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Intensity of Agricultural Land Use

The larger the amount of fertilizers and pesticides used, and the greater the number of livestock kept, the higher the pressure exerted on biodiversity.
Recording crop plant yields in kilograms per hectare and numbers of farm animals in livestock units (LUs) per hectare, the E7 indicator reflects the intensity of use to which Switzerland's agricultural land is subjected.
The indicator covers kilogram-per-hectare yields of the seven crop plants most widely cultivated in Switzerland, e.g. wheat, barley and potatoes. However, this only provides a rough idea of land use intensity, since crop yields may also be influenced by other factors such as climate, soil fertility, selected varieties, or pest infestation. Throughout all crop plants covered, yields tend to be growing in the long term.
Livestock numbers, too, can only give an approximate indication of land use intensity, since the latter is also determined by the breeds and the method of animal husbandry each farmer chooses. Between 1999 and 2011, the number of farm animals—expressed in livestock units—has increased by 4.3% in Switzerland as a whole.

Status: April 2013

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Using large amounts of fertilizer in plant production or keeping large numbers of farm animals causes biodiversity to decline. The intensity of agricultural land use is assessed by crop yields in kilograms per hectare and by livestock units (LUs) per hectare. However, it must be borne in mind that crop yields are not only determined by the use of fertilizers, but also by weather conditions and varieties grown.

Development in Switzerland

Plant production

Figures 1 to 7 below illustrate yields per hectare of the seven crop plants most frequently cultivated in Switzerland, indicating annual means as of 1975 (1985 for triticale). Curves represent moving averages formed over past periods of five years each, with—consequently—first values computed for 1979 and 1989 respectively. Using the averaging approach smoothes fluctuations due to weather and other causes, allowing the general trend of land use intensity to emerge more clearly.

Fig. 1: Wheat yields in Switzerland 1975-2011 (moving averages formed over 5 years each)

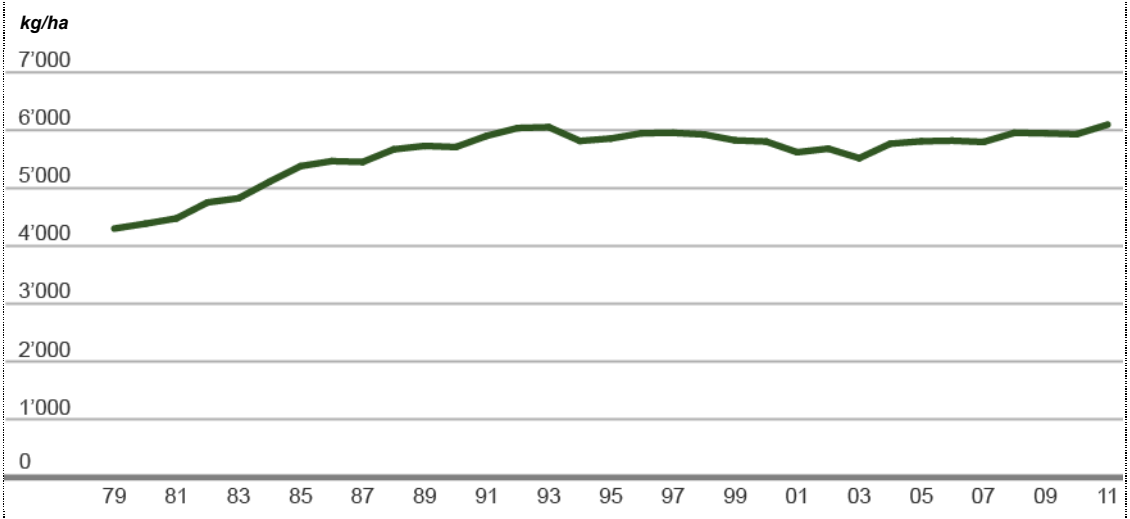

Fig. 2: Barley yields in Switzerland 1975-2011 (moving averages formed over 5 years each)

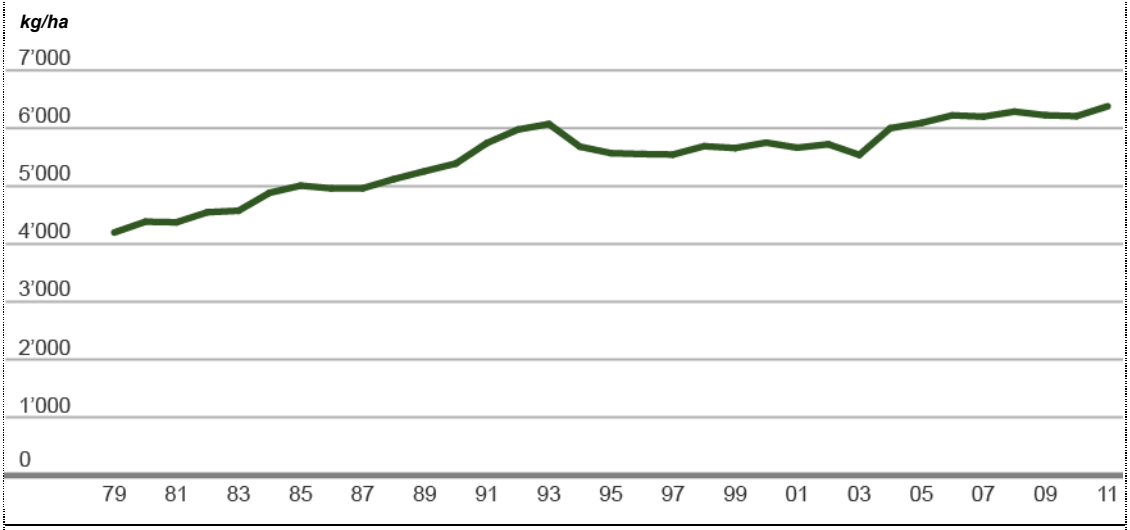

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Fig. 3: Triticale yields in Switzerland 1985-2011 (moving averages formed over 5 years each)

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Fig. 4: Corn yields in Switzerland 1975-2011 (moving averages formed over 5 years each)

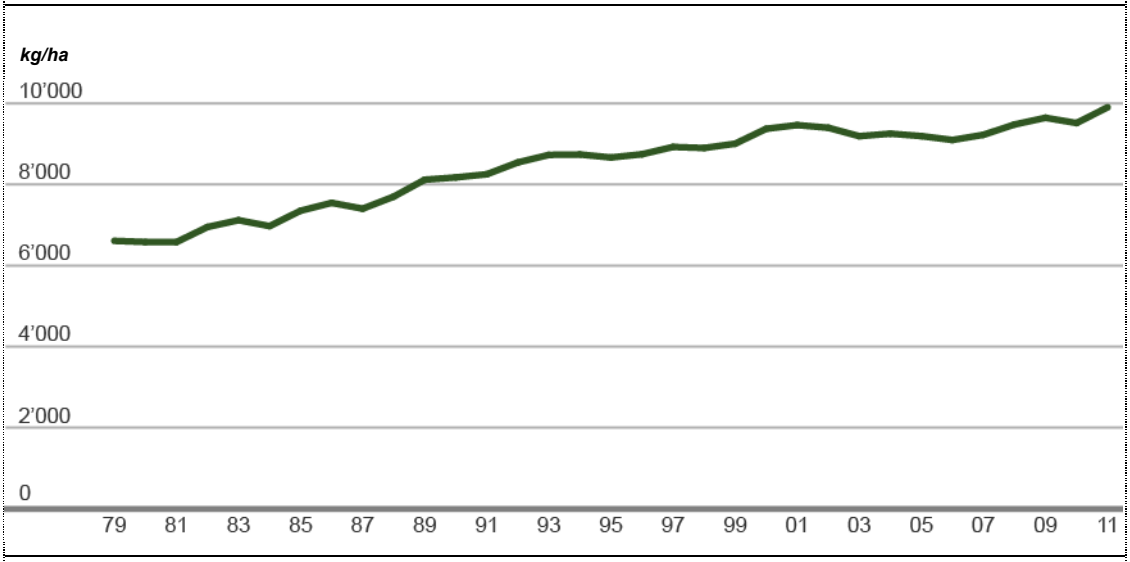


Fig. 5: Potato yields in Switzerland 1975-2011 (moving averages formed over 5 years each)

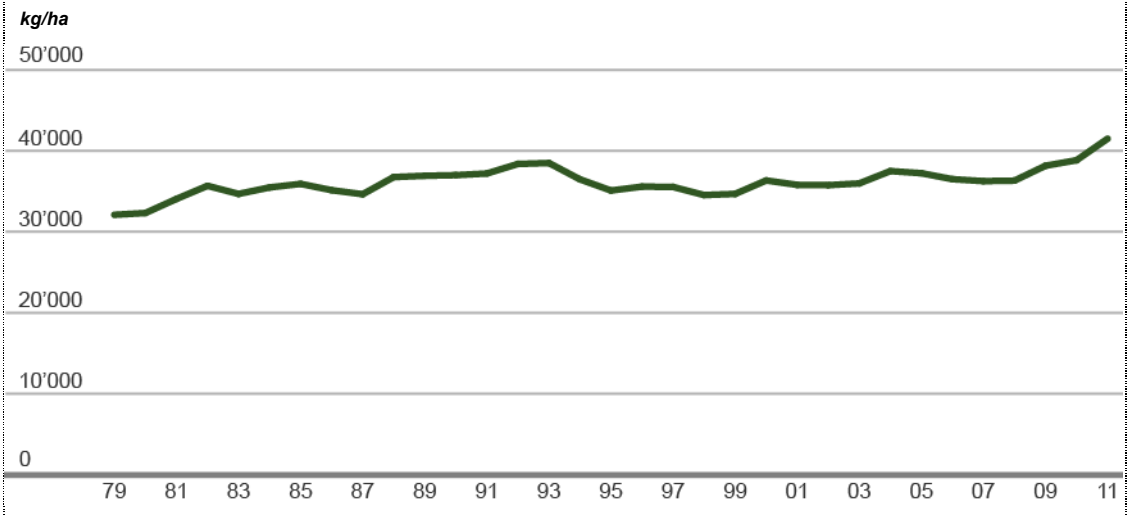


Fig. 6: Sugar beet yields in Switzerland 1975-2011 (moving averages formed over 5 years each)

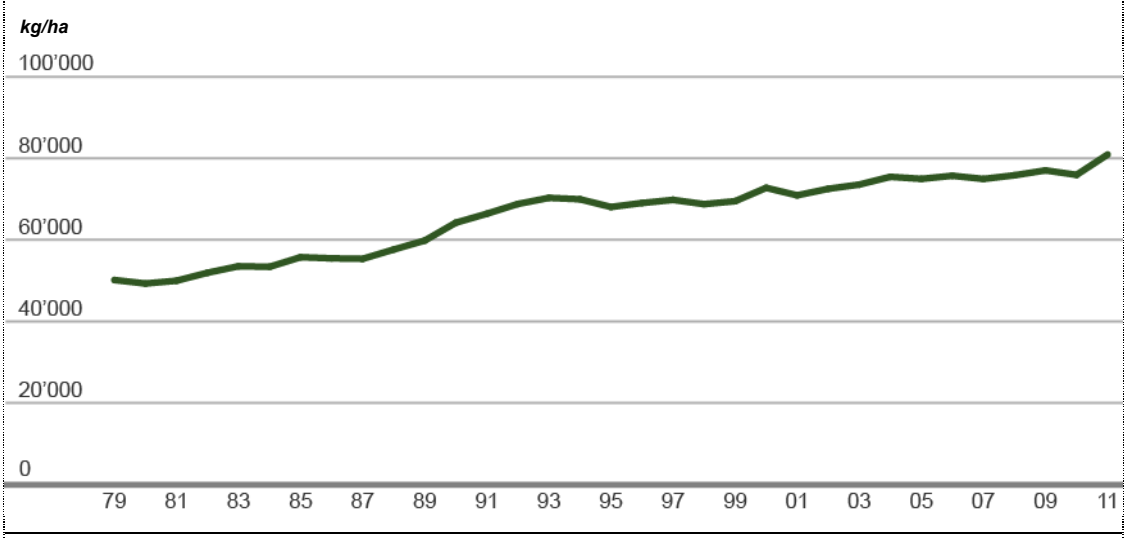
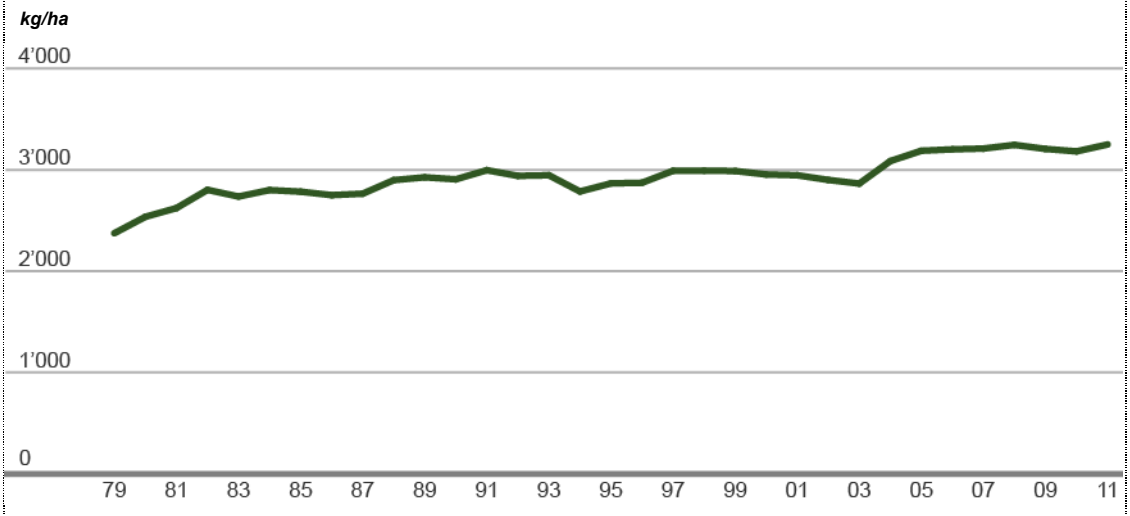


Fig. 7: Rapeseed yields in Switzerland 1975-2011 (moving averages formed over 5 years each)



Comments

- Compared to one hundred years ago, yields of Switzerland's major crops have more than doubled due to optimized cultivation techniques, new varieties bred for greater yield potential, improved nutrient supply and more intense plant protection measures. Since the 1990s, yields have not only been increasing less markedly, but in some years, they even slightly declined with regard to certain crops such as wheat, potatoes or triticale.
- Between 1975 and 1990, mean wheat and barley yields per hectare increased by roughly a third. In the 1990s, yields of both crops remained at similar levels. In recent years, however, yields of all crops

have been growing again, albeit to a varying extent. The most marked increase has been recorded for sugar beet yields.

- 1992 marked the introduction of extensive cereal cultivation (pursuant to art. 55 of the Swiss Ordinance on Direct Payments). These so-called “extenso” cereals are characterized by lower yields than cereals grown conventionally. Cultivating extenso cereals may affect curve shapes, given the fact that it has consistently been making up 40% to 50% of Switzerland’s cereal cultivation areas since 1996.
- At first glance, potato yields per hectare have been changing only little for roughly 20 years. However, mean potato yields in the first five years covered by statistics (1975-1979) are 23% lower than yields reported for the last five years (2007-2011).
- Sugar beet yields have been increasing in an almost continuous fashion.
- In 2011, the most widely grown crop plants took up 207’312 hectares, covering somewhat more than half of Switzerland’s arable land (403’815 hectares) and roughly one fifth of the utilized agricultural area (1.05 million hectares). Specifically, Swiss farmers grow 82’707 hectares of food grain, 62’565 hectares of feed grain, 31’485 hectares of root crops, 25’698 hectares of oilseeds, 3’859 hectares of legumes, and 998 hectares of renewable raw materials (provisional 2011 figures from the 2012 FOAG Report on Agriculture).

Livestock numbers

Switzerland's Clean Water Act (CWA) indirectly determines maximum numbers of livestock, since it stipulates the quantity of solid and semi-liquid manure farmers are allowed to distribute on their land, i.e. three fertilizer livestock units (FLUs) per hectare (art. 14 of the CWA). One FLU approximately corresponds to the volume of solid and semi-liquid manure a cow weighing 650 kilograms (= 1 LU) produces per year. At 1.20 LUs/ha (2011), average livestock numbers are distinctly below that limit. However, in certain regions and on certain farms, the CWA limit is exceeded in a significant manner.

Under the Clean Water Act, cantons are required to reduce the admissible number of FLUs whenever the local soil carrying capacity, the altitudinal zone, or topographic conditions call for it. The need for assessing livestock farms as regards possible FLU reduction is determined by FLU guidance values which have been established for each region. The FLU guidance value is 2.5 FLUs/ha in the plains, 1.8 to 2.1 FLUs/ha in the hills, and 1.1 to 1.4 FLUs/ha in the mountains.

Table 1 below lists numbers of livestock per hectare of utilized agricultural area in Switzerland. For annual means of all cantons, please refer to "Development in the regions".

Tab. 1: Mean livestock numbers in Switzerland, expressed in livestock units per hectare

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Switzerland	1.15	1.14	1.14	1.15	1.14	1.14	1.15	1.16	1.16	1.24	1.19	1.20	1.20

Comment

Average livestock numbers changed only little from 1999 to 2007, even though they have been tending to increase in recent years. What strikes the eye is the 0.08 LU leap between 2007 and 2008 followed by a 0.05 LU decline in 2009. In 2010, average livestock numbers reincreased by 0.01 LU per hectare.

Status

April 2013. E7 data are updated each year based on the latest statistics supplied by the Agroscope Reckenholz-Tänikon ART federal research station and the Federal Office for Agriculture.

Development in the regions

Plant production by altitudinal region

Figures 8 to 14 below illustrate yields of Switzerland's seven most important crop plants calculated by agricultural region, i.e. plains, hills, and mountains. However, since some of these crops are hardly or not ever grown in the hills and/or mountains, the E7 indicator only consider means based on data gathered on at least twenty farms.

Fig. 8: Wheat yields in the regions 1975-2011 (moving averages formed over 5 years each)

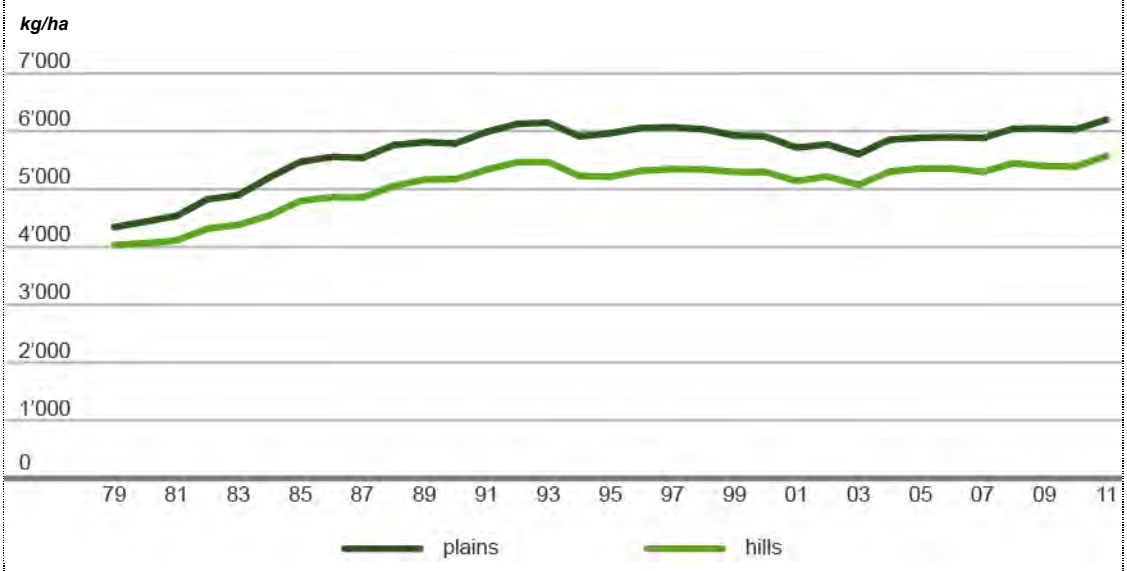


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Fig. 9: Barley yields in the regions 1975-2011 (moving averages formed over 5 years each)

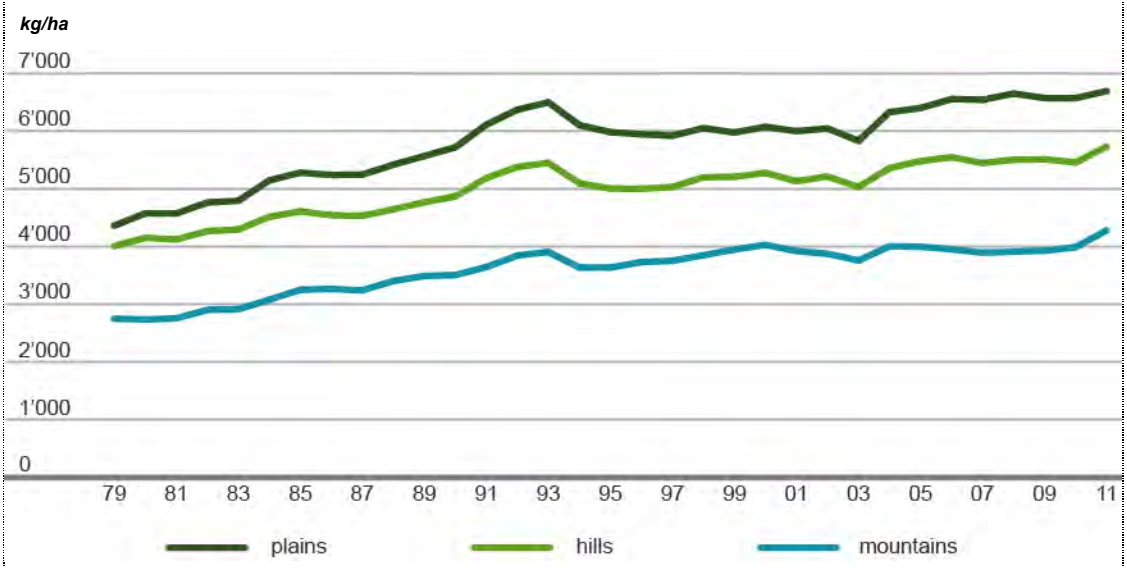

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Fig. 10: Triticale yields in the regions 1985-2011 (moving averages formed over 5 years each)

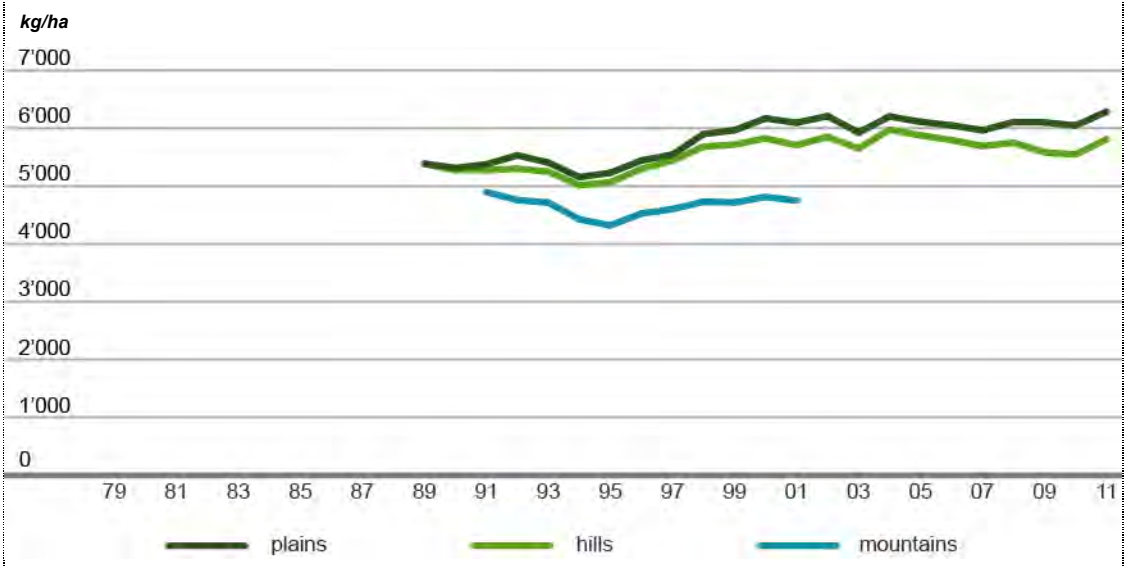

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Fig. 11: Corn yields in the plains 1975-2011 (moving averages formed over 5 years each)

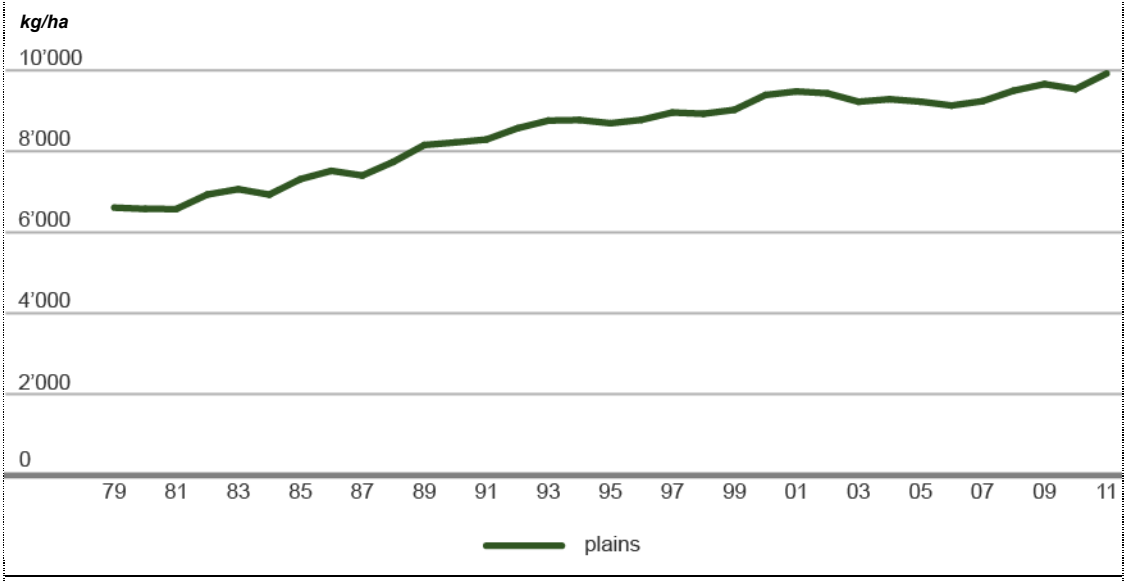

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Fig. 12: Potato yields in the regions 1975-2011 (moving averages formed over 5 years each)

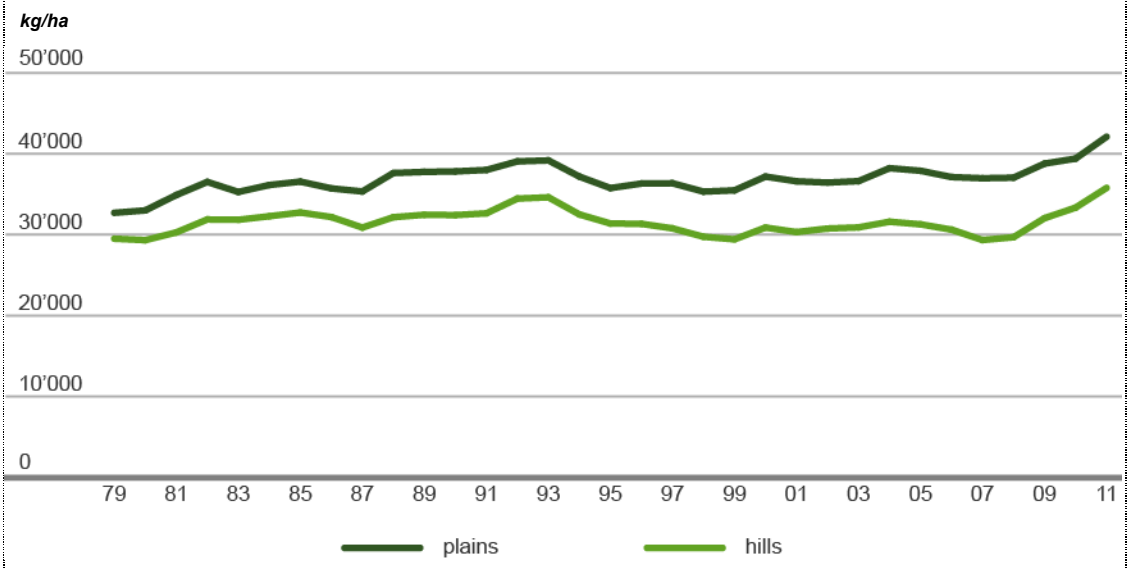

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Fig. 13: Beet root yields in the plains 1975-2011 (moving averages formed over 5 years each)

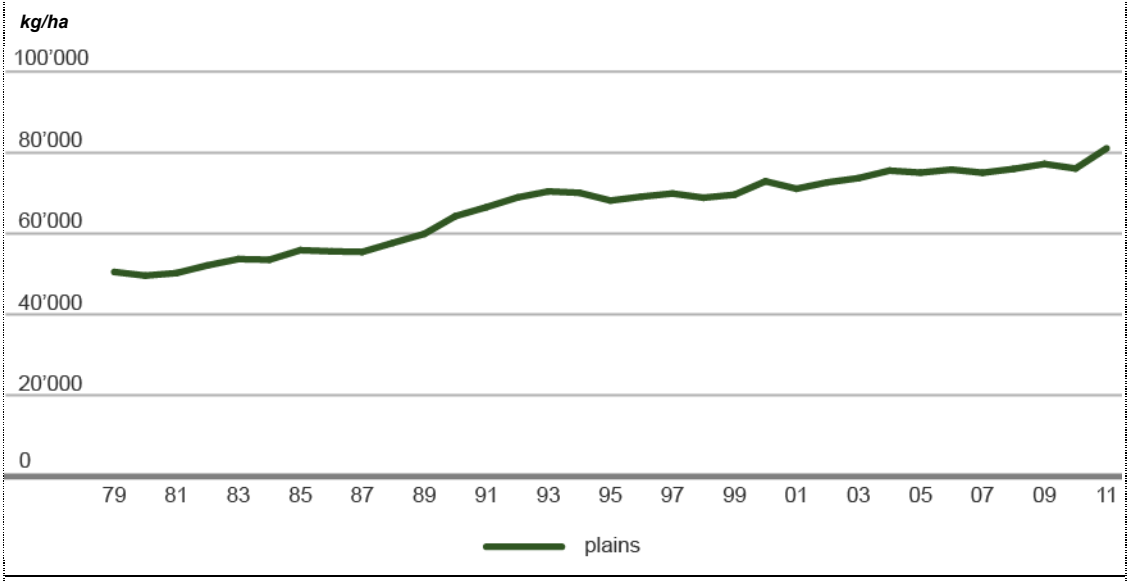

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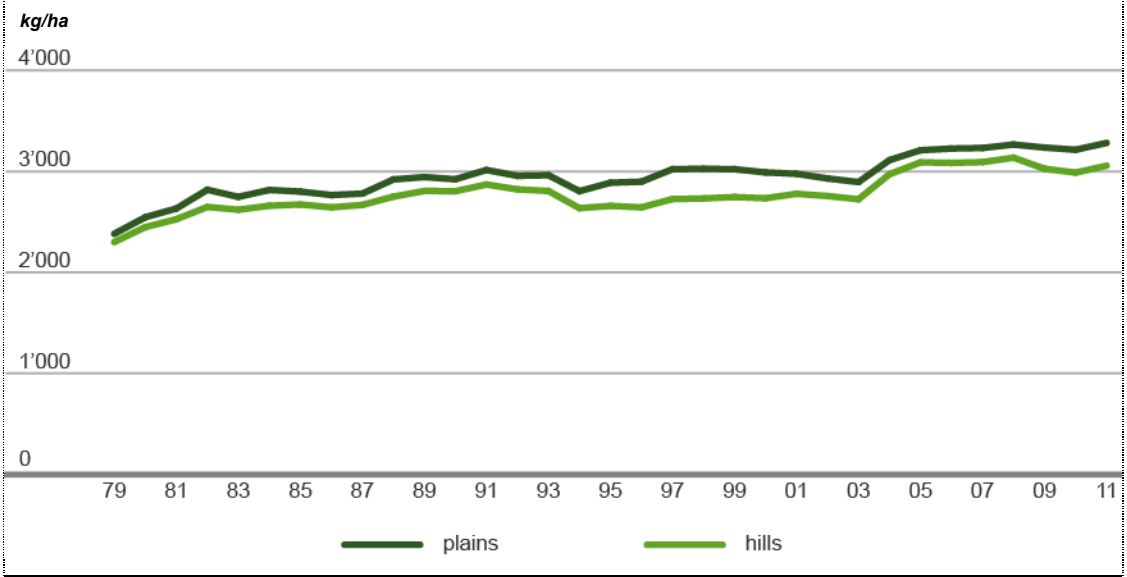
Fig. 14: Rapeseed yields in the regions 1975-2011 (moving averages formed over 5 years each)



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Comments

- Due to climatic differences, yields in the hills and mountains are lower than yields in the plains.
- In the period under review, yield curves have been found to take one of roughly three different shapes: They either present a more or less continuous increase (corn, beet root), or they show yields to always vary to a similar extent (potatoes) even though on the whole, they have been increasing compared to initial values (1975-79 mean) mainly owing to rising yields in recent years, or they display upsurges

intermixed with constant phases or even declines, followed by another yield increase (rapeseed, barley, wheat). While it is not quite clear what causes these differing curve shapes, they might reflect cultivation efforts, climate fluctuations and extensive cultivation methods (cereals and rapeseed) on the one hand, or the use of mineral fertilizers and plant protection agents on the other.

- As regards wheat and rapeseed, yields have developed in parallel in all regions. Triticale yields, however, only increased in the plains and hills, until finally the sample size of farms participating in the survey in the mountains dropped below n=20 in 2002. In recent years, overall yields have been increasing again slightly after tending to stagnate or even decline somewhat in the noughties. Barley, too, had been following a slightly different trend in the mountains compared to plains and hills, as increases first fell behind and then leveled off or even turned into decreases. The latest data, however, reveal no difference anymore.
- Potato yields have been growing both in the plains and in the hills, with the difference in yields continuously increasing until recently, when it redeclined to some extent.
- Corn yields in Switzerland's agricultural regions mostly correspond to corn yields generated in the plains, causing nationwide and plains curves to be practically identical. A similar situation is observed regarding beet root.

Livestock numbers

Table 2 below lists livestock numbers in Switzerland's individual cantons expressed in livestock units per hectare of a canton's utilized agricultural area.

Tab. 2: Livestock numbers in the cantons (in LUs per hectare)

Cantons	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AG	1.13	1.13	1.14	1.14	1.12	1.14	1.17	1.18	1.18	1.21	1.21	1.22	1.23
AI	1.85	1.82	1.81	1.83	1.84	1.84	1.86	1.87	1.91	1.97	1.92	1.93	1.90
AR	1.42	1.46	1.45	1.44	1.46	1.45	1.47	1.48	1.45	1.52	1.50	1.50	1.49
BE	1.25	1.21	1.20	1.22	1.22	1.23	1.23	1.24	1.24	1.33	1.27	1.27	1.27
BL/BS	1.02	1.05	0.95	0.96	0.94	0.93	0.95	0.97	0.98	1.00	0.99	0.99	0.97
FR	1.26	1.22	1.22	1.23	1.23	1.27	1.28	1.29	1.30	1.38	1.32	1.33	1.32
GE	0.24	0.22	0.24	0.22	0.22	0.21	0.21	0.22	0.22	0.23	0.22	0.20	0.19
GL	1.01	1.01	1.03	1.02	0.97	1.03	1.03	1.03	1.08	1.24	1.07	1.09	1.07
GR	0.81	0.78	0.77	0.77	0.77	0.74	0.75	0.75	0.76	0.91	0.76	0.77	0.76
JU	0.86	0.86	0.88	0.91	0.89	0.88	0.90	0.90	0.91	0.97	0.93	0.93	0.92
LU	1.86	1.90	1.93	1.95	1.95	1.95	1.95	1.99	1.99	2.03	2.03	2.05	2.05
NE	0.78	0.76	0.79	0.79	0.79	0.77	0.78	0.79	0.77	0.82	0.85	0.86	0.86
NW	1.72	1.67	1.68	1.68	1.65	1.62	1.64	1.65	1.63	1.74	1.64	1.64	1.65
OW	1.52	1.51	1.51	1.52	1.51	1.51	1.53	1.54	1.57	1.75	1.54	1.55	1.54
SG	1.59	1.58	1.60	1.59	1.60	1.62	1.66	1.66	1.61	1.75	1.70	1.70	1.72
SH	0.65	0.69	0.70	0.71	0.69	0.68	0.70	0.72	0.73	0.75	0.73	0.74	0.76
SO	1.03	1.01	1.03	1.03	1.04	1.00	1.02	1.03	1.03	1.06	1.06	1.06	1.06
SZ	1.35	1.31	1.32	1.31	1.30	1.29	1.30	1.32	1.30	1.41	1.31	1.30	1.31
TG	1.60	1.62	1.62	1.63	1.59	1.61	1.63	1.66	1.68	1.71	1.73	1.76	1.77
TI	0.69	0.68	0.68	0.70	0.68	0.66	0.66	0.65	0.65	0.76	0.60	0.62	0.63
UR	1.08	1.05	1.02	1.04	1.03	1.02	1.04	1.01	1.02	1.22	1.01	1.01	0.99
VD	0.67	0.67	0.69	0.66	0.65	0.64	0.63	0.65	0.65	0.71	0.67	0.66	0.66
VS	0.59	0.57	0.59	0.60	0.60	0.62	0.61	0.62	0.62	0.74	0.63	0.65	0.64
ZG	1.51	1.52	1.53	1.53	1.50	1.50	1.49	1.51	1.56	1.62	1.60	1.60	1.60
ZH	0.97	0.96	0.95	0.94	0.93	0.91	0.92	0.93	0.92	0.97	0.96	0.96	1.01

Comments

- Some cantons in Central Switzerland (LU, NW, OW, ZG) and Eastern Switzerland (SG, AI, TG) feature a large percentage of big livestock farms. In these cantons, livestock numbers exceed 1.5 livestock units per hectare.
- Geneva, Schaffhausen and Waadt are home to many farms specializing in crop farming or growing special crops and keeping only a small number of animals or none at all. As a result, livestock numbers in these cantons are low, amounting to only 0.2 to 0.7 LU per hectare.
- Both in the Alpine cantons of Graubünden, Wallis and Tessin and in the Jura region cantons of Jura, Neuenburg and Waadt, livestock numbers were below one livestock unit per hectare in 2009.
- While livestock limits are sometimes being exceeded at a community or regional level, these exceedances cannot be extracted from cantonal data.
- Against 2007, 2008 livestock numbers have increased in all cantons by an average 0.08 LU/ha of the utilized agricultural area (UAA). Percent increases were found to be temporarily substantial in some cantons, with Graubünden in the lead at 19.7%, followed by Uri (19.6%), Wallis (19.4%), Tessin (16.9%) and Glarus (14.8%). In other words, livestock numbers primarily augmented in Alpine cantons, which raises some concern from a biodiversity point of view.
- In 2009, however, livestock numbers temporarily declined again by 0.05 LU per hectare of the UAA both on a national level and in most cantons, only to reincrease in 2010. Cantons to deviate from this trend were Neuenburg and Thurgau, where numbers keep increasing, and Aargau and Luzern, where numbers stayed the same.
- In 2011, livestock numbers recorded in 11 cantons declined against the previous year, with Appenzell Innerhoden showing the most marked drop at 0.03 LU/ha. At the other end of the spectrum, St. Gallen registered an increase of 0.02 LU/ha in the same period of time. In 2000, livestock numbers in that canton had resulted in 1.58 LUs/ha of the UAA, a figure that increased to 1.72 LUs/ha by 2011.

Status

April 2013. E7 data are updated each year based on the latest statistics supplied by the Agroscope Reckenholz-Tänikon ART federal research station and the Federal Office for Agriculture.

Significance for biodiversity

Wherever agricultural land use is intensified, biodiversity tends to suffer. Intensively using fertilizers and pesticides or keeping large numbers of livestock depletes grasslands. However, the E7 indicator can only provide a rough representation of land use intensity, since crop yields and livestock numbers are influenced by other factors as well.

Yields of Switzerland's major crops have been dramatically boosted within the last hundred years. Not until the 1990s did the parameters of agricultural policy change, with environmental awareness growing among the general public. Farmers began to accept lower yields in favor of sustainable land use, and direct payments from the federal government were introduced to make up for financial losses caused by these lower yields. Once new farming methods such as integrated production (1993), proof of ecological performance (1999), organic farming, or extensive cultivation of cereals (1992) were being subsidized, they reduced the use of nutrients like nitrogen, phosphorus and potassium, resulting in more moderate yield growth rates. In return, restrained use of fertilizers and pesticides, complemented by small-scale fields and heterogeneous farming, favors biodiversity.

But it is not always yield reduction that does it: Even though originally aimed at increasing yields, quite a few new farming methods just happen to promote biodiversity as well. For example, unlike thirty years ago, corn is no longer sown on bare soils, but on soils covered with so-called companion plants. Contributing to structural diversity, such plants provide food and habitats for small animals.

Analyses of Z9 ("Species Diversity in Habitats") indicator data will show whether the change in farming methods has indeed managed to increase biodiversity on arable land.

From 1999 until 2006, livestock numbers in Switzerland hardly changed, continually fluctuating between 1.14 and 1.16 LUs/ha of the UAA. In 2008, however, livestock numbers increased significantly to 1.24 LUs/ha of the UAA. Even though numbers declined to 1.19 LUs/ha of the UAA in 2009, they reincreased by 0.01 LUs the very next year and have remained considerably higher than in 1999 ever since. Yet biodiversity would benefit from smaller livestock numbers, since aside from lower feed imports, fewer cattle mean less trampling damage and less nitrogen (semi-liquid manure) in the soil (cf. indicator E6 "Nutrient Supply in the Soil"), which is likely to increase plant diversity. Again, analyses of Z9 indicator data will clarify this issue.

Grazing in itself is not essentially bad for biodiversity, as it creates valuable habitats. Grazing cows, sheep, or goats slow down forest encroachment of semi-open landscapes (e.g. on forest pastures), which harbor a high diversity of typical species.

Purchasing additional feedstuffs, however, is problematic not only because of its effect in Switzerland, where fertilizer balances are being upset, but also because of its negative environmental impact in feed producing countries. In Brazil, for example, soybeans are grown at the expense of near-natural ecosystems. As calculated by Bossard et al. (2010), concentrates imported by Swiss farmers require 200,000 to 250,000 hectares of arable land abroad, an area almost equal to Switzerland's total arable land of roughly 280,000 hectares. Except for the period of 2004 to 2006, the amount of feedstuffs imported into this country has kept increasing for the past 25 years.

Definition

Changes in the yields of various selected crop plants in relation to the corresponding areas under cultivation, and changes in livestock numbers in relation to utilized agricultural areas.

Various commercially significant crop plants are monitored individually.

Numbers of farm animals are converted into livestock units (LUs).

Surveying methods

Plant production

Mean yields are reported in kilograms per hectare. Yields are calculated for Switzerland as a whole and for its agricultural regions.[1] For this purpose, seven widely cultivated crop plants were selected: wheat, barley, triticale, corn, potatoes, sugar beet and rapeseed. In 2005, these crops were grown on roughly 50% of the country's arable land. As some of these crops are hardly or not at all cultivated in the hills and mountains, the indicator reports only means based on data gathered on at least twenty farms.

Plant production data are extracted from a sample: Roughly 3,500 of a total of more than 60,000 farms subsidized with direct payments by the federal government annually send their farm accounting data to the Agroscope Reckenholz-Tänikon ART federal research station. In charge of the central analysis of farm accounting data, the ART reports on the economic development based on reference farms. Reference farms are not selected at random, since no farmer can be bound to keeping detailed records.

As farms are not selected randomly but rather by proportionally stratified quota sampling, normal data distribution cannot be guaranteed, so confidence intervals will not be computed.

Curves represent moving averages formed over 5 years each.

Livestock numbers

Numbers of farm animals are converted into livestock units (LUs; 1 LU ≈ 1 cow weighing 650 kilograms) and reported in relation to hectares of utilized agricultural area in order to arrive at mean livestock numbers (stocks) per hectare (LUs/ha of the UAA). Conversion factors for each species of farm animal are determined by the Swiss Ordinance on Agricultural Terminology (OAT) depending on the amount of nitrogen and phosphorus produced by each species. LUs/ha measure the intensity of animal husbandry.

Livestock data are extracted from a nationwide farm survey established by the Federal Office for Agriculture FOAG and the Federal Statistical Office FSO, listing details on the breeds and numbers of farm animals kept on each farm. Evaluations made by the federal offices are based on standardized questionnaires that must be filled in by farmers. Their statements, which refer to an appointed day in early May, are verified by national and cantonal authorities and managed in the FOAG's central database.

Livestock numbers are calculated for Switzerland as a whole and for individual cantons. They have been established for the period under review starting in 1999.

[1] Article 2 of the Swiss Ordinance on Agricultural Zones lists the criteria used for demarcating agricultural zones. These zones have been grouped into the following three regions:

- plains: plains zone

- hills: hill zone, mountain zone I

- mountains: mountain zones II to IV

Further information

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Related indicators

> M4 “Ecological Compensation Areas”

> M5 “Areas Farmed Organically”

Additional sources of information

> www.blw.admin.ch/index.html?lang=en website of the Federal Office for Agriculture FOAG

> http://www.blw.admin.ch/dokumentation/00018/00498/index.html?lang=en summary of the 2012 Agricultural Report

> www.agroscope.admin.ch/org/index.html?lang=en website of the Agroscope research stations for agriculture, nutrition and the environment

> www.admin.ch/ch/d/sr/910_91/app1.html conversion table for livestock units (not available in English)

> www.admin.ch/ch/d/sr/814_20 Clean Water Act (not available in English)

> www.admin.ch/ch/d/sr/910_13/index.html Ordinance on Direct Payments (not available in English)

> www.admin.ch/ch/d/sr/912_1/index.html Ordinance on Agricultural Zones (not available in English)

> www.visionlandwirtschaft.ch Analyses and propositions regarding Switzerland’s agricultural policy (no information in English)

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> Bosshard, A.; Schläpfer, F.; Jenny, M. 2010: Weissbuch Landwirtschaft Schweiz. Haupt, Bern. 212 S.

This information is based on the German-language document 1010_E7_Basisdaten_2011_v1.doc dated April 24, 2013.