British Food Journal

An evaluation of Swiss agriculture's contribution to food security with decision support system for food security strategy

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Received 20 December 2017
Revised 9 April 2018
Accepted 21 May 2018

Abstract

Purpose – The purpose of this paper is to estimate the domestic agriculture's contribution to food security in the case of missing imports of food and feed to the food supplies of the country.

Design/methodology/approach – This paper uses the Decision Support System for food Security Strategy and Supply Management (DSS-ESSA) to simulate whether a country with as low a level of self-sufficiency (around 60 per cent) as Switzerland would theoretically be capable of supplying its own population with a sufficient quantity of domestically produced food. The authors try to estimate the short-term and long-term impacts of the missing imports of food and feed on the energy supply in Switzerland.

Findings – Findings are summarised as follows. Starting with the long-term impact, the results show that in the long-term an energy supply of 2,340 kcal/person/day would be possible if the appropriate available cultivated area and optimised production existed. However, in the short-time, the potential and the time required to adapt and expand agricultural production depends primarily on the crop-rotation land available and on the existing infrastructure.

Research limitations/implications – In the present version of DSS-ESSA no economic and environmental module has been integrated.

Originality/value – The current model version has been funded by the Swiss Federal Office for Agriculture and aims at supporting Swiss policy-makers to guide changes. Numerous additional data such as technical production contexts are regularly checked by experts.

Keywords Optimisation, Food products, Crisis, Swiss food security, Decision support system model

Paper type Case study

1. Introduction

The FAO's definition says that food security "exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". Food is only considered insecure if basic nutrition demands cannot be fulfilled even at a significant sacrifice. For understandable reasons, a large part of the international discourse on supply security focusses on the ability to reliably supply people in the poorer parts of the world with sufficient quantities of food (Pinstrup-Andersen, 2009; Godfray *et al.*, 2010). Besides this discourse, however, there exists a further, more strongly future-oriented and hypothetical debate on supply security in wealthier countries. This debate in Switzerland deals with the question whether the available cultivated areas can ensure the long-term supply of the population with foodstuffs. On the one hand, this concerns the competition between the different types of use of the limited availability of arable land in spatial planning and, on the other hand, the systemic resilience in short periods. This debate deals with the issue of system resilience in times of crisis, whether the latter are triggered by political intervention (Woertz, 2017) or climate change (Parry *et al.*, 1999; Nelson *et al.*, 2010; Wheeler and von Braun, 2013). As, for example, in Canada (Rideout *et al.*, 2007; Tarasuk *et al.*, 2014) and Japan (Balaam, 1984; Gasparatos, 2011; Koizumi, 2013), this issue is also discussed in Switzerland with more-than-usual intensity. In addition to examining theoretical considerations on the interdependencies between national and global supply security (Becker *et al.*, 2014),

British Food Journal
© Emerald Publishing Limited
0007-070X
DOI 10.1108/BFJ-12-2017-0709

researchers in Switzerland work with a national government-funded optimisation model (Decision Support System for food Security Strategy and Supply Management (DSS-ESSA) Hättenschwiler and Flury, 2007; Mann *et al.*, 2012) for food security. A wide range of agricultural sector modelling studies address the effects of policy changes in Switzerland on agricultural production. However, these studies do not optimise simultaneously the food security and crisis impact in the Swiss supply chains of agriculture. In contrast, the DSS-ESSA model offers a powerful tool to simulate the link between food security and crisis scenarios. This system integrated the global food security strategy of the country. The main goal of this strategy is to guarantee a sufficient food supply covering the basic needs of the population, if normal market mechanisms fail. This strategy includes many supply domains, such as special measures for trade, stockpiling, domestic food production and processing and consumption control.

2. Agriculture production and food security in Switzerland

The supply situation with foodstuffs is currently very good in Switzerland. Switzerland's level of food self-sufficiency varies by food category. In 2014, self-sufficiency in animal products: eggs, meat and dairy was 100 per cent. By contrast, self-sufficiency in plant-based foods was only 46 per cent because it is heavily weather-dependent. Overall in 2014, Switzerland produced 60 per cent of the food it consumed. In volume terms, Switzerland accounts for only around one per cent of agricultural imports worldwide, although imports per capita are one of the highest for any country. This is primarily due to the relatively high population density in Switzerland, as well as its limited useful agricultural land owing to its topography and climate. Certain basic foodstuffs, such as rice, durum wheat and palm oil are imported in large quantities, as are feedstuffs (primarily soya). In the event of poor domestic harvests of grain or potatoes, Swiss food suppliers turn to imports to make up the shortfall. Switzerland therefore depends on imports to secure supplies of plant-based foods (grain, fruit and vegetables, oil seed and vegetable oils) in particular, but also those of agricultural inputs (feedstuffs, fertilizers and seeds). In the present study, the agriculture's contribution to food security is evaluated by estimating the short-term and long-term impacts of the missing imports of food and feed on the energy supply in Switzerland. Section 2 presents the agriculture production and food security in Switzerland. The remainder of the paper is organized as follows: Section 2 presents the agriculture production and food security in Switzerland. Section 3 presents the DSS-ESSA model and methodology used for estimating domestic production under a crisis scenario. Section 4 presents the crisis scenario used. Results of the analysis of potential are presented in Section 5, Section 6 presents the sensitivities analyses and Section 7 concludes the paper.

2.1 *Swiss food security strategy*

Under Article 102 of the Federal Constitution, the federal government has the task of ensuring that the country is supplied with essential goods and services if the economy is no longer able to independently fulfil its supply function in the event of severe shortages. It takes preventive action so that it is able to do this. Furthermore, in exercising its powers in this regard, it may depart from the principle of economic freedom if the circumstances so require. The National Economic Supply (NES) organisation ensures that supply disruptions and shortages that the private sector cannot remedy on its own do not have serious consequences for Switzerland. To this end, in the event of crisis NES ensures the availability of important goods and services that are essential to the functioning of the Swiss economy or of vital importance to the population. In addition to certain basic foodstuffs, energy and therapeutic products, these specifically include supply infrastructures related to logistics, power grids and information and communication technologies, as well as the services that are based on them. Securing these supply-critical goods, infrastructures and services require effective instruments of contingency planning and crisis management on the part of NES. This means that the measures that have been prepared must be feasible and geared to current challenges.

In 2014, NES undertook an in-depth review of its strategic orientation and amended it in line with current requirements so that it can continue to fulfil the remit laid down in the NESA. NES focusses on ensuring supplies of vital goods and services in the foodstuffs, energy, therapeutic products, logistics and Information and Communication Technology (ICT) sectors. For each of these supply processes, the strategy can be divided into two phases: prevention and intervention. The strategy defines targets not just for the inter-prevention phase during a supply shortage, but also phase for ordinary circumstances. During this prevention phase, supply processes should be made more resilient to avoid state intervention for as long as possible. NES helps certain companies and sectors to improve their preparations, and in doing so encourages information-sharing between the actors concerned. At the same time, it prepares public-sector action for the intervention phase.

The intervention phase involves three different intervention levels of objectives depending on the severity of phase in the supply shortage. The more serious a shortage becomes, the more far-reaching the intervention in the economy and the instruments used. At the first level, the aim is to guarantee supplies by bridging gaps in the supply of certain goods and services. According to its plans, NES should be able to ensure that demand for vital goods is met for at least three months (level A). Great importance is therefore attached to strategic stockpiling. As ordered by the federal government, various sectors keep stocks of crucial goods, such as foodstuffs, mineral oil, therapeutic products and fertilisers, which can be released into the market where necessary. If supplies cannot fully be guaranteed for more than three months, the second level of intervention is to introduce accompanying measures to reduce demand (level B). These might, for example, ban the use of certain goods or services, or restrict their sale. If it is no longer possible to satisfy demand in the case of a severe and persistent shortage, the third level of intervention comes into play, in which the population is supplied with a reduced level of vital goods and services (level C). The primary objective here is to ensure that the goods or services that remain available are distributed as fairly as possible according to need. The NES strategy sets out specific supply targets for vital goods and services (foodstuffs, energy, therapeutic products, logistics and ICT), with objectives for both the prevention and the intervention phases. The general idea is to remain at the lowest possible level of intervention and to keep state action to the minimum, in accordance with the principle of subsidiarity.

3. Method for evaluating Swiss food security

In order to evaluate Swiss food security, the DSS-ESSA model is used to simulate and evaluate the food security. The DSS-ESSA model is an optimisation tool that allows the FONES to prevent food crises. For concrete cases of crisis (yield falls, impossibility to import), the model optimises the food supply of the population, the area to be cultivated, the livestock required and the processing and use of the products. The simulated duration of the crisis is variable, generally extending over three years, with monthly monitoring during the first semester. The beginning of the crisis can be freely chosen. The DSS-ESSA is a dynamic recursive optimisation model of the Swiss food supply sector. There is one sub-model for animal and crop production, one for factor management and one for import/export balancing. Figure 1 illustrates the interaction between crop production, livestock, processing and nutrition. Crop and livestock primary and secondary products are all integral parts of the model and interact in the solution process. Cattle, poultry and pig feed rations are formed from activities that process crops into protein, energy and trace elements necessary for the respective animal diets. The model covers 49 agricultural commodities: 36 crops (wheat, corn, soybeans, sunflower, rapeseed, sugar beets, etc.),

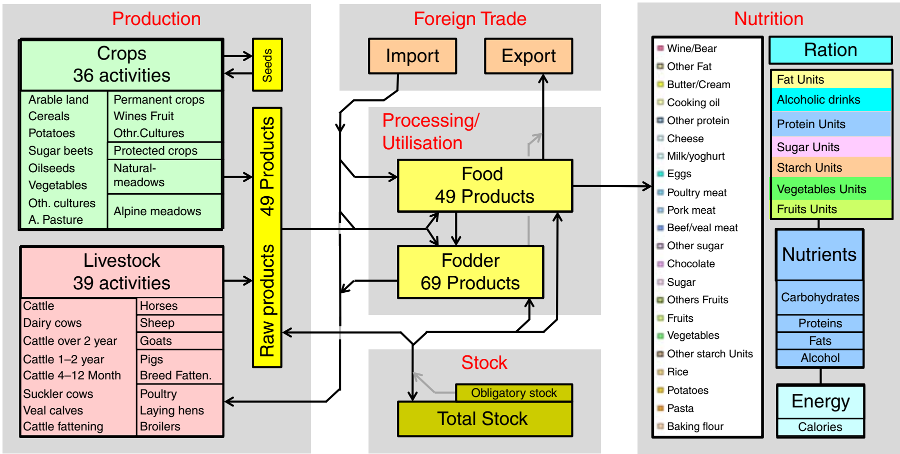

Figure 1.
Structure of the DSS-ESSA model

39 livestock activities and livestock-related products (e.g. beef and veal, pork, poultry and raw milk) and 6 dairy products (fluid milk, butter, cheese, non-fat and dry milk, whole dry milk and other dairy products). In addition, coverage includes 20 coupled products. The objective function of DSS-ESSA consists of the minimisation of the calorie deficit and the deviation balanced basket of goods/nutrients to reference 2015 values to cover the energy and nutritional requirements of the population. The key restrictions of the model are: cultivated areas: productivity, limits set by rotation:

- Livestock: constraints related to forage consumption, herd renewal.
- Processing: food and feed production, processing capabilities.
- Foreign trade: import and export of food and fodder.
- Storage: balance of stored quantities, storage capacities.
- Nutrition: calorie and nutrient needs, eating habits.

Depending on need, the observation period of a model optimisation can be a few months up to several years, with the start time of the crisis being a randomly chosen month. The model system takes into account the initial state, e.g., the stocks usually available at this time and crops that have already been sown, as well as the development over time of the model sizes, e.g., the rearing of young stock with the transfer of the animal population from one age category to the next.

4. Scenario definition

This analysis of potential shows the contribution that domestic production could potentially make to the nation's food supply in the event of zero imports of agricultural products and assuming optimal use of agricultural croplands. It is therefore rooted in the tradition of the "NP90" Nutritional Plan last published in 1990 (Kohlas *et al.*, 1988) and ARE (2006), without, however, focussing on a concrete scenario. At the same time, it takes up the topic of crop-rotation land (CRL), which constitutes the basis of being able to produce a minimum quantity of food energy (calories) for the population from the nation's own land. According to the "CRL" sectoral plan implemented in 1992, a minimum quota of 438,560 hectares of CRL must be available, of a quality corresponding to the 2006 enforcement aid of the Swiss Federal Office for Spatial Development (ARE, 2006).

The crisis scenario described here, foresees a 100 per cent reduction of imports and exports of food and feed. Domestic production of seed is also required in principle. Since no significant seed production currently takes place in Switzerland for turnips, oilseed rape and vegetables, seed imports for these crops are tolerated. For the analysis of potential, it is also assumed that additional input factors such as fertilisers and plant-protection products, fuels and machinery are available in sufficient quantities. In principle, the total area of field crops is limited in the DSS-ESSA to the current arable land area of around 404,000 ha (SBV, 2013/2015). To enable full use of the plant-food production potential, this potential arable land is increased to the level of the permanent meadows to the 438,560 ha area of the CRLs designated in accordance with the CRL (CRL) sectoral plan. This expansion is based on the assumption that a percentage of the land currently used as permanent grassland is of CRL quality (according to the 2006 Enforcement Aid). Yields on the CRL additionally used as arable land would probably be lower than on the currently used arable land; at the same time, the repurposing of the best permanent meadows would lead to lower average yields on the grassland. Since, however, an average safety deduction of 10 per cent is already taken into account in the model, no additional reduction in plant yields occurs for the analysis of potential. Moreover, it is assumed that the production factors not directly modelled in the system—in particular, fertilisers and plant-protection products—are available to the extent that the reduced yields can at least be achieved. It is precisely in a situation without feed imports, however, such as that on which the analysis of potential is based, that the lower input of feed nutrients, together with decreasing livestock populations, could lead to a decreasing fertiliser supply in the form of farmyard manure. On the other hand, it is generally possible to supply a percentage of the missing input factors in other ways—in the case of fertilisers, for example, via phosphorus recovery from waste materials (FOEN, 2009). Nevertheless, in order to simulate the case of missing input factors, which also serve to reduce yields, a sensitivity analysis with a further 10 per cent reduction in yields was carried out.

In order to ensure lasting productivity through a balanced crop rotation, the DSS-ESSA—in accordance with the CRL Sectoral Plan—requires a minimum of 22 per cent temporary leys; with reference to the CRL, this corresponds to 96,500 ha. By comparison, temporary leys currently account for approximately 33 per cent of arable land. The effect of different percentages of temporary ley is also investigated in the sensitivity analyses.

Particularly in dairy farming, it is to be expected that the feeding of concentrates will be significantly reduced, to enable increasing use of the arable land to grow crops for direct consumption by humans. For this reason, specified milk yields will be reduced to levels that can still be achieved with a roughage ration of close to 100 per cent (Thomet and Reidy, 2013); the average milk yield per cow and year falls from around 6,900 kg at present to 6,085 kg. It is assumed that, reflecting the current situation, feed grains such as barley and maize will not be used to any great extent in the human diet. For this reason, their processing into foodstuffs is not permitted in the model. A switch to additional bread grain production is, however, possible within the scope of the overall model restrictions. No mandatory stocks are used, because the analysis of potential is not investigating a crisis situation, but rather the medium- to long-term nutritional potential of the cropland without looking at any imports or exports of food and feed.

5. Results of the analysis of potential and sensitivities analyses

The results of analysis of potential shows that with optimisation of domestic production under the crisis scenario condition, in the medium- and long-term, it is possible to provide the 8.14 million Swiss population with energy supply of 2,340 kcal/person/day, corresponding to 78 per cent of the current average energy level of 3,015 kcal/p/d (Figure 2). This meets the minimum requirements recommendations 2,300 kcal/person/day

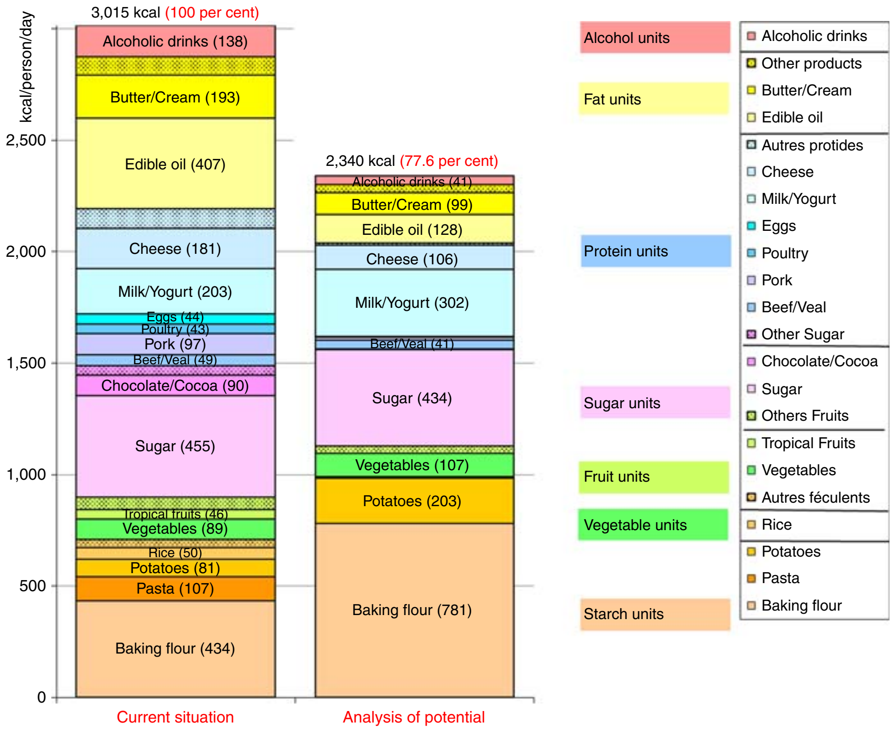

Figure 2.
Impact on energy supply per person and day

and was defined as a target value. The food ration would differ significantly from current consumption habits, both in terms of products (e.g. avoidance of pasta, rice and beer; significantly lower availability of meat, fruits and vegetables product and higher percentage of carbohydrates with a significant decrease in vegetable and animal fats in particular. There is consistent evidence indicating that a dietary pattern higher in plant-based foods and lower in animal-based foods (especially red and processed meat) is both healthier and associated with a lesser impact on the environment. In the optimised situation of the energy supply, the starchy foodstuffs (starch units) are increased by 40 per cent, despite the significant decrease in total energy supply. In particular, the rations of baking flour and potatoes increase. By contrast, the intake of sugar units decreases by 27 per cent, primarily due to a drop in imports of sugar. The energy supply from high-protein foods (protein units) decreases by 33 per cent in comparison to reference levels. With milk, there is a shift from processed milk products towards drinking milk, as this reduces processing losses, or the percentages used for feed (whey, skimmed milk). At just over 60 per cent of reference levels, the supply of fat units is reduced. This is mainly because of a significant decrease in plant fats, since the reduction in imports of edible oils is nowhere near offset by the increased cultivation of oilseed rape. Moreover, supplies of fruit and alcohol units are declining (both down by 70 per cent), again chiefly as a consequence of absent imports. By contrast, the decrease in vegetable imports is well compensated in terms of quantity by the increase in domestic production, with the amount of vegetable units increasing by 20 per cent. We also see a similar trend for the ration shares of the essential nutrients. Table I illustrates the change of ration shares of the essential nutrients. This table shows that the carbohydrate ration increases by 6 per cent as a result of an increase in starches by +33 per cent and decreases in

		Current situation			Analysis of potential		Change
	g	kcal	Percentage	*g*	kcal	Percentage	%
Carbohydrate	335	1,340	44	355	1,422	61	+6
of which starch	148	591	20	197	787	34	+33
of which sugar	187	749	25	159	635	27	−15
Protein	103	412	14	75	298	13	−28
Vegetable protein	39	155	5	43	173	7	+11
Animal protein	64	257	9	31	126	5	−51
Fat	127	1,147	38	64	580	25	−49
Vegetable fat	64	572	19	21	186	8	−68
Animal fat	64	574	19	44	395	17	−31
Alcohol	17	116	4	6	41	2	−65
Total energy supply		3,015	100		2,340	100	−22.4

Table I.
Impact on the supply of essential nutrients per person and day

sugar by −15 per cent. The decrease of the protein by 28 per cent can be explained by the increase of the vegetable protein by 11 per cent and the decrease of the animal protein by 51 per cent. However, the fat deceases by 49 per cent due to a drop in imports of rapeseed oil and nuts and the decrease of animal fats by 31 per cent. This makes substantial changes in eating habits necessary—particularly as regards eggs, which are used as ingredients in a wide variety of meals. Within the energy supply, the available share of carbohydrates lies above Swiss Federal Nutrition Commission (FNC) recommendations, whilst shares of fat and protein lie within the recommended limits (Figure 3).

In view of the decreasing share of fat and alcohol and the increase in vegetable energy supply, the shifts can be rated as thoroughly positive from a nutritional perspective, whilst the daily rations must be regarded as negative in terms of their high carbohydrate content, lipid profile and decrease in fruit consumption.

5.1 Change in livestock sector

With zero imports of food and feed imports, there is a major change in livestock numbers, which cannot be maintained at present-day levels (Figure 4). The number of animals will decline to ensure food security over the first year. The results show that there is a

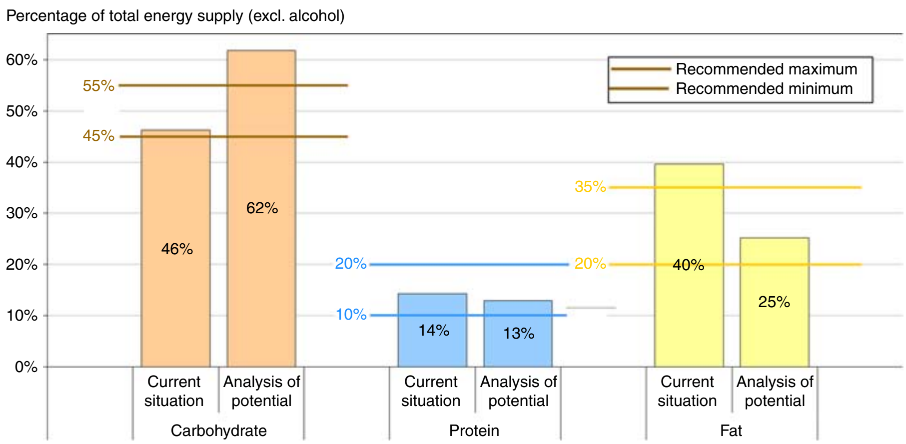

Figure 3.
Percentages of essential nutrients out of total energy supply as compared to the recommendations

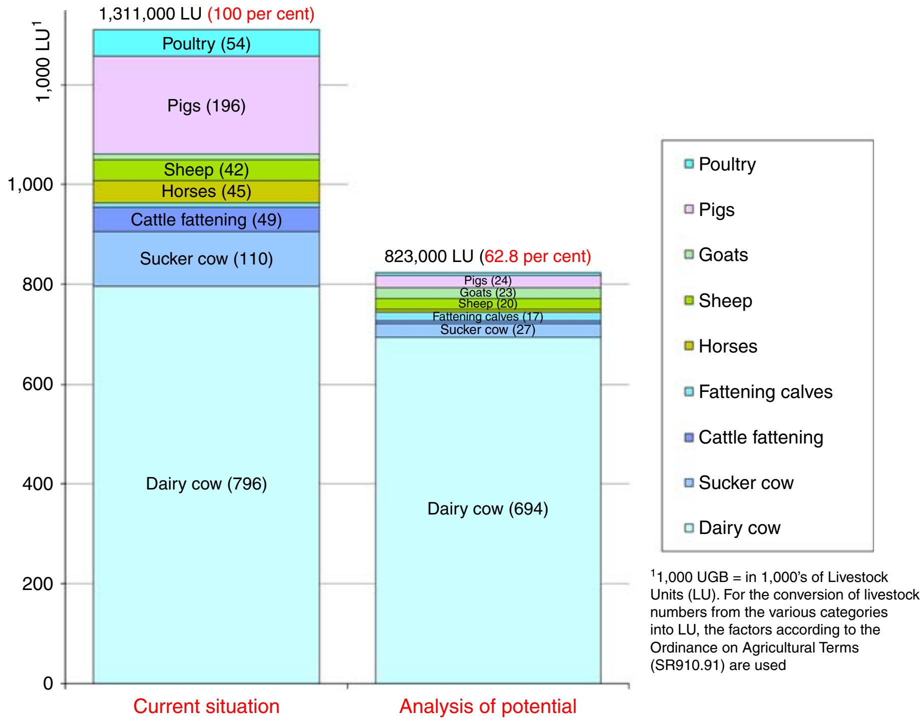

Figure 4.
Impact on the animal livestock

tendency to increase animals feeding on roughage to the detriment of animals feeding on concentrated feeds. The fattening-pig and poultry populations are thus reduced by approximately 90 per cent. In the case of livestock consuming roughage, dairy numbers can remain almost at the current level 700,000 LU (−13 per cent), whilst suckler cow numbers are reduced by 75 per cent, given their lower efficiency. The number of livestock-fattening cattle decreased by (−90 per cent) in contrast, the number of fattening veal are double. To value dairy production, the sheep and goats will be used to produce milk, the number of sheep will decrease significantly (−50 per cent), while the number of goats will increase. The animal production will therefore decrease significantly, only milk and beef will be reduced slightly in comparison with the current situation (milk and milk products −18 per cent, beef and veal −17 per cent). The reduction in animal production can be explained by the fact that vegetable products directly consumed by the population have a higher energy efficiency than that used by animals as fodder. Currently, 50 per cent of the rotated land is used to produce fodder. In addition, livestock in Switzerland are highly dependent on foreign fodder: 50 per cent of the feed given to pigs and poultry is imported.

5.2 Land use change

In crops production, optimisation of the model leads to considerable changes in land use compared to the present (Figure 5). The total arable land rises from 403,860 ha to the CRL area of 438,560 ha, which corresponds to the 1992 CRL Sectoral Plan guidelines and was defined in the model as an upper limit. The optimisation of the food supply leads to a reduction in arable land use for feed production. The temporary-ley area is

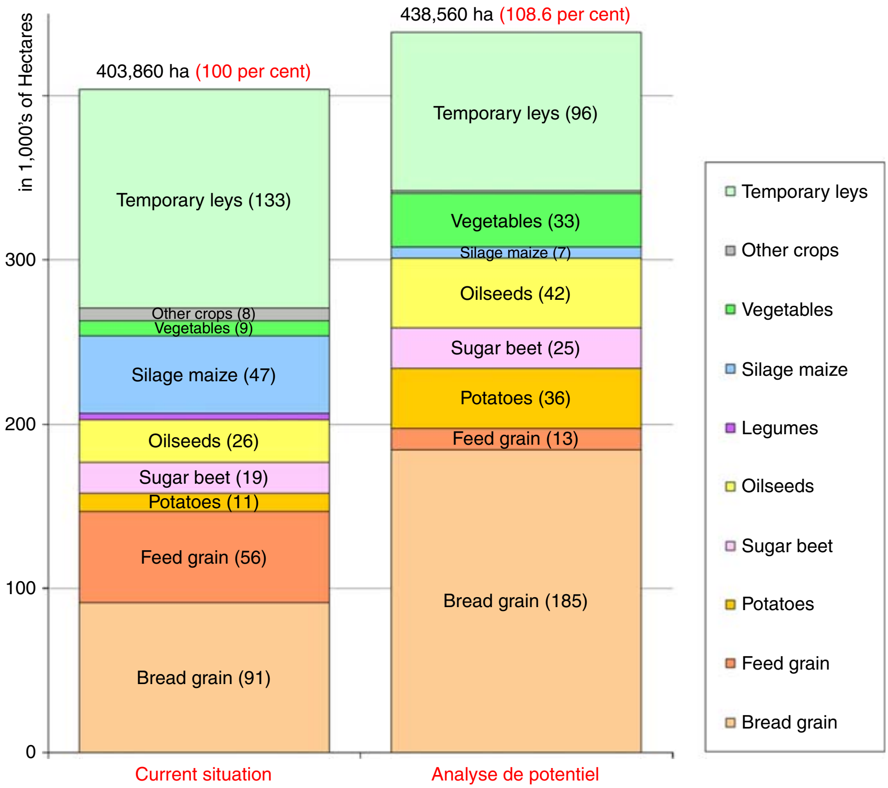

Figure 5.
Impact on the arable land use

reduced to the minimum required, the cultivation of silage maize decreases by 40,000 ha to 7,000 ha, and the feed-grain area falls by 43,000 ha to 13,000 ha. In contrast, the percentage of grain used for human consumption increases significantly. Thus, bread grain cereals increased from 94,000 ha to 185,000 ha, with their share in the arable land increasing from 23 to 42 per cent. For the other crops, there is an increase in the area of potatoes (+25,000 ha), vegetables (+24,000 ha), rapeseed (+16,000 ha) and sugar beet (+6 000 ha). The extension of vegetable crops can be explained by the constraints imposed on other crops (restrictions related to rotation, processing capacity and share in the food ration).

6. Sensitivity analysis

Within the scope of sensitivity analyses, an investigation is conducted to determine how "robust" the above core statements are. Below, we examine the influence of temporary-ley content, target weighting, reduction of yield level, increase of Swiss population (+10 per cent) and reduction of import (–80 per cent) on food supply.

6.1 Impact of the share of temporary ley

Within the scope of sensitivity analyses, an investigation is conducted to determine how "robust" the above results statements are. Below, we examine the influence of temporary-ley content, target weighting and yield level on food supply. According to the CRL Sectoral Plan, the minimum temporary-ley content of arable land is 22 per cent. The results presented above were also based on this percentage. Temporary-ley content could crucially influence the energy supply. For this reason, three scenarios were calculated to assess the impacts on food supply:

- 0 per cent (Corresponds to a state in which arable crops are cultivated each year over all of the CRL).
- 8.5 per cent (Corresponds to the additional CRL compared to the present, and hence to a state in which arable crops are cultivated approximately every year on the land currently used for arable crops, whilst the presumably less-well-suited additional land is for the most part reserved for temporary-ley cultivation).
- 33 per cent (Corresponds to current temporary-ley content).

The resultant shows that the increase of the share of the temporary meadows on arable land which would accompany a decline in supplies of dietary. The reduction of the share from 22 to 0 per cent or 8.5 per cent leads only to a slight increase in the energy supply compared to the results of the analysis of potential (+2.3 per cent and +2.1 per cent, respectively). Various limitations such as crop-rotation restrictions and processing capacities prevent a further expansion of most arable crops. However, with the increase in temporary-ley content from 22 per cent to the current situation of 33 per cent, supply, which stands at 2,223 kcal/person/day (−5.1 per cent), will fall short of the minimum target value of 2,300 kcal/person/day.

6.2 Impact of the target weighting of the nutritional units

Different simulations were carried out with different weightings of the various nutritional targets in order to test the stability of the analysis of potential with respect to the target weighting defined in the DSS-ESSA. If the nutritional units—i.e., the current shares of food groups—are more strongly weighted *vis-à-vis* a highest possible energy supply, the quality of the product basket improves. The previously high carbohydrate content of the energy supply is significantly reduced, and the protein and fat content increased. This, however, leads to an energy supply that is 5.8 per cent lower than that of the analysis of potential. Further sensitivity calculations have shown that the supply level is strongly dependent on the demands made on the quality of the product basket (e.g. a significant reduction in the case of higher meat or egg rations).

6.3 Impact of the reduction of yield

As already mentioned, the DSS-ESSA model takes into account an average safety deduction of 10 per cent for crop yields. According to Lobell and Field (2007), recent global temperature increase induced a reduction in global wheat, barley and maize yields. Possible consequences of climate change on agriculture can also be observed in Switzerland. For example, the drought in the year 2003 caused a reduction of average crop yields in Switzerland up to 10 per cent. Niklaus Lehmann (2008) shows that global warming decreases wheat yield levels in all study regions in Switzerland between 4 and 10 per cent. For this reason, we have adopted a 10 per cent reduction of yield. In the simulated situation without food and feed imports, necessary raw materials (e.g. fertiliser, seed) might also only be available in insufficient quantities, which could entail an even sharper reduction in yield. Sensitivity calculations have shown that a further 10 per cent reduction in crop yields leads to an approximately −7 per cent lower energy supply. Part of the decreases in yield can therefore be offset by the unchanged animal performance; moreover, the optimisation process means that with an increasing deficit, the energy supply is more strongly weighted than the remaining targets.

6.4 Additional sensitivity analysis

The additional sensitivity analysis showed that a reduction of 80 and 20 per cent food and feed imports leads to increase of energy supply to, respectively, 8 (2,362 kcal/person/day) and 19 per cent (2,789 kcal/person/day) compared to the results of the analysis of potential. The increase of 10 per cent in Swiss population leads to 11 per cent reduction of total energy supply compared to the potential analysis.

7. Conclusions

This paper uses the DSS-ESSA to simulate whether a country with as low a level of self-sufficiency (around 60 per cent) as Switzerland would theoretically be capable of supplying its own population with a sufficient quantity of domestically produced food. The results of analysis of potential show that with optimisation of domestic production under the crisis scenario condition, in the medium- and long-term, it is possible to provide the 8.14m Swiss population with energy supply of 2,340 kcal/person/day that meet the minimum requirements recommendations 2,300 kcal/person/day was defined as a target value. However, the food ration would differ significantly from current consumption habits, both in terms of products (e.g. avoidance of pasta, rice and beer); significantly lower availability of meat, fruits and vegetables product and higher percentage of carbohydrates with a significant decrease in vegetable and animal fats in particular. When interpreting the analysis of potential, various limitations must be borne in mind. First—as already shown—not all food waste generated in the value chain is taken into account. This has an impact on the available energy content, and possibly also on the percentages of essential nutrients out of the total amount of available energy. According to various studies, losses during consumption currently stand at 15–20 per cent on average. The resulting energy supply in the DSS-ESSA would thus still need to be adjusted by these disregarded losses in order to account for the actual energy input. However, there is consistent evidence indicating that a dietary pattern higher in plant-based foods and lower in animal-based foods (especially red and processed meat) is both healthier and associated with a lesser impact on the environment. To achieve the aforementioned results, it is above all the appropriate agricultural land—and CRL in particular—that is required in the necessary quantities and qualities sufficient input factors and resources such as energy (fuels, electricity, machinery, labour, seed, fertiliser, plant-protection products, water and warehousing and processing capacities, etc.) must be available. Pursuant to Swiss Law, the Swiss Confederation is responsible for preserving sufficient suitable cultivated land, especially CRL, so that, in times of severe shortage, an adequate basis for supplying the country may be ensured. For this reason, however, this land must also remain qualitatively and quantitatively available in future. In addition to providing other multifunctional services, Swiss agriculture contributes to assuring that the population is supplied with foodstuffs. In the event of a crisis, supplies do not depend primarily on domestic production, but on the foodstuff available in the mandatory stockpiles and the supply chain. However, the maintenance of the compulsory stocks include directly consumable foodstuffs such as sugar, rice and cooking oil, and products that need to be processed before consumption, such as bread grain have to be held of essential level. Production factors such as fertilisers, seed and feedstuffs are also stockpiled. Enough is stocked to cover the average requirements in Switzerland for three to six months. This means that certain sectors of the economy are required to maintain stocks of these goods as a contribution to security of supply of essential goods. The Federal Office for Agriculture deals with the challenges and potentials of resource-conserving food and feed production. Here, attention must be paid to the sustainable use of arable land and permanent grassland for food production.

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