scheduled for October and the occupancy falls to zero, i.e. the farmer starts from the beginning according to the development from Figure 3. Under these circumstances, the cash flow falls even below the level of the scenario without any diversification and it is clear that the own meat processing proves to be the buffer that protects the farmer in the unfavorable situation. The described scenario settings mean that the cash flow reaches the level of

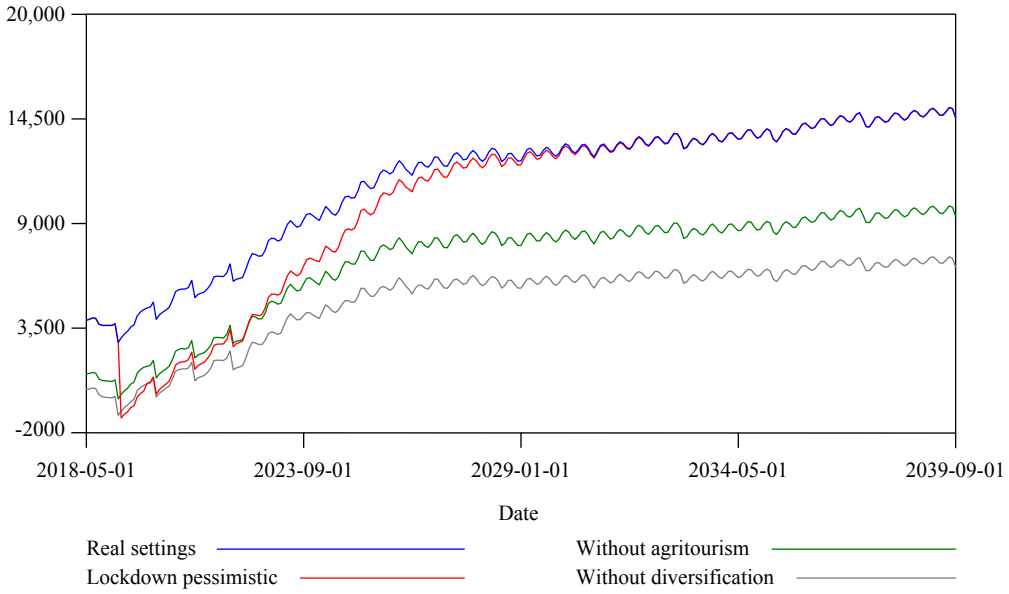

Figure 9. Case study – farm's cash flow under conditions of pessimistic lockdown.

the situation without lockdown in approximately 10 years and the total loss would reach more than 275,000 EUR in prices of 2020.

Figure 10 represents the sensitivity analysis for the lockdown – the drop now varies from 100% to 30% and the simulation tests the reopening from August to October. The lowest edge of the filled area is the pessimistic scenario from the previous figure.

In the most optimistic scenario with reopening in August and only 30% drop (the upper edge of the filled area if Figure 10), the total loss will reach 55,600 EUR. In case of reopening in August without the drop (i.e. occupancy continues on the same level as before the lockdown) the total loss reaches 22,000 EUR. Despite the losses, when compared with the other scenarios, even the most pessimistic lockdown scenario is in the long term significantly better than any scenario with limited diversification (Figure 11).

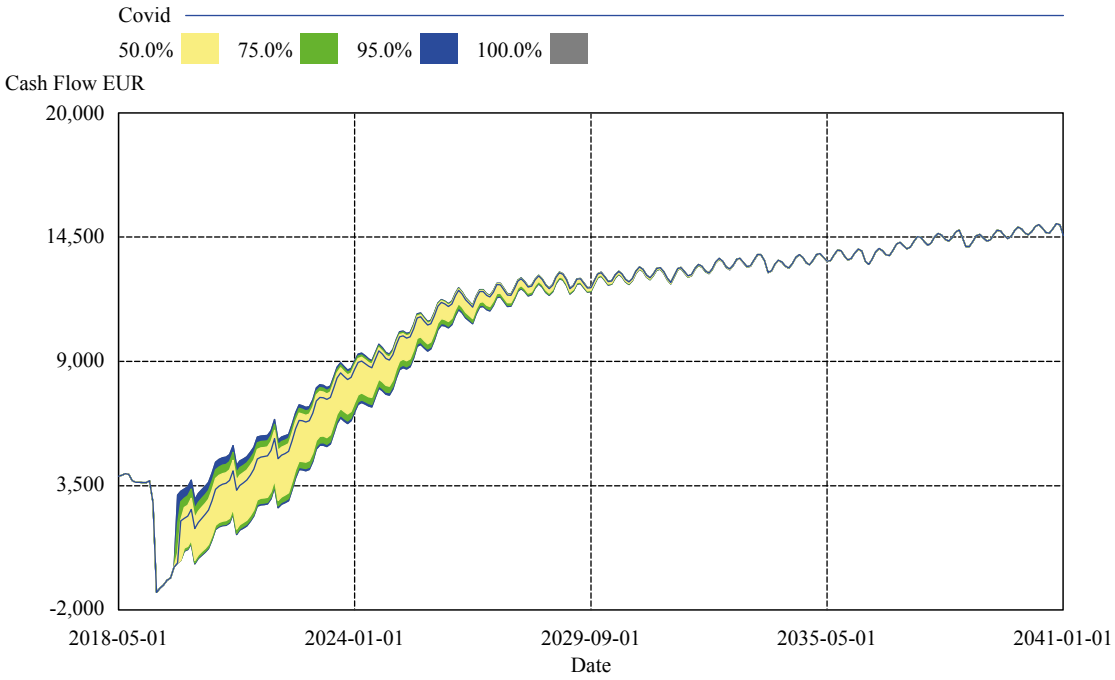

Figure 10. Case study – farm's cash flow under conditions of lockdown.

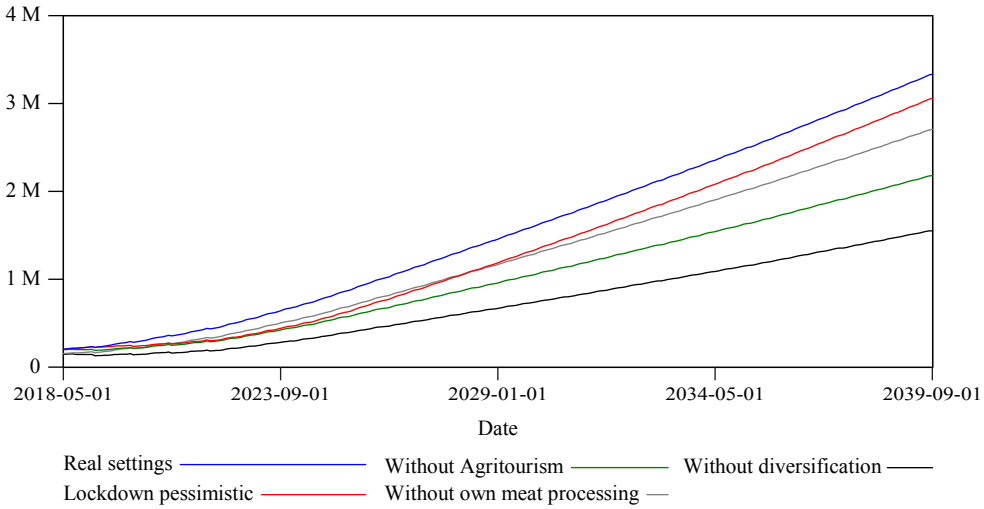

Figure 11. Case study – farm's aggregated cash flow: long term comparison of lockdown impact.

For new services and strategies on the farm, Václavík (2008) recommends activities closely connected with the main skills of the farm's owner or offer and the possibilities of the particular farm. Diversification requires new skills and knowledge (Markantoni *et al.*, 2014; Stotten *et al.,* 2019), which could be the serious barrier to entering the market for farmers. Nevertheless, the diversification strategy significantly improves the overall business output. Utilization of the synergy effect even improves the processes and simplifies the distribution processes. When Meadows (2008) lists the leverage points according to their strength, the change of constants (in the case of beef cattle farms, e.g. level of subsidies or price of meat) has usually the lowest impact on the behavior of the system. On the other hand, adding new loops, information flows, or even new goals (in our case adding new links and variables on agritourism) are all higher leverage points with better ratio of effort/change.

Utilizing various forms of diversification mitigates the risk of other activities. On the other hand, even farmers admit that they cannot perpetually diversify or improve their services. The limit to growth does not necessarily have to be the physical one but the growth could be limited by the managerial capabilities (Senge, 2006). The average salary in Czech agriculture is one of the lowest in the economy and reaches only 75.25% of the average gross monthly wage in the Czech Republic (Czech Statistical Office, 2020c). Together with the low profitability (Syrůček *et al.,* 2017) under these circumstances, the small or medium sized farm cannot afford the professional manager that would shift the managerial limit to growth.

One of the characteristics of modelling is deliberate simplification. The model cannot represent the whole reality and as a result, it has its limits. Understanding these limits helps understanding the presented results and provides options for future research. The presented model does not incorporate the work supply and the qualification of the workers. This topic was in important issue before the COVID-19 crisis as the unemployment rate in the Czech Republic was very low and small farmers were not able to offer wages that would be competitive on the labor market. Another important limit of the research is the focus on livestock farms. Despite the model includes land and allows different kinds of crops, the model structure focuses mainly on the livestock modelling and the land works mainly as the production limit.

4. Conclusions

Small farmers as pure primary producers have a weak position in the market. Therefore, a change in the business model towards new markets and products, e.g. via diversification, can help strengthen their position. Both vertical and structural diversification represents an active strategy. It mitigates the risks arising from the primary position in the market and increases stability and cash flow level, as well as primary capital turnover.

The paper shows the simulations of hypothetical farms of three different sizes calibrated on official data and the case study of the application of the management flight simulator on small beef farm. In both case we evaluate the impact of the agritourism on the economic performance of the farm. The results of our simulation scenarios show that:

- Under the equilibrium circumstances of fully developed agritourism, the minimal average ratio of agritourism cash flow to cash flow from primary production of beef is 1.02 for average farms from the size group of cattle of 51-100 heads.
- Under the equilibrium circumstances of fully developed agritourism, the minimal average ratio of agritourism cash flow to cash flow from primary production of beef is 3.13 for average farms from the size group of cattle of 11-50 heads.
- Under the equilibrium circumstances of fully developed agritourism, the minimal average ratio of agritourism cash flow to cash flow from primary production of beef is 2.02 for average farms from the size group of cattle of 11-100 heads.
- Diversification into more areas represents the risk mitigation when some diversification strategy faces undesirable conditions.

- Case study shows how agritourism improves the economic output of the beef cattle farm more than the farm-to-table strategy.
- Even under conditions of one season lockdown, agritourism brings long term benefits.

From the beginning of the research, we deal with the trust of the problem owners – farmers. To fulfil the fifth (education and debate) and sixth (implementation of changes) steps of the system dynamics process we needed to earn the trust of the problem owners. This effort led to the implementation of the detailed structure of the livestock – at the beginning we planned a more aggregated form, but the farmers need to see their herd, otherwise, the willingness to apply the proposed changes is low (Krejčí *et al.,* 2019).

Our effort in this area is concluded in the form of the management flight simulator for the Czech individual farmers focused on livestock production. The software is downloadable (https://prezentace.czu.cz/en/farmasim/software) and provides the tool for the evaluation of decisions, scenario analysis and 'what if?' analysis in 10-year period. The user interface allows setting for the main livestock productions in the Czech Republic – production of beef cattle, dairy cattle, goats, sheep, pig and poultry (and any combination of these productions). The simulator works with various types of subsidies, fixed capital divided into main types, three types of capacities (land, stable, storage), etc. Figure 12 shows the basic user interface. The whole model for the simulator contains more than 1,800 variables and constants (of which 342 are stock variables).

The following step is the English mutation of the simulator. Future plans consist of addition the agritourism subsystem and its user interface into the free simulator. Since diversification is not the possibility for every farmer and the higher profitability of by-products could result in overshadowing of the primary production, our research will also focus on the optimization of herd management processes.

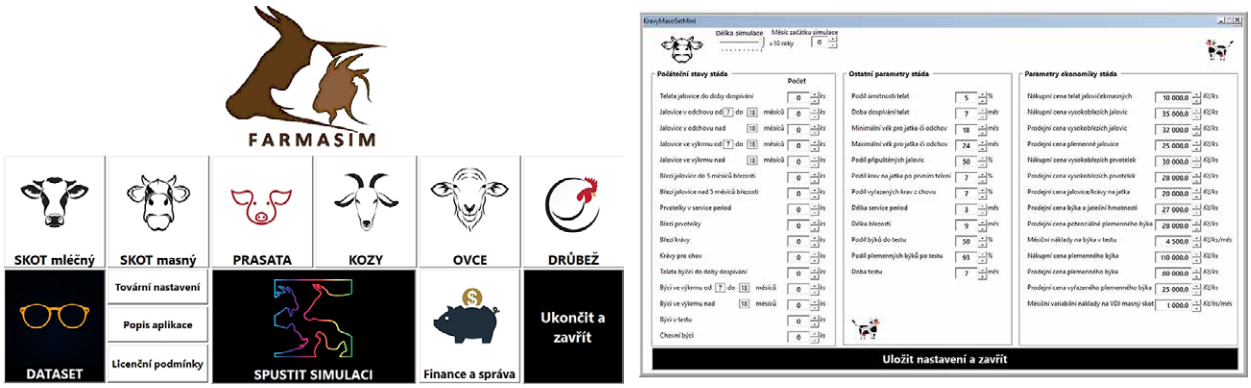

Figure 12. Management flight simulator for livestock farming FARMASIM – user interface (in Czech).

Supplementary material

Supplementary material can be found online at https://doi.org/10.22434/IFAMR2020.0076

Table S1. Key model parameters.

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