Renewable Agriculture and Food Systems: 19(1); 47–56 DOI: 10.1079/RAFS200360

The ability of organic farming to nourish the Austrian people: an empirical study in the region Mostviertel-Eisenwurzen (A)

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Accepted 9 August 2003 **Research Paper**

Abstract

A sustainable agricultural and food system is characterized by two qualities: availability of high-quality, healthy food along with the 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 food produced 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 the case of the hypothetical conversion to organic farming, food production decreases in absolute numbers. Despite this reduction, the local population can be sufficiently supplied with food energy, both in the 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 six times the local demand, the degree of self-supply of plant products (especially fruit and vegetables) covers only two-thirds of the demand after conversion. Moreover, our calculations show how a change of consumption patterns affects the demand for imported feedstuff. 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 seems a promising strategy for achieving a sustainable agricultural and food system.

Key words: organic farming, food security, food balance

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 for reducing this pressure on the environment, which is created throughout the entire food system[1].

Two objectives characterize a sustainable agricultural and food system. First, 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)[2] for the USA, Bechmann et al. (1992)[3] for Germany and Alroe and Kristensen (2001)[4] for Denmark. On the other hand, Pommer and Rintelen (1997)[5] 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 meat consumption continues to remain high. Lampkin (1994)[6] 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)[7] 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 3360 km^2 with a population of 238,000. The agricultural area amounts to 165,000 ha, 13% of which is 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. 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 pattern, 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[8].

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%; W. Knaus, personal communication 2002), as well as processing losses in the case of oilcrops[9], 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 such as 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 official statistics[10], ten typical farm types of conventional and organic farming are determined by means of cluster analysis. These farm types comprise two 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

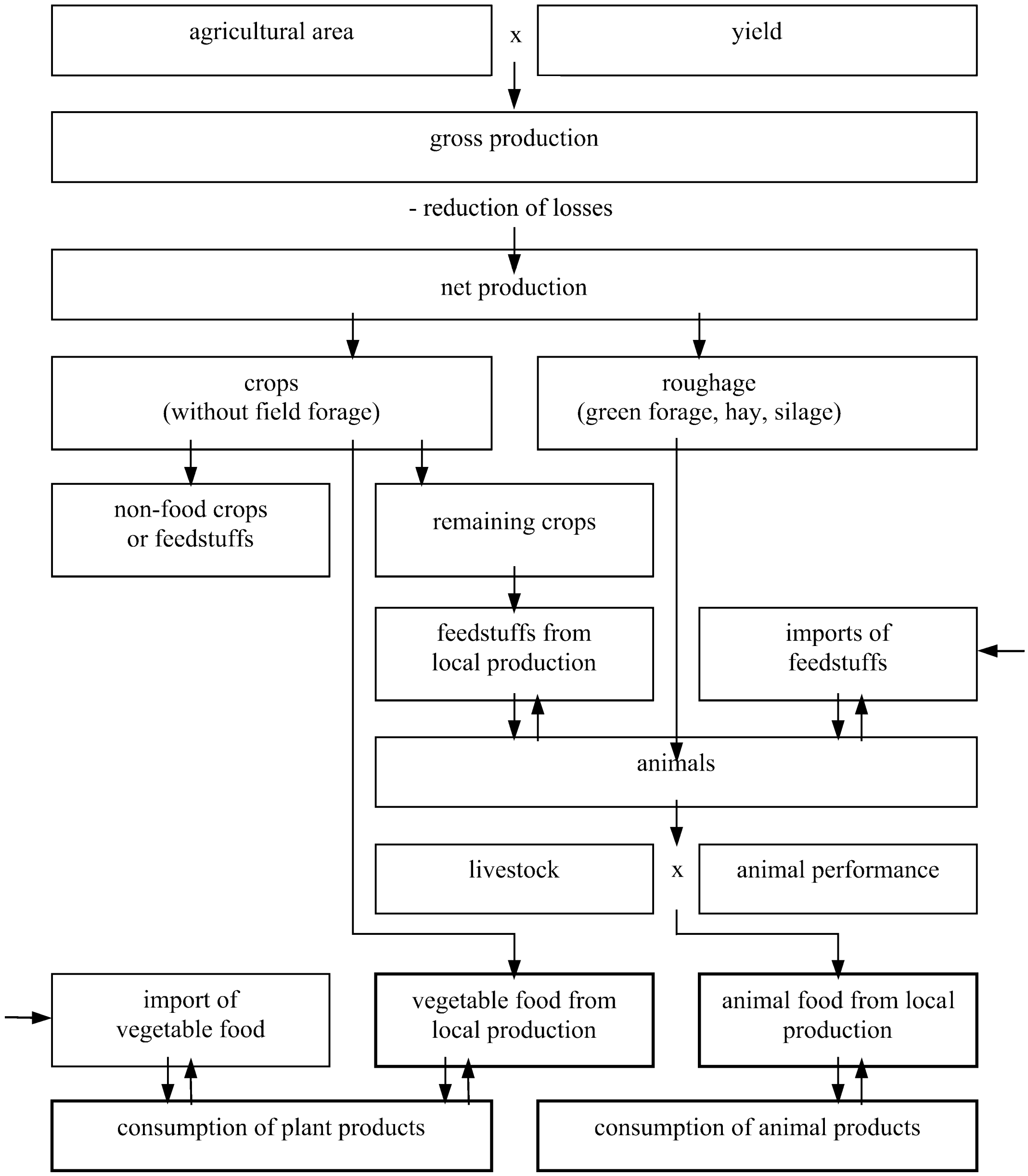

Figure 1. Calculation scheme. Bold frames = major results. Modified from Seemüller (2000)[7].

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 ten 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 (Tables 1 and 2).

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 × 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[12–39], from local data[40–42] and from author's own data collected on farms and from agricultural advisors of the region[43]. 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, and –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%).

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

Crops	Basic scenario Conv. ha	Org. ha	Total ha	%	Org. scenario and org.-alternative scenario Total 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[1]	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

Org., organic; Conv., conventional.
[1] Wheat, spelt, rye, winter and summer barley, oats, mixed grain, 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.
Sources: INVEKOS (1998)[10], LFBIS (1999)[11], authors' own calculations

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 separately, according to conventional and organic cultivation methods, by multiplying the respective common feeding rations indicated in the literature for the various livestock[44–48] and in expert opinions (W. Knaus, personal communication 2002; W. Zollitsch, personal communication 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[49] are applied as a starting point. The total food consumption amounts to 3639 kcal $person^{-1} day^{-1}$, 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 favor of vegetable food[50–57]. Table 3 shows how the recommendations differ in detail from the average Austrian diet according to the FAO[49], both in terms of the generally lower total energy supply (2300 kcal $person^{-1} day^{-1}$) as well as the higher proportion of vegetable food. In the recommendations, 300 kcal $person^{-1} day^{-1}$ 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

Table 2. Changes in livestock 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

Org., organic; Conv., conventional.
[1] Cattle and breeding cattle, suckling cows, yearling heifers.
Sources: INVEKOS (1998)[10], LFBIS (1999)[11], authors' own calculations.

Table 3. Current versus recommended consumption of various food products.

Food product	Current consumption		Recommended consumption		Recommendation in % of current consumption
	kcal person^{-1} day^{-1}	g person^{-1} day^{-1}	kcal person^{-1} day^{-1}	g person^{-1} day^{-1}	
Cereals	910	313	1026	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	2134		2051		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	1183		574		49
Food total	3317		2625		79

[1] Recommended consumption only honey.
[2] Without bananas, pineapple and citrus fruits.
[3] Recommended consumption only butter.
Sources: Cleveland et al. (1997)[51], DACH (2000)[54], Buhmann and Berweger (2001)[55], FAO (2001)[49], US FDA (2001)[56], WHO (1998)[58], authors' own assumptions.

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

	Basic scenario			Org. scenario			Org.-alternative scenario		
Product	**Production**	**Demand**[1]	**dss**[3]	**Prodction**	**Demand**[1]	**dss**[3]	**Production**	**Demand**[2]	**dss**[3]
	- - kcal person^{-1} day^{-1} - -		%	- - kcal person^{-1} day^{-1} - -		%	- - kcal person^{-1} day^{-1} - -		%
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 person^{-1} year^{-1} (from FAO, 2001[49]) by 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 person^{-1} year^{-1} by the population figures of the region Mostviertel-Eisenwurzen (approx. value: 238,000).
[3] dss = degree of self-supply = production as a percentage 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.

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 the one hand, the degree of self-supply regarding vegetable food (only 65%) is low, as in the organic scenario, and, on the other hand, the production of animal food greatly exceeds the demand. With a degree of self-supply of 399%, these data exceed 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 basic 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 for 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 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

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 fresh mass - - - - - - - - - - - - - - - - - - -		
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.

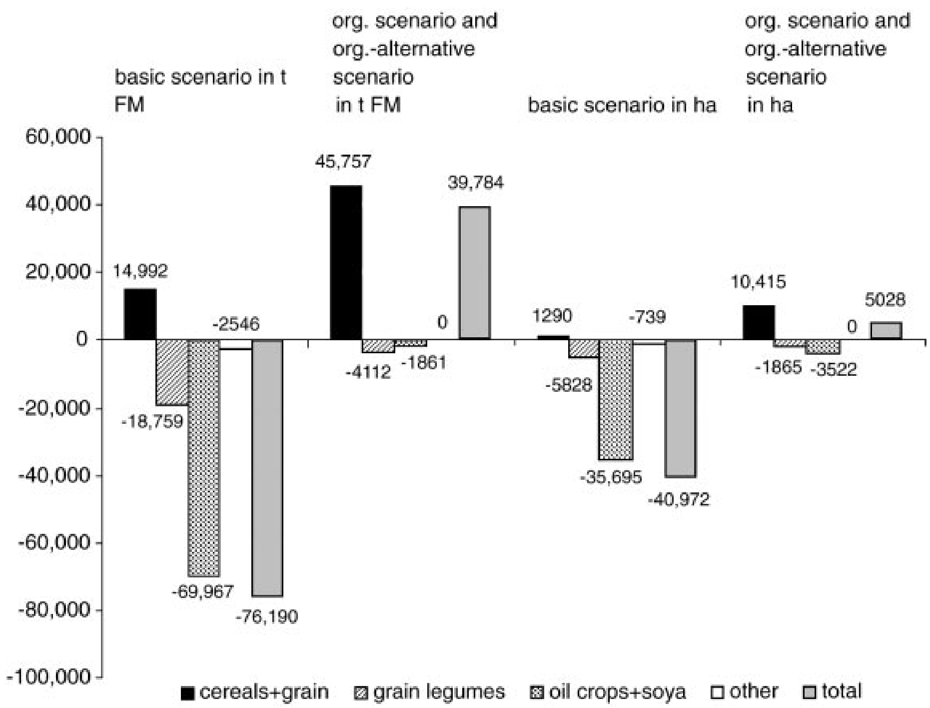

Figure 2. Import demand for feedstuffs (-) and export potential for feedstuffs (+), as well as the theoretically required or available cultivable area in the scenarios. Org., organic; FM, fresh mass. Source: authors' own calculations.

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) go hand in hand with a high import of feedstuffs. Oil cake, oil meal and soybeans (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 supplied sufficiently with food energy, both in the case of an average Austrian diet and a diet based on the recommendations of nutritional science. Therefore, the feared shortage of supply reported in the literature can 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, production exceeding the local demand is none the less 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 six times the local demand, the self-supply of plant products is only 63% (organic scenario) or 65% (organic-alternative scenario) after the conversion. Fruit and vegetables, especially, 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 livestock could ameliorate the demand and supply imbalances investigated in the scenarios. Reduced livestock and the resulting lower demand for feedstuffs 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 favorable combination that enables local supply of most of the required food. This combination is therefore a promising strategy on the way to a sustainable agricultural and food system.

Acknowledgements. The authors would like to thank Prof. Werner Zollitsch and Dr. Wilhelm Knaus, Department of Livestock Sciences, University of Natural Resources and Applied Life Sciences, Vienna, for their valuable support.

References

1 Jungbluth, N. 2000. Umweltfolgen des Nahrungsmittelkonsums. Beurteilung von Produktmerkmalen auf Grundlage einer modularen Ökobilanz. Dissertation an der Eidgenössischen Technischen Hochschule Zürich. dissertation.de, Berlin.

2 Langley, J.A., Heady, E.O., and Olson, K.D. 1983. The macro implications of a complete transformation of U.S. agricultural production to organic farming practices. Agriculture, Ecosystems and Environment 10:323–333.

3 Bechmann, A., Meier-Schaidnagel, R., and Rühling, I. 1992. Landwirtschaft 2000 – Ist flächendeckende ökologische Landwirtschaft finanzierbar? Szenario für die Umstellungskosten der Landwirtschaft in Deutschland. Greenpeace, Hamburg.

4 Alroe, H.F. and Kristensen, E.S. 2001. Researching alternative, sustainable agricultural system. A modelling approach by example from Denmark. In M. Matthies, H. Malchow, and J. Kriz (eds). Integrative Systems Approaches to Natural and Social Sciences – Systems Science. Springer Verlag, Berlin.

5 Pommer, G. and Rintelen, G. 1997. Vor- und Nachteile einer starken Ausbreitung des Ökologischen Landbaus. In LBP (Bayerische Landesanstalt für Bodenkultur und Pflanzenbau) (eds). Nachhaltigkeit landwirtschaftlicher Anbauverfahren. Schriftenreihe der LBP 3/97. p. 26–41.

6 Lampkin, N.H. 1994. Estimating the Impact of Widespread Conversion to Organic Farming on Land Use and Physical Output in the United Kingdom. In N.H. Lampkin and S. Padel (eds). The Economics of Organic Farming. CAB International, Wallingford, UK. p. 343–358.

7 Seemüller, M. 2000. Der Einfluss unterschiedlicher Landbewirtschaftungssysteme auf die Ernährungssituation in Deutschland in Abhängigkeit des Konsumverhaltens der Verbraucher. Werkstattreihe No. 124, Öko-Institut e.V. Verlag, Freiburg.

8 US Department of Agriculture, Center for Nutrition Policy and Promotion. 1996. The Food Guide Pyramid. In: Home and Garden Bulletin 252. Available at website: http://www.health.gov/dietaryguidelines/dga2000/document/build.htm (verified 15 November 2001).

9 Hui, Y.H. 1996. Bailey's Industrial Oil and Fat Products. Edible Oil and Fat Products: Processing Technology. John Wiley & Sons, New York.

10 INVEKOS (Integriertes Verwaltungs- und Kontrollsystem). 1998. Daten über flächen- und tierbestandsbezogene Förderungen landwirtschaftlicher Betriebe in der Region Mostviertel-Eisenwurzen. BMLFUW (Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft) and LFRZ (Land- und Forstwirtschaftliches Rechenzentrum), Wien.

11 LFBIS (Land- und forstwirtschaftliches Betriebsinformationssystem). 1999. Daten der Agrarstrukturerhebung 1999 und Allgemeine Viehzählung 1999 für die Region Mostviertel-Eisenwurzen. BaWi, Wien.

12 Böckenhoff, E., Hamm, U., and Umhau, M. 1986. Analyse der

Betriebs- und Produktionsstrukturen sowie der Naturalerträge im alternativen Landbau. Berichte Über Landwirtschaft. 64:23.
13 Schulze Pals, L. 1993. Ökonomische Wirkungen des Extensivierungsprogrammes auf die Umstellung landwirtschaftlicher Betriebe. In U. Zerger (ed.). Forschung im ökologischen Landbau. SÖL-Sonderausgabe No. 42. Stiftung Ökologie & Landbau, Bad Dürkheim. p. 328–335.
14 Mühlebach, J. and Näf, E. 1990. Die Wettbewerbsfähigkeit des biologischen Landbaus. Schriftenreihe der Eidg. Forschungsanstalt für Betriebswirtschaft und Landtechnik (FAT), No. 33. FAT, Tänikon.
15 Schulze Pals, L. and Nieberg, H. 1997. Öffentlich Förderung Teil 1: Folgen der Umstellung auf ökologischen Landbau. In I. Lünzer and H. Vogtmann (eds). Ökologische Landwirtschaft: Pflanzenbau – Tierhaltung – Management. Springer, Berlin.
16 FAT (Forschungsanstalt für Agrarwirtschaft und Landtechnik Tänikon). 1992. Bericht über biologisch bewirtschaftete Betriebe 1990. FAT, Tänikon.
17 FAT (Forschungsanstalt für Agrarwirtschaft und Landtechnik Tänikon). 1993. Bericht über biologisch bewirtschaftete Betriebe 1991. FAT, Tänikon.
18 FAT (Forschungsanstalt für Agrarwirtschaft und Landtechnik Tänikon). 1994. Bericht über biologisch bewirtschaftete Betriebe 1992. FAT, Tänikon.
19 FAT (Forschungsanstalt für Agrarwirtschaft und Landtechnik Tänikon). 1995. Bericht über biologisch bewirtschaftete Betriebe 1993. FAT, Tänikon.
20 FAT (Forschungsanstalt für Agrarwirtschaft und Landtechnik Tänikon). 1996. Bericht über biologisch bewirtschaftete Betriebe 1994. FAT, Tänikon.
21 BMLF (Bundesministerium für Land- und Forstwirtschaft). 1994. Grüner Bericht. Bericht über die Lage der österreichischen Landwirtschaft 1993. BMLF, Wien.
22 BMLF (Bundesministerium für Land- und Forstwirtschaft). 1995. Grüner Bericht. Bericht über die Lage der österreichischen Landwirtschaft 1994. BMLF, Wien.
23 BMLF (Bundesministerium für Land- und Forstwirtschaft). 1996. Grüner Bericht. Bericht über die Lage der österreichischen Landwirtschaft 1995. BMLF, Wien.
24 BMLF (Bundesministerium für Land- und Forstwirtschaft). 1997. Grüner Bericht. Bericht über die Lage der österreichischen Landwirtschaft 1996. BMLF, Wien.
25 BMLF (Bundesministerium für Land- und Forstwirtschaft). 1998. Grüner Bericht. Bericht über die Lage der österreichischen Landwirtschaft 1997. BMLF, Wien.
26 BMLF (Bundesministerium für Land- und Forstwirtschaft). 1999. Grüner Bericht. Bericht über die Lage der österreichischen Landwirtschaft 1998. BMLF, Wien.
27 BMLFUW (Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft). 2000. Grüner Bericht. Bericht über die Lage der österreichischen Landwirtschaft 1999. BMLFUW, Wien.
28 BMELF (Bundesministerium für Ernährung, Landwirtschaft und Forsten). 1990. Agrarbericht 1990. Agrar- und ernährungspolitischer Bericht der Bundesregierung. Drucksache 11/6387. BEMLF, s.l.
29 BMELF (Bundesministerium für Ernährung, Landwirtschaft und Forsten). 1991. Agrarbericht 1991. Agrar- und ernährungspolitischer Bericht der Bundesregierung. Drucksache 12/70. BEMLF, s.l.
30 BMELF (Bundesministerium für Ernährung, Landwirtschaft und Forsten). 1992. Agrarbericht 1992. Agrar- und ernährungspolitischer Bericht der Bundesregierung. Drucksache 12/2038. BEMLF, s.l.
31 BMELF (Bundesministerium für Ernährung, Landwirtschaft und Forsten). 1993. Agrarbericht 1993. Agrar- und ernährungspolitischer Bericht der Bundesregierung. Drucksache 12/4257. BEMLF, s.l.
32 BMELF (Bundesministerium für Ernährung, Landwirtschaft und Forsten). 1994. Agrarbericht 1994. Agrar- und ernährungspolitischer Bericht der Bundesregierung. Drucksache 12/6750. BEMLF, s.l.
33 BMELF (Bundesministerium für Ernährung, Landwirtschaft und Forsten). 1995. Agrarbericht 1995. Agrar- und ernährungspolitischer Bericht der Bundesregierung. Drucksache 13/400. BEMLF, s.l.
34 BMELF (Bundesministerium für Ernährung, Landwirtschaft und Forsten). 1996. Agrarbericht 1996. Agrar- und ernährungspolitischer Bericht der Bundesregierung. Drucksache 13/3680. BEMLF, s.l.
35 BMELF (Bundesministerium für Ernährung, Landwirtschaft und Forsten). 1997. Agrarbericht 1997. Agrar- und ernährungspolitischer Bericht der Bundesregierung. Drucksache 13/6868. BEMLF, s.l.
36 BMELF (Bundesministerium für Ernährung, Landwirtschaft und Forsten). 1998. Agrarbericht 1998. Agrar- und ernährungspolitischer Bericht der Bundesregierung. Drucksache 13/9823. BEMLF, s.l.
37 BMELF (Bundesministerium für Ernährung, Landwirtschaft und Forsten). 1999. Agrarbericht 1999. Agrar- und ernährungspolitischer Bericht der Bundesregierung. Drucksache 14/347. BEMLF, s.l.
38 BMELF (Bundesministerium für Ernährung, Landwirtschaft und Forsten). 2000. Agrarbericht 2000. Agrar- und ernährungspolitischer Bericht der Bundesregierung. Drucksache 14/2672. BEMLF, s.l.
39 Offermann, F. and Nieberg, H. 2000. Economic Performance of Organic Farms in Europe. University of Hohenheim, Department of Farm Economics, Stuttgart.
40 Statistik Austria. 1998. Feldfruchtproduktion 1998 nach politischen Bezirken. Schriftliche Mitteilung des Referats Pflanzliche Produktion. Statistik Austria, Wien.
41 Statistik Austria. 1999. Feldfruchtproduktion 1999 nach politischen Bezirken. Schriftliche Mitteilung des Referats Pflanzliche Produktion. Statistik Austria, Wien.
42 Statistik Austria. 2000. Feldfruchtproduktion 2000 nach politischen Bezirken. Schriftliche Mitteilung des Referats Pflanzliche Produktion. Statistik Austria, Wien.
43 Kaliski, O. and Kratochvil, R. 2001. Regional- und volkswirtschaftliche Aspekte einer regionalen Umstellung auf den Biologischen Landbau am Beispiel der Region Mostviertel-Eisenwurzen. Vorläufiger Endbericht. Institut für Ökologischen Landbau der Universität für Bodenkultur, Wien.
44 Kirchgessner, M. 1997. Tierernährung. Leitfaden für Studium, Beratung und Praxis. Verlags Union Agrar, München.
45 Jeroch, H., Drochner, W., and Simon, O. 1999. Ernährung landwirtschaftlicher Nutztiere: Ernährungsphysiologie, Futtermittelkunde, Fütterung. Ulmer, Stuttgart.
46 BMLF (Bundesministerium für Land- und Forstwirschaft). 1999. Standarddeckungsbeiträge für den Biologischen Landbau 1999/2000. BMLF, Wien.
47 BMLFUW (Bundesministerium für Land- und

Forstwirtschaft). 2000. Standarddeckungsbeiträge und Daten für die Betriebsberatung 1999/2000/2001. Ausgabe Ostösterreich. BMLFUW, Wien.

48 LBL (Landwirtschaftliche Beratungszentrale Lindau) (eds). 2000. Betriebsplanung. LBL, Lindau.

49 FAO (Food and Agriculture Organization). 2001. FAOSTAT Nutrition Data. Food Balance Sheet. Available at Web site: http://apps.fao.org/lim.500/wrap.pl?FoodBalanceSheet&Domain=FoodBalanceSheet&Language=english (verified 17 August 2001).

50 FDG (Forschung im Dienst der Gesundheit). 1991. Die Nationale Verzehrsstudie. Ergebnisse der Basisauswertung. Wirtschaftsverlag NW, Bremerhaven.

51 Cleveland, L.E., Cook, D.A., Krebs-Smith, S.M., and Friday, J. 1997. Method for assessing food intakes in terms of servings based on food guidance. American Journal of Clinical Nutrition 65:1254–1263.

52 Elmadfa, I. (ed.). 1998. Österreichischer Ernährungsbericht 1998. Bundesministerium für Frauenangelegenheiten und Verbraucherschutz, Bundesministerium für Arbeit, Gesundheit und Soziales, Wien.

53 Elmadfa, I. and Leitzmann, C. 1998. Ernährung des Menschen. Eugen Ulmer, Stuttgart.

54 DACH (Deutsche Gesellschaft für Ernährung, Österreichische Gesellschaft für Ernährung, Schweizerische Gesellschaft für Ernährung, Schweizerische Vereinigung für Ernährung). 2000. Referenzwerte für die Nährstoffzufuhr. Umschau Braus, Frankfurt am Main.

55 Buhmann, C. and Berweger, T. 2001. Lebensmittel-Pyramide. Ausgewogen essen. Midena und Fona, Lenzburg.

56 US FDA (United States Food and Drug Administration). 2001. Nutrition and your Health. Dietary Guidelines for Americans. Available at Web site: http://www.csfan.fda.gov/~dms/utguide.html (verified 31 May 2001).

57 Hahn, A. 2001. Nahrungsergänzungsmittel. Wissenschaftliche Verlagsgesellschaft, Stuttgart.

58 WHO (World Health Organization). 1998. Preparation and Use of Food-based Dietary Guidelines. WHO Technical Report Series 880. WHO, Geneva.