Organic farming´s ability to nourish the Austrian people: an empirical study in the region Mostviertel-Eisenwurzen (A)

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Abstract. *A sustainable agricultural and food system is characterized by two qualities: availability of high-quality, healthy food along with best possible preservation of natural resources. Organic farming is discussed as a solution model for the complementary achievement of both aims. Taking the region Mostviertel-Eisenwurzen (A) as a case study, the present investigation examines the regional self-reliance in food production by means of three scenarios. In the basic scenario, the current land use of the region is set against the present-day food demand of the local population. The organic scenario assumes that the farming method of the region adheres 100 % to the guidelines of organic farming. The produced food is set against the current food demand, as in the basic scenario. In the third scenario – the organic-alternative scenario – the 100 % organically produced food is set against a food demand of the local population that follows the recommendations of nutritional science comprising more plant-based diets.*

The results show that in case of the hypothetical conversion to organic farming, the food production decreases in absolute numbers. Despite this reduction, the local population can be sufficiently supplied with food energy both in case of the average Austrian diet as well as in a diet according to the recommendations of nutritional science. The number of people that can be supplied outside the region is higher in the nutritional science diet than in the average Austrian diet, despite the lower total net export quantity. While egg, meat and milk production are up to 6 times the local demand, the degree of self-supply of plant products (especially fruit and vegetables) covers only 2/3 of the demand after the conversion. Moreover, our calculations show how a change of consumption patterns affect the demand for feedstuff-imports. The region changes from being a net importer of concentrate (76,190 t fresh mass) at the starting point to a gross exporter (39,784 t fresh mass) in the organic and the organic alternative scenario. In summary, agricultural production according to the guidelines of organic farming and a diet following the recommendations of nutritional science seem a promising strategy for achieving a sustainable agricultural and food system.

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Introduction

Food security, healthy food and the corresponding farming method have increasingly shifted into the public interest due to the latest food scandals as well as to the increase of diet-related diseases. In particular, incorrect nutrition as far as quality is concerned is a phenomenon that plays a role not only in the so-called developing countries but also in the western world. At the same time, food production in intensively managed farming systems frequently places massive pressure on the environment. Getting the agriculture sector right is crucial to reducing this pressure on the environment, which is created through the entire food system (Jungbluth, 2000, 6f).

Two objectives characterize a sustainable agricultural and food system: Firstly, the availability of high-quality (i.e. with a higher content of valuable substances), healthy food (i.e. with a lower content of harmful substances), and secondly the simultaneous preservation of natural resources. Organic farming is being discussed as a model for the complementary achievement of both aims. Several scientific studies have pursued the question whether the above-mentioned aims can be achieved by organic farming. The following authors examined the consequences of an extensive conversion to organic farming and see no threat to covering the domestic consumption in their countries: Langley et al. (1983) for the USA, Bechmann et al. (1992) for Germany and Alroe and Kristensen (2001) for Denmark. On the other hand, Pommer and Rintelen (1997) predict shortages in oilseeds in the event of a partial conversion of Bavarian agriculture to organic farming. In a full conversion to organic farming, they predict shortages in the meat supply if the meat consumption continues to remain high. Lampkin (1994) assumes that in Britain, provided the present-day consumption habits remain the same, the food supply from domestic production would be endangered at a conversion rate above 30 % because national consumption would then exceed national production. For Germany, Seemüller (2000) calculates that converting the entire agricultural area to organic farming would be feasible without a need for additional farmland or imports if the share of animal calories is reduced from an average of 39 % to 24 %; the latter value approximates Italian dietary habits. This aim can be achieved by 2024 if the present-day dietary trend continues (reduction in the share of animal products annually by 2.1 % from 1990 to 1996 in Germany).

The present study estimates the consequences of an extensive conversion to organic methods on food production. It also develops a concrete alternative concerning food demand via altered consumption habits. Finally, the effects of an extensive conversion are set against the altered consumption patterns.

Region of Study

The region Mostviertel-Eisenwurzen is situated in the southwest of the Austrian Federal Province Lower Austria and covers an area of 3,360 km² with 238,000 people living here. The agricultural area amounts to 165,000 ha, of which 13 % are managed according to organic farming guidelines. This proportion of organically managed area exceeds that in the rest of Austria. At the same time, conventional farming is intensive compared to other parts of Austria (high density of livestock, high proportion of maize).

Methods

Scenarios

The present study analyzes three scenarios.

Basic Scenario. The present-day land use of the region Mostviertel-Eisenwurzen (87 % of the agricultural area is managed

conventionally, 13 % organically) is compared with the food consumption of the population. In this scenario, consumption is defined as the average diet of the Austrian population. The underlying question is whether the population can be fully supplied with locally produced food, and how many additional people could be supplied, given such consumption.

Organic Scenario. The organic scenario differs from the basic scenario mainly in respect to the farming method: 100 % of the production in the region is assumed to be organic. At the same time we assume that only food originating from organic farming is demanded by the local population, in accordance with the new offer. The produced food is also set against the Austrian present-day average consumption, as in the basic scenario. Here we also examine the number of people outside the region that can be supplied with food from this agricultural area.

Organic-Alternative Scenario. This scenario modifies the above organic scenario with respect to food consumption patterns. Instead of the average Austrian consumption, the locally, organically produced food is compared to the recommendations of nutritional science. We investigated how many people within and outside the region can be sufficiently supplied with food after conversion to organic farming, if these people follow the recommendations of the food pyramid (US. Department of Agriculture, Center for Nutrition Policy and Promotion, 1996).

Calculation scheme

Figure 1 outlines the methodology for the determination of both the local production of plant and animal products as well as of the imports of plant products and feedstuffs. The crop areas of the single crops are multiplied by the respective yields, differentiating between organic and conventional production systems.

From the thus calculated gross production we subtract storage losses of cereals (-10 %), potatoes (-15 %), vegetables (-25 %) and roughage (-5 % to –15 %, Knaus, 2002), as well as processing losses in the case of oilcrops (Hui, 1996) to determine net production. The non-food crops or feedstuffs such as renewable raw materials are excluded from the net yield of crops (without field forage) and are omitted in the following calculations. While plant foods are consumed directly by humans, the other crops, together with the net yield of green forage and roughage, go into the calculation of the local feedstuffs production. In the following, the term feedstuff comprises concentrates like maize and grain as well as roughage. In a next step, livestock and animal performance – again differentiated between organic and conventional farming – are used to calculate the necessary imports of feedstuffs (taking locally produced feedstuffs into account). Finally, the calculated amount of plant and animal food is compared with the food demand of the local population.

Land Use and Livestock

Based on the official statistics (INVEKOS, 1998), 10 typical farm types of conventional and organic farming are determined by means of cluster analysis. These farm types comprise 2 different dairy farms, a suckling cow farm, a sheep farm, a fattening cattle farm, a fattening pig farm, a breeding pig farm, a poultry farm, a commercial farm and one mixed farm. The conversion to organic farming in scenarios 2 and 3 assumes that the farm types remain the same and that the partition of the cultivated area (grassland versus arable area) also remains the same. Within each of the 10 farm types the use of the arable area and the livestock numbers of the organically managed cluster are transferred to the conventionally managed clusters. For this reason, in scenarios 2 and 3 the land use changes and livestock become reduced (Table 1).

Food Production

The gross production of plant products is calculated by multiplying the respective crop area with its yield, differentiating between conventional and organic production (Fig. 1). An analogous procedure is used for the animal production (livestock x animal performance). The amount of plant and animal yields, as well as their reduction due to the conversion to organic farming, is deduced from various sources: from the literature (Böckenhoff et al., 1986, 23; Schulze Pals, 1993; Mühlebach and Näf, 1990, 22; Schulze Pals and Nieberg, 1997, 9f; FAT, 1992-1996; BMLF, 1994-1999; BMLFUW, 2000; BMELF, 1990-2000, Offermann and Nieberg, 2000), from local data (Statistik Austria, 1998, 1999, 2000) and from author's own data collected on farms and from agricultural advisors of the region (Kaliski and Kratochvil, 2001). We assume the following decrease in yield due to the conversion: -16 % for field forage and intensively managed grassland (for extensive grassland yield remains constant), -15 to -32 % for cereals, -32 % for grain peas, -40 % for root crops, -50 % for oil crops. For animal performance we assume: -10 % of the milk yield, -25 % of the slaughter weight in beef production (maintaining the same keeping duration), an increase of slaughter weight of pigs by +11 % (increasing the fattening duration by +64 %), and a decrease in laying performance of the laying hens by -9 % (increasing the keeping duration by +10 %).

Production of and Demand for Feedstuffs

As explained in the Calculation scheme section, the amount of available, locally produced feedstuffs comprises the crops available for feed purposes (feeding grains, maize for silage, grain maize) together with the net yield of green forage and roughage. In the basic scenario, the demand of feedstuffs is calculated seperately according to conventional and organic cultivation methods by multiplying the respective common feeding rations indicated in the literature for the various livestock (Kirchgessner, 1997; Jeroch et al., 1999; BMLF, 1999; BMLFUW, 2000; LBL, 2000) and in expert opinions (Knaus, 2002, Zollitsch, 2002). For scenarios 2 and 3, the feeding rations of organic farming are adopted for all animals. These feedstuff demands are then compared with the regional feedstuff production. The difference between these two values represents the required imports of feedstuffs.

Food Demand

For both the basic scenario and the organic scenario, the daily food requirements in kilocalories (kcal) according to the Food Balance Sheets of the FAO (2001) are applied as a starting point. The total food consumption amounts to 3,639 kcal per person and day, with 67 % of the energy being vegetable food and 33 % animal food. The diet recommendations for the organic-alternative scenario are based on the food pyramid, the recommendations of the Deutsche Gesellschaft für Ernährung (DGE) (ratio of 10:30:60 for protein:fat:carbohydrates relating to the energy content of these nutrients) and literature recommendations concerning a reduction of animal food in favour of vegetable food (FDG, 1991; Cleveland et al., 1997; Elmadfa, 1998; Elmadfa and Leitzmann, 1998; DACH, 2000; Buhmann and Berweger, 2001; U.S. FDA 2001; Hahn, 2001). Table 3 shows how the recommendations differ in detail from the average Austrian diet according to the FAO (2001) both in terms of the generally lower total energy supply (2,300 kcal per person per day) as well as the higher portion of vegetable food. In the recommendations, 300 kcal per person per day are calculated for luxury food, i.e. sweets, tropical and subtropical fruit, alcohol, coffee, and cocoa. This is

approximately half of the actual consumption of this food group in Austria. Since most of these goods have to be imported, they are omitted from the further food production/food consumption comparison.

Results

Food Production and Demand

Table 4 sets food production and food demand of the three scenarios against each other. The self-supply data in the basic scenario demonstrate impressively that the study area qualifies as a food export region at the starting point. This applies in particular to animal products, where production exceeds local demand by 176 %. As regards vegetable food, local demand is only slightly exceeded; here, greater surpluses exist only for cereals and sugar beet. In case of a regional land use according to organic farming guidelines (with unchanged dietary habits), the degree of self-supply concerning both vegetable food all food groups decreases dramatically. This is because, compared with the basic scenario, sugar beet production ceases, meat and egg production drops by approximately one third, and vegetable oil production decreases by three quarters. The situation in the organic-alternative scenario is different: On one hand the degree of self supply regarding vegetable food (only 65 %) is similarly low as in the organic scenario and on the other hand the production of animal food by far exceeds the demand. With a degree of self supply of 399 %, this data exceeds the comparative value of the starting situation (basic scenario) by 123 percentage points.

Likewise, the degree of self supply for all food groups combined exceeds that of the basic scenario.

Export Potential of Food

The changes in food production, food demand and degree of self supply in the scenarios correspond to the theoretically available regional export potential. In absolute numbers, the potential exports decrease due to the lower production of many products after conversion. The net export quantity potential (exports minus necessary imports for the local population) decreases in the organic scenario (201,742 t) versus the basis scenario (294,210 t) by approximately one quarter and decreases again slightly in the organic-alternative scenario (195,877 t, see Table 5) due to the increasing import demand of fruit and vegetables. How does this affect the number of people outside the region that can be supplied by the regional agriculture? Assuming the same dietary habits as the local population, this number decreases for cereals in scenarios 2 and 3 due to the lower production in organic farming or due to the locally higher demand related to altered dietary habits, respectively (Table 5). Sugar beet production ceases completely after the conversion and the export potential therefore drops to zero. The export potential of animal products mirrors the supply within the region (Table 4). While the lower value for scenario 2 is due to the conversion of the farming system, the potential export quantity of scenario 3 exceeds by far the comparative value due to altered demand, in particular for milk and meat.

Import Demand for Feedstuffs

In calculating potential food exports, one must consider that production, especially in the case of intensively managed farming systems, involves the use of both renewable and non-renewable resources from outside the region. In the case of large-scale imported feedstuffs, the transportation issue and their predominant origin from so-called third world countries are problematic ecologically and sociologically. Figure 2 shows that the comparatively high net

exports of food in scenario 1 (Table 5) goes hand in hand with a high import of feedstuffs. Oil cake, oil meal and soya beans (defined as oil crops and soya in Fig. 2), which together already amount to more then 90 % of the imported feedstuffs in the basic scenario, take up 35,695 ha of arable area outside the region (Fig. 2). This corresponds to 15 times the arable land used for the production of feedstuffs in the region itself! Based on the conversion of agricultural production to the organic farming method in scenarios 2 and 3, the region changes from being a feedstuffs importer to being a feedstuffs exporter due to the heavily reduced demand for feeding grains and the phase out of oil meal.

Conclusions

This study shows that a hypothetical conversion of the intensively managed farmland in the region Mostviertel-Eisenwurzen (A) to organic farming would decrease the total food production. Despite this reduction, however, the local population can be sufficiently supplied with food energy both in the case of an average Austrian diet and a diet based on the recommendations of nutritional science. The feared shortage of supply reported in the literature can therefore not be confirmed. More food is currently produced than consumed in Austria. From a national point of view, a slight reduction in the food production does not create a food security problem. In the region studied, a production exceeding the local demand is nonetheless desirable in order to guarantee the supply for densely populated areas whose population is dependent on external supply. The Mostviertel-Eisenwurzen region can contribute to this supply. The organic and organic-alternative scenarios show that people outside the region can also be supplied with cereals, milk, meat and eggs after the conversion. The number of outside people supplied is higher in the "nutritional science"

recommended diet than in the average Austrian diet, despite the lower total net exports.

Examining the production numbers of single products or product groups shows a distinct disproportion between plant and animal products. While eggs, meat and milk are produced up to 6 times the local demand, the self-supply of plant products is only 63 % (organic scenario) or 65 % (organic-alternative scenario) after the conversion. Especially fruit and vegetables are produced in insufficient amounts to cover local demand. The same holds true for feedstuffs: Grain legumes are cultivated in insufficient amounts in all three scenarios, whereas grain maize exhibits surpluses. Altered land use and reduced livestocks could ameliorate the demand and supply imbalances investigated in the scenarios. Reduced livestocks and the resulting lower feedstuffs demand would enable plant products to be cultivated on a larger part of the agricultural area for direct human consumption. This would better fill the demand for plant products, a demand that none of the scenarios could cover. In addition to these suggested production-related changes, the calculations show that altered consumption patterns affect the demand for feedstuff imports: The region changes from being a net importer of concentrate (76,190 t fresh mass) at the starting point to a gross exporter (39,784 t fresh mass) after the conversion to organic farming.

In summary, agricultural production according to organic farming guidelines and a diet following the recommendations of nutritional science represent a favourable combination that enables the local supply with most of the required food. This combination is therefore a promising strategy on the way to a sustainable agricultural and food system.

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┌─────────────────────────────┐       ┌─────────────────────────────┐
│      agricultural area      │   x   │            yield            │
└─────────────────────────────┘       └─────────────────────────────┘
                    │
                    ▼
┌───────────────────────────────────────────────────────────────────┐
│                         gross production                          │
└───────────────────────────────────────────────────────────────────┘
                    │        - reduction of losses
                    ▼
┌───────────────────────────────────────────────────────────────────┐
│                          net production                           │
└───────────────────────────────────────────────────────────────────┘
           │                                    │
           ▼                                    ▼
┌─────────────────────────┐         ┌─────────────────────────────┐
│          crops          │         │          roughage           │
│   (without field forage)│         │  (green forage, hay, silage)│
└─────────────────────────┘         └─────────────────────────────┘
      │          │                              │
      ▼          ▼                              │
┌──────────┐  ┌──────────────────┐              │
│non-food  │  │ remaining crops  │              │
│crops or  │  └──────────────────┘              │
│feedstuffs│         │                          │
└──────────┘         ▼                          │
          ┌──────────────────┐  ┌──────────────────┐
          │ feedstuffs from  │  │   imports of     │◄──
          │ local production │  │   feedstuffs     │
          └──────────────────┘  └──────────────────┘
                │   ▲      │      │   ▲
                ▼   │      ▼      ▼   │
          ┌───────────────────────────────┐
          │            animals            │
          └───────────────────────────────┘
                          │
                          ▼
          ┌──────────┐      ┌──────────────────┐
          │livestock │  x   │animal performance│
          └──────────┘      └──────────────────┘
                │                   │
                ▼                   ▼
┌──────────┐ ┌──────────────┐ ┌──────────────┐
│import of │ │vegetable food│ │ animal food  │
│vegetable │ │from local    │ │ from local   │
│food      │ │production    │ │ production   │
└──────────┘ └──────────────┘ └──────────────┘
   │  ▲         │  ▲              │  ▲
   ▼  │         ▼  │              ▼  │
┌────────────────────────┐ ┌────────────────────────────┐
│consumption of plant    │ │consumption of animal       │
│products                │ │products                    │
└────────────────────────┘ └────────────────────────────┘
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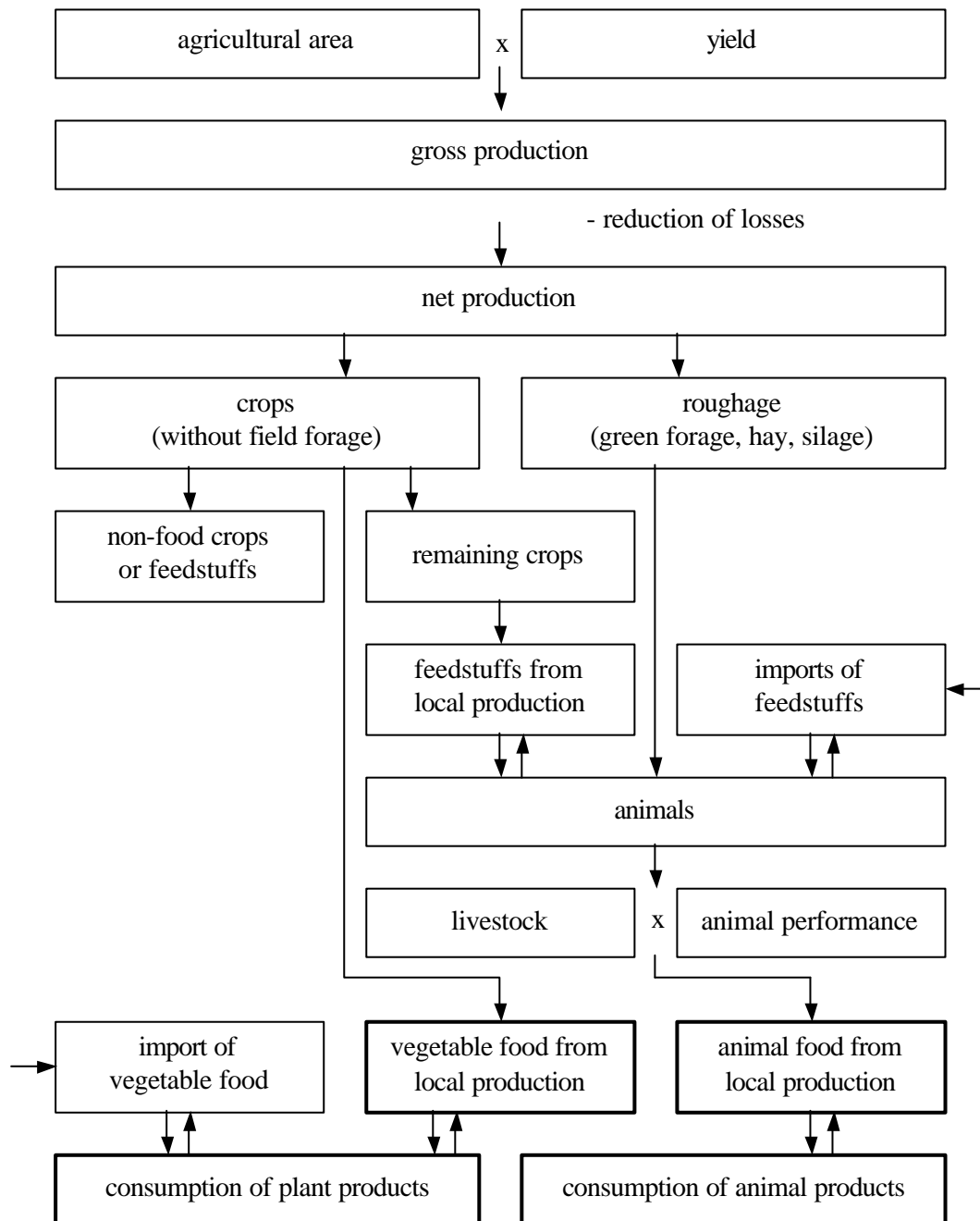
bold frames: major results

Figure 1: Calculation scheme

source: Seemüller (2000), modified

Table 1. Change in the use of the agricultural area due to regional farming according to organic farming guidelines

crops	basic scenario				org. scenario and org.-alternative scenario	
	conv	**org**	**total**		**total**	
	ha	**ha**		**%**	**ha**	**%**
agricultural area	143,955	21,472	165,427	100.0	165,427	100.0
arable area	73,073	2,135	75,208	45.0	75,208	45.0
grassland	70,882	19,337	90,219	55.0	90,219	55.0
arable area						
cereals	30,895	883	31,778	42.3	36,071	48.0
maize[2]	22,607	106	22,713	30.2	5,275	7.0
field forage[3]	10,186	952	11,138	14.8	24,186	32.2
grain legumes	3,335	90	3,225	4.3	5,562	7.4
oil crops[4]	2,331	41	2,371	3.2	1,804	2.4
sugar beet	1,610	1	1,611	2.1	0	0.0
potatoes and vegetables	246	33	279	0.4	677	0.9
other[5]	2,064	29	2,094	2.8	1,634	2.1
grassland						
extensive grassland[6]	5,882	1,633	7,515	8.4	7,515	8.4
intensive grassland[7]	65,001	17,704	82,704	91.7	82,704	91.7

[1] wheat, spelt, rye, winter- and sommer barley, oats, winter- and summer maslin, triticale

[2] grain maize, corn cob mix, maize for silage

[3] alfalfa, clover, clover/grass, temporary grassland, forage grasses

[4] rape, sunflower, soya, oil squash

[5] feeding beet, green fallow

[6] meadows of one cutting, rough grazing, alpine pasture, other extensively used meadows. Extensive grassland also includes the region's 750,000 apple and pear trees, which are extensively managed. Intensive fruit production is not important in the region.

[7] meadows with multiple cuttings, litter meadows with stone fruit trees, meadows

source: INVEKOS (1998), LFBIS (1999), authors' own calculations

Table 2. Changes in livestocks due to regional farming according to organic farming guidelines

animal species or specialization of production	basic scenario			org. scenario and org.-alternative scenario	
	conv	org	total	total	
	head of stock			head of stock	% of basic scenario
cattle	106,279	15,554	121,832	105,165	86.3
fattening calfs (milk)	1,042	222	1,264	902	71.4
fattening heifers	4,078	363	4,441	3,024	68.1
fattening bulls	23,255	1,404	24,659	16,577	67.2
dairy cows	58,320	8,562	66,881	66,881	100.0
other cattle [1]	19,584	5,003	24,587	17,781	72.3
pigs	306,570	2,398	308,968	128,762	41.7
piglets	120,859	499	121,358	48,843	40.2
gilts and fattening pigs	154,103	1,831	155,934	67,208	43.1
breeding sows	31,608	68	31,676	12,711	40.1
sheep	16,142	7,.306	23,448	23,448	100.0
goat	4,159	1,090	5,249	5,249	100.0
fattening poultry	1,616,171	2,913	1,619,102	527,841	32.6
laying hens	991,005	31,293	1,.022,298	353,158	34.5
turkey hens	68,530	950	69,480	16,090	23.2

[1] cattle and breeding cattle, suckling cows, yearling heifers

source: INVEKOS (1998), LFBIS (1999), authors' own calculations

Table 3. Current versus recommended consumption of various food products

food product	current consumption		recommended consumption		recommendation in % of the current consumption
	kcal / person/ day	amount in g/ person/day	kcal / person/ day	amount in g / person/day	
cereals	910	313	1,026	353	113
potatoes	115	182	104	165	91
sugar, sweetener[1]	452	123	37	12	8
legumes	8	3	17	6	215
nuts	37	16	0	0	0
oil crops	34	9	0	0	0
vegetable oils	402	44	463	51	115
vegetables	68	272	105	412	154
fruit[2]	108	228	299	645	277
plant products total	**2,134**		**2,051**		**96**
meat	421	253	89	53	21
animal fat[3]	333	51	146	20	44
milk	358	765	275	588	77
eggs	50	36	50	35	99
fish	21	39	15	27	69
animal products total	**1,183**		**574**		**49**
food total	**3,317**		**2,625**		**79**

[1] recommended consumption only honey

[2] without bananas, pineapple and citrus fruits

[3] recommended consumption only butter

source: Cleveland et al. (1997), DACH (2000), Buhmann and Berweger (2001), FAO (2001), U.S. FDA (2001), WHO (1998), authors' own assumptions

Table 4. Production, demand and degree of self-supply of various products in the three scenarios

product	basic scenario			org. scenario			org.-alternative scenario		
	production	demand[1]	dss[3]	prodction	demand[1]	dss[3]	production	demand[2]	dss[3]
	in kcal / person/day		in %	in kcal / person/day		in %	in kcal / person/day		in %
plant products	**2,402**	**2,134**	**113**	**1,336**	**2,134**	**63**	**1,336**	**2,051**	**65**
cereals	1,503	910	165	1,229	910	135	1,229	1,026	120
potatoes	34	115	29	51	115	44	51	104	49
sugar, sweetener[4]	684	452	151	0	452	0	0	37	0
legumes	0	8	0	0	8	0	0	17	0
nuts	0	37	0	0	37	0	0	0	
oil crops	0	34	0	0	34	0	0	0	
vegetable oils	169	402	42	43	402	11	43	463	9
vegetables	9	68	13	9	68	14	9	105	9
fruit[5]	4	108	4	4	108	4	4	299	2
animal products	**3,260**	**1,183**	**276**	**2,292**	**1,183**	**194**	**2,292**	**575**	**399**
meat	1,114	421	265	481	421	114	481	89	542
animal fat[6]	0	333	0	0	333	0	0	146	0
milk	1,880	358	525	1,730	358	483	1,730	275	628
eggs	265	50	530	81	50	163	81	50	164
fish	0	21	0	0	21	0	0	15	0
total	**5,662**	**3,317**	**171**	**3,628**	**3,317**	**106**	**3,641**	**2,625**	**194**

[1] The demand is calculated by multiplying the average Austrian consumption in t per person and year (FAO 2001 with the population figures of the region Mostviertel-Eisenwurzen (approx. value: 238,000).

[2] The demand is calculated by multiplying the consumption according to the recommendations of nutritional science in t per person and year with the population figures of the region Mostviertel-Eisenwurzen (approx. value: 238,.000).

[3] dss = degree of self-supply = production in % of the demand

[4] The production includes solely sugar in the basic scenario; the requirements include solely honey in the organic-alternative scenario.

[5] Bananas, pineapple and citrus fruit are not included because they cannot be produced in the region (included under luxury food in this study).

[6] The production of animal fat is contained in other groups such as meat and the demand includes solely butter in the organic-alternative scenario.

source: authors' own calculations

Table 5. Number of people from outside the region that can be supplied with food from the region under the three scenarios

| food product	basic scenario	organic scenario	organic-alternative - scenario
	net export quantity in t FS		
food products total	294,210	201,742	195,877
	net export quantity in number of people that can be supplied outside the region		
cereals	155,034	83,934	47,438
sugar	122,192	-	-
meat	391,941	33,730	1,052,837
milk	1,012,084	911,821	1,257,259
eggs	1,024,560	149,294	153,067

source: authors' own calculations
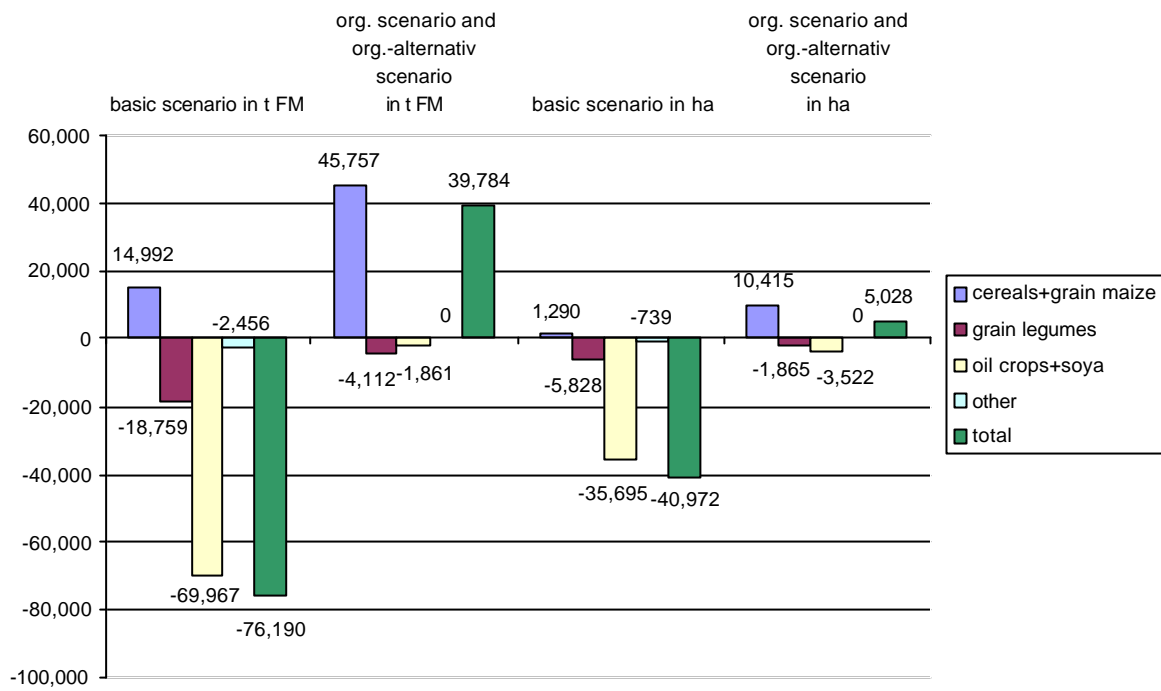
Figure 2. Import demand for feedstuffs (-) and export potential for feedstuffs (+) as well as the theoretically required or available cultivable area in the scenarios.

source: authors' own calculations