Reduction of the environmental risks of fertilisers and pesticides

Swiss Agency for the Environment, Forests and Landscape SAEFL

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Full version of the report adopted by the Swiss Federal Council on 21 May 2003

English translation of the original German-language report of 2003

Published by the Swiss Agency for the Environment, Forests and Landscape SAEFL
Berne, 2005

Availability

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PART I: INTRODUCTION

1 Task: Motion 94.3005 of UREK-S (Committee for Environment, Regional Planning and Energy of the Council of States)

1.1 Revision of the Law on Environmental Protection (LEP)

With the proposed amendment to the *Law relating to the Protection of the Environment (LPE) of 7 June 1993,* the Swiss Federal Council proposed in a can formulation the introduction of incentive taxes on mineral fertilisers and surplus farm manure - both because of their environmentally relevant N [nitrogen] and P [phosphorus] content -, and on plant protection products (PPPs). Parliament did not want incentive taxes on stocks, but acknowledged the Federal Council's request in the form of a motion (Motion 94.3005 of the Committee for Environment, Regional Planning and Energy of the Council of States, CERPE-S).

Wording of the motion of 27 January 1994:

> "The Federal Council is charged with laying before parliament within five years a bill on the introduction of incentive taxes on mineral fertilisers, surplus manure and plant protection products, should the recently introduced environmental and agricultural policy instruments for environmentally compatible management of agriculture fail to have the intended effect. Otherwise the Federal Council shall report to the parliament that the instruments already introduced have achieved the intended effect."

1.2 Purpose of the motion

The referred motion takes up the Federal Council's intention which it expressed in the can formulation. The Federal Council was also of the opinion that these incentive taxes should only be introduced if it should prove impossible to reduce environmental pollution sufficiently by means of the measures contained in the *Law on Agriculture (LAgr, SR 910.1),* the *Water Protection Law (LWP, SR 814.20)* and the *Law on Environmental Protection (LEP, SR 814.01,* including the Ordinances relating to Water Protection, to Hazardous Substances and to Air Pollution Control).

The motion further requires a presentation of the effects which have been achieved by means of the agri-ecological instruments for environmentally-friendly management of agriculture (newly introduced legislation for agriculture).

The motion does not define the term "effect". In the context of any incentive taxes, the "achieved effect" means that restricted and selective application of agrochemicals – namely fertilisers and plant protection products (PPPs) – which reduces environmental pollution and prevents the endangering of persons, animals or plants.

This report summarizes and assesses the currently available data for responding to the motion in two separate parts (fertilisers, PPPs).

Current objectives from various reports from the administration and research institutes make it possible to assess the need for, and appropriateness of, incentive taxes on mineral fertilisers, surplus manure[1] and plant protection products.

1.3 From prohibition to a market economy incentive system

1.3.1 Development over time

Since the 1970s, environmental protection and water protection legislation under police law (ordinances and prohibitions) and legislation in agriculture (support legislation) have undergone a change. Efforts regarding agrochemicals (fertilisers, PPPs) were always aimed at reducing inputs into the environment. New findings from agricultural research and advisory services have multiplied the number of measures but also refined them.

It is possible to distinguish three different phases, which overlap in time and supplement each other in terms of scope:

- **Technical environmental protection** (1970s): based on water protection legislation, "technical" environmental protection was carried out in those years with the nationwide introduction of sewage treatment plants and the beginning of the remediation of storage facilities for farm manure (slurry pits). The sewage treatment plants were later equipped with improved purification steps, which mainly brought about a marked reduction in non-agricultural P-input into water bodies.

- **Combating causes, and the polluter pays principle** (1980s): the Law on Environmental Protection (LEP) of 1983 laid the foundation for nationwide environmental protection. The LEP introduced many new instruments for reducing environmental pollution. Maximum emission levels and impact thresholds (air pollution control, soil conservation) are important control criteria. One of the guiding principles of the LEP is the *polluter pays principle* which lays the cost of prevention and remediation on those who cause emissions.

  The Ordinance relating to Hazardous Substances (OHS) of 1986 laid the legal foundation for maximum levels and restrictions on use, e.g. "buffer zones" and bans on use, for the application of fertilisers (farm manures, waste fertilisers and mineral fertilisers) and plant protection products (PPPs). The ban on the use of P for detergents was also introduced in this period (1985).

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1 SAEFL (together with OAGR), *"Strategie zur Reduktion von Stickstoffemissionen"*, Schriftenreihe Umwelt no. 273, 142 pp. (1996).

OAGR, *"Evaluation der Ökomassnahmen und Tierhaltungsprogramme – Zweiter Zwischenbericht"* (in current connection; 167 pp., June 1999).

Braun M. et al., *"Phosphor- und Stickstoffüberschüsse in der Landwirtschaft und Para-Landwirtschaft"*, ISSN 1013-154X, Schriftenr. FAC-Liebefeld no. 18, 70 pp. (1994).

IAW-ETHZ, Institute of Agricultural Economics of the ETHZ, *"Technischer Bericht über die Auswirkungen der Agrarreform auf das Stickstoffverlustpotenzial der Landwirtschaft in der Zeit von 1994 bis 1998"*, 82 pp., abridged version (September 1999).

Agroscope FAL (Agroscope – Swiss Federal Research Station for Agroecology and Agriculture), *"Nährstoffbilanz der schweizerischen Landwirtschaft für die Jahre 1975 bis 1995"*, cf. pp. 21, §3.2, ISBN 3-905608-20-0, Schriftenreihe no. 28 (1999).

Fertiliser application principles[2] are available as a practical implementation aid for assessing fertiliser application questions and for education and training of farmers. They contain *inter alia* recommendations on soil utilisation and soil cover (nitrate problem in groundwater). The fertiliser application principles of that time were created for the agricultural advisory services and the cantonal enforcement authorities.

- **Economic incentive systems** (1990s): the measures of the LEP were supplemented by economic incentive schemes. Incentive taxes were introduced for VOCs [volatile organic compounds] and "extra light" fuel oil in 1997.

  Financial contributions for ecological production methods in agriculture were set up in the agricultural policy AP 2002. The direct payments introduced in the first half of the 1990s were intended to speed up the ecological reorientation in agriculture (cf. Art. 31a and 31b of the former LAgr). The instruments for this were reinforced and differentiated in the new agricultural legislation[3], based on an article of the Federal Constitution (Art. 104 FC).

1.3.2 Co-ordination of federal law provisions

The existing legislation relating to agriculture consists of a tightly woven network of harmonized or co-ordinated decrees and implementation aids (guidelines, principles) of different environmental and agricultural provisions (ODP, OWP, OHS, Guidelines for Water Protection in Agriculture[4]).

The usual provisions laid down in the laws on water protection, (LWP, OWP), environmental protection (OHS, OAPC) and animal protection must be complied with for direct payments. An important requirement regarding N and P is a *balanced nutrient budget for the entire farm holding* laid down in the legislation on agriculture (cf. Art. 70 Para. 1 LAgr in conjunction with Art. 6 ODP and Sect. 2.1 Annex ODP). Fertiliser application plans and fertiliser application according to individual farm site potential are further measures in this direction. Moreover, in the case of PPPs, the LAgr prescribes *ecological selection and targeted application*.

*[**ODP** = Ordinance relating to Direct Payment of 1998;*
***OWP** = Ordinance relating to Water Protection of 1998;*
***OAPC** = Ordinance relating to Air Pollution Control of 1985]*

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2 Agroscope FAL and Agroscope RAC, *"Grundlagen für die Düngung im Acker- und Futterbau – GRUDAF'01" (guidelines for fertiliser application), AGRAR*Forsch., 8, 6, 80 pp. (June 2001).

OAGR, SAEFL, *"Düngen zur richtigen Zeit"*, Merkblatt, BBL-Vertrieb Publikationen, 3003 Berne, Form.-No. 319.012 available in German, French and Italian, 4 pp. (1996).

3 Swiss Federal Council, *"96.060 Botschaft vom 26. Juni 1996 zur Reform der Agrarpolitik: Zweite Etappe (Agrarpolitik 2002)"*, 473 pp., Parts I–IV.

4 OAGR/SAEFL, *"Guidelines for Water Protection in Agriculture – Farm Manure"*, 100 pp. (July 1994).

2 Basic comments on the incentive taxes

2.1 Incentive taxes as an instrument

Direct payments (DP), which depend on *proof of ecological achievement (PEA; German: "ökologischer Leistungsnachweis – ÖLN")*, are an important economic instrument of the new *agricultural policy as from the year 2002 (AP 2002*). They are intended *inter alia* to promote targeted application of PPPs, balanced nutrient budget and environmentally-friendly and sustainable production (cf. the considerations in *Parts II* and *III* of this report).

Incentive taxes on the aforementioned auxiliary substances aimed at reducing environmental pollution would have the following effects:

- The **tax on mineral fertilisers** would be an incentive for more targeted application of mineral fertilisers. Manure would be revalued.
- The **tax on surplus manure** would create incentives to make more use of manure on farmers' own *agricultural land suitable for fertiliser application (LSF).* The direct consequence of this would be that **numbers of livestock** would be adjusted in line with farmers' own or leased LSF.
- The **higher cost of PPPs** would increase users' own interest in complying with environmental provisions and in using PPPs more sparingly (appropriate amount for effect at the right time in the right place). It would support the damage threshold concept (assessment of the need for PPPs case by case) and promote the environmentally-friendly use of PPPs. Finally, farmers would be more interested in expert advice on plant protection.

These effects of environmental law incentive taxes should also have a positive impact in the effective enforcement of agri-ecological conditions (environmentally-friendly substance-related cycles, measured and targeted use of PPPs).

2.2 Original concept for incentive taxes under the LEP

In the proposed amendment to the LPE[5] of 7 June 1993 the following system of taxes was proposed:

- imposition of taxes on imported products and products marketed by domestic manufacturers;
- in the case of manure, they should be geared to surplus amounts under slurry transfer contracts (measured according to cattle manure units CMU[6] or according to their N- and P-content);
- charge of CHF 1.00 per kg N or kg P;

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5 Swiss Federal Council, *"93.053 Botschaft vom 7. Juni 1993 zu einer Änderung des Bundesgesetzes über den Umweltschutz (USG/LEP)"*, 137 pp.

6 ***1 CMU*** = ***1 Cattle Manure Unit [DGVE - Düngergrossvieheinheit]*** = annual fertiliser element content of 105 kg N and 15 kg P of a cow weighing 600 kg with a milk yield of 5,000 kg (cf. Art. 14 Para. 8 LWP in conjunction with Art. 23 OWP and OAGR/SAEFL, *" Guidelines for Water Protection in Agriculture – Farm Manure"*, 100 pp., July 1994).

- improving the incentive effect through full earmarking for specific purposes (financing measures in agriculture), namely for ecological education and training of farmers (advisory service) and for federal ecological contributions (encouraging environmentally compatible behaviour and environmentally-friendly production in accordance with *AP 2002*).

Incentive taxes and income earmarked for specific purposes should achieve a perceptible and sustainable incentive effect. The level of the tax would therefore have to be set so that the prices of mineral fertilisers and PPPs would increase by around 30–50 per cent. A corresponding charge would have to be levied on surplus manure – taking account of expenditure and return in livestock production.

2.3 The effect of incentive taxes

Various authors see incentive taxes on agro-auxiliary substances as having an important effect. In its reports on incentive taxes[7], the IAW-ETHZ [Institute of Agricultural Economics of the Swiss Federal Institute of Technology, Zurich] assumes that for example a 40 per cent increase in prices for mineral N-fertilisers would result in a reduction in consumption of 8–24 per cent depending on how intensively the land was farmed. An average price increase for PPPs, differentiated according to environmental risk, of 20 per cent should reduce the environmental risk by about 55 per cent.

However, these studies were carried out before 1995, i.e. before the introduction of the new agricultural policy instruments. Nevertheless, it is emphasised in the cited reports by the IAW-ETHZ that an incentive tax imposed to supplement the measures in AP 2002 would be less effective.

3 Agri-ecological stage targets in AP 2007

A basic distinction must be made between *long-term ecological targets* under environmental law and *agri-ecological stage targets* under agricultural law:

- **long-term ecological targets** define the sustainable level of environmental protection, which is defined by the longer-term acceptable pollution load capacity of ecosystems. The progress and status of environmental measures under laws on environmental protection, water protection and nature conservation are measured against these ecological targets.
- **agri-ecological stage targets** define the aims to be achieved in the agricultural sector within a specified period. The framework conditions provided by federal agricultural policy (AP) and environmental law should make it possible for agriculture to achieve these. This is checked in the context of the *Federal Office*

7 Lehmann B. et al., *"Lenkungsabgaben auf Dünger"*, IAW-ETHZ, 117 pp. (1993).
Bidaux A., Gaillard R. and Lehmann B., *"Etude de divers modèles de taxes d'incitation différenciées portant sur les pesticides utilisés en agriculture"*, ETHZ study commissioned by SAEFL (1992).

for Agriculture's (OAGR) evaluation periods of several years in accordance with the *Ordinance relating to Sustainability in Agriculture of 1998 (SR 919.118).*

The agri-ecological targets for the period up to 2005 proposed by the OAGR under AP 2007 are summarized in *Table 1*. Some of these stage targets are taken from AP 2002.

Table 1: Stage targets under AP 2007 for the period up to 2005.[1]

Agri-environment sector	Measured quantity	Basis	Stage targets 2005
Total ecological compatibility	Annual N-balance	96,000 t N*)(1994)	N-loss potential 74,000 t
	Annual P-balance	20,000 t P (1990)	Reduction to 10,000 t of P-surplus1)
Agricultural practice	Annual quantity of PPP used	ca. 2,200 t active ingredients (1990/92)	Reduction to 1,500 t of active ingredients1)
Impact on the environment	NH_3-emissions	53,500 t N (1990)	Reduction by ca. 4,800 t N**)
	Biodiversity	ca. 1,080,000 ha AL [agricultural land] (1990/92)	65,000 ha ecological compensation areas in lowland regions
	Nitrate	-	90 % of catchment sites are below 40 mg/l***)
Influence of society on development of agriculture	Use of agricultural land [AL]	ca. 1,080,000 ha AL (1990/92)	98 % farmed in accordance with ecological achievement criteria or organic farming principles

*) The nitrous oxide emission estimated to be 2,000 t per year lower is not taken into account (only ca. 6,000 t instead of 8,000 t N-losses for 1994, i.e. an N-loss potential of 94,000 t instead of the given 96,000 t).[2]

**) The international obligation under the Convention on Long-Range Transboundary Air Pollution (UN/ECE) requires a reduction of 13 per cent by 2010, i.e. of 7,000 t N. This N-quantity in the form of ammonia is included in the 22,000 t N/year.

***) Desired target by 2007 under the Federal Office for Public Health (OPH) Action Plan *"Environment and Health"*: nitrate content in 99 per cent of drinking water catchment areas <40 mg nitrate/l.

1) In the longer term, a reduction in phosphorus pollution of surface waters caused by agriculture and a reduction in the input of PPPs of 50 per cent each must be achieved.

The OAGR together with the SAEFL and other interested parties intends to develop further these agri-ecological stage targets for 2005 with regard to the continuation of AP 2007.

1 Swiss Federal Council, *"02.046 Botschaft vom 29. Mai 2002 zur Weiterentwicklung der Agrarpolitik (Agrarpolitik 2007)"*, 290 pp.; cf. Table 15, p. 4771 (2002).

2 cf. *Agroscope* FAL, *"Lachgasemissionen aus der Schweizer Landwirtschaft"*, Schriftenreihe no. 33, 131 pp., Reckenholz (2000).

PART II: MINERAL FERTILISERS AND SURPLUS MANURE

1 Procedure

1.1 Preliminary remarks

The target and actual situations, based on present and future N- and P-pollution caused by agriculture, are presented and compared below. At the same time, the regional problem of surplus manure is examined (definition "surplus manure" cf. *Part II, Annex 2).*

Possible measures are proposed based on the established failure to reach targets. These include for example measures to support cantonal enforcement in areas with surplus manure.

All these measures are based on federal environmental legislation which already applies to agriculture.

1.2 Analysis of the situation

Analysis of the current conditions in the fertiliser and fertiliser application sector is based on the latest emission- as well as balanced N- and P-budgets. The latter are in turn based on regional studies of lakes in the Swiss Plateau, specifically in the typical catchment area of the Lake of Baldegg (cf. *Part II, Annex 3).* Studies by the IAW-ETHZ are also used.

1.3 Definition of targets

Targets for the maximum permitted input of N and P into the environment can differ greatly depending on evaluation criteria (cf. *Part I, Chap. 3).*

In agriculture, balanced nutrient budgets under the *Ordinance relating to Hazardous Substances (OHS)*[3] must basically be calculated sharply defined **for each plot of land** taking account of the nutrient levels in the soil. Under the *Ordinance relating to Direct Payments*, a balanced nutrient budget is calculated **for the entire farm holding** *(Suisse-Balance* at integrated production level [IP-level]; cf. proof of ecological achievement criteria *"balanced nutrient budgets").*

Nutrient balancing – the so-called *Suisse-Balance* – also takes account of basic production technology in livestock farming. The aim is to specify fertiliser application levels for the agricultural holding which do not endanger the environment (limitation of emissions).

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3 Ordinance of 9 June 1986 on environmentally hazardous substances (Stoffverordnung, OHS), SR 814.013, Ann. 4.5, No. 3; 1992 harmonized and tightened; also cf. SAEFL: *"Erläuterungen über Düngung und Umwelt – Vorschriften und Empfehlungen des Bundes"*, Vollzug Umwelt, 75 pp. (1996); OAGR/SAEFL, *"Düngen zur richtigen Zeit"*, Merkblatt, BBL-Vertrieb Publikationen, 3003 Berne, Form. No. 319.012 available in German, French and Italian, 4 pp. (1996).

Another objective is to lay down **pollution-orientated targets** – so-called ecological targets – which are more oriented to substance-related cycles. In this case, pollution levels are first assessed (e.g. high fertiliser accumulation in the soil, P-content in water bodies, ground level/immission concentrations of air pollutants). Then emission targets are worked out on the basis of the relationship between maximum acceptable pollution levels and emissions (nutrient requirement, limit values for P discharge into water bodies, maximum emission limits for air pollutants).

The target conditions for a medium-term timeline are determined by the agri-ecological stage targets laid down in agricultural policy – the year 2002 for N, the year 2005 and later for P. However, they should always be measured according to long-term ecological targets, which, based on environmental legislation, must be met by all those emitting environmental pollution as a whole. Thus the agri-ecological stage targets for N were laid down in a specific *N Strategy Report*[4]. It was drawn up by a group of experts as a result of a joined commission by the *Swiss Federal Department of Home Affairs* and the *Swiss Federal Department of Economic Affairs.*

Both this expert report and the evaluation reports by the OAGR[5] specify N-target values in steps to reduce environmentally relevant N-surpluses in agriculture.

2 Environmental problems due to nitrogen and phosphorus

2.1 Preliminary remarks

Excessive inputs of N- and P-compounds into the environment are important causes of environmental pollution. In the environment N and P move in sometimes complicated substance-related cycles; N in particular can radically change its chemical form. Finally, N- and P-compounds end up not only in soil, groundwater and surface waters, but also in the air (gaseous N-compounds).

At present two aspects are important:

- In Switzerland – but also in Europe[6] – N-inputs into the environment, mainly from households, agriculture, transport and industry, are markedly higher than the relevant environmental legislation permits.[7]
- The consequences of high levels of environmental pollution due to N and P continue to be clearly distinguishable or detectable in vulnerable areas despite measures already taken.

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4 SAEFL (together with OAGR), *"Strategie zur Reduktion von Stickstoffemissionen"*, Schriftenreihe Umwelt no. 273, 142 pp. (1996).

5 OAGR, *"Evaluation der Ökomassnahmen und Tierhaltungsprogramme – Zweiter Zwischenbericht"*, 167 pp. (June 1999).

6 European Environment Agency, *"Nutrients in European ecosystems"*, ISBN 92-9167-163-0, 155 pp. (1999).

7 BFS and SAEFL, *"Umwelt in der Schweiz 1997 – Daten, Fakten, Perspektiven"*, ISBN 3-303-02034-5, 376 pp. (1997).

Commission of the European Communities, *"Environment 2010: our future, our choice" – The sixth environment action programme"*, COM (2001) 31 final, 2001/0029 (COD), 81 pp. (24.01.2001).

2.2 Nitrogen (N)

2.2.1 Preliminary remarks

There is a complicated natural nitrogen cycle between water, soil and air. Air itself is known to consist of over 79 per cent gaseous nitrogen (N_2). However, this is not chemically active and does not cause any environmental problems. However, there are also natural and therefore unavoidable, chemically active N-compounds (due to micro-organism activity, electrical discharges such as lightning in the atmosphere etc.). But these contribute less than 10 per cent to total Swiss N-emissions[8].

A major source of nitrogen pollution is pollution of water bodies, air and soil from manmade emissions. Regional evaluations require expensive mathematical models, which can show the relationships between emissions and immissions (ground level concentrations).

Annual consumption of N mineral fertilisers in Switzerland totalled around 69,000 t in 1989/92 and was still about 52,000 t[9] in the year 2000.

Pollution of the environment from N causes imbalances in vulnerable ecosystems:

- **Ammonia (ammonium) and nitrogen oxides**[10] encourage acidification and over enrichment of extensively farmed grassland and natural ecosystems. Biodiversity decreases because fertile plant growth is often stimulated by these N-compounds in those places where it is not wanted. N-vulnerable natural plant communities are therefore affected in locations far from the nitrogen source (e.g. species depletion on oligotrophic, species-diverse sites, on upland moors and arid sites, also on banks and in water meadows and in the other nature conservation areas of lowland and mountain areas).

  Forest trees in particular also suffer from growth stress due to the aforesaid N-compounds. Excessive N-input into forest soils causes imbalances in the nutrient supply of forest trees (disturbed nutrient conditions). The symbiotic root fungus (mycorrhiza)[11] of forest trees are adversely affected. Trees are quite dependent on mycorrhiza for the uptake of nutrients from the forest soil.

  N-pollution of forests and forest soils also causes heavier parasite infestation of forest trees. In the woodland areas of the Swiss Plateau, in three to five years as much nitrogen is deposited from airborne sources as would be needed annually for a normal crop yield from a comparable area of agricultural land.[12]

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8 SAEFL (together with OAGR), *"Strategie zur Reduktion von Stickstoffemissionen"*, Schriftenreihe Umwelt no. 273, 142 pp. (1996); cf. Table *"N-Bilanz 1994"*, p. 29.

9 Federal Office of Statistics, *"Einblick in die schweizerische Landwirtschaft"*, Edition 2002.

10 *Agroscope* FAL, *"Ammoniak-Emissionen in der Schweiz: Ausmass und technische Beurteilung des Reduktionspotenzials"*, ISBN 3-905608-17-0, Schriftenreihe no. 26, 107 pp. (1997).

Agroscope FAT, *"Ammoniak: Kosten der Emissionsminderung – Betriebswirtschaftliche Beurteilung der Möglichkeiten zur Reduktion der Ammoniak-Emissionen in der Schweiz"*, ISBN 3-9521054-2-2, Schriftenreihe no. 44, 130 pp. (1997).

11 SAEFL, *"Ausgewählte Probleme in Waldböden"*, Schriftenreihe Umwelt no. 56, 100 pp. (1986).

12 Canton Berne environment report, *"Waldschadeninventar 1997 im Kanton Bern"* (1998).

- **Nitrogen oxides as NO_x** arise as a gaseous compound mainly in combustion processes. Such NO_x compounds are toxins which directly affect the lungs. As precursor substances, they contribute substantially to the formation of ozone in ground level air layers, which impairs health and vegetation.
- **Nitrate** as another N-compound with environmental impact is leached out of soils – even out of forest soils. This endangers groundwater quality *inter alia*.

2.2.2 N from agriculture

Listed below are the most important N-emissions from agriculture for the year 1994[13], namely 96,000 t N (47 per cent) of total Swiss N-emissions of 201,000 t N:

- **Air:** ammonia and nitrous oxide emissions into the air cause around 30 per cent of total N-emissions (59,000 t N out of 201,000 t N). Ammonia and nitrous oxide emissions (51,000 t N and 8,000 t N)[14] mainly originate from livestock farming (manures). Livestock production is responsible for 80 per cent of total Swiss ammonia emissions. Around 75 per cent of this is derived from cattle farming (34,000 t N per year) and around 20 per cent from pig farming (9,000 t N)[15]. In quantitative terms, ammonia is the most important agricultural N-air emission (cf. *Table 2).*
- **Water bodies:** nitrate and ammonium emissions into water bodies are responsible for one fifth of total N-emissions (37,000 t N out of 201,000 t N)[16]. Pollution of waters by N-compounds is heavily dependant on the type of agricultural crops grown and on land use management or soil cover, the timing and rate of fertiliser application, weather and time of year.[17] N-losses as a result of nitrate leaching are the second most important N-emission from agriculture (cf. *Table 2* and *3).*

13 *Agroscope* FAL, *"Lachgasemissionen aus der Schweizer Landwirtschaft"*, Schriftenreihe no. 33, ISBN 3-905608-26-X, 129 pp. (2000).
SAEFL (together with OAGR), *"Strategie zur Reduktion von Stickstoffemissionen"*, Schriftenreihe Umwelt no. 273, 142 pp. (1996); cf. Table *"N-Bilanz 1994"*, p. 29.

14 ditto SAEFL (1996); cf. Table *"N-Bilanz 1994"*, p. 29.

15 *Agroscope* FAL, *"Ammoniak-Emissionen in der Schweiz"*, ISBN 3-905608-17-0, Schriftenreihe no. 26, 107 pp. (1997).

16 ditto SAEFL (1996); cf. Table *"N-Bilanz 1994"*, p. 29.

17 Canton Berne – Office for Water Protection and Waste Management (GSA), *"Massnahmen zur Verminderung der Phosphor- und Stickstoffverluste aus der Landwirtschaft in die Gewässer – dargestellt am Beispiel von 20 hydrologischen Einzugsgebieten im Kt. Bern"*, Editor: V. Prasuhn et al., 216 pp. (1997).

Table 2: 1994 N-losses into the environment due to agriculture.[18]

Total environmentally relevant N-losses: **96,000 t**			
of which:			
N into surface waters	N into groundwater as **nitrate**	N into the air as **nitrous oxide***)	as **ammonia**
3,000 t	**34,000 t**	**8,000 t**	**51,000 t**

**) Not taking account of the latest Agroscope FAL estimated value from the year 2000 (ca. 6,000 t N for 1994).*[19]

2.2.3 N from households, transport, trade and industry

- **Air:** in 1994, the emission sources households, transport, trade and industry were responsible for about a quarter of total nationwide N-emissions into the air through the combustion of fuels (49,000 t N out of 201,000 t N). That year these three polluter groups released N mainly as nitrogen oxides.

  Transport was responsible for around 60 per cent. The future tightening of exhaust gas regulations for motor vehicles planned in the EU will achieve a further reduction in nitrogen oxide levels.

- **Water bodies:** around 18 per cent of total N-emissions into surface waters (37,000 t N out of 201,000 t N) were from sewage plants (effluent from households, trade and industry).

2.3 Phosphorus (P)

2.3.1 Preliminary remarks

Phosphorus is an essential nutrient for all plants. Without P there would be no plant life. Plant "productivity" is dependent on the P-supply (further informations on occurrence and impact of P in water bodies cf. *Part II, Annex 1).* The information below is mainly limited to the agricultural question in connection with P.

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18 SAEFL (together with OAGR), *"Strategie zur Reduktion von Stickstoffemissionen"*, Schriftenreihe Umwelt no. 273, 142 pp. (1996); cf. Table *"Schätzung Summe umweltrelevanter N-Frachten Landwirtschaft"*, p. 124; and following footnote for FAL (2000).

19 *Agroscope* FAL, *"Lachgasemissionen aus der Schweizer Landwirtschaft"*, Schriftenreihe no. 33, ISBN 3-905608-26-X, 129 pp. (2000).

Table 3: N-emission balance for 1994 according to emission groups.[20]

	Emissions according to source		
	Natural causes	Households, transport, trade and industry	Agriculture
Total	**19,000 t**	**86,000 t**	**96,000 t*)**
	Emissions into environmental sectors		
	Water bodies	Air	
Total	**92,000 t**	**109,000 t*)**	

***)** Not including the latest *Agroscope* FAL estimates for nitrous oxide for 1994.

2.3.2 Agricultural cause of P-pollution in water bodies

For years attention has been focused on surplus phosphorus from agriculture (particularly from manure; cf. *Fig. 1* and *2* and *Table 4).* This circumstance has impacted on the revised water protection legislation of 1991 with a new, comprehensive agricultural legal framework:

- detailed provisions for farm holdings with animal husbandry (Art. 14 LWP in conjunction with Art. 22–28 OWP);
- land use management and advice compatible with water bodies (Art. 27, 51, 77 and 78 LWP).

In areas with high numbers of livestock the main P-content in manure comes from bought in concentrated and fattening feeds. These animal feeds allow a higher density of fattening animals to be kept than would be possible with the crop yields from the farm's own or leased land. As a result, the quantity of manure and the P-content in the soils fertilised with manure increase.

2.3.3 National P-content in fertilisers and crop yields

Unlike manure, the quantity of P-mineral fertilisers used has more than halved since the beginning of the 1990s.[21] Reasons for this are the efforts made by the agricultural advisory services and implementation of the provisions on plant-based fertiliser application laid down in the Ordinance relating to Hazardous Substances (Annex 4.5 OHS). Even in areas with high numbers of livestock, the amount of phosphorus applied in mineral fertilisers makes up only a negligible part of the regional P-content (cf. *Part II, Annex 3, Sect. 1).*

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20 SAEFL (together with OAGR), *"Strategie zur Reduktion von Stickstoffemissionen"*, Schriftenreihe Umwelt no. 273, 142 pp. (1996); cf. Table *"N-Bilanz 1994"*, p. 29.
Agroscope FAL, *"Lachgasemissionen aus der Schweizer Landwirtschaft"*, Schriftenreihe no. 33, ISBN 3-905608-26-X, 129 pp. (2000).

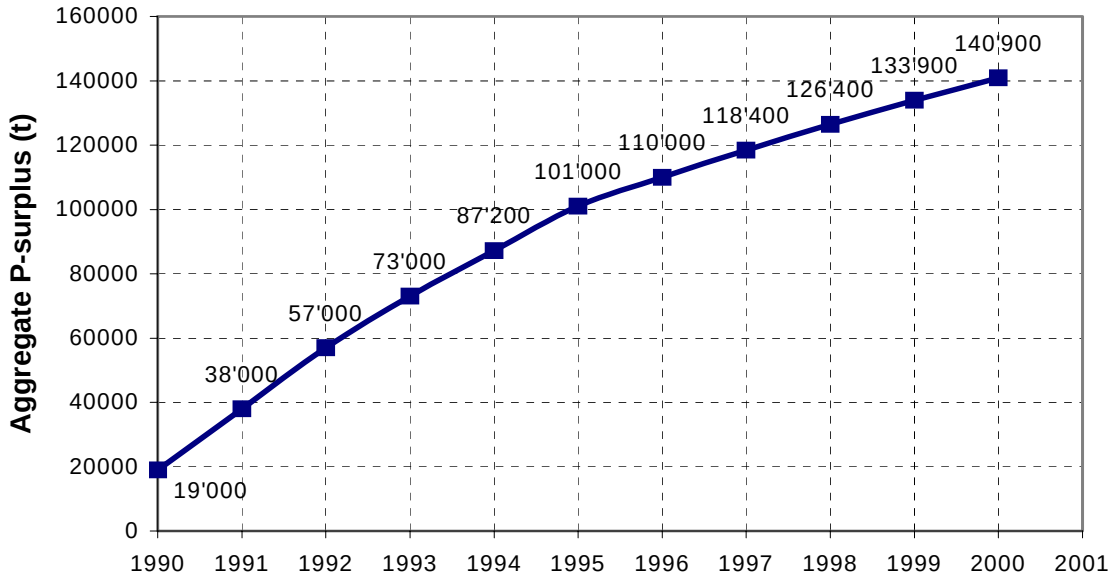
21 OAGR, *"Evaluation der Ökomassnahmen und Tierhaltungsprogramme – Bereich Stickstoff und Phosphor"*, 3rd Interim Report, Ch. 5.3, p. 9 (2000).

Viewed nationally, however, there are balanced conditions between the P-content in manure (slurry, solid manure) and plant P-uptake from the soil. *Figure 2* also shows that, purely arithmetically, mineral fertilisers would be superfluous if farm manures could be evenly distributed over the total *agricultural land suitable for fertiliser application (LSF).* This is known to be not the case; P-surpluses therefore do occur – at least regionally (cf. *Chap. 2.3.4).*

Table 4: National annual P-content in fertilisers, from atmospheric particulate matter and in fodder and food plants (1998).

P-Input	**Volume** (in t)
Farm manure Mineral fertilisers Recycling fertilisers (compost, sewage sludge) Deposition (atmospheric dust)	23,000 6,000 4,000 1,000
Total P-input	**34,000**
P-Uptake	**Volume**
Animal feeding Foodstuffs	24,000 2,000
Total P-uptake	**26,000**
P-surplus (input minus uptake)	**8,000**

Figure 1: Aggregate national annual P-surplus from 1990 to 2000. According to this, P-levels in soils, particularly of areas with high numbers of livestock, have accumulated in 10 years to around 140'000 t P.



Annual P-input in agriculture at present totals 16,000 t P – mainly as mineral and recycling fertilisers and in animal feeding stuffs (cf. *Fig. 2)*. This surplus in P-fertiliser application fell by around 11,000 t in the period from 1992 to 1998, but from 1998 still amounted to about 8,000 t per year (cf. *Fig. 1).* However, this surplus accumulated in the soil or, in unfavourable circumstances, was washed directly into water bodies. Precise measurements on the Lake of Sempach revealed that with unfavourable weather and soil conditions, up to 6 per cent of the P directly reached the lake.[22]

There are large regional differences in animal husbandry; the main regions for livestock fattening are in central and eastern Switzerland. P-mineral fertilisers will continue to be essential in future (such as in arable farming areas with low numbers of livestock, e.g. western Switzerland). Surplus manure is clearly a regional problem.

2.3.4 Regional P-problems

In principle, the balanced P-budget calculation, which is usually carried out on a national basis, does not take account of specific regional P-surpluses in manure. A total of some 23,000 t P per year is in circulation in manure (slurry and solid manure).[23] The annual P-content in surplus manure, which mainly occurs regionally, is estimated to be approximately 1,700 t (cf. *Part II, Annex 4).*

This soil and water-related P-problem is directly connected with pig fattening, which is often independent of land, and supplementary fattening. In these cases livestock feeding is intensive.

From experience, the established owned or leased agricultural land suitable for fertiliser application is no longer sufficient for environmentally sound utilization of the large volume of manure.

Owners of fattening establishments are therefore forced to find suitable customers for their surplus manure and to conclude transfer contracts with them. This usually creates other problems: most customers do not wish to commit themselves for any length of time. Moreover, on-site water pollution controls are difficult for the cantonal enforcement authorities.

Although manure transfer contracts are permitted under water protection legislation, they do not provide a sustainable solution to the regional problems of surplus manure. From experience, such water-critical conditions are frequently found in cantons in the Swiss Plateau with lake catchment areas.

Over 12 years ago, the **Associations of Lakeside Municipal Authorities**[24] were set up to solve regional problems. This happened for the first time on the Lake of Sempach – a clear sign of the desire for joint environmental or water protection action within an entire lake district (cf. *Part II, Annex 3).*

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22 Baumann P., *"Problemgebiet Sempachersee, ergriffene und erwogene Massnahmen"*, In: Phosphat in Landwirtschaft und Umwelt, FAC-Schriftenreihe no. 1, p. 97–138 (1987).

23 *Agroscop* FAL, *"Nährstoffbilanz der schweizerischen Landwirtschaft für die Jahre 1975 bis 1995"*, cf. p. 21, §3.2, ISBN 3-905608-20-0, Schriftenreihe no. 28 (1999).

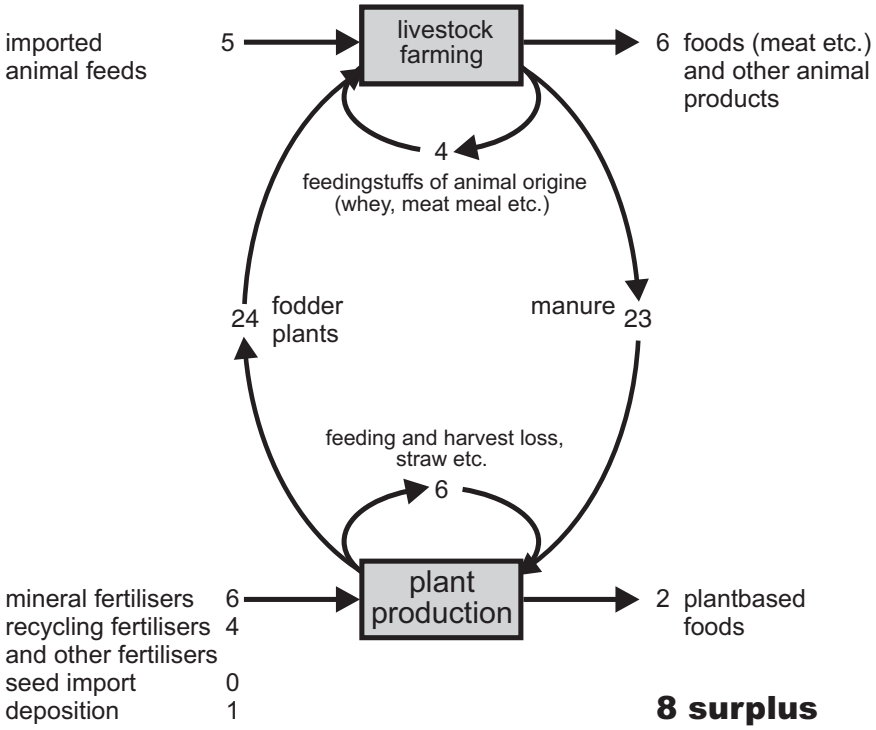
24 Association of Lakeside Municipal Authorities, Cantonal Office for Environmental Protection Lucerne, Cantonal Central Office for Ecology in Agriculture, *"Der Sempachersee muss leben"*, information leaflet, 6 pp. (1990).

A regional example shown in *Annex 3 (Part II)* illustrates the complex P-problems in the catchment area of the Lake of Baldegg, which counts high numbers of livestock.

Other lakes with similar water protection problems are generally acknowledged to be the Lake of Greifensee, Lake of Hallwil, Lake of Sempach and Lake of Zug.[25] However, even small and very small water bodies such as Lake of Gerzensee and Lake of Mauen have eutrophication problems caused by agriculture.

Eutrophication: nutrients are discharged into a lake; there they stimulate algal bloom and decomposition of the algae uses up the oxygen in the water.

Figure 2: Phosphorus cycle in Swiss agriculture for 1998 – including P-surplus (in 1,000 t P/year).[26]



[25] SAEFL, *"Der Zustand der Seen in der Schweiz"*, Schriftenreihe no. 237, 159 pp. (1994).

[26] *Agroscope* FAL, *"Nährstoffbilanz der schweizerischen Landwirtschaft für die Jahre 1975 bis 1995"*, ISBN 3-905608-20-0, Schriftenreihe No. 28, p. 21, Fig. 5 (1999) – including personal communications by E. Spiess, Agroscope FAL (May 2000).

2.3.5 Assessment of the supply of available P in soils

The nutrients available to plants in soils are assessed according to an official extraction method and related scale drawn up by the federal agricultural research stations.[27] This scale divides soils into five supply classes, which also apply for P:

Class A:	poor;
Class B:	moderately supplied;
Class C*):	**adequately supplied;**
Class D:	accumulation;
Class E:	over enriched.

**) Class C acts as the calculation basis for determining guideline fertiliser application standards that obey to the plant requirements of each single crop on normally supplied soils.*

However, current Swiss methods of P-analysis[28] do not permit assessment of **total** P-accumulation in soils. National Swiss data on easily available P-levels of soils are known for the test period 1972 to 1985.[29] Based on these past results of the 1970/ 1980s, it is clear that most agricultural soils were very well supplied with P. The relevant data for 1985 are as follows:

- ***open arable land*** in Class D ca. 30 per cent and in Class E ca. 14 per cent;
- ***grassland*** in Class D ca. 26 per cent and in Class E ca. 20 per cent.

Other regional P-evaluations for the years 1986–1990 show similar conditions.[30] The most recent estimates of P-levels, as well as of available P in soils, support the findings of these earlier studies.[31]

Regions which currently have high P-accumulation are for example soils in the catchment area of the Lake of Baldegg (Classes D and E; cf. *Tab. 5):*

- grassland with over 60 per cent of all meadow areas;
- arable land with around 35 per cent of all arable land areas.

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27 *Agroscope* FAL and *Agroscope* RAC, *"Grundlagen für die Düngung im Acker- und Futterbau – GRUDAF'01", AGRAR*Forsch., 8, 6, 80 pp. (June 2001).

28 Frossard E., *"Le rôle de la fertilité du sol dans l'agriculture durable"*, Revue suisse Agric., 28, (4), 193–198 (1996).

Fardeau J.-C. et al., *"Pouvoir fixateur des sols vis-à-vis du phosphore: Conséquences sur la fertiliser application phosphatée"*, Perspectives Agricoles, no. 147, 65–72 (May 1990).

SRVA-Lausanne, *"PHOSPHORESCENT"*, 88 p. (March 1991).

Lammers A., *"Phosphatformen und Phosphatfreisetzung in hochgedüngten Böden Europas"*, ISBN 3-89675-202-2, 179 pp., Diss. at the Lehrstuhl für Bodenkunde, Techn. Univ. München-Weihenstephan, EU commissioned project, Munich (1997).

29 Siegenthaler A. et al., *"P-Versorgung unserer Böden 1981 bis 1985"*, FAC-Schriftenreihe no. 1, Oktobertagung 1987 über Phosphor in Landwirtschaft und Umwelt, 11–21 (1987).

Flisch R., *"Ergebnisse der Bodenuntersuchungen 1972 bis 1986"*, Mitt. Schweiz. Landw., 11, 281–294 (1987).

30 Siegenthaler A. et al., *"Regionale Auswertung der Bodenuntersuchungsergebnisse in Acker- und Futterbau von 1986 bis 1990"*, Schweiz. Landw. Forsch., 32, H. 1/2, 123–134 (1993).

31 Frossard E. et al., *"Phosphor in Böden – Standortbestimmung Schweiz"*, VU-368-D or -F, SAEFL Schriftenreihe Umwelt no. 368, 174 pp. (2004).

Table 5: P-supply of agricultural soils in the catchment area of the Lake of Baldegg.[32]

Supply classes	**Arable land** (%)	**Grassland** (%)
A	5	1
B	13	7
C	46	30
D	**26**	**41**
E	**10**	**21**

The Ordinance relating to Hazardous Substances (OHS) lays down that application of manure – in this case mainly liquid manure from pig breeding enterprises – should be measured according to plant nutrient requirements. The P-accumulation in the soil must be taken into account (cf. Sect. 31 Para. 1 Let. a Annex 4.5 OHS).

If the OHS was obeyed to for each plot of land, class D soils had to be fertilised very sparingly with P – approximately half the amount of fertiliser – and those in class E not at all.

In areas with high numbers of livestock, farm holdings which want to obtain direct payments would have to adapt their balanced nutrient budgets for the entire holding (*Suisse-Balance* of SRVA/LBL[33]) to the local fertiliser or fertiliser application conditions according to the Ordinance relating to Direct Payments (ODP; individual farm site potential including supply condition of the soils, fertiliser application plans; cf. Art. 6 in conjunction with Annex Sect. 2 ODP). The cantons usually have detailed information on the P-conditions of their animal husbandry farmers.

Taking Canton Fribourg[34] as an example, this is shown as follows: 3,374 farm holdings currently participate in the cantonal direct payments programme. In the period from 1952 to 1998, over 100,000 soil samples were analysed in that canton. In addition, about 3,000 balanced nutrient budgets per year are calculated. Moreover, around 200 new electronically administered fertiliser application plans are currently drawn up every year (oral notification; cf. *FURCA* programme of the SRVA-Lausanne). Finally, in Canton Fribourg around 900 manure transfer contracts are followed or monitored.

32 Canton Lucerne, *"Phosphorprojekt Baldeggersee – Verminderung der P-Belastung von oberirdischen Gewässern aus der landwirtschaftlichen Bewirtschaftung"*, 53 pp. (2000).

33 Agricultural Advisory Services (**SRVA:** *Service romand de vulgarisation agricole Lausanne;* **LBL:** *Landwirtschaftliche Beratungszentrale Lindau* [Swiss Agricultural Advisory Board].

34 Canton Fribourg Agriculture Institute (LIG/IAG), *"Jahresbericht 2000"*, cf. p. 78 (2001).

3 Target assessment for nitrogen (N) and for phosphorus (P)

3.1 Target assessment for N

3.1.1 Preliminary remarks

As a result of environmental chemical pollution from different forms of N (mineralization, nitrification or denitrification), there are also different targets principally defined for air and water bodies. Below, these are differentiated according to the categories *"N-input into the air"* and *"N-input into water bodies"*.

3.1.2 N-input into the air

- **Ammonia emissions (NH_3):** maximum annual emissions of 25,000–30,000 t N are permitted as a *long-term ecological target* (the value for 1994 was around 55,000 t N).[35] This is around half the national ammonia emissions in 1994 or slightly more than half of agricultural emissions.[36] The OAGR proposed initially a reduction of ca. 5,000 t N as an *agri-ecological stage target* under the AP 2007.
- **Nitrous oxide emissions (N_2O):** so far neither a *long-term ecological target*, which could act as a concrete emission target, nor an *agri-ecological stage target* has been laid down at either national or international level. Agricultural N_2O-emissions nationwide in the year 2000 totalled ca. 8,000 t N (latest estimates give only 6,000 t N[37]).
- **Nitrogen oxide emissions (NO_x):** they must be reduced to such a level that in accordance with the Air Pollution Control Ordinance (cf. Art. 1 OAPC) persons, animals and plants, their biological communities and habitats are not at risk. According to explanations by the *Swiss Expert Commission for Air Pollution Control*, a reduction in total Swiss NO_x-emissions of between about 70 and 80 per cent is required in order to achieve this target (based on the maximum level in the mid-1980s).[38]

  For this reason, annual emissions from households, transport, trade and industry – including agriculture – should not total more than 11,000–16,000 t NO_x-N as a *long-term ecological target*. If this maximum emission limit is met together with the targets for ammonia, over enrichment of vulnerable soils or ecosystems from airborne causes can be reduced to an environmentally sound level.

35 SAEFL (together with OAGR), *"Strategie zur Reduktion von Stickstoffemissionen"*, Schriftenreihe Umwelt no. 273, 142 pp., Berne (1996); cf. Table *"Zusammenfassende Übersicht"*, p. 37.

36 99.077 Federal Council Report of 23 June 1999 on Federal and Cantonal Air Pollution Control Measures.

37 *Agroscope* FAL, *"Lachgasemissionen aus der Schweizer Landwirtschaft"*, Schriftenreihe no. 33, ISBN 3-905608-26-X, 131 pp. (2000).

38 Swiss Expert Commission for Air Pollution Control, *"Ozon in der Schweiz"*, SAEFL-Schriftenreihe no. 101, 271 pp. (1989).

3.1.3 N-input into surface and underground waters

Ammonium, nitrite, nitrate: the targets for these N-compounds in water bodies differ. The *long-term ecological targets* of the *N Strategy Report*[39] are stricter than the general targets proposed in the OAGR's Evaluation Report.[40]

Measures regarding the ecologically-based quality targets under OWP[41] to reduce nitrate must be continued consistently (cf. result of the Berne *"Nitrate Workshop 2001")*[42]. The same applies to the sustainability targets for health-based precautions (stage target from 2005: 90 per cent of all drinking water catchments have a nitrate content of less than 40 mg nitrate per litre).[43]

3.1.4 Basic information in the report by the IAW-ETHZ on N-losses

The technical report by the IAW-ETHZ[44] contains calculations on environmentally relevant and non-relevant N compounds (in the case of the latter e.g. N_2 from denitrification).

Based on a study conducted in 1995 with 260 farmers with agricultural book-keeping, the following results were submitted on N-fertiliser application in 1999 (manure and mineral fertilisers; period 1994–1998):

- N-losses (environmentally and non-environmentally relevant) from agriculture have fallen nationally by nearly 10 per cent, namely from 123,000 t N to around 111,000 t N (reduction 12,000 t N).
- The level of excess N-fertiliser ("over enrichment"; input into water bodies and air) has fallen by about 25 per cent, i.e. from ca. 25,000 t N to ca. 19,000 t N.
- The volume of N-fertilisers used has fallen by about 9 per cent, namely from over 115,000 t N to 105,000 t N (reduction of over 10,000 t N – mainly mineral fertilisers).
- In the *lowland areas,* the trend towards N-reduction is stronger. In the *mountain areas* on the other hand, N-losses are increasing slightly due to supplementary fattening of pigs and more productive dairy cattles, and also for structural reasons.
- In the case of ammonia emission from animal husbandry, i.e. from farm manures, there was a below-average result with a reduction of just 2,000 t N (nationally only from 51,000 t N to 49,000 t N, i.e. about –4 per cent).

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39 SAEFL (together with OAGR), *"Strategie zur Reduktion von Stickstoffemissionen"*, Schriftenreihe Umwelt no. 273, P. 35 ff. (1996).

40 OAGR, *"Evaluation der Ökomassnahmen und Tierhaltungsprogramme – Bereich Stickstoff und Phosphor"*, 3rd Interim Report, 31 pp. (May 2000).

41 cf. Nr. 12 Para. 5 and 22 Para. 2 Ann. 2 as well as Nr. 212 Ann. 4.

42 OPH, OAGR, SAEFL, Proceedings of *"Workshop Nitrat vom 4. Mai 2001 – Standortbestimmung 2000/2001"*, 5 pp. (2001).

43 OPH, SAEFL, *"Nachhaltige Entwicklung – Aktionsplan Umwelt und Gesundheit"*, 25 pp. (July 1997).

44 IAW-ETHZ, Institute of Agricultural Economics of the Swiss Federal Institute of Technology, Zurich, *"Technischer Bericht über die Auswirkungen der Agrarreform auf das N-Verlustpotenzial der Landwirtschaft in der Zeit von 1994 bis 1998"*, 82 pp., abridged version (September 1999).

- Nitrate leaching fell nationally from 32,500 t N to 29,000 t N (around –11 per cent). In representatively selected groundwaters and spring waters in the test canton of Berne for example, nitrate levels have only fallen by 0.9 mg/l in five years.

3.1.5 Agri-ecological stage target to reduce N emissions

The *N Strategy Report* (SAEFL/OAGR) is based on differentiated recommendations and targets. It typically includes measures under Article 62a LWP in intensively farmed areas (vegetable cropping and arable farming), where the nitrate level in drinking water is still above the tolerance value of 40 mg/l or above the quality requirements of 25 mg/l for exploited groundwater. The OAGR's *Evaluation Report* quotes as an *agri-ecological stage target* an average reduction in the nitrate concentration of selected, generally representative ground- and spring waters of 5 mg nitrate per litre.[45]

The *N Strategy Report* recommends as a minimum target a national reduction in environmentally relevant N-losses of around 22,000 t N by the year 2002 – based on 96,000 t N in 1994 (cf. N Strategy Report p. 11 and 12).

The overall reduction of 22,000 t N should take place in two stages according to the N Strategy Report:

- **14,000 t** by 1998 *(stage 1)* and
- a further **8,000 t N** by 2005 *(stage 2)*.

However, because these targets could not be reached, the Swiss Federal Council deferred them until 2005 under AP 2007.

The more organically a holding is farmed, the lower the levels of N-overenrichment, N-fertiliser application and N-losses. Environmentally relevant N-losses due to agriculture have only fallen from 96,000 t N in 1994 to about 89,000 t N (in 1998). This means that the *agri-ecological stage target* of 82,000 t N for 1998 laid down in the *N Strategy Report* has not been reached. Instead of a reduction of 14,000 t N, only 7,000 t N was achieved.[46]

However, according to IAW-ETHZ, and also *AGRAR*Forschung[47], a clear-cut reduction in total nitrogen is said to have been achieved. This finding applies mainly to nitrates, which entered water bodies, but was less obvious for ammonia into the air.

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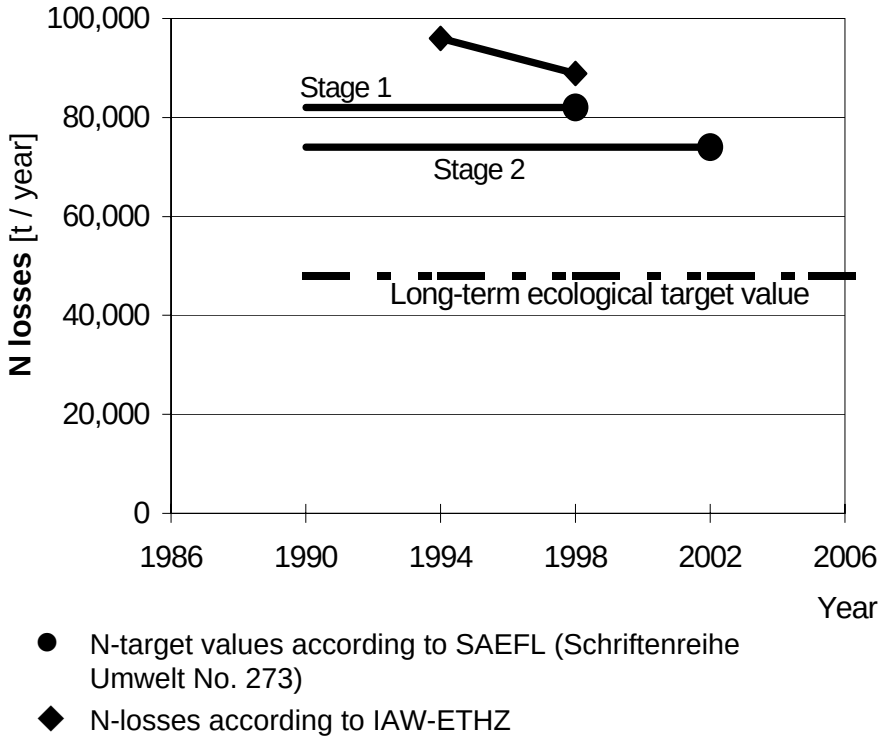
45 **For N** (from the air; into water bodies):
- SAEFL (together with OAGR), *"Strategie zur Reduktion von Stickstoffemissionen"*, Schriftenreihe Umwelt no. 273, 142 pp. (1996);
- OAGR, *"Evaluation der Ökomassnahmen und Tierhaltungsprogramme – Zweiter Zwischenbericht"*, 167 pp. (June 1999).

46 IAW-ETHZ, cf. p. 8 (1999).

47 Spiess E., *"Stickstoff- und Phosphorbilanz der Schweizer Landwirtschaft"*, *AGRAR*Forsch., 7, 261–264 (1999).

Figure 3: N-losses and target values by 2002.



Both studies – IAW-ETHZ and *AGRAR*Forschung – establish that the results are insufficient compared with the set targets. In terms of size, the target deficits are entirely comparable in both studies. N-losses caused by agriculture should fall by over 20 per cent between 1994 and 2002 (cf. *Table 6).*

Table 6: Review of agri-ecological stage targets and long-term ecological targets for N from agriculture (in t).

Source	Losses	Stage targets		Level reached	Ecological target
	1994	*1998*	*2002*)*	*1998*	**48,000**
SAEFL[48]	96,000**)	**82,000**	**74,000**	89,000	

*) According to Federal Council proposal (May 2002) for AP 2007; deferred to 2005.

**) Not including the latest *Agroscope* FAL estimate for nitrous oxide for 1994.

48 SAEFL (together with OAGR), *"Strategie zur Reduktion von Stickstoffemissionen"*, Schriftenreihe Umwelt no. 273, P. 57 (1996).
Agroscope FAL, *"Lachgasemissionen aus der Schweizer Landwirtschaft"*, Schriftenreihe no. 33, ISBN 3-905608-26-X, 131 pp. (2000)

Conclusions and prognosis

The *agri-ecological stage target* for 2002, namely the reduction of environmentally relevant N-losses from 96,000 t to 74,000 t, cannot be reached. It is about 8,000 t short of the target. It even fell 7,000 t N short of the agri-ecological target of 82,000 t N for 1998.

It will not be possible to reach the *agri-ecological stage target* for 2002 even if

- the agri-ecological and water protection measures have been implemented and take full effect and
- special measures were taken in vulnerable areas to prevent agricultural run-off and leaching of water-polluting substances – principally N – in accordance with Article 62a LWP.

In order for them to take full effect, more time is needed as well as more consistent enforcement of the applicable legal frame.

3.2 Target assessment for P

3.2.1 Under the water protection legislation

The *Water Protection Ordinance (OWP)* does not lay down precise limits for the P-content of lake water which causes eutrophication. However, as an ecological target for surface waters it specifies that *"... water quality shall be such that ... other pollutants which could enter the water as a result of human activities do not cause unnaturally high production of biomass".*[49] An additional requirement for standing waters specifies *inter alia* that the nutrient content shall not permit more than average production of biomass. Moreover, for lakes it specifies that the oxygen content shall in no case fall below 4 mg/l.[50]

The *"Plan to reduce P-pollution in surface waters from farming"*[51] establishes that, based on experience regarding the cause of eutrophication of Swiss surface waters, the *target value* of maximum 30 mg total-P/m^3 lake water, calculated from the objectives laid down in water protection law, is set too high.

A scientifically exact procedure would require this water protection *target value* to be determined for each individual lake. However, this would necessitate a comprehensive study of the chemical properties of a lake and its inflows as well as mathematical, computer-based modelling, which would be too costly.

In view of the nutrient accumulation in soils, in the catchment area of the Lake of Sempach for example, only 20 per cent of the annual P-requirement of crops should be provided by fertilisers.[52] The local **cantonal CMU site limit values** could act as a useful intervention benchmark for limiting the quantity of fertilisers.[53]

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49 cf. Ann. 1 Nr. 1 Para. 3c OWP.

50 cf. Ann. 2 Nr. 13 Para. 2 and 3b OWP.

51 OAGR/SAEFL (1998), cf. p. 7.

52 Gächter R., *"Die bodenbürtige P-Belastung des Sempachersees"*, gas wasser abwasser (gwa), 79, 6, 460–466 (1999).

53 Art. 14 Para. 6 LWP in connection with the harmonised CCMA decision (cf. *Part II, Ann. 6, Ch. 2.2).*

3.2.2 Under the Ordinance relating to Substances and the Ordinance relating to Direct Payments

Both ordinances require a balanced nutrient budget. Account must be taken of fertiliser accumulation (nutrients) in the soil. As already explained, in the case of sparingly soluble P, high P-accumulation has taken place in fertilised soils in areas with high numbers of livestock as a result of intensive fertiliser application.

Decades ago this was mainly caused by application of P mineral fertilisers. Since the 1970s the cause has been the slurry from pig breeding enterprises. A *long-term ecological target* is intended to reduce this P-accumulation in the soil to supply class C. This is the only way in which sustainable, environmentally sound fertiliser application can be achieved in the long term (fertiliser application according to individual farm site potentials and based on fertiliser application plans; cf. Art. 6 ODP). The OAGR's balanced nutrient budget calculation[54] and current NADUF data[55] for water bodies support this assessment.

The *long-term ecological target* is:
No surplus application of P-fertilisers and no P-accumulation in soils.

3.2.3 References to the remediation programme under Article 62a LWP

Special targets were drawn up for remediation areas under Article 62a LWP with regard to the regional measures for reducing P-pollution due to excessive amounts of manure. Each farm holding in the programme should for example:

- plan at least 10 per cent ecological compensation areas,
- carry out time- and quantity-related restrictions on fertiliser application (only 80 per cent of nutrient requirements) and
- follow a crop rotation programme in which percentages of potatoes, maize and beet do not exceed 20 per cent of open arable land.[56]

Regional agri-ecological water protection measures under Article 62a LWP will undoubtedly have a positive effect on animal husbandry in areas with high numbers of livestock. However, what has been achieved so far with P in agriculture provides few clues regarding actual general effects to reduce pollution in the environment.

For example, it remains unclear whether the ratio between P-input und P-uptake in animal husbandry and in vegetable cropping is actually falling, remaining constant or is even continuing to rise in some regions. As already mentioned, the LWP Article 62a-programmes are still in their infancy.

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54 OAGR, *"Evaluation der Ökomassnahmen und Tierhaltungsprogramme"*, 2nd Interim Report, p. 78, fig. 21 and 22 (June 1999).
personal communication e. spiess, *Agroscope* FAL (may 2000).

55 SAEFL, *"NADUF – Messresultate 1977–1998"*, Schriftenreihe Umw. no. 319, 241 pp. (2000).

56 Canton Lucerne, *"Projekt Sempachersee – Verminderung der P-Belastung von oberirdischen Gewässern aus der landwirtschaftlichen Bewirtschaftung"*, 52 pp. (1999); in conjunction with the "*Verordnung vom 24. September 2002 des Regierungsrats des Kantons Luzern über die Verminderung der Phosphorbelastung der Mittellandseen aus der landwirtschaftlichen Bewirtschaftung"* ("Cantonal Ordinance relating to the Reduction of the Pollution of the Lakes of the Swiss Plateau with Phosphorus in Agricultural Cultivation of 24.09.2002").

3.2.4 Agri-ecological stage target to reduce P-pollution

In accordance with the OAGR's *Eco-Evaluation Report*[57], P pollution of soils caused by agriculture should be halved by 2005 (cf. *Fig. 4).* In precise terms, an annual P-surplus of less than 9,500 t P must be achieved.[58] This *agri-environmental stage target* has already been reached according to the OAGR. The current surplus is estimated to be 8,000 t P (cf. *Fig. 2* and *Table 7).*

Table 7: Review of agri-ecological stage targets and long-term ecological targets for P from agriculture (in t).

Phosphorus	**Surplus**	**Agri-environm. stage targets**	**Long-term ecological targets**
	1998	*as from ca. 2005*	
Total fertilisers	8,000	**8,000***)	Lowest possible surplus manure; balanced nutrient budget *(without 10 per cent tolerance).* **Long-term aim:** to reduce P-accumulation in soil (no more P-levels in classes D and E).
Surplus manure	1'700[59]	**1'200**	

*) OAGR stage target already reached.

Causes of this reduction in P in agricultural fertiliser use are:

- Lower consumption of **P-mineral fertilisers** particularly in arable farming and in arable crops. In the last twelve years, consumption fell to around a third (from 16,000 t P in 1990 to 6,000 t P today). The import of animal feeding stuffs containing phosphorus also fell in the last 20 years from 10,000 t P to around 5,000 t P.[60]
- The **new water protection provisions of 1991** are gradually taking effect; however, this is not yet true for *inflow areas* newly introduced with the Water Protection Ordinance; OWP.
- The **conversion of many agricultural holdings** to more environmentally-friendly or greener production methods such as IP [integrated production] and organic farming.

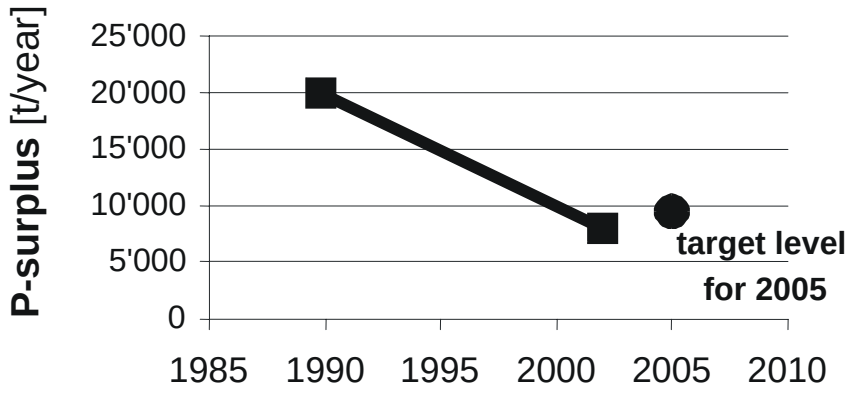
57 OAGR, *"Evaluation der Ökomassnahmen und Tierhaltungsprogramme – Zweiter Zwischenbericht"*, P. 67 (June 1999).

58 The original national P-surplus in agriculture was reduced from 20,000 t P (1990) to 8,000 t P (mainly as a result of a markedly lower consumption of currently around 6,000 t P-mineral fertilisers); cf. also: *Agroscope* FAL, *"Nährstoffbilanz der schweizerischen Landwirtschaft für die Jahre 1975 bis 1995"*, Schriftenreihe no. 28, ISBN 3-905608-20-0, p. 26, Fig. 10 (1999).

59 cf. *Part II, Annex 4.*

60 *Agroscope* FAL, *"Nährstoffbilanz der schweizerischen Landwirtschaft für die Jahre 1975 bis 1995"*, Schriftenreihe no. 28, ISBN 3-905608-20-0, p. 25, Fig. 9 (1999).

Figure 4: P-surpluses 1990 and OAGR stage target for 2005.



Conclusions and prognosis

For mineral fertilisers:

- The agri-ecological target for 2005, namely halving national P-surpluses to below 9,500 t, has already been reached with the current level of 8,000 t.
- Prerequisite for sustainability is further consistent implementation of agri-ecological, environmental and water protection measures (ODP, OHS, OWP).

For surplus manure:

- There are unsolved problems in areas with high numbers of livestock with regional manure surpluses of around 1,700 t P. The same applies for some very high P-levels in the fertilised soils of such areas (class D and E).
- In these regions remediation measures under Article 62a LWP – and participation in such projects – are to be promoted.

4 The way to long-term ecological targets

4.1 Approaching the long-term ecological targets for N

- **In water protection:** the evolution of N-fluxes determined in studies of water bodies[61] shows only stable conditions despite falling inputs from agriculture. Therefore the prognosis for agriculture compared with analysis by the IAW-ETHZ is less optimistic from the ecological point of view.

  According to the *N Strategy Report*[62], nitrate concentrations in exploited groundwater resources must be reduced in the medium term to below currently existing requirements (25 mg/l). For nitrate input into groundwater this means a reduction of about 50 % in the medium term (i.e. by between 15,000 and 20,000 t N – from 34,000 t N; cf. *Table 2).* Such long-term considerations must also take note of the binding **international targets** (cf. *Part II, Annex 7),* which have been negotiated as part of the *International Conferences on the Protection of the North Sea.* According to these, N-inputs into the North Sea should have been halved by 1995.

- **In air pollution control:** a reduction in ammonia volatilisation into the air of around 50 % is required – relative to the level of emissions in 1994[63] – (from 55,000 t N to between about 25,000 and 30,000 t N; the OAGR considers 35,000 t N to be perfectly possible[64]).

In terms of ground level concentrations, air pollutants containing N and their deposition exceed the *"critical loads"* for N-vulnerable ecosystems by a different amount according to the region and in some cases by a large margin. NABEL data[65] for the period from 1985 to 2001 show no reduction in wet N-inputs (annual loads for nitrate and ammonium). The chemical pressure on soils from acidification is slowly reducing, but primarily due to the marked fall in sulphur inputs. Eutrophication of the environment due to N on the other hand continues to be high. 65 to 70 per cent of all ecosystems are still heavily polluted with N.[66]

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61 SAEFL, *"NADUF – Messresultate 1977–1998",* Schriftenreihe Umwelt no. 319, 241 pp. (2000).

62 SAEFL (together with OAGR; 1996), Schriftenreihe no. 273: in the report, the long-term ecological targets are defined so that *"...when complied with, according to the current state of knowledge, human beings and ecosystems in Switzerland are adequately protected".* These targets were laid down in accordance with the ecological effects of N.

63 SAEFL (together with OAGR), *"Strategie zur Reduktion von Stickstoffemissionen",* Schriftenreihe no. 273, p. 37 (1996).
dito; cf. Tab. *"Zusammenfassende Übersicht über die N-Emissionen",* p. 37.

64 cf. Protocol of 03.08.01 on *"Workshop Nitrat vom 4. Mai 2001 – Standortbestimmung 2000/2001",* Berne.

65 SAEFL, *"NABEL – Luftbelastung 2001",* Schriftenreihe Umwelt no. 343, 217 pp. (2002) and previous NABEL reports.

66 SAEFL, *"Atmospheric Deposition of Nitrogen to the Swiss Seeland Region*", Umwelt-Materialien no. 116, 122 pp. (1999).
SAEFL, *"Critical Loads of Nitrogen and their Exceedances – Eutrophying, Atmospheric Deposition",* Schriftenreihe Umwelt no. 275, 82 pp. (1996).
SAEFL, *"Stickstoffeintrag aus der Luft in ein Naturschutzgebiet",* Umwelt-Materialien no. 28, 135 pp. (1994).

4.2 Approaching the long-term ecological targets for P

The result for P matched the target until the middle of the 1990s. Future development of P is moving in the desired direction provided balanced nutrient budgets in animal husbandry are consistently kept in line with individual farm site potential or the vulnerable area measures under Art. 62a LWP in P-polluted areas are successful in the medium term.

At present, no real progress has yet been made with P-surpluses in manure in areas with high numbers of livestock (especially reducing P-levels in soils fertilised with manures). Moreover, the real reason for the marked P reduction in surface waters continues to be the high effectiveness of sewage treatment plants.

4.3 Target deficits for both N and P

The planned targets for N- and P-pollution can be assessed in brief as follows:

- **For N** (cf. *Tables 2* and *6):* in the case of total N-pollution caused by agriculture, the stage target laid down in the *N Strategy Report*[67] cannot be reached by 2002. This requires a reduction in environmentally-relevant N-losses of **22,000 t N.** The target shortfall in 1998 of 7,000 t N is too great (a reduction in N of only 7,000 instead of 14,000 t). Despite measures under *AP 2002* and environmental protection and water protection, the expected shortfall from the agri-ecological stage target of 74,000 t N is still around 8,000 t N even in 2002.

  The long-term ecological target of reducing the annual loss of environmentally-relevant N-compounds by 50 per cent – from 96,000 t N per year to around **48,000 t N** – can only be achieved with greater commitment from the federal government and cantons with regard to fertiliser application, land use management and air pollution control.

- **For P** (cf. *Table 7):* as a result of environmental and water protection measures since the beginning of the 1990s as well as AP 2002, the national average for mineral fertilisers and imported animal feeding stuffs will reach the OAgr's agri-ecological stage target set for 2005, namely halving P-surpluses (calculated according the *Suisse-Balance* for the entire holding).

  However, in productive livestock fattening areas with high numbers of animals and excess P, no sustainable environmental effect will be achieved without further measures, because of the P-content in manure and in over enriched soils (cf. Art. 14 and 27 LWP in conjunction with Art. 62a LWP, and Art. 6 ODP in conjunction with Section 2.1 Annex ODP).

  The prerequisite in this case would be: fertiliser application in accordance with **individual farm site potential** and in accordance with **fertiliser application plans** (e.g. similar to the *FURCA* programme of SRVA-Lausanne). Specifically, as a minimum the number of livestock must be adjusted in line with the proven agricultural *land suitable for fertiliser application (LSF)* and with the respective **P-content** of the soil to be fertilised.

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67 SAEFL (together with OAGR), *"Strategie zur Reduktion von Stickstoffemissionen"*, Schriftenreihe Umwelt no. 273, p. 102 (1996).

The particular problem for example of "long-distance transport" of surplus slurry from traditional livestock fattening areas into arable farming areas with no livestock (e.g. from central Switzerland into western Switzerland) requires the rapid development of a reliable and environmentally compatible intercantonal enforcement practice. The solution to this water protection problem lies in the enforcement powers of the cantons.

For political reasons, this particular problem was not regulated nationally in the Water Protection Law (LWP) but only regionally – aimed at livestock fattening regions with high numbers of livestock *(normal range of the farm locality – NRFL;* cf. Art. 24 OWP). Therefore, in the case of manure, there is no directly applicable federal regulation for an environmentally sound solution to the problem of "long-distance transport".

The recipient farm holdings which take surplus manure from other cantons would have to be controlled by the local cantonal authority. Transfer contracts would have to be examined individually in close collaboration with the respective cantonal authority of the donor holding. Therefore, in order to solve this intercantonal problem, a generally binding agreement would be advisable at the level of the *Conference of the Heads of Cantonal Environmental Protection Agencies (CHEPA).* An appropriate agency for national monitoring of manure transport across cantonal boundaries is being established on the instructions of the CHEPA (central registration of all these intercantonal manure transfer contracts).

5 Final assessment of incentive taxes on fertilisers

5.1 Incentive taxes in the light of agri-ecological stage targets

- The **2002 agri-ecological stage target for N** aims at a national reduction of annual N-losses in agriculture of 22,000 t N (based on 96,000 t N in 1994).

  Conclusion: this target has not been met.

- The **2005 agri-ecological stage target for P** aims at halving annual P-surpluses caused by agriculture. This P-target has already been reached, principally due to the national reduction in the use of P-mineral fertilisers (reduction to 8,000 t P in relation to the year 2000).

  The measures for P-mineral fertilisers which have taken effect under environmental and agricultural law (AP 2002) have proved to be effective.

  Conclusion: incentive taxes are not necessary for mineral fertilisers.

5.2 Incentive taxes on surplus manure?

5.2.1 Target conformity

Unlike the case of N- and P-mineral fertilisers, an incentive tax on surplus manure – measured according to P – would essentially be necessary in areas with high numbers of livestock (cf. wording of motion 94.3005 UREK-S). This requirement

can be justified by the high regional P-surpluses, including the large P-accumulation in those soils, and also by the high N-losses into the air of such areas.

Incentive taxes on surplus manure would be fully in line with the target because:

- they would reduce surplus manure in vulnerable areas in an administratively simple and controllable way (those liable could be registered in a simple way on the basis of the now compulsory manure transfer contracts – cf. Art. 14 Para. 5 LWP);
- the high P-accumulation in soils and ammonia emissions into the air, particularly in areas with high numbers of livestock, would be stabilised and subsequently slowly reduced;
- they would create additional incentives for consistent enforcement of previous agri-ecological and environmental policy measures;
- no substitutional effects would be expected in agricultural fertiliser application or in animal husbandry of areas vulnerable to water pollution impacts (new environmental hazard e.g. due to an upturn in the amount of mineral fertilisers used).

5.2.2 Expedience

Since motion 94.3005 UREK-S was submitted in January 1994, new measures have been introduced in regions vulnerable to water pollution under Article 62a LWP. These are currently being implemented at considerable financial and technical expenses by the agricultural advisory services taking part in the programme and the farmers interested.

The ecological effect of this programme, which is only in its early stages, cannot yet be definitively assessed. It is expected that the first successful results will be achieved in years ahead with the fall in regional surplus manures in the livestock fattening areas of the lake catchment regions of central Switzerland, which are subject to high phosphorus levels.

In view of these efforts and for general agricultural policy reasons, incentive taxes on surplus manure are not expedient.

5.2.3 Alternative

The alternative to the introduction of incentive taxes (cf. wording of motion 94.3005 UREK-S) lies – as explained – in a marked reduction of surplus manure under existing agri-ecological framework provisions (e.g. ODP) and with regional remediation measures under Article 62a LWP.

Prerequisite: ODP, Article 62a LWP, but also OHS and OAPC, and the accompanying framework for implementation of GRUDAF'01[68] compatible with water protection are consistently and transparently enforced (prevention of enlargement of animal numbers in livestock fattening).

68 *Agroscope* FAL and *Agroscope* RAC, *"Grundlagen für die Düngung im Acker- und Futterbau – GRUDAF'01", AGRAR*Forsch., 8, 6, 80 pp. (June 2001).

The success of these measures will be dealt with as part of the annual OAGR evaluation – primarily with emphasis on water protection and air pollution control.

5.3 Reduction of surplus manure by 2010 – SAEFL agri-ecological stage target

5.3.1 Agri-ecological stage target 2010

If all essential aspects are considered, it should be possible to reduce the P-content of surplus manure, or the amount of surplus manure itself, by a third by the year 2010 compared with the 1998 level.

***Stage target*:** From 2010 no more than around 1,200 t P per year should have to be transferred to recipient farms as surplus manure by respective farm holdings with animal husbandry (reduction of around 500 t P).

Until then, implementation of environmental measures, in particular water protection measures, and those relating to IP and organic farming by the federal and cantonal environmental and agricultural authorities in areas with high numbers of livestock must contribute noticeably more than in the past to reducing surplus manures.

Animal husbandry (especially animal fattening) in vulnerable areas must be more closely bound to farmers' own and leased agricultural land *approved for fertiliser application (LFA)* and must be conducted in accordance with the technically required rules of land use management in traditional agriculture (cf. Art. 2 Para. 1 Let. b LAgr in conjunction with Art. 6 ODP).

In addition, the P-content of all relevant concentrated feed (cf. "environmentally-friendly animal feed")[69] must be better adjusted to the needs of individual livestock. Their species-based feeding must be transparently directed towards long-term ecological targets for individual farms (standard in the farm fertiliser application plans).

5.3.2 Surplus manure unavoidable?

Even with SAEFL's ecological stage target for 2010 to reduce surplus manure by a third, this environmental problem in agricultural fertiliser application and agricultural utilisation of the soil cannot be definitively solved by that time.

This is due to the particular structures in livestock farming, i.e. rural land-dependent, partially land-dependent and completely land-independent animal husbandry. Traditional animal husbandry, including that according to the rules of IP and even organic farming, will not be able to give up manure transfer contracts for the time being due to economic and also regional/structural reasons.

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69 Kessler J., *"Phosphor im Schweinemastfutter – die Zeit drängt"*, Die Grüne, 40, 25–26 (05.10.1990).
Kessler J. et al., *"Phosphor sparen dank Phytase: Erste Ergebnisse beim Mastschwein"*, Landw. Schweiz, Bd. 5, 1/2, 5–9 (1992).
Zentralstelle für Ökologie in der Landwirtschaft Kt. LU [Canton Lucerne Central Office for Ecology in Agriculture], *"Vorgehen bei der Bewerbung als Ökofutter-Lieferant"*, 2 pp. (January 1994).
Canton Lucerne Environmental Protection Office, *"Merkblatt für Ökofutter-Einsatz"*, 5 pp. (February 1994).

There will continue to be such contracts between farm holdings in future. However, in terms of numbers, and assessed according to an ecologically acceptable transfer distance for the transport of surplus manure to suitable recipient farm holdings, the number of contracts should be reduced to an extent which is as environmentally-friendly as possible. This means – as a matter of priority – closing the phosphorus nutrient cycle in organic and IP animal husbandry, or reducing animal husbandry on rural farm holdings.

Result: Due to the particular, regional structure of Swiss animal husbandry, it will not be possible in the medium term to prevent surplus manures entirely. However, they should be reduced to a level which is as environmentally compatible as possible – taking account of ecologically and economically acceptable travel distances for the transport of manures (mainly within the *normal range of the farm locality – NRFL).*

5.3.3 Checking target attainment

- ***Under environmental law:*** under *Article 50 Para. 1 LWP* the federal and cantonal authorities shall check the effects of measures under LWP and inform the general public about water protection and the condition of water bodies. The co-ordinating federal office in matters of surplus manure is SAEFL.

  Under *Article 58 Para. 1 LWP* the cantons shall carry out surveys which are necessary to enforce the LWP. They shall notify the federal offices, in this case SAEFL, of the results.

Article 46 LEP specifies that everyone is under the obligation to provide the authorities with the information they need to enforce the LEP and if necessary to carry out inquiries or submit to them. The Swiss Federal Council and the cantons shall have the power to order that registers be kept, giving *inter alia* details of the types, amounts and evaluation of substances and that these be made available to the authorities on request. The Swiss Federal Council shall further have the power to order that information be submitted concerning substances which can endanger the environment (e.g. the P-content covered by manure transfer contracts).

These environmental protection provisions under police law therefore make it possible to monitor or check the progress and effect of cantonal measures to reduce surplus manure from the point of view of environmental law.

In principle the cantons are responsible for enforcing environmental protection regulations under police law. However, the Confederation may act as co-ordinator as part of its supervisory role (cf. enforcement aids such as guidelines, instructions etc., enforcement-based discussion platforms at CMBPE/CCMA and CHEPA/-CHAGR[70]).

[70] *CMBPE* = *Conference of Cantonal Ministers for Building, Planning and Environmental Protection* [Bau-, Planungs- und Umweltschutzdirektorenkonferenz];
CCMA = *Conference of Cantonal Ministers for Agriculture* [Landwirtschaftsdirektorenkonferenz];
CHEPA = *Conference of Heads of Swiss Environmental Protection Agencies* [Konferenz der Vorsteher der Umweltschutzamtsstellen der Schweiz];
CHAGR = *Conference of the Heads of Swiss Agricultural Agencies* [Konferenz der Landwirtschaftsämter der Schweiz].

- ***Under agricultural law:*** under *Article 8* of the *Ordinance of 7 December 1998 on the Assessment of Sustainability in Agriculture,* the OAGR shall periodically report on the development of farmers' ecological performance and the effect of agriculture on the natural living conditions. It shall assess the quantitative and qualitative effects of agricultural policy using national, regional and farm-related ecological indicators.

  Under *Article 11* of this Sustainability Ordinance, the OAGR shall draw up and publish annually a report on the results of the assessment of agriculture from the point of view of sustainability. Finally, individual OAGR publications on different assessment areas are also possible.

The OAGR will therefore also have to report on developments in the area relating to the reduction of surplus manures as part of its annual evaluation of agri-ecological performance.

6 Greater commitment by the Confederation and Cantons to fertiliser application, land use management and air pollution control: three packages of measures

As explained, ecological achievements (cf. Art. 70 Para. 1 Let. b, c, d and e LAgr) as well as measures under Water Protection Law, the Ordinance relating to Hazardous Substances and the Air Pollution Control Ordinance provide the necessary enforcement basis for achieving the targets in animal husbandry or in handling manure in vulnerable areas (cf. "P-Remediation" Ordinance of Lucerne of 2002)[71].

Firstly, P-surpluses in the manure (slurry) of livestock fattening areas, primarily in the vulnerable lake catchment areas of central and eastern Switzerland, must be greatly reduced, not least because of valuable biotopes. Measures which reduce N-losses nationwide are also needed. In addition, corresponding accompanying measures must ensure that other areas, which are not currently polluted with N and P, continue to remain so in future.

In order to improve and simplify cantonal implementation – also with a view to improving ***independent, transparent control of achievements*** – the following three packages of measures must be carried out under **existing environmental law and agri-ecological regulations**:

[71] Cantonal Government of Lucerne, *"Verordnung vom 24. September 2002 über die Verminderung der Phosphorbelastung der Mittellandseen durch die Landwirtschaft",* no. 703a. [Ordinance of 24 September 2002 relating to phosphorus pollution of lakes in the Swiss Plateau from agriculture].

- **MEASURE 1:** the present ***"Guidelines of July 1994 for Water Protection in Agriculture"*** (OAGR/SAEFL) and other federal recommendations on the subject of manures (farm holdings with animal husbandry) are to be revised by the year 2005, as part of water protection and environmental legislation – including enforcement experience under AP 2002. These basic guidelines support the cantonal enforcement authorities and agricultural advisory services to harmonise and to coordinate the implementation.
- **MEASURE 2:** the ***individual farm site potential*** in accordance with proof of ecological achievement (PEA, cf. Ordinance relating to Direct Payments, ODP) plays a key role in environmentally sound fertiliser application and utilisation of soils (cf. also Annex 4.5 Ordinance relating to Hazardous Substances). This term includes for example local yield limits for plant cropping, nutrient accumulation in the soil, plot-specific balanced nutrient budgets and exposure (gradient of slope).

  The *individual farm site potential* presently is only defined at the beginning and only for the subject of ***substance*** **carrying capacity of the soil under water protection legislation** (cf. Guidelines for water protection in agriculture, part VII: *"Recording the nutrient requirement").* The content of assessment principles suitable for practical enforcement has yet to be drawn up. SAEFL arranges for projects (monitoring of local nutrient fluxes) and presents results which can be used in implementation within a recommended frame period of time.
- **MEASURE 3:** a national reduction of ***ammonia emissions*** into the air from agricultural sources can be expected under the Air Pollution Control Ordinance (OAPC) with consistent enforcement of preventive limitation of emissions in accordance with Article 4 OAPC and with the help of cantonal air pollution control action plans (cf. Art. 2 Para. 5 and 31 to 34 OAPC)[72].

  These action plans are used to lower excessive immissions (N-input into vulnerable ecosystems). The necessary framework conditions must be established in order to facilitate implementation and to make measures to reduce emissions more economically acceptable (incentive strategy, promotion programmes for low-emission technologies)[73].

[72] cf. *"Bericht vom 23. Juni 1999 des Bundesrats über die lufthygienischen Massnahmen des Bundes und der Kantone (99.077)"* and Federal Council Report of 1 March 2000 on Legislature Planning 1999–2003; see also: SAEFL communication No. 13 on the OAPC (2002).

[73] cf. Federal Council answer of 07.03.2003 to the *ordinary question by Graf (no. 02.1157)* of 13.12.2002 on *"Schleppschlauchverteiler gegen zu hohe Ammoniakwerte in der Landwirtschaft",* and answer of Federal Minister Leuenberger to the *Scherer ordinary question (no. 02.5048)* of 18.03.02 on the OAPC.

ANNEXES to Part II – *FERTILISERS*

ANNEX 1: Significance of P to plants and water bodies

1 Basic information about P[1]

Plants can only grow if P is present in the soil or is supplied through fertiliser application. Algae are plants. P is therefore also a growth-inducing factor for them in lakes and slow flowing waters (e.g. backwaters). If P-levels in the water rise significantly, the mass of algae also increases ("fertilising effect").

Algal blooms occur when there is a N:P ratio in the water of between 8:1 and 12:1. When the algae die, they then sink into the deeper water strata. If this happens, the oxygen in the lake water is consumed because of the microbial breakdown of algae (decomposition).

As a result, P from the algae is mineralised and deposited in the lake sediment (bottom "sludge"). This P stored in the lake sediments may return to the lake water if the oxygen in the deep water has been completely consumed (anaerobic conditions). The newly released P subsequently is available to the algae again in the spring after the annual lake water mixing, which takes place in the autumn.

The P in surface waters originates from many sources. The decomposition of dead aquatic plants described above always releases P-compounds into the water naturally. To these are added considerable amounts of P from trade and industry. These are e.g. detergents and losses from animal manures and mineral fertilisers. Added to the equation is also P which has built up in the "soil accumulation" as a result of agricultural fertiliser application over many years. Such P subsequently may be fed to water bodies due to soil erosion.[2] However, as an example soil erosion occurs very rarely on the Lake of Baldegg, although run-off and leaching of P does occur near that lake. There are differences here: erosion is more likely to occur in arable farming, whereas run-off is more likely to take place in the utilisation of fodder crops (from grassland).

Fish can barely survive in near to deoxygenated water strata and die in anoxic water strata. Furthermore, near the banks of watercourses, sunlight can no longer penetrate deep water due to shading by algae. This is how valuable natural water meadows disappear even in shallow strips near the banks.[3] Biodiversity near and in lakes is lowered and the biological condition of such lakes is deteriorated. Such changes in lakes can only be reversed at great cost.

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1 cf. e.g. Werner W., *"Ökologische Aspekte des Phosphor-Kreislaufs"*, UWSF – Z.Umweltchem.Ökotox., 11, 6, 343–351 (1999).

2 Gächter R., *"Die bodenbürtige P-Belastung des Sempachersees"*, gwa, 79, 6, 460–466, (1999); ditto, *"Massnahmen zur Sanierung des Baldeggersees und seines Einzugsgebiets"*, 15 pp. (2000; *unpublished).*

3 Arnold P. et al., *"Wasser- und Ufervegetation"*, Mitteilungen der Naturforschenden Gesellschaft Luzern, Bd. 33, 89–104 (1993).

2 Studies of P in water bodies

P-pollution of water bodies has been investigated *inter alia* in a federal monitoring programme running since the 1970s *(NADUF = Nationale analytische Daueruntersuchung der schweizerischen Fliessgewässer [National Long-Term Analytical Investigation of Swiss Rivers]).* This programme concentrates on a few larger or more heavily polluted rivers (e.g. Glatt in the canton of Zurich).

In addition, the P-levels of polluted, eutrophic (over-enriched) lakes and their inlets have for years been periodically measured in regional monitoring projects. This mainly involves the lakes of Sempach, Hallwil and Baldegg in some intensively-farmed areas of Lucerne and Aargau.[4]

However, direct attribution by means of water analysis of the source of P to the different causes is not possible. In the environment, biological and chemical processes take place which change the different "P-fractions" (forms of chemical compounds) of the various emission sources.

Therefore, emission sources (originators of pollution) must be determined by means of statistical evaluation of air deposition, volume of waste water and mass of fertilisers, numbers of livestock and agricultural yields. Modelling of the P-cycle makes it possible to reliably attribute P-quantities to individual originators e.g. for the catchment area of Lake Constance[5] or in regional P-projects for the Lake of Sempach and Lake of Baldegg[6] (Art. 62a LWP).

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4 SAEFL, *"Der Zustand der Seen in der Schweiz"*, Schriftenreihe Umwelt no. 237, 159 pp. (1994).
Grünig K., Prasuhn V., *"Phosphorverluste durch Bodenerosion", AGRAR*Forschung, 8, 1, 30–35 (2001).

5 International Water Pollution Control Commission for Lake Constance (IWPC-LC), *"Phosphor und Stickstoff aus diffusen Quellen im Einzugsgebiet des Bodensees 1996/97"*, ISSN 1011-1263, IGKB-Bericht, 83 pp. (1999).

6 Canton Lucerne, *"Phosphorprojekt Sempachersee"* and *"Phosphorprojekt Baldeggersee"*, each ca. 50 pp. (January 1999 and January 2000).

ANNEX 2: What is "surplus manure"?

1 Introduction

"Manure" is deemed to mean liquid manure, dung, liquid from dung, products of the separation of liquid manure, silo fluid and similar wastes from animal husbandry, (cf. Annex 4.5 OHS). It must be used solely for fertiliser application and in no case shall be disposed of – e.g. by incineration or depositing on waste disposal sites (cf. Art. 14 Para. 2 LWP).

"Surplus manure" is not a term defined in law. However, it is directly connected with the enforcement of provisions governing farm holdings with animal husbandry under LWP and OWP as well as under the OHS.

The *Ordinance relating to Hazardous Substances (OHS)* requires that fertilisers should be used in a way which is compatible with the environment and taking into account the nutrient requirements of the plants and nutrients present in the soil (cf. Art. 9 and 10 OHS in conjunction with Annex 4.5 Nr. 31 Para. 1 Let. a OHS). Consequently, balanced fertiliser application or a balanced nutrient budget must be maintained in every case. Farm holdings with too many livestock animals – calculated according to the proven agricultural land approved for fertiliser application – therefore produce too much manure and thus give rise to "surplus manure".

The *Water Protection Law* (Art. 14, 15, 27, 51, 77 and 78 LWP) and the *Water Protection Ordinance* (Art. 9 and 22–27 OWP) on the other hand contain special provisions, which are directly applicable to manures in agriculture, for farm holdings with livestock such as cattle, pigs and poultry. These legal provisions require assessment of water protection compatibility and utilization of manure from animal husbandry in accordance with the available area approved for fertiliser application (e.g. nutrient carrying capacity of the soil in areas for fertiliser application with manure, prohibition of disposal aso.; cf. Art. 14 LWP).

The quantitative criteria for assessing surplus manure are often based solely on the P-flux. It is well known and possible to reliably determine and assess the P-flux in quantitative terms, unlike the N-flux (e.g. P-accumulation in the soil, P-excretion from livestock, P-levels in water).

2 Water protection assessment

2.1 Sufficient utilization area for manures

As already mentioned, surplus manures arise whenever a farm holding with animal husbandry does not have sufficient of its own or leased agricultural land on which to apply slurry and solid manure in a way which is compatible with the soil and water quality. In such cases, the livestock farmer must find the agricultural land he lacks in the vicinity of his holding and secure it by contract.

This is on the strict condition that recipient farm holdings also maintain balanced nutrient budgets even after accepting surplus manures (cf. Art. 26 Para. 2 OWP; and observing a zero tolerance balance).

2.2 Limitation of travel distance in the normal range of the farm locality (NRFL)

If a livestock farmer's **own or leased agricultural** land counts less than 50 % of the land needed and approved for the utilization of all his manures, he must conclude all transfer contracts for his surplus manure strictly within a narrow radius around the site of his holding. This compulsory contract area around his farm site is limited to a travel distance of 6 km – in exceptional cases 8 km – (cf. Art. 24 OWP on the *normal range of the farm locality, NRFL).*

It was hoped at the beginning of the 1990s that such measures would reduce environmental impacts caused by slurry in areas with high numbers of livestock. Anyone who does not find sufficient contract areas within his NRFL is definitely obliged to lower his livestock numbers. The Confederation offered special closure contributions in the early 1990s to all holders of animal husbandry in surplus. However, this project was not successful with respect to the animal husbandries in question. The relevant *Ordinance relating to the closure of animal husbandry farms*[1] was therefore repealed prematurely.

2.3 Exemptions from the limitation on travel distance

If the fraction of own or leased agricultural land of a farm holding with animal husbandry is in excess of 50 % of the area required (so-called *"50 %-clause"),* the respective farmer may look for the land needed and approved for fertiliser application without restrictions, if necessary nationwide, and secure it by contract. The only travel distance restrictions in such cases are economic and energy considerations.

Farm holdings which keep poultry, horses and the like and which act in the public interest (pig farming which reuses waste – feeding of waste food and waste from slaughtering), and holdings for agricultural research etc. do not need to comply with the NRFL travel distance of 6 km. They may also transport their surplus manure further than this distance to fertilise off-farm agricultural land.

However, processes for treating surplus manure (e.g. separation of liquid manure) or drying do not provide exemption from compliance with the NRFL regulation in the case of insufficient owned or leased agricultural land.

2.4 Conditions in joint enterprise farming

If an agricultural holding forms a joint enterprise with another agricultural holding (e.g. holding with no cattle and a cattle-rearing holding), this joint enterprise may exist within a radius of 15 km (cf. Art. 12 *Ordinance relating to Direct Payments* and Art. 10 Para. 1a *Agricultural Terms Ordinance).*

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1 Verordnung vom 13. Januar 1993 über Beiträge zur Stillegung von Betrieben, zum Abbau von Tierbeständen und als Anpassungshilfen (Betriebs-Stillegungsverordnung); abrogated.

Under the water protection legislation, such holdings are deemed to be a single holding. The 6-km travel distance limit is hardly ever applied for these holdings because sufficient own and leased agricultural land is usually proven (50 %-clause met in any case).

3 Summary

Surplus manure arises whenever there is insufficient owned and leased agricultural land necessary for environmentally compatible utilization of the manure produced. In such cases, there is a clear disproportion between the quantity of manure and the nutrient requirement of a farm holding’s agricultural land approved for fertiliser application.

Anyone who has to transfer more than half his manure to other agricultural holdings may deliver to such recipient holdings only within a maximum travel radius of 6 km (in exceptional cases 8 km). However, treatment of liquid manure does not provide exemption from the provisions of the NRFL. The legislator wanted to control "liquid manure tourism" by holdings with insufficient land of their own (mainly non-rural farm animal fattening units).

In most cases, the effect of this regulation is not restrictive. Rural holdings and certain joint operations (arable farm with a partner in animal husbandry) practically always meet the so-called *NRFL provision.* They therefore have no difficultly proving that they own or lease agricultural land approved for fertiliser application appropriate for at least half the volume of manure produced on their holding.

Experience shows that only financial considerations limit travel distance in such cases (transport costs in comparison with income from fattening, value of manure as a fertiliser etc.).

ANNEX 3: Problems of P-surpluses – illustrated by a regional case study

1 Background

Numerous expert articles have reported the efforts made over decades to solve the problems of water protection caused by livestock fattening in the canton Lucerne. These publications give an exemplary and detailed analysis of the P-problem and possible ways of resolving it in the region of the lakes of Sempach and Baldegg.

The reports were written by both the cantonal authorities and agri-scientifc and limnological researchers. The sometimes very complex relations between water protection and agriculture in the aforementioned lake regions are thus presented in summary form (chronologically).[1]

[1] Gächter R., *"Der Beitrag der Landwirtschaft zur Eutrophierung der Gewässer in der Schweiz – Ergebnisse von direkten Messungen im Einzugsgebiet verschiedener Vorfluter"*, Schweiz.Zeitschr.Hydrol., 34, 1, 41–70 (1972).

Baumann P., *"Untersuchungen im Einzugsgebiet des Sempachersees zur Feststellung der Phosphorbelastung des Sees durch die Landwirtschaft"*, Gas, Wasser, Abwasser, 64, 3, 89–102 (1984).

Baumann P., *"Zusammenarbeit zwischen Gewässerschutzfachstelle und landwirtschaftlicher Beratung am Beispiel der Zentralstelle für Ökologie des Kt. LU"*, Gas, Wasser, Abwasser, 67, 1, 1–6 (1987).

Zimmermann W. et al., *"Landwirtschaft und Umwelt im politischen Alltag"*, 357 pp., BBL-Vertrieb Publikationen, 3003 Berne (1987).

Baumann P., *"Weitergehende Gewässerschutzmassnahmen im Einzugsgebiet der luzernischen Mittellandseen im Bereich der Landwirtschaft"*, Gas, Wasser, Abwasser, 68, 1, 1–16 (1988).

Canton Lucerne, Environmental Protection Office, *"Merkblatt für den Gewässerschutz in der Landwirtschaft"*, Press release of 20.01.1988.

Stadelmann P., *"Zustand des Sempachersees vor und nach der Inbetriebnahme der seeinternen Massnahmen: Künstlicher Sauerstoffeintrag und Zwangszirkulation 1980–1987"*, wasser, energie, luft, 80, H. 3/4, 81–96 (1988).

Gächter R. et al., *"Auswirkungen der Belüftung und Sauerstoffbegasung auf den P-Haushalt des Sempachersees"*, wasser, energie, luft, 81, 335–341 (1989).

Canton Lucerne, Environmental Protection Office, Agriculture Department, Central Office for Ecology in Agriculture, Agricultural Credit Bank of Canton Lucerne, Farmers Union of Canton Lucerne, Arbeitsgemeinschaft Luzerner Bergbevölkerung, *"Gemeinsame Absichtserklärung über den Umweltschutz in der Luzerner Landwirtschaft"*, 5 pp. (February 1992).

Gächter R. et al., *"Gewässerschutz und Seeforschung"*, in: Sempachersee, Mitteilungen der Naturforschenden Gesellschaft Luzern, Band 33, 343–378 (1993).

Knoepfel P. et al., *"Gewässerschutz in der Landwirtschaft – Evaluation und Analyse des föderalen Vollzugs"*, ISBN 3-7190-1298-0, Ökologie und Gesellschaft, Bd. 7, 300 pp., Helbing & Lichtenhahn (1993).

Koller P., *"Zusammenarbeit mit der kantonalen Gewässerschutzbehörde am Beispiel des Kantons Luzern"*, Conference of 30.04.1993 of Schweizerischen Arbeitsgemeinschaft für landwirtschaftliches Bauen und Hoftechnik, 6 pp. (1993).

(Continuation of footnote 1)

Canton Lucerne, Environmental Protection Office, and Agriculture Department, *"Lösungsansätze zur Hofdüngerproblematik im Kt. Luzern"*, 65 pp. (1994).

Canton Lucerne, Central Office for Ecology in Agriculture, *"Vorgehen bei der Bewerbung als Ökofutter-Lieferant"*, 2 pp. (January 1994).

Canton Lucerne, Environmental Protection Office, *"Merkblatt für Ökofutter-Einsatz"*, 5 pp. (February 1994).

SAEFL, *"Der Zustand der Seen in der Schweiz"*, Schriftenreihe Umwelt no. 237, 159 pp. (1994).

Gächter R. et al., *"Dünger düngt Sempachersee"*, *AGRAR*Forsch., 3, 329–332 (1996).

Wehrli et al., *"Zehn Jahre Seenbelüftung: Erfahrungen und Optionen"*, Schriftenreihe EAWAG no. 9 (1996).

Stadelmann P. et al., *"Massnahmen zur Seensanierung: Beispiel des Baldeggersees"*, gas, wasser, abwasser, 77, 1, 16–33 (1997).

Blum J., *"Erfahrungsbericht aus den 4 Pilotprojekten"*, LBL course 99.205 on water protection in agriculture, 14 pp. (1999).

Sempachersee Municipalities Association, Canton Lucerne Environmental Protection Office, Cantonal Agriculture Department, Cantonal Ecology Office, *"Projekt Sempachersee – Verminderung der P-Belastung von oberirdischen Gewässern aus der landwirtchaftlichen Bewirtschaftung"*, 52 pp. (January 1999); ditto, *"Phosphorprojekt Baldeggeree"*, 53 pp. (January 2000).

Lakes of Sempach, Baldegg and Hallwil Municipalities Association, *"Merkblatt über die Phosphorprojekte an den Mittellandseen des Kantons Luzern"*, *"Vertrag über besonders seegerechtes Verhalten (Seevertrag)"*, *"Regelung über Aufstockung von Tierbeständen und Hofdüngerübernahme im Einzugsgebiet der Mittellandseen"*, Lake Lucerne and Swiss Plateau Lakes Phosphorus Project (2000).

Braun M. et al., *"Wirkungskontrolle der Öko-Massnahmen in der Landwirtschaft – Phosphorbelastung der Oberflächengewässer durch Abschwemmung"*, Study of the catchment area of the Lippenrütibachs of the lake of Sempach in Canton Lucerne, BFS/*Agroscope* FAL, 132 pp., ISBN 3-303-07057-1, Neuenburg (2001).

Herzog P., *"Baldeggersee – Auswertung der Zuflussuntersuchungen 1995 bis 1999"*, Canton Lucerne, Environmental Protection Office, 37 pp. (2001).

Braun M. et al., *"Abschwemmung von Phosphor"*, *AGRAR*Forsch., 8, 1, 36–41 (2001).

Stadelmann P. et al, *"20 Jahre Sanierung und Überwachung des Baldeggersees"*, Mitt. Naturfor.Gesell.Luzern, 37, 115–164 (2002).

Lakes of Baldegg and Hallwil Municipalities Association, *"Vereinbarung über Stallstillegung und Beschränkung des Tierbestandes"* (2002).

Cantonal Government of Lucerne, *"Verordnung vom 24. September 2002 über die Verminderung der Phopshorbelastung der Mittellandseen durch die Landwirtschaft"*.

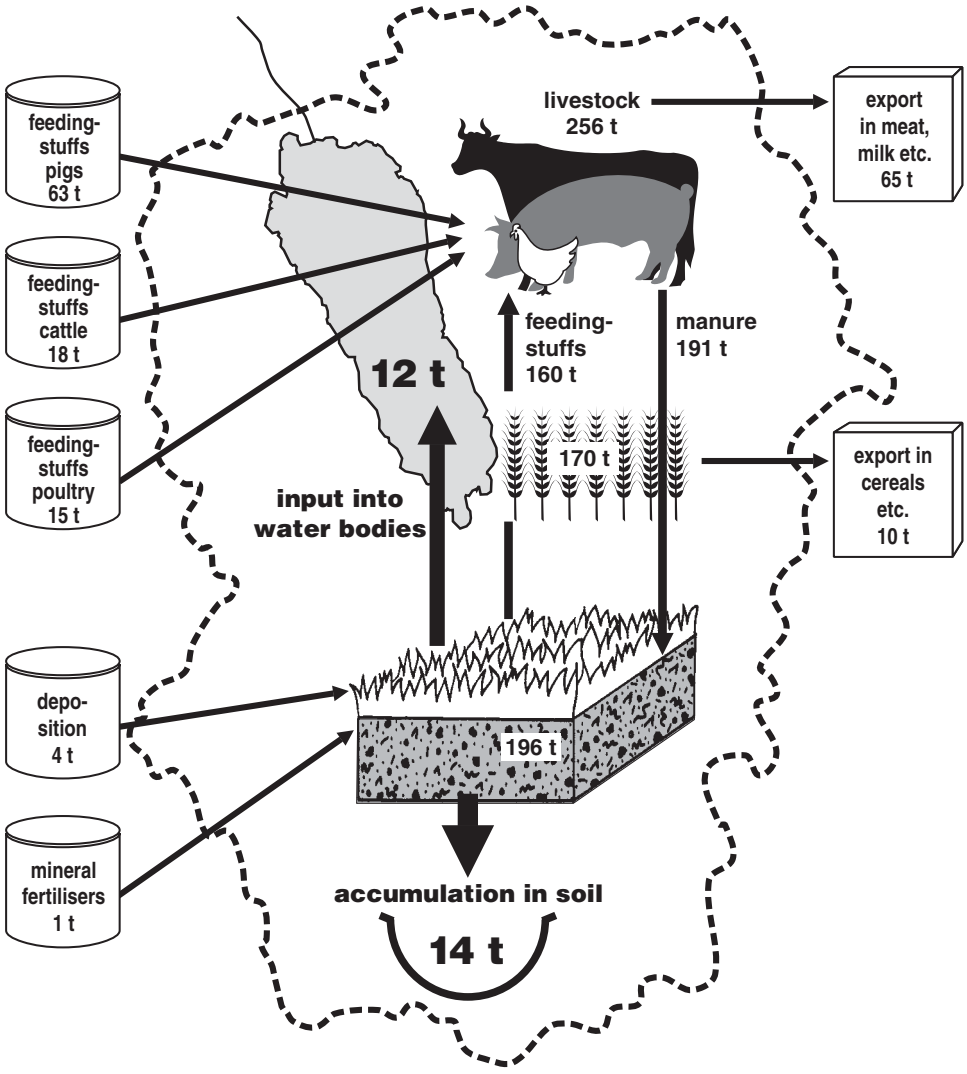
Canton Lucerne, Environmental Protection Office, *"Faktenblatt Seesanierung"*, 7 pp. (2002).

Schmidlin J. and Koch B., *"Problemlösung Baldeggersee – Ansätze zur Lösung der Phosphor- und Ammoniakprobleme"*, Report commissioned by Pro Natura, 59 pp. (2003).

2 The example of the Lake of Baldegg[2]

The relevant agricultural land in the **catchment area of the Lake of Baldegg** measures 56 km^2, and the lake surface area is 5.2 km^2. The number of agricultural livestock holdings is 380. The regional P-cycle in the catchment area shows that the actual **P-problem is due to manure and not to mineral fertilisers** (cf. *Fig. 1).*

Figure 1: Annual P-balance in the catchment area of the Lake of Baldegg.



[2] Canton Lucerne, *"Phosphorprojekt Baldeggersee – Verminderung der P-Belastung von oberirdischen Gewässern aus der landwirtschaftlichen Bewirtschaftung"*, 53 pp. (January 2000).

Of the 256 t P which are taken up in animal feeding stuff (hay, grass, concentrated feed) by livestock in the catchment area, 14 t P per year accumulate in the soils fertilised with manure. A further 12 t P enter directly into the lake (run-off). This gives a total of 10 per cent, which enter soils and the lake as surplus (compared with the total P-content in manure).

The present assessment principles for the problem of surplus manure show clearly in the example of a well-documented regional case over many years that, in areas with high numbers of livestock, no real success has yet been achieved in finding a sustainable solution to this environmental problem (water protection).

In areas with high numbers of livestock, particularly in pig fattening enterprises, there is still a notable imbalance between the land approved for fertiliser application and the number of livestock in such areas (P-level in soils, number of fattening animal units, i.e. nutrient flux related occupant numbers).

ANNEX 4: Estimation of the P-content in surplus manures

1 Introduction

The P-amount in all surplus manures, which on the basis of individual transfer contracts have to be delivered to farm holdings with a proven nutrient requirement, is so far not known. From experience it is mainly P-flux in pig slurry from soil-independent fattening holdings, but also occasionally P in slurry or solid manure from poultry farming and beef production.

The pig keeping data published annually by the Swiss Federal Office of Statistics [OST][1] are sufficient to make a reasonably accurate estimate of this P-content in surplus pig slurry. Until recently these statistics could also be used to assess the different pig fattening classes on the set survey day.

Using the P-values typical for each production animal, which can be found in the *"Guidelines of July 1994 for Water Protection in Agriculture"* (OAGR/SAEFL), the total P-content can be determined for the individual pig age classes. In this way an approximate calculation can be made of the P-content in the relevant surplus slurries.

2 Relevant numbers of livestock

The numbers of relevant fattening livestock were as follows in 1998:[2]

- Pigs 1,487,000 head = 1,055,000 fattening pig units (FPU[3])
- Poultry 6,735,000 head = 42,000 CMU [cattle manure units] *(à 100 LHU[4]).*

The 1998 OST Report is the last one to contain the pig fattening classes important for precise N and P calculations – in subsequent years the OST recorded only the total number of pigs and breeding sows. It is known that the number of fattening pigs rose again to 1,498,000 head in 2000.

The highest possible number of livestock (fattening) per holding is limited under the *Ordinance of 26 November 2003 on maximum livestock numbers in meat and egg*

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1 OFS, *"Einblick in die schweizerische Landwirtschaft 1999"*, order no. 214-9900, ISBN 3-303-07052-0, Neuenburg, 124 pp. (2000). *Note:* the OST edition for 2001 (ISBN 3-303-07058-X) no longer contains the usual fattening age classes for pigs. The OST Report for 1999 was therefore used for this estimate (data for 1998).

2 ditto, p. 95.

3 Fattening pig unit (FPU)
The total of 1,055,000 FPU is calculated from the OST'99-statistics (cf. OST-footnote 1), p. 95, as follows:
– 298,000 pigs à 0.6 FPU;
– 297,000 pigs à 1.0 FPU;
– 132,000 pigs à 1.2 FPU;
– 152,000 sows à 2.7 FPU and
– 6,400 boars à 1.5 FPU.
The 601,000 piglets are accounted for with the 152,000 sows.

4 LHP = laying hen unit

production (Maximum Stock Numbers Ordinance, MSNO)[5]. This economics-based ordinance is thus an important federal decree which also has effects in terms of water protection.

For example, no more than 250 sows, 1,500 fattening pigs, 18,000 laying hens etc. may be farmed per holding. If a holding uses up the maximum number of animals in a particular livestock category, it may not farm any animals from another category.

3 Relevant number of pig farms

In 1998 there was a total number of 17,500 pig farms[6]. These included:

- with 100–500 pigs[7] approximately 3,450 farms
- with more than 500 pigs approximately 505 farms

4 Estimate of the P-content in pig farming

An annual total of **3,100 t P** occurs in the combined manure of all 17,500 farms (total 1,055,000 FPU). The recognised problems of surplus manure are caused mainly by those farms that fatten pigs in weight classes 30–80 kg or over 80 kg. 3,955 farms are relevant for the estimate below (cf. *Section 3* above*).*

These farms have a total of around 635,000 FPU[8]. Approximately **1,900 t P** is produced every year in pig farming of these weight classes 30–80 kg and above. This P-content is distributed as follows among the aforementioned fattening holdings:

- The **500 fattening holdings**[9] with over 500 pigs produce around **1,000 t P** every year. A large number of them can be considered land-independent and therefore produce the bulk of relevant surplus manure.
- The other approximately **3,500 holdings**[10]**,** which on the set date were fattening 100–500 pigs, are thus responsible for the remaining **900 t P**. Of this about half i.e. around 500 t, is delivered to recipient holdings under transfer contracts.

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5 SR 916.344.

6 OST, *"Einblick in die schweizerische Landwirtschaft 1999"*, p. 90 (2000).

7 These holdings keep pigs mainly in the weight class 30 to over 80 kg, totalling 635,000 FPU (cf. following footnote; of these $^3/_7$ of all pigs are in weight class 31–50 kg, $^3/_7$ in 51–80 kg and $^1/_7$ in over 80 kg).

8 On the OST survey date for 1998, approx. **179,000 fattening pig units** (FPU; with 297,000 pigs at 0.6 FPU**)** were counted in weight class **31–50 kg** approx. **297,000 FPU** (with around 297,000 normal fattening pigs at 1.0 FPU) in **51–80 kg** and approx. **159,000 FPU** (with 132,000 pigs at 1.2 FPU) in **>80 kg**; total therefore **635,000 FPU** (cf. OST, *"Einblick in die schweizerische Landwirtschaft 1999"*, p. 95). This gives an annual P-content of **1,900 t** (cf. Table 7, *"Guidelines of July 1994 for Water Protection in Agriculture"*, OAGR/SAEFL).

9 They fatten 387,000 pigs (cf. OST, *"Einblick in die schweizerische Landwirtschaft 1999"*, p. 90). ***Assumption:*** of these 166,000 are young pigs at 0.6 FPU, 166,000 of medium weight at 1 FPU and about 55,000 finishing pigs at 1.2 FPU (distributed across the weight classes in accordance with the percentages given in the OST total statistics 1998 of $^3/_7$, $^3/_7$ and $^1/_7$). This gives **332,000 FPU** or ca. **1,000 t P** (1 FPU at 3 kg P).

The total quantity of P in surplus slurry from pig fattening therefore amounts to approximately **1,500 t.** It must be delivered to farm holdings with a proven nutrient requirement by means of manure transfer contracts. This quantity corresponds to slightly less than half the total quantity of P produced in pig slurry in Switzerland.

5 Estimate of the P-content in poultry farming

About **680 t P**[11] per year is produced in the combined manure of all 21,680 poultry farms. The majority of this is produced on conventional rural farms and in supplementary fattening of poultry.

About 99 % of all fattening birds are kept on the nearly 700 broiler farms with over 1,000 birds.[12] These produce approximately **220 t P** per year.

6 Total P-content in regional surplus manures

- Regional or local surplus manures occur mainly in pig and poultry fattening.
- In **pig fattening** about 1,500 t P is produced as regional surplus slurry in the proper sense (45 % of an annual 3,100 t P from total pig keeping).
- In **poultry rearing** about 220 t P is produced as surplus manure in the proper sense (33 % of an annual 680 t P from total poultry keeping).
- The annual P-content in surplus manure from pig and poultry fattening which is relevant for possible incentive taxes is about **1,700 t P.**

In the case of surplus manures, owners of both pig fattening and poultry fattening holdings must submit all necessary transfer contracts to the cantonal authorities for inspection (cf. Art. 26 and 27 OWP).

Beef production farms generally do not produce any significant surplus manures. Moreover, 1,640,000 animals corresponding to around 1,005,000 CMU are kept in cattle farming (dairy farming including fattening).

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10 They keep approx. 712,000 pigs of each age class (cf. OST'98, p. 90). ***Assumption:*** about half of them produce surplus manure (450 t P of the total 900 t P).

11 3,502,000 fattening chickens per year at 6.5 kg P/100 birds and 2,270,000 laying hens per year at 20 kg P/100 birds (228 t P + 454 t P = total approx. 680 t P).

12 OST, *"Einblick in die schweizerische Landwirtschaft 1999"*, p. 91 (2000); about 3,464,000 of a total 3,504,000 fattening birds.

7 Financial value of N and P in surplus manures

- **Market price of N and P:**

  – 1 kg P in a marketable P-mineral fertiliser costs around 2.2 €;

  – 1 kg N in frequently used N-mineral fertilisers accordingly costs CHF 1 €.

- **Value of N and P in relevant regional surplus manure:** the 1,500 t P and 9,500 t N[13] in the surplus manure of pig breeding enterprises relevant for water protection have a value of approximately **12 million €** per year.
- **Value in relation to slurry per pig fattening unit (FPU):** converted to the normally diluted slurry produced annually per FPU[14] a P-value of 7 € per 2.2 m^3 is obtained.

  If N is added, the total value per 2.2 m^3 amounts to approximately **20 €.**
- **Value of the N and P in surplus manure from poultry:** the value of the 220 t P and 990 t N in the surplus manure of the relevant poultry fattening farms amounts to around **1.4 million €.**[15]

Surplus manure in Switzerland has a value of approximately **14 million EURO** (only with reference to the N- and P-content).

13 21,000 t N in total, of which about 9,500 t N in the significant surplus manure (calculated analogously by the P-percentage).

14 1 m^3 pig slurry contains approx. 1.4 kg P and 7 kg N. 1 FPU produces around 2.2 m^3 normally diluted slurry per year.

15 ***For P:*** the value of the 220 t P from farms with over 1,000 birds amounts to approx. 500,000 €.
For N: the N-surplus in poultry fattening is 990 t N (analogous to the P-surplus of 33% in poultry farming); this N-content has a value of approx. 900'000 €.

ANNEX 5: Environmental and agricultural policy instruments

1 Water and environmental protection legislation[1] relating to N and P

1.1 The Water Protection Law (LWP)

The LWP plays a crucial role with regard to N- and P-fluxes. As a result of the revision of the LWP of 1991, this law introduced vital, directly applicable provisions for farmers which were stricter (farm holdings with animal husbandry, utilisation of the soil, advisory services, adaptation of storage facilities for farm manure, adjustment of CMU in line with proven agricultural land approved for fertiliser application – LFA):

- **Article 14** LWP lays down **local limit values** for the highest possible number of *cattle manure units (CMU).* The maximum load for manure measured against the proven agricultural land approved for fertiliser application is basically 3 CMU/ha (federal maximum value).

  The **cantons are obliged to lay down a local site dependant CMU-scale** according to soil pollution load capacity, elevation and topographical conditions (e.g. in the form of areas of impeded agriculture; cf. *"Guidelines of July 1994 for Water Protection in Agriculture"*, OAGR/SAEFL). In practice, however, the cantons currently focus primarily on the *Suisse-Balance*, which is less effective in terms of water protection (it is known to allow 10 % tolerance upwards; cf. *Chap. 2.3 Annex 6)*, and in rare cases on specific fertiliser application plans under ODP and OHS.
- **Article 27** LWP prescribes **utilisation of soils**, which precludes contamination of water bodies by fertilisers – in accordance with the state of the art. The inflow areas under the Water Protection Ordinance (OWP)[2] place greater importance on utilisation of the soil that is compatible with waters in the area near and in the catchment areas of water bodies.
- According to **Article 51** LWP the cantons must provide a **fertiliser application advisory service** for farm holdings with animal husbandry (with respect to solving manure problems).
- **Article 77** requires **remediation of storage facilities for farm manure**s according to the urgency of each individual case, and no later than the end of October 2007 (15 years after the law entered into force; a shorter deadline applied for IP holdings namely 31.12.1999[3]).
- **Article 78** specifies that the **maximum permitted quantity of manure** calculated as CMU/ha must have been laid down no later than October 1997 according

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1 Systematic collection of federal law, accessible under: *http://www.bk.admin.ch/ch/d/sr/sr.html.*
SAEFL, *"Erläuterungen über Düngung und Umwelt – Vorschriften und Empfehlungen des Bundes"*, 75 pp. (August 1996).

2 UVEK, Comments on the Water Protection Ordinance (September 1998).

3 Conference of Cantonal Ministers for Agriculture (LDK), *"Bericht über die Harmonisierung des Vollzugs im Gewässerschutz"*, 7 pp., adopted by the cantonal authorities (June 1995).

to the urgency of each individual case (depending on the agricultural land approved for fertiliser application).

Relevance for P: detailed provisions governing the treatment of waste water (P from households and industry) and the handling of animal manures are given in the Water Protection Ordinance (OWP). The maximum value for the livestock density of 3 CMU/ha has an indirect effect on P. It corresponds to a P-content of 45 kg (cf. Art. 23 OWP). The plot-specific balanced nutrient budgets required under OHS – also with regard to the P-accumulation in fertilisable soils – help to reduce the P-content.

Relevance for N: the important provisions here are predominantly those relating to achieving a balanced nutrient budget. (Art. 14 Para. 1 LWP) and to the utilisation of soils (Art. 27 Para. 1 LWP). The quantity of mineral fertilisers and manures (or maximum permitted livestock density) are reduced to environmentally compatible levels to protect water bodies (cf. Annex 4.5 Nr. 31 Para. 2 OHS in conjunction with Part 1 Chap. 4 of the *"Guidelines for Water Protection in Agriculture").* At the same time, a reduction in ammonia emissions can also be achieved – depending on the chosen production technique. In any case the *Swiss Fertilising Concept [Schweizerisches Düngungskonzept]* explained in the aforementioned Guidelines and the OHS specify that existing manures from the farm holding must be used first.

Article 62a LWP which entered into force on 01.01.1999 provides a direct incentive to reduce N- and P-emissions from agriculture. This provides the legal basis for federal contributions to targeted remediation measures in vulnerable areas to prevent run-off and leaching of hazardous substances (in this case mainly N and P).

1.2 The Water Protection Ordinance (OWP)

The Water Protection Ordinance (OWP) which entered into force on 01.01.1999 lays down the technical provisions for handling animal manures (maximum nutrient load limits, transfer contracts, transport distances, storage provisions). Furthermore, the increased planning intentions applicable in water protection policy also has a direct effect on the utilisation of soils in agriculture (cf. Chap. 5 and Annex 4 OWP).

The quality requirements for the permissible nitrate level in groundwaters were set at 25 mg nitrate per litre. The reason for this nitrate value is mainly to protect the environment against excessive levels of this nutrient compound and other agro-chemicals or pollutants from agriculture which also occur concurrently with this environmental indicator.

Moreover, the competent Federal Offices for Public Health, for Agriculture and the Swiss Agency for the Environment, Forests and Landscape (OPH, OAGR and SAEFL) confirmed the joint, preventive public health and environmental protection policy with regard to nitrate loads in food and the environment at a *Nitrate Workshop* on 4 May 2001 in Berne.

1.3 The Law on Environmental Protection (LEP) and the Ordinance relating to Hazardous Substances (OHS)

Article 28 LEP specifies that handling of substances shall not pose a danger to the environment nor indirectly to persons.

As mentioned above, **Annex 4.5 of the OHS** gives practical provisions for the use of fertilisers. *Inter alia* the following principles apply: fertilisers must be applied in a way which is compatible with the local site, and the environmentally relevant nutrients present in the soil and the nutrient requirement of the plants must be taken into account (Section 31). Restrictions on the use of fertilisers which contain N and slurry also apply (Nr. 321 Para. 2 in conjunction with the OAGR/ SAEFL the hand-out leaflet[4] *"Fertilising at the correct time"*). Finally, fertilisers shall not be used in a 3 m-wide strip alongside hedges, copses and surface waters (Nr. 33 Para. 1 in conjunction with KIP/PIOCH instructions[5]). A new regulation to include prohibition of use of fertilisers along the edges of woodland is presently planned (3 m band along "visible" standing timber).

The cantons promote environmentally-compatible behaviour of farmers when they apply fertilisers, and ensure that **expert advice** is offered (cf. Art. 60 Para. 1 OHS analogous to Art. 51 LWP). The cantons provide financing for this advisory service. They control respect of the environment and may even prescribe compulsory advice for farmers in polluted areas (Art. 60 Para. 3 OHS).

1.4 The LEP and the Air Pollution Control Ordinance (OAPC)

Emissions of nitrogen oxides (NO_x), which mainly occur as a result of combustion of fuels, are reduced in Switzerland by means of the following provisions (based on Art. 11 and 12 LEP):

- **NO_x maximum emission levels** of the OAPC for stationary sources (industrial and trade plants, combustion installations);
- **Cantonal action plans** in accordance with OAPC for areas in which excessive air pollution levels occur despite preventive limitation of N input into the environment.

Road transport legislation also provides for special regulations relating to preventive limitation of emissions for motor vehicles: **NO_x maximum emission levels for motor vehicles** laid down in the VTS[6], TAFV 1[7], TAFV 3[8] and FAV 4[9].

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4 OAGR/SAEFL, *"Düngen zur richtigen Zeit"*, 4 pp., available from the federal BBL office – Vertrieb Publikationen, no. 319.012 in German, French or Italian (1996).

5 KIP/PIOCH, *"Pufferstreifen richtig messen und bewirtschaften"*, 8 pp., Vertrieb LBL, 8315 Lindau (1999).

6 Verordnung vom 19. Juni 1995 über die technischen Anforderungen an Strassenfahrzeuge (VTS), SR 741.41.

7 Verordnung vom 19. Juni 1995 über technische Anforderungen an Transportmotorwagen und deren Anhänger (TAFV 1), SR 741.412.

8 Verordnung vom 2. September 1998 über technische Anforderungen an Motorräder, Leicht-, Klein- und dreirädrige Motorfahrzeuge (TAFV 3), SR 741.414.

9 Verordnung vom 22. Oktober 1986 über die Abgasemissionen von Motorfahrrädern (FAV 4), SR 741.435.4.

Emissions of ammonia (NH_3), which principally originate from **storage facilities for farm manures** are limited by the following provisions:[10]

- If the emissions are collected and extracted (closed installations), then the preventive values given in Annex 1 OAPC shall apply; subject to additional or different provisions laid down in Annexes 2–4 OAPC.
- Diffuse emissions (open installations) shall be limited under Art. 4 OAPC as much as technology and operating conditions will allow, provided this is economically acceptable.

If no ambient air quality standards are laid down in Annex 7 OAPC, the cantons may apply **Art. 2 Para. 5 OAPC**, under which air pollution levels are considered excessive if according to paragraph 5a they endanger persons, animals, plants, their biological communities and habitats or according to letter d they harm soil fertility, vegetation or waters.

If several sources contribute to excessive air pollution levels, under Articles 31–34 OAPC the cantonal authorities must draw up and implement an **action plan**. In the case of N-input from the air into vulnerable ecosystems, air pollution levels are excessive as defined by Article 2 Paragraph 5a OAPC *("critical loads"* are exceeded, cf. *"UN/ECE Convention on Long-Range Transboundary Air Pollution").* This sets the conditions for cantonal action plans. These exist for NO_x but not yet for ammonia.

1.5 The Law on Nature Conservation and Protection of Habitats (LNH)

Under the LNH, the Confederation and cantons pay contributions for habitats for native species of animals and plants threatened with extinction (biotopes; cf. Art. 18a and 18b LNH as well as federal payments under Art. 18d Para. 1 and Para. 2 LNH in conjunction with Art. 17 and 18 LNH). However, these contributions are reduced by those contributions which are paid under ODP. Nevertheless, the LNH also helps to lower N- and P-fluxes.

2 Agricultural legislation relating to N and P

2.1 Introduction

In agricultural legislation[11] the free market and ecological direct payments (DP) are the two pillars of agriculture affecting income. Ecological direct payments (DP for special services according to Art. 31b of the former LAgr were introduced for the first time in the early 1990s.

10 SAEFL, *"Ammoniak (NH3)-Minderung bei der landwirtschaftlichen Nutztierhaltung"*, Communication no. 13 on the Air Pollution Control Ordinance (OAPC), Vollzug Umwelt, 10 pp. (2002).

11 Law on Agriculture (LAgr) of 29 April 1998 and associated Ordinances from 01.01.1999.

Under Article 104 Paragraph 3a of the Constitution, farmers must provide proof that they have made *ecological achievements* in order to benefit from direct payments. The consequence of this was conversion of agriculture to at least the IP standard.[12]

According to agricultural statistics, by 1999 about 95 % of all agricultural holdings had converted to IP or BIO-farming.[13] There are other incentives for particularly natural, environment- and animal-friendly forms of production.[14]

The provision of the Constitution which instructs the Confederation to protect, *"... the environment against damage due to increased application of fertilisers, chemicals and other agrochemicals"* is important for the problem of N and P.[15]

2.2 Proof of ecological achievement (PEA)

The PEA consist of six criteria (cf. Art. 70 Para. 2 LAgr; the PEA is specified in the ODP):

- *animal-friendly livestock farming;*
- *balanced nutrient budgets;*
- *appropriate proportion of ecological compensation areas;*
- *regulated crop rotation;*
- *appropriate soil protection,*
- *selection and targeted application of plant protection products.*

Both fertiliser application practice and measures concerning the utilisation of soils and crop rotation affect N- und P-emissions. From the point of view of production technology, they are key criteria for the reduction or prevention of N- und P-losses.

2.3 Direct payments (DP) and special ecological contributions

The direct payments (DP) for transparently proven ecological achievement shall be calculated in such a way that *"... the special ecological achievement is worthwhile"*. This provides a considerable incentive and has a controlling effect in favour of the reduction of N and P-application. In addition, special contributions are paid for special ecological achievements i.e. particularly natural, environment- and animal-friendly forms of production, as well as for extensive utilisation of soils and as summer pasturing contributions (cf. Art. 76 and 77 LAgr).[16]

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12 Swiss Federal Council, *"90.060 Botschaft vom 26. Juni 1996 zur Reform der Agrarpolitik: Zweite Etappe (Agrarpolitik 2002)"*, and Cantonal agri-ecological policy guidelines with the same aim.

13 According to the OAGR's *"Evaluation der Ökomassnahmen und Tierhaltungsprogramme – Vierter Zwischenbericht [Evaluation of ecological measures and stock rearing programmes – fourth interim report"]* of June 2001 the area of IP and organic farming rose between 1993 and 1999 from 198,000 ha to nearly 1 million ha. It makes up almost 95 % of total agricultural land (AL). Total ecological compensation areas rose in the same period from 51,500 ha to 88,500 ha (target value in the lowland area alone is 65,000 ha).

14 This is an additional incentive for example for converting to organic farming. The number of organic farms rose in the period from 1993 to 1999 from around 1,200 to 4,750 (cf. *OAGR Fourth Interim Report*, June 2001).

15 Article 104 Para. 3d of the Federal Constitution (FC).

16 SRVA/LBL, *"Tableau synoptique des contributions fédérales selon l'utilisation du sol et contributions fédérales liées à la production animale"*, 2 p. (1999).

2.4 Ecological compensation areas

The obligation to set aside ecological compensation areas has a local effect on the use of N and P, because such areas require extensive farming. In Article 7 ODP the minimum area of the ecological compensation areas which must be proven per holding is set at 3.5 % of the land for special crops and 7 % of other agricultural lands.[17]

The *Ecological Quality Ordinance*[18] *(OEQ)* ensures that the qualitative effects of ecological measures are actually achieved (biodiversity). The OEQ provides financial support for ecological compensation areas of special biological quality on agricultural land (AL) and for linking these areas.[19] They include for example extensively and less intensively used grassland, wet meadows for cutting bedding, hedges and copses (cf. Art. 3 and 4 OEQ).

2.5 Balanced nutrient budgets in accordance with the Ordinance relating to Direct Payments (ODP)

Article 6 ODP in conjunction with Section 2 Annex ODP lays down the key data for a balanced nutrient budget. This regulation has an extensive effect. Permissible fertiliser inputs must be in accordance with the nutrient requirements of plants and the individual farm site potential (including nutrient reserves in the soil) based on the *Suisse-Balance* – or on fertiliser application plans (cf. e.g. *FURCA* of the SRVA). However, fertiliser surpluses up to 10 % are permitted under the technical Annex to the ODP.

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17 LBL, SRVA, *"Wegleitung für den ökologischen Ausgleich auf dem Landwirtschaftsbetrieb"*, 12 pp. (March 2001).

18 *Verordnung vom 4. April 2001 über die regionale Förderung der Qualität und der Vernetzung von ökologischen Ausgleichsflächen in der Landwirtschaft* (Öko-Qualitätsverordnung, OEQ), SR 910.14.

19 LBL, SRVA, *"Öko-Qualitätsverordnung – Zeigerpflanzen Wiesen – Alpennordseite"*, leaflet, 12 pp. (March 2002) and *"Qualität und Vernetzung im ökologischen Ausgleich – Erläuterungen zur Öko-Qualitätsverordnung (OEQ)"*, 8 pp. (December 2001).

ANNEX 6: Spotlights on environmental and agricultural enforcement

1 Introduction

In principle, liquid pig manure – whether treated or untreated – which is produced in the catchment area of lakes polluted with P, given the high P-levels in the soils there, must be completely removed to other regions where there is still a proven requirement for nutrients under the framework provisions of the OHS.

Particularly as a result of the clearly increasing number of long-distance transport operations, there is now a risk of disproportionate expenditure in terms of energy, organisation and money – quite apart from new environmental hazards (harmful gases, dangerous gas pressure in the slurry tanks etc.). At the same time, the reliability of the necessary joint water protection controls between the cantons involved is declining, or completely absent.

With regard to the enforcement problem, slurry transport touches on the practicality, reasonableness and also the proportionality of administrative measures.

Effective **regional solutions** must be found, by means of which the targets laid down in legislation can be reached at least in the medium term and the existing framework conditions can be met (e.g. zero tolerance in balanced nutrient budget with inclusion of the P-accumulation in the soil in accordance with Nr. 31 Annex 4.5 OHS and Art. 14 Para. 1 LWP). The obligation to use manure or the strict ban on its disposal (cf. Art. 14 Para. 2 LWP) must always be observed. *Table 1* allows an approximate assessment of the potential effect on the environment due to enforcement of the applicable environmental and agricultural legislation (cf. *Chap. 2.4* below*).*

Balanced nutrient budget in practice

- According to ODP (cf. Art. 6 and Nr. 21 in the Annex to ODP) a balanced nutrient budget, i.e. a balance based as far as possible on fertiliser application plans (including accumulation in the soil), must be determined according to plant requirements and individual farm site potential. At present a tolerance of up to +10 per cent is still possible in N- und P-balancing *(Suisse-Bilanz)*[1] for the entire agricultural holding.
- The recognised calculation forms are based on the assumption that the average supply level of the soil is always *adequate* (supply class C) and the soil is therefore *not over enriched*.
- The calculated balanced nutrient budget for the entire agricultural holding is not plot specific; it defines a specific N- and P-fertiliser quota for each individual agricultural holding.

1 OAGR, SRVA, LBL, *"Wegleitung Suisse-Bilanz"*, 21 pp. (March 2002).

Table 1: Summary of approximate assessment of the current qualitative effect of environment-related legal provisions being enforced (use of mineral fertilisers and manure).

Legal framework	Measure	Mineral fertilisers		Manure	
		N	P	N	P
Measures with an extensive effect					
LAgr/ODP	Balanced nutrient budget	++	++	+	+
LWP	Run-off and leaching ban	(+)	(+)	(+)	(+)
LWP/OWP	CMU objectives	0	0	(+)	(+)
LEP/LWP	Reduction of fertiliser consumption	+++	+++	0	0
Measures with a plot-specific effect					
LAgr Art. 76	Contributions for ecological achievement	(++)	(++)	(+)	(+)
LWP/OWP	Measures in the inflow areas (fertiliser application)	(++)	(++)	(++)	(++)
OHS	Prohibition and buffer zones	++	++	+	+
LNC	Subsidies, biotope protection	++	++	+	+

+++ large effect
++ medium effect
\+ small effect
0 no effect
( ) effect expected but not yet proven
LNC *Law relating to Nature Conservation.*

2 Cantonal efforts to solve the P-problem

2.1 Introduction

The typical regional example of the Lake of Baldegg given in *Annex 3* above shows clearly that, despite numerous official measures to implement environmentally-friendly use of manure, considerable P-surpluses continue to enter soils and lakes.

In Canton Lucerne, the following measures have been taken in chronological order since about the mid-1980s:

- Remediation of **storage facilities for farm manure** (cf. Art. 77 LWP);
- Feeding of **"environmentally-friendly animal feed"** (nutrient content of feed adjusted according to the P-requirements of the livestock)[2];
- Ordering of **balanced nutrient budgets** including manure transfer contracts (cf. Art. 14 Para. 5, Art. 78 LWP and Art. 26 OWP);

2 Canton Lucerne Environmental Protection Office, *"Merkblatt für Ökofutter-Einsatz"*, 5 pp. (February 1994).
Kantonale Fachstelle für Ökologie in der Landwirtschaft, Sursee [Cantonal Central Office for Ecology in Agriculture, Sursee], *"Vorgehen bei der Bewerbung als Ökofutter-Lieferant"*, 2 pp. (January 1994).

- Permitting the **separation of liquid manure** (cf. Art. 15 LWP);
- Decision in favour of cantonal **"incentive taxes"** on surplus manure.
- **Cantonal Government Ordinance** on reduction of the phosphorus pollution of lakes in the Swiss Plateau of Canton Lucerne due to agriculture.

As early as February 1992, a binding joint declaration of intent by all interested parties from agriculture, water protection, advisory services, lakeside municipal authorities and agricultural associations was signed in Canton Lucerne to promote co-operation and this is still valid to this day.[3]

Today for example, cantonal "incentive taxes" can be levied on any manure (quantity in CMU) for which it has not been possible to submit transfer contracts and where the number of livestock has not been reduced accordingly (CHF 500 per surplus CMU, in case of recurrence CHF 1,000).[4]

In addition, it is already being examined whether **surplus manures** can be transported **into more distant regions of the country** (e.g. into Canton Vaud). Disposal of manure contravenes the LWP (cf. Art. 14 para. 2 LWP: obligation to reuse in agriculture and horticulture only).

The "normal range of the farm locality" (NRFL) of a *6 km travel distance* under Article 24 OWP is only binding for land-independent livestock keeping (cf. *Part II Annex. 2*). However, the NRFL does not affect supplementary fattening on rural farm holdings with sufficient owned or leased land.

2.2 Decision of the Conference of Cantonal Ministers for Agriculture (CCMA)

With regard to the obligatory cantonal water protection task of enforcing local CMU limits (cf. Art. 14 Para. 6 LWP), the *Conference of Cantonal Ministers of Agriculture (CCMA)* has adopted a proposal for national harmonisation of co-ordinated enforcement in local CMU-limitation.[5]

Unfortunately, subsequent implementation of this decision was unsuccessful. Cantons with particular livestock farming related water protection problems did not implement the local CMU limits effectively enough.

The reason put forward for this was that they wanted to implement or comply with the allegedly "stricter" *Suisse-Bilanz* for the entire farm holding laid down in the Ordinance relating to Direct Payments (ODP) – enforcement of the binding local cantonal CMU limits was therefore not an issue any more (cf. *Chap. 2.3* below*)*.

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3 Canton Lucerne, Environmental Protection Office, Agriculture Department, Central Office for Ecology in Agriculture, Agricultural Credit Bank of Canton Lucerne, Farmers Union of Canton Lucerne, Arbeitsgemeinschaft Luzerner Bergbevölkerung, *"Gemeinsame Absichtserklärung über den Umweltschutz in der Luzerner Landwirtschaft"*, 5 pp. (February 1992).

4 Canton Lucerne, *"Einführungsgesetz vom 27. Januar 1997 zum Bundesgesetz über den Schutz der Gewässer"*, Article 34 Para. 1 and 2.

5 Conference of Cantonal Ministers for Agriculture (CCMA), *"Bericht über die Harmonisierung des Vollzugs im Gewässerschutz"*, 7 pp.; adopted by the executive cantonal authorities (June 1995).

2.3 CMU limits versus balanced nutrient budgets

A paper published by the LBL [Swiss Agricultural Advisory Board] in Lindau on the question of compliance with local CMU limits in the context of a balanced nutrient budget[6] shows what follows. About **15 per cent of all farm holdings** with animal husbandry reported a balanced nutrient budget even when they exceeded the federal limit value of **3 CMU.** The same findings applied to the specific site limit values of CMU specified in accordance with the CCMA proposal. This result therefore does not support the aforementioned assertion that nutrient balancing has a stricter effect than the said CMU limits of the federal LWP.

2.4 Regional remediation projects under federal law in the cantons

The Confederation has approved three P-projects by Canton Lucerne, which under **Article 62a LWP** are intended to support and reinforce the more extensive measures for remediating P-surpluses in the catchment area of the Lakes of Sempach, Baldegg and Hallwil. These are considered to be P-pilot projects. At the Lake of Sempach over 80 farmers have already agreed to take part – that is over 20 per cent of farms in the catchment area of the lake.

The aim of these remediation projects is to achieve a **sustainable solution to the environmental problems** in vulnerable water protection areas in the medium term. They can only be solved if targeted, in some cases rigorous measures – linked with high costs – are taken to limit livestock numbers and to improve utilisation of the soils. These measures demand commitment from all the parties involved (farmers, advisory services, canton, water suppliers) and financial compensation which offers sufficient incentive for voluntary participation, for example in stabilizing or even reducing the amount of manures or numbers of livestock.

In the Lake of Baldegg P-project, Canton Lucerne is to contribute at least CHF 3.1 million out of the total costs of approximately CHF 14.3 million in the planned project period from 2000 to 2009. In the Lake of Sempach project, the relevant costs amount to CHF 13.1 million or nearly CHF 3 million as the canton's share.

The canton would then have to provide around CHF 600,000 per year for ten years for the two lake catchment areas. Annual costs for surplus P of CHF 10/kg are calculated on the basis of this (CHF 6 million per 60 t P-surplus; cf. cantonal P-reports on the Lakes of Sempach and Baldegg). This corresponds to CHF 150 per 1 CMU (calculated as 15 kg of P per CMU per year).

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6 Swiss Centre for Agricultural Extension LBL Lindau ZH, *"Auswertung von Nährstoffbilanzen auf Landwirtschaftsbetrieben – Gesamtbetrieblicher Nährstoffhaushalt und Düngergrossvieheinheiten im Vergleich"*, 108 pp. (October 1999).

ANNEX 7: International conventions, agreements and measures

1 Introduction

The nutrient elements N and P in waters and N in the air are carried over long distances, across national boundaries, and consequently are often deposited far from the sources of emissions (e.g. in the North Sea).[1] For this reason, international efforts have been made in recent years in the UNO, EU and regionally (for the Rhine, Lake Constance etc.) to reduce inputs of N and P into the environment through joint agreements, targets and measures. Switzerland is party to such agreements.

Germany is currently making great efforts to reassess and redirect agricultural policy with greater emphasis on consumer protection and ecology. In agricultural animal husbandry for example a limit of 2 CMU/ha is to be laid down in livestock keeping.[2] A DVGW working paper on the subject is also being prepared.[3]

International efforts are listed below, but without assessing in detail their effect or target attainment.

2 OSPAR Convention

The 1992 OSPAR Convention[4] – in force since 1998 – developed from two conventions from the 1970s, namely the *Oslo Convention* of 1972 (measures against marine pollution from ships) and the *Paris Convention* of 1974 (measures against marine pollution from land-based sources). The Contracting States thereby undertook to do everything possible to prevent and remove marine pollution in the North East Atlantic resulting from human activities.

Switzerland, as a state situated upstream from the catchment area of the North Sea, also acceded to the OSPAR Convention in 1994. The OSPAR Convention envisages that measures should take account of the state of technology and environmentally compatible practices and that the polluter pays principle should apply wherever possible:

- The aim of *"Recommendation 88/2 on the reduction in inputs of nutrients to the Paris Convention Area"* is to reduce inputs of N und P by 50 per cent compared with 1985 (total inputs from all sources).
- *"Recommendation 89/4 on a coordinated programme for reduction of nutrients"* recommends harmonisation of measures in the three areas of agriculture, treat-

1 SAEFL, *"Umsetzung des Konzepts der Critical Loads im Rahmen der Genfer Konvention"*, Forum für Wissen, cf. p. 14/15 (1997).

2 Künast R., Bundesministerin für Verbraucherschutz, Ernährung und Landwirtschaft, *"Regierungserklärung vom 8. Februar 2001 zur neuen Verbraucherschutz- und Landwirtschaftspolitik"*.

3 DVGW – Deutsche Vereinigung des Gas- und Wasserfachs e.V., *"Technische Regel/-Arbeitsblatt W 104 über beste verfügbare Umweltpraxis in der Landwirtschaft"*, 30 pp. (Draft of December 2002).

4 Further information under: *http://www.ospar.org/eng/html/welcome.html* (topic: *"measures")*.

ment of waste water and industry, in order to meet the N- and P-reduction targets. The following measures are recommended for the agricultural sector: balanced nutrient budget, reduction of excessive livestock numbers, sufficient storage facilities in winter for farm manures, creation of buffer zones free of fertilisers beside waters and soil cover in winter (crop layer or "evergreen").

- *"Recommendation 92/7 on the reduction of nutrient inputs from agriculture into areas where these inputs are likely, directly or indirectly, to cause pollution"* concentrates solely on agriculture. N- and P-inputs into the environment should essentially be reduced by a decrease in ammonia volatilisation, nitrate leaching, P-run-off and direct inputs from farms. No percentage reduction targets are set for individual input pathways. However, the Annex to *Recommendation 92/7* contains a list of measures relating to agricultural practice in order to reduce or prevent nutrient losses.

3 International Commission for the Protection of the Rhine against Pollution (ICPR)

As part of the Action Programme *"Rhine 2000"* Rhine riparian states set themselves the target of reducing N- and P-inputs by 50 per cent between 1985 and 1995. The ICPR carried out an inventory of N- and P-inputs for the years 1986 and 1996. It can be seen from these that the reduction target was not reached for N. This is basically due to the diffuse inputs from agriculture.[5]

However, it has been established that Swiss legislation applicable in this problem area is sufficient and no further measures are necessary.[6]

4 International Conferences on the Protection of the North Sea (ICPNS)

Switzerland has taken part in the *Conferences of Ministers responsible for the protection of the North Sea* since the third ICPNS of 1991 in The Hague. The Conferences are not focussed on a binding convention under international law. They make use of those existing international conventions which are applicable to the North Sea. A large number of decisions of the *Conferences on the Protection of the*

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5 ICPR, *"Diffuse Nährstoffeinträge in Gewässer – Gesamtbilanz für das Rheineinzugsgebiet unterhalb der schweizerischen Seen"*, 43 pp., PLEN3/92, Berne (17.12.1992).
ICPR, *"Reduktion des Gesamtstickstoffs"*, 7 pp., PLEN 3/92 (09.07.1992).
ICPR, *"Katalog möglicher Massnahmen zur Verminderung des Stoffeintrags in die Gewässer aus diffusen Quellen"*, 20 pp., PLEN 11/91 (02.07.1991).
ICPR, *"Bestandsaufnahme der Phosphor- und Stickstoffeinträge 1996"*, 36 pp., K 54-00 Cd 22-00 (rev. 13.10.2000).
SAEFL, *"Verminderung des Nährstoffeintrags in die Gewässer durch Massnahmen in der Landwirtschaft – Bericht einer Studie über das Rheineinzugsgebiet der Schweiz unterhalb der Seen"*, Schriftenreihe Umwelt no. 293, 100 pp., Berne (1997).

6 Ministry for Environment, Traffic, Energy and Communication (ETEC), *"ETEC proposal of 22 December 2000 to the Federal Council regarding the Rhein Conferences of Ministers of 29 January 2001 in Strasburg";* Quote: *"Conclusions for Switzerland: No extension or adaptation at the law or ordinance level is required to implement the programme. The required measures are covered by the programmes running in Switzerland within the framework of implementation of the various water protection, nature conservation, and agricultural legislation. Further measures are not necessary."*

North Sea invite e.g. the *OSPAR Commission* to take relevant measures to implement these agreements. At the 2nd ICPNS of 1987 in London, the North Sea states adopted a declaration of intent to reduce N- and P-inputs into the North Sea by around 50 per cent between 1985 and 1995. Both the OSPAR Commission and the ICPR have adopted these targets.

5 International Water Protection Commission for Lake Constance (IGKB)

The catchment area of Lake Constance covers areas of Switzerland, Liechtenstein, Vorarlberg (Austria) and the German federal states of Bavaria and Baden-Württemberg. Joint targets and measures concerning the input of substances into the inflow waters of Lake Constance were prescribed. A comparative report on P-pollution of the lake is available.[7]

6 UNO Climate Convention

At the UNO Conference on Environment and Development in Rio (UNCED-Rio 1992), a framework agreement on climate change (Climate Convention) was signed and this entered into force in March 1994. This provided for stabilization of emissions of six greenhouse gases by the year 2000, including nitrous oxide (N_2O). In the *Additional Protocol of Kyoto* (1997; entry into force 2003/2004 at the earliest), the signatory industrial states undertake to adopt nation-specific reduction targets for the period 1990–2008/12.

7 Convention on Long-Range Transboundary Air Pollution (Geneva Convention for the Region of the UN/ECE)

The Convention includes the countries of Western and Eastern Europe together with the USA and Canada. It was signed in Geneva in 1979 *(Geneva Convention).* Since then numerous binding protocols on reducing emissions of sulphur, nitrogen oxides, ammonia, volatile organic compounds, persistent organic pollutants (POP) and heavy metals have been signed. These should ensure that in the longer term *critical loads* for vulnerable ecosystems are no longer exceeded.

Critical loads are deemed to be those pollutant inputs below which and within a prolonged period of time no harmful effects are to be feared in vulnerable ecosystems. They are set at different levels for each ecosystem.

In the *Protocol on control of acidification, eutrophication and ground level ozone,* which was signed at the end of 1999, the following emission reductions were set as a stage target for Switzerland compared with 1990:

- for sulphur 40 %;
- for nitrogen oxides 52 %;
- for volatile organic compounds 51 %;
- for ammonia 13 %.

7 Prasuhn V., *"Phosphor und Stickstoff aus diffusen Quellen im Einzugsgebiet des Bodensees 1996/97", Agroscope* FAL – commissioned by IGKB, ISSN 1011-1263, Report no. 51, 84 pp. (1999).

As already mentioned, important work on setting ecological targets for emission, dispersal and deposition of N-compounds has been carried out for the UN/ECE region under the *Convention on Long-Range Transboundary Air Pollution.* The vulnerability of ecosystems to inputs of pollutants, which cause acidification and over enrichment or eutrophication, has been determined.

Critical loads can be used as the basis for determining nation-specific percentages for emission reduction, which are necessary for achieving stage targets of protection levels. This approach was chosen within the framework of the latest *"Protocol on control of acidification, eutrophication and ground level ozone"*. *Critical loads* have also been published in the WHO/Europe *"Air quality guidelines for Europe"*.[8]

The European Community selected a similar procedure as that in the *Protocol on control of acidification, eutrophication and ground level ozone* in its *Directive 2001/81/EG of 23.10.2001 on national emission ceilings for certain atmospheric pollutants*.

8 EU Directive

Under the *Nitrate Directive*[9], the EU obliges its Member States to organise land use management in such a way that 170 kg total N/ha per year is not exceeded in applied manure (close to 2 CMU).

Protection of the population against health hazards due to nitrates is assured in the EU with a maximum value of 50 mg nitrate per litre of drinking water.[10] The EU *Scientific Committee for Food* has thoroughly examined the subject of nitrate in food (including drinking water).[11] Its report closed with the recommendation that the measures for ecological and health limitation of nitrate should be resolutely pursued. In Swiss food law a tolerance value of 40 mg nitrate per litre drinking water applies (also valid for infants).

The EU has admonished Member States which have not implemented the aforementioned *Nitrate Directive 91/676* into binding national law by the set date, in a first evaluation report from Brussels (cf. also *Second EU Annual Report)*.[12] In the meantime, proceedings are pending against four EU Member States (Greece, Luxemburg, the Netherlands and Austria) for non-compliance with the EU Nitrate Directive and for infringement of the Treaty.

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8 WHO Regional Office for Europe, *"Air Quality Guidelines for Europe"*, second edition, ISBN 1358 3, WHO Regional Publications, European Series no. 91, 273 pp. (2000).

9 EU Council, *"Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources"*, 91/676/EEC, Official Journal no. L 375/1–8 (31.12.1991).

10 EU Council, *"Directive of 15 July 1980 relating to the quality of water intended for human consumption"*, 80/778/EEC, Official Journal L 229/0011-0029 (30.08.1980).

11 EU Scientific Committee for Food, *"Opinion on Nitrate and Nitrite"*, Annex 4 to Document III/5611/95 (22.09.1995).

12 EU Commission, Report on the *"Implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources"*, ISBN 92-78-25027-9, COM(97) 473, 19 pp. (1997).
European Commission, "Second annual survey on the implementation and enforcement of Community environmental law", ISBN 92-828-9324-3, 106 pp. (2000).

The EU policy on nitrate reduction is being resolutely pursued for ecological reasons and as a health precaution.

The EU rules on N also have an indirect impact on P (fertiliser application practice for manure and land use management). Swiss legislation on water protection, environmental protection and agriculture relating to the environmentally compatible use of manures largely corresponds to the EU framework regulations on fertiliser application. EU member states are free to order additional measures in the area of fertilisers and fertiliser application, including incentive systems or **incentive taxes.**[13]

13 EU Commission (Directorate-General for Agriculture), *"Agriculture and Environment"*, ISBN 92-827-3941-4, Booklet on the Common Agricultural Policy (CAP), 53 pp. (1997).

PART III: PLANT PROTECTION PRODUCTS (PPPs)

1 Incentive taxes on PPPs

1.1 Preliminary remarks

With regard to the possible introduction of incentive taxes on plant protection products (PPPs), it is firstly a question of defining the desired effect of the economic instruments, i.e. the desired handling of PPPs. To this end, the benefits and risks of PPP use must be compared.

On the benefit side, protection of crops against harmful organisms and thus the safeguarding of crop yields is to the fore. Maintenance of agricultural plant cultivation and protection of human and animal health against natural toxins (e.g. aflatoxins) in harvested crops are also important aims of PPP use.

On the risk side, PPP residues in harvested crops or in the environment and thus possible damage to beneficial animals or uninvolved organisms including persons are important. When using PPPs, the highest possible benefit with the lowest possible risk should be achieved. The variety of products and the complexity of effects and secondary effects require measures at several levels.

1.2 Assessment principles

According to a study commissioned by the European Commission[1], instruments such as incentive taxes cannot be assessed solely on the basis of the effect to be achieved or the desired effectiveness. Rather, criteria relating to acceptance, implementation, political context and possible effects on income distribution must also be considered.

1.3 Effect / effectiveness

Depending on the intended effect, e.g. a 10 % reduction in the consumption of PPPs, the level of the incentive tax must be set so that the tax creates the necessary incentives (increase in the prices of PPPs). The effectiveness of an incentive tax on PPPs is heavily dependent on the price elasticity of demand. According to the aforementioned study, in Europe these price elasticities amount to at least –0.2 and at best –0.5 (i.e. with a price elasticity of –0.5, a price increase of 20 % would be necessary in order to achieve a 10 % reduction in the use of PPPs). As a comparison, price elasticity in Switzerland in the period 1978–1987 was –0.1 according to an estimate by Bidaux and Gantner[2]. That means therefore that a price increase of 20 % would lead to a reduction in consumption of 2 %.

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1 Wageningen Agricultural University, *"Additional EU Policy Instruments for Plant Protection Products"*, Synthesis Sub-Report, Oppenheimer Wolf & Donnelly, Brussels (1997).

2 Bidaux A. and Gantner U., *"Comment freiner l'emploi des engrais minéraux et des pesticides en agriculture?"*, PNR-22, Sol, no. 50 (1990).

In addition to price elasticity, the type of calculation is also important for the effectiveness of an incentive tax. A simple reduction in the amount of PPPs used is often a poor indicator for the reduction of the risks connected with the use of PPPs. A tax on the sale price of PPPs does not always take account of the risk for persons and animals linked to the use of PPPs, because the most expensive products are not always the most dangerous.

In order to achieve greater effectiveness with regard to reducing the risk of PPPs, as a minimum there should be a tax on the actual consumption of active ingredients per kg and ha. Ideally, a scale of taxes according to risk would have to be levied for the individual active ingredients. A study by Bidaux, Gaillard and Lehmann[3] commissioned by SAEFL revealed that using this kind of incentive tax, with an average price increase of 20 % (0 % duty on PPPs with low environmental risk, 40 % on PPPs with medium and 80 % on those with high environmental risk), a reduction in environmental risk of 55 % can be expected.

The difficulty of this kind of taxation system lies in assessing the risks for each individual active ingredient or at least for categories of active ingredients. Thus far it has not been possible to agree on a method which would express all risks associated with a PPP in a single figure for such a classification.

The aforementioned European study comes to the following conclusion in this respect: *"In view of the large number of active ingredients and the different conditions for use of the PPPs, it is very difficult to define a generally acceptable indicator which would make it possible to quantify the environmental risk posed by the use of the PPPs."*

1.4 Acceptance

It is understandable that those directly affected will not greet the introduction of a new tax with enthusiasm regardless of its form. In the present socio-economic climate (opening up of markets, restructuring etc.), the introduction of an incentive tax will meet with little acceptance. Given the constant reduction in the price of agricultural products, farmers see the PPP tax primarily as a threat of even greater loss of income. They fear either an increase in operating costs due to higher PPP prices or a reduction in yields due to lower use of PPPs. Acceptance is no greater in the chemical industry since here a possible reduction in turnover is expected because of lower sales.

The greater the planned price increase in order to reduce PPP use, the more difficult it will be to ensure acceptance of this tax. On the other hand, acceptance can be greatly increased if the form of the tax imposed is selected on the basis of the environmental risk associated with the use of PPPs and not just the price elasticity of PPP demand.

3 Bidaux A., Gaillard R. and Lehmann B., *"Etude de divers modèles de taxes d'incitation différenciées portant sur les pesticides utilisés en agriculture"*, ETHZ study commissioned by SAEFL (1992).

1.5 Effects on income distribution

As already mentioned, the introduction of an incentive tax on PPPs could possibly have an effect on the income of farmers and the chemical industry. According to the aforementioned European study, the loss of income registered by the industry would often be greater than that of farmers. Moreover, part of any losses would be more or less compensated depending on how revenue from the incentive tax was used.

In fact revenue could be used entirely to promote more environmentally-friendly agricultural production. On the one hand this would strengthen the control effect of the tax and on the other would prevent agriculture as a whole having to accept losses. Instead of earmarking the tax for specific purposes, the possibility of a general refund to agriculture could be examined, for example by means of a reduction in other taxes (cf. example Denmark, *Chap. 1.8.2).*

1.6 Political framework

Incentive taxes on PPPs are only sensible if they supplement measures already taken as part of agricultural policy. Within Swiss agricultural policy it was first decided to assess the effects of the new instruments regarding more environmentally-friendly agriculture.

The agricultural reform carried out since the beginning of the 90s aims to dismantle federal government price support. The most important stages of this policy are as follows: 1993 introduction of the system of direct payments based on Article 31a and 31b of the Law on Agriculture (LAgr; separation of price and incomes policy; from now on, proof of ecological achievement is the most important criterion for support); 1995 strengthening of the market with the introduction of product and origin labelling; 1996 approval of Article 31^{octies} of the Constitution by the people (new definition of the responsibilities of agriculture; confirmation of the role of ecology); gradual dismantling of price support as part of AP 2002 [Agricultural Policy motion of 2002]. The free market is assuming increasing importance.

After almost fifty years of guaranteed prices, farmers are now forced to adapt to the new circumstances. Prices, which have been falling for some years, show how difficult this change is. An improvement in competitiveness is therefore essential. Competitiveness can be improved mainly through product differentiation (label etc.) and by reducing production costs. The latter is inconsistent with a tax and in the final analysis is crucial for its acceptance. Should the imposition of a tax still prove necessary, in order to implement the generally recognised polluter pays principle rooted in the Constitution, the present pressure on production costs and the competitiveness of domestic versus imported products would have to be considered.

Art. 160 Para. 7 of the LAgr prescribes that the import and placing on the market of agrochemicals authorised in Switzerland and abroad is allowed. The objective of the new import regulation is to reduce the price of PPPs on the Swiss market. The relevant enforcement regulations are drawn up in the *Ordinance of 23 June 1999 relating to the Registration of Plant Protection Products (Plant Protection Products Ordinance),* which entered into force on 1 August 1999. The decision on the purpose and expedience of incentive taxes must also take account of this new political background.

1.7 Implementation

The imposition of a tax on PPPs is generally simple and associated with relatively modest administrative costs. There is a risk of evasion of the tax (e.g. black market or parallel import of PPPs), but it would be very small or non-existent if a uniform tax were introduced throughout Europe.

1.8 Situation in Europe

1.8.1 Preliminary remarks

In Europe several countries already have a tax on PPPs. Various approaches for a system of taxes are summarised below using three examples.

1.8.2 Denmark

- Originally four different approaches for setting the incentive tax were examined: a tax based on the environmental impact, the quantity of active ingredient, the standard dose and the sale price of the product.
- An incentive tax on the final sale price was decided (obligatory maximum price on the label).
- When it was introduced in 1995, the tax was set at 13 % of the final sale price (including tax) for herbicides, fungicides, growth regulators and repellents, and at 27 % for insecticides and soil disinfection products. In 1998 the tax was increased to 25 and 35 %, respectively, of the final sale price.
- Consumption fell by 10–13 % between 1995/96 and 1997. However, it is not certain whether this was solely attributable to the incentive tax. With the increase in the tax in 1998, an additional fall in consumption of 8–10 % was hoped for.
- Revenue flowed back into agriculture via lower taxes on agricultural land.
- From 1998 the additional revenue was used in a more specific way and is earmarked to support organic production and for water protection measures.
- The price elasticity of demand is estimated to be 0.5.
- The administrative costs correspond to 0.5 % of the revenue.
- In view of the fact that a tax based on the environmental impact presupposes a relevant assessment system for the environmental risk which is not yet available, this approach was not initially considered. However, it is being followed up.

1.8.3 Sweden

- In 1984 an environmental tax of 4 SEK (ca. 0.40 €) per kg active ingredient was introduced. An additional incentive tax of 29 SEK (ca. 3 €) on the standard dose per ha followed in 1986, and in 1988 the environmental tax was increased to 8 SEK (ca. 0.80 €) per kg active ingredient.

- In 1991 the highest incentive tax was 46 SEK per standard dose/ha (ca. 4.5 €/ha).
- Since 1994 there has no longer been an incentive tax, but instead an environmental tax of 20 SEK (ca. 2 €) per kg active ingredient. This corresponds to an average increase in the price of PPPs of 5 %. At present, discussions are being held whether to replace the environmental tax of 20 SEK (ca. 2 €) per kg active ingredient with a tax based on the standard dose (50 SEK, i.e. 5 € per ha).
- Revenue is not earmarked for special purposes.
- The administrative costs amount to around 0.05 % of the revenue.
- According to Swedish estimates, around 10 % of the reduction in PPP use is due to the tax on PPPs.

1.8.4 United Kingdom (UK)

- A financing charge on PPP turnover was introduced 30 years ago, but it is not an incentive tax.
- The rate of the charge is between 1 and 2 % of PPP turnover of registered firms.
- The charge is earmarked to finance the approval procedure, market control, application data, environmental monitoring and consultancy.
- The rate of the charge is set on the basis of the annual budget. This means no reserves are built up.

1.8.5 Comparison and evaluation

The incentive taxes in Denmark and Sweden were introduced as part of national action programmes to reduce the risk of PPPs. Both countries set a target for their action programme of halving PPP consumption. Consumption is measured in kg of active ingredient. Denmark also set itself the target of reducing the treatment intensity by half.

The treatment intensity indicates how often on average the total area of open arable land is treated with the PPPs sold per year. The calculation is based on normal doses (recommended amounts used per ha).

Denmark introduced this additional parameter because certain PPPs have a high biological impact even in very small amounts and therefore are used in much smaller amounts than other (often older) products.

A reduction in the amount used cannot therefore be directly equated with a reduction in the environmental risk. The latter depends on the chemical, physical and biological properties of the PPPs used and must be determined by means of a complex procedure.

Since an index which takes account of the differing environmental impact of the different PPPs is not available at present. Denmark provisionally considers the treatment intensity to be the best measure for evaluating the action programme. The tax in the UK was introduced for purely fiscal reasons to cover the administrative costs incurred directly by the PPPs (polluter pays principle).

In the year 2000 France was the first country to introduce a scale of taxes on PPPs according to risk (taxe générale sur les activités polluantes, TAGP). This is based on the risk classification for the labelling (risk statements) and is 0–1.7 € per kg active ingredient.

The *Commission of the European Communities* is temporarily abstaining from the introduction of a uniform EU-wide incentive tax on PPPs in its proposal for a *"thematic strategy on the sustainable use of pesticides"*[4]. Instead it is proposing harmonisation of value added tax applying the normal public benefit rate.

To date no country has levied incentive taxes differentiated according to the environmental risk of individual PPPs, because division into different risk classes is not very easy. France introduced this form of differentiated tax for the first time in the year 2000. An undifferentiated tax only achieves satisfactory control by means of very marked price increases. An incentive tax differentiated according to the environmental risk of the products is more effective.

At present, efforts are being made to harmonise the different taxes on PPPs within the common EU policy. In a first stage, tariffs for the approval of PPPs are to be standardized. A basic tax of the order of 200.000 € for the approval procedure of a single product is being mentioned. The *European Commission* is also proposing harmonisation of the value added tax on PPPs. This is intended to avoid distortions in the increasingly free market (grey market or parallel imports). However, the introduction of a uniform incentive tax throughout the EU is not foreseeable at present.

1.9 Alternatives to the incentive tax

The British example of a purely financing tax on PPPs offers an alternative to the incentive tax. A financing charge on PPPs corresponds to the polluter pays principle and is also effective if it brings in sufficient revenue to cover certain tasks of the state. These state tasks must be clearly defined from the outset: e.g. financing the development of a database on the consumption and application of PPPs or financing information and training programmes for users of PPPs.

If sufficient financial resources can be made available with a lower tax (e.g. 1–2 % of the sale price), it is certainly easier to implement this type of tax. However, the advantages it offers also depend on the intended and achieved effect of the funds used. Possible positive effects of measures financed in this way should not be underestimated: e.g. better cultivation methods or effective control of results, which shows approximately the development of the risk associated with the application of the PPPs.

4 Communication of the Commission to the Council, the European Parliament and the Economic and Social Committee, *"Towards a Thematic Strategy on the Sustainable Use of Pesticides"*, COM(2002) 349 final, Brussels 01.07.2002 (http://europa.eu.int/comm/environment/ppps/home.htm)

The EU study already mentioned in *Chapter 1.2* recommends that the value added tax (VAT) rate for PPPs be raised throughout Europe and where possible graduated according to the risk associated with the active ingredients. According to the study, this differentiated VAT on PPPs should be accompanied by the following measures:

- Preparation of a national programme to reduce the risk associated with the application of a PPP;
- Promotion of research and use of resistant crop varieties;
- Acceleration of the revision of the approval procedure for PPPs: more detailed information on active ingredients and their risks;
- Recognition of the programmes for integrated production;
- Promotion of test programmes for PPP application techniques.

Various EU countries have an incentive tax or financing charges on PPP turnover. The latter is earmarked to finance the approval procedure, market control and application data.

2 Agricultural and environmental policy instruments

2.1 Preliminary remarks

The article of the Constitution relating to agriculture approved by the Swiss people in a referendum in 1996[5] gives environmental protection a high priority. The article expressly records *inter alia* the concern of the Swiss people regarding the use of plant protection products:

"The Confederation shall protect the environment against harmful effects caused by excessive use of fertilisers, chemicals and other auxiliary substances."

Agricultural and environmental policy strategy is based on three pillars (regulations and prohibitions – financial incentives – raising awareness and persuasion), which contain the following regarding the use of PPPs:

- The approval procedure for PPPs is a key instrument which the Confederation uses to protect the environment.
- Direct payments are linked to *proof of ecological achievement (PEA)* and are part of the control measures to which farmers who use particularly environmentally-friendly cultivation systems, are entitled.
- Research, training and advisory services make a major contribution towards ensuring that farmers use plant protection products carefully by raising their awareness.

5 Art. 104, SR 101.

2.2 Approval procedure, general obligation of due diligence and restrictions on use

Plant cultivation is important in Swiss agriculture. However, yield is threatened by plant diseases, insect infestation and weeds. PPPs often have to be used, in order to protect agricultural crops and to safeguard the yield. They may only be placed on the market or imported if they are approved in Switzerland. Assessment of PPPs covers both their suitability and their secondary effects. This ensures that the benefits and risks of PPPs are weighed against each other as part of the approval procedure.

Based on extensive investigations (application documents), the concentrations in the environment resulting from the anticipated use of the PPPs are estimated using risk scenario modelling and are compared with the maximum permissible concentrations. A product is only approved if, when used in accordance with the regulations, the permitted concentrations are not exceeded and the environment is not endangered.

The approval obligation is an effective preventive measure for reducing the risks of PPPs and corresponds to the precautionary principle under public health and environmental protection. Approval can only be granted when all the following particulars have been verified:

- identity of the active ingredient and the PPP;
- physical, chemical and technical properties;
- residual activity and application;
- toxicological analysis;
- possible residues in harvested crops, food and animal feedstuffs;
- fate and behaviour in the environment;
- ecotoxicological analysis: e.g. secondary effects on beneficial animals, toxicity for birds etc.

The approval certificate specifies the indication of use of the PPPs: the instructions for use prescribe in binding terms, against which pathogens and pests, in which crops and at in what dose the PPPs may be used and what precautions must be taken. If new findings concerning the properties or secondary effects of PPPs become known, the approval authority must be informed. The aforementioned documents relating to safety shall be assessed by the OAGR together with the OPH and SAEFL in accordance with the procedure described above.

Preferential approval is given to those PPPs which have fewer secondary effects for the same indication. This may mean subsequent stipulation of a time limit or restriction of use for already approved PPPs, as soon as new and better PPPs are available. PPPs may therefore be withdrawn from supply or made subject to further conditions, if necessary. Such conditions may include e.g.: reduction of the permitted dose, restriction of the number of applications, extension of the waiting time (= period between the last PPP application and the harvest) or prohibition of use on particular crops or at certain stages of growth. The approved PPPs are published annually in the *"PSM-Verzeichnis" [federal* ***Register of PPPs].***

Presently around 400 active ingredients are approved and on the market. According to the OAGR, over 80 problematic active ingredients were withdrawn from the official register between 1990 and 1998 and around 200 new ones were added, including about 40 beneficial organisms and products of natural origin. In this way,

it was possible to reduce the risk of the development of resistance and loss of efficacy as well as residues in foodstuffs, groundwater and soil.

The heavy metals copper (Cu) and mercury (Hg) as examples demonstrate the following: consumption of Cu, which is traditionally used as a fungicide, but which accumulates in the soil, fell from ca. 10 kg/ha to 4 kg/ha per year on treated areas. The dose could be reduced as a result of more targeted use and restrictions on application. In the medium term, investigations have to be carried out into whether use of Cu can be avoided completely. Hg compounds, which were used for seed dressing, and halogenated PPPs were banned in the *Ordinance of 1986 relating to Hazardous Substances (OHS).*

The use of atrazine, for example, has also been increasingly restricted in recent years, after it was detected in groundwater. Today use of this active ingredient is only permitted once a year in maize growing up until 30 June in a maximum dose of 1 kg/ha and since 1 January 1999 only outside karst areas. Approval for application on other crops and along railway tracks and roads was withdrawn. As a result of these measures, atrazine pollution of groundwater has fallen significantly.[6] Nevertheless, atrazine remains detectable in groundwater for decades to come.

Under the *Law on Environmental Protection* (Art. 27 and 28 LEP), substances shall only be used in such a way that they, their derivatives or waste cannot pose a danger to the environment or indirectly to persons. Any person who supplys substances to the market must inform purchasers about the possible impact on the environment and provide instructions so that when handled properly, persons and the environment are not endangered.

The OHS puts these provisions into practical terms:

- *Articles 9* and *10* specify the general obligation of due diligence and prescribe moderate application. They emphasize that the manufacturer's instructions for use and the information on the label are compulsory.
- *Article 45* requires that PPPs only be used professionally under the direction of a technical expert with a *technical permit.* The technical permit is issued to anyone who has passed a specialist examination.
- Application from the air and regional applications of rodenticides are linked to a special *utilisation permit* procedure with conditions *(Art. 46)*.[7]
- *Annex 4.3 Section 3 Paragraph 1* prohibits the application of PPPs in nature conservation areas, fens and marshes, hedges and copses and in a strip 3 m wide along these, in surface waters and in a 3 m wide strip along banks, and in groundwater protection zones S1. Moreover, the use of some PPPs is prohibited in zone S2 due to their mobility and biodegradability.
- The use of herbicides is also prohibited on roofs and terraces, on storage areas, on and alongside roads, paths and municipal squares and on embankments and green verges alongside roads and railway tracks. In exceptional cases, the treatment of

6 D. Gut et al., *"Triazin-Situation in der Schweiz", AGRAR*Forsch., 5, (4), 194–195 (1998). S. Müller et al., *"Atrazine and its primary metabolites in Swiss lakes"*, Environ. Sci. Technol., 31, 2104–2113 (1997).

7 BAZL, OAGR, SAEFL, *"Wegleitung – Anwendungsbewilligung für das Ausbringen von Stoffen, Erzeugnissen oder Gegenständen aus der Luft"*, Vollzug Umwelt, 28 pp. (1998).

individual plants is permitted on embankments, green verges and on cantonal roads if non-chemical methods are unsuccessful (*Ann. 4.3 Sect. 3 Para. 2).*

- The application of herbicides is also extensively restricted in the vicinity of railway lines (*Ann. 4.3 Sect. 3 Para. 2d and Para. 5;* OFT[8] instructions). Only herbicides for foliar application with the active ingredients glyphosate or sulphosate are permitted, and only outside groundwater protection zones S1 and S2.

The *Ordinance relating to Forests (ORF)* prohibits the use of PPPs in woodland apart from a few exceptions *(Art. 26).*

2.3 The reform of Swiss agricultural policy

In recent years, the *Swiss Federal Council* has passed several measures as part of the legislation on agriculture, which are intended to reduce the use of PPPs.

2.3.1 Ordinance of 7 December 1998[9] relating to Direct Payments (ODP)

Since the introduction of AP 2002, i.e. since 1999, *Integrated Production (IP)* has been a prerequisite for direct payments. IP is therefore *de facto* mandatory, no longer receives additional compensation and from now on continues under the name of *"proof of ecological achievement for direct payments" (PEA).* The PEA correspond to current IP (cf. the bullet points listed below). Under the *Law of 29 April 1998 on Agriculture (LAgr),* the PEA include *inter alia* the selection and targeted application of PPPs. Before then, the technical rules for this were laid down in the OAGR guidelines. Under AP 2002 they were transferred to the mandatory ODP:

- Priority must be given to the use of natural regulation mechanisms and organic and mechanical methods.
- The damage threshold and recommendations of forecasting and warning services must be considered. Decision-making guidelines, which are based on risk profiles, must be considered in the selection of PPPs.
- Certain plant protection methods or types of PPPs are prescribed or prohibited.

The economic targets of the new agricultural policy also include the revised price policy. In order to promote greater competitiveness, the new agricultural policy also aims to reduce the prices of agricultural crop products. As a result, the farmer must reduce his production costs and this means that the farmer’s interest in reducing expenditure on PPPs also increases.

2.3.2 Remediation programmes under the Water Protection Law of 24 January 1991[10] (LWP)

Since 1999 payments can be made under Art. 62a LWP to reduce run-off and leaching of hazardous substances into water bodies. These payments can therefore also be used in principle for programmes to reduce the input of PPPs.

8 OFT = Federal Office for Traffic
9 SR 910.13
10 SR 814.20

2.4 Research

Many research projects by the federal agricultural research stations *(Agroscope* RS) are aimed at optimised plant protection. In addition, various research programmes are also important for this subject, for example plant selection. This traditionally places great importance on resistance to diseases. There are also research projects on cultivation systems, IP and organic farming (BIO), which contribute greatly towards environmentally-friendly use of PPPs. Some projects are outlined as follows.

In the subject of plant diseases, the computer-based system *"PhytoPRE"* for the forecasting, monitoring and control of late blight of potato has been developed and continually improved since 1989 with the support of SAEFL. The aim is to reduce the use of fungicides without increasing the risk of attack. Closely networked recording of the incidence of infection throughout Switzerland, detailed study of late blight susceptibility of varieties contained in the national list of varieties and selection of the most favourable time for treatment and the most appropriate active ingredients allow safer plant protection, which is able to meet the high requirements for environmental compatibility and yield security.[11] The system *"PhytoPRE"* functions thanks to the intensive co-operation between scientists and practitioners.

Sparing and environmentally compatible use of PPPs requires suitable spraying equipment. New equipment was therefore developed and tested in research projects in conjunction with manufacturers. For example, in fruit-growing and viticulture, recycling equipment was tested, in which pesticide drift was collected and fed back into the equipment. In this way it was possible to save 30–80 % of the PPP volume and to reduce environmental pollution accordingly.[12] However, high investment costs and restricted means for use on steep slopes have thus far prevented large-scale spreading of such equipment.

2.5 Training and advisory service

Knowledge of the processes and interrelations in natural and agricultural ecosystems forms an important basis for professional selection and application of PPPs. Therefore, in 1986 with the OHS the obligation to obtain a technical permit for professional or commercial use of PPPs was introduced. This has been put into practical terms in four departmental ordinances of the FDHA [Swiss Federal Department of Home Affairs].[13] In the agricultural sector, around 12.000 people by the end of 1998 had obtained a technical permit by means of an examination. There are a further 3.800 in the sectors of forestry, horticulture and special uses without relevant professional training (railways, roads and sports grounds). The examination covers the following specialist areas:

- principles of ecology;
- legislation and general precautions;

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11 Ruckstuhl M., Forrer H.-R., Fried P.M., *"Krankheitsvorbeuge und gezielte Bekämpfung der Kraut- und Knollenfäule der Kartoffel"*, unpublished FAL Interim Report (1998).

12 Siegfried W., Holliger E., *"Applikationstechnik im Obst- und Weinbau"*, FAW Test Report (1996).

13 Ordinance of 16 April 1993 relating to the Technical Permit of Use of PPP in Agriculture (SR 814.013.552), in Gardening (SR 814.013.553), for Special Uses (SR 814.013.551 and in Forestry (SR 814.013.52).

- environmentally-friendly plant treatment;
- action, environmental compatibility and application of PPPs;
- equipment: knowledge and proper handling.

The curriculum for the basic training of farmers, including the sectors of viticulture, fruit-growing and horticulture, was completely revised with these objectives in mind in 1995. Anyone who passes the final examination at agricultural colleges and vocational training schools therefore receives the aforementioned technical permit at the same time as their qualification.

Agricultural advisory services in the subject of plant protection are provided by a variety of sources. The cantonal advisory and plant protection services carry out group and individual consultations and further practical training with specifically trained experts. Both the agricultural advisory boards (*Swiss Agricultural Advisory Board, LBL*, in Lindau, and the *Sevice romand de vulgarisation agricole, SRVA*, in Lausanne) for their part offer professional development events for advisers and provide practice-based leaflets. The *Agroscope* RS run information points on different plant protection problems as a direct link between research and advisory services. Various label organisations and PPP firms also conduct their own advisory services.

The approval obligation for PPPs corresponds to the precautionary principle and is an important preventive measure for keeping the risks posed by these hazardous substances to the minimum possible. The principle of *proof of ecological achievement (PEA)* anchored in the new agricultural policy (AP 2002) and ecological contributions for ecological balance, extensive production of cereals and oil seed rape and for organic farming are also appropriate instruments for reducing the environmental risk from agricultural production. The improvement of training and advisory services also contributes greatly to a targeted and appropriate use of PPPs.

3 International programmes and agreements

3.1 Preliminary remarks

Swiss experts are not only working towards environmentally compatible plant protection practice within Switzerland. They also take part in conferences and working groups of various international organisations. Switzerland uses this opportunity to exchange experience and information with other countries and to help draw up internationally harmonised regulations.

3.2 OECD: Organization for Economic Cooperation and Development

Since 1993 the environmental directorate of the OECD has run a pesticides working group in which OECD member states, the EPPO, the EU, the FAO, industry, the WHO and the WWF are represented. The *Working Group on Pesticides (WGP)* of

the OECD meets regularly to discuss, co-ordinate and approve the current work of the pesticide programme. It is primarily a matter of harmonising regulations and directives which govern the approval, trade and application of PPPs. The programme to reduce the risks of PPPs was given particular importance here because it became apparent that most member states are very much concerned with this problem. Switzerland is involved as a co-organiser and active participant.

As part of the *OECD Pesticide Risk Reduction Programme*, an *"OECD/FAO Workshop on Integrated Pest Management (IPM) and Risk Reduction"*[14] took place in Neuchâtel in summer 1998. The workshop was organised by OAGR and SAEFL and its aim was to discuss the role of IPM for risk reduction and to draw up recommendations on how IP is to be implemented in agriculture as an appropriate agri-ecological measure. The most important recommendations concern:

- development of a national *PPP Action Programme,* which supports the application of IP;
- promotion of applied IP research and advisory services;
- formation or promotion of a partnership IP discussion platform;
- introduction of financial incentives for the application of IP or the dismantling of systems which hinder this;
- improvement of information and training on IP for all interested parties including consumers;
- drafting of directives and minimum requirements for sustainable agriculture including basic principles for control of results;
- improved and harmonised PPP approval and promotion of IP-compatible products.

The degree to which this list of recommendations is carried out can be used as a "benchmark" for the state of IP implementation. In Switzerland the necessary foundations for rapid implementation of ecological forms of agriculture were laid with the reform of agricultural policy and the associated economic incentives for putting ecological concerns into effect. Switzerland therefore already obeys to many parameters contained in the list of recommendations.

In recent years, "PPP indicators" have been developed and discussed in several countries[15]. 23 countries and organisations responded to an OECD[16] survey. 14 (Australia, Denmark, Germany, United Kingdom, France, Holland, Norway, Portugal, Sweden, Hungary, the USA as well as the EU, UNEP and WHO) already use or are developing indicators for assessing the environmental risk of PPP use. Development of such indicators is also planned in Switzerland (cf. *Chap. 4.4).*

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14 OECD, *"Report of the OECD/FAO Workshop on Integrated Pest Management and Pesticide Risk Reduction, Neuchâtel, Switzerland, 28 June–2 July 1998"*, Environmental Health and Safety Publications, Series on Pesticides no. 8 (1999).

15 Cf. *"2nd OECD Workshop on Pesticide Risk Reduction"*, Braunschweig, 1–3 June 1999; http://www.oecd.org/dataoecd/32/40/2078023.pdf

16 OECD, *"Results of the OECD Survey of National Pesticide Risk Indicators"*, Second Workshop on Pesticide Risk Indicators, Braunschweig, Deutschland (1–3 June 1999).

At present risk indicators are being developed within the OECD. These are intended to support advisory services, to help lay down practical environmental as well as agricultural policy targets and to enable a meaningful evaluation of measures already introduced.

4 Evaluation instruments

4.1 Indicators for risk assessment

As explained in *Chapter 2*, various measures contribute to an ecological PPP use as far as possible. This also reduces the risk for the environment. However, the degree of the risk associated with the application of a PPP depends on many factors such as e.g. toxicity of the active compound, amount applied, soil properties, weather conditions, resulting concentration in the environment. Assessment of the risk is therefore only possible by means of a complex procedure, which is based on many environmentally relevant specific data. A number of EU countries have so far developed simplified indicators. These make it possible to highlight trends in environmental risk. The indicators used can be divided into two groups according to the purpose of their use, namely:

- **Indicators for advising** farmers and for their self-supervision and
- **Indicators to evaluate** agricultural and environmental policies.

4.2 Indicators for advice and self-supervision

The first PC advisory programmes aimed at making it possible to reduce environmental pollution from application of PPPs were developed in Denmark, the Netherlands and UK. A Danish programme gives informations on the most appropriate PPP for use against a particular pest and on the optimal dose.[17] It also refers to the environmental hazard posed by the different products. A programme used in the Netherlands[18] is similar to the Danish one and also allows data to be entered on the plot (e.g. soil type) and the application method. The programme is also used as an environmental performance indicator (for self-supervision by comparison over years and with neighbouring farms). Finally, the University of Hertfordshire (UK) is developing a programme which is intended to help comply with the requirements of *"Good Agricultural Practice" (GAP).*[19]

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17 Gyldenkaerne, S., *"Integrating environmental risk assessment in PC Plant Protection"*, 13. Danske Planteværnskonference: Pesticider og Miljø, SP rapport 3, 85–95 (1996).

18 Reus, J. and Pak, G., *"An environmental yardstick for pesticides"*, Med. Fac Landbouw en Milieu, Utrecht (1993).

19 Johnston, A. and Lewis, K., *"Effectiveness of environmental performance measures in ensuring sustainable development: the water and agricultural industries highlighted"*, Sustainable Development, vol. 3, 140–148 (1995).

A study carried out in 1993 by the *"Schweizerische Gesellschaft für Phytomedizin"* [SGP – Swiss Society for Phytiatry] revealed on the one hand that it is difficult for users to obtain useful information on PPPs (too many different sources). On the other hand, it also showed that insufficient data are available on the environmental risk of PPP use. The study came to the conclusion that a comprehensive and practical information system, which takes account of present environmental protection needs, would be useful for Switzerland.

A representative survey was therefore conducted to evaluate and compare information and decision support systems of other countries. Experts from OECD countries, the European Union (CAPER Project) and industry (ECPA) were also contacted. The information systems were assessed according to set criteria. The 10 systems which best fulfilled the criteria are presented in the study by Witz[20].

4 of the 10 systems were examined more closely. This was done from three different perspectives: environmental aspects, economic efficiency and practical suitability. Three systems calculate the environmental risk associated with application and express this in terms of a risk index. However, none of the systems take into consideration the impact on biodiversity and beneficial animals.

From a practical point of view, all four systems are applicable. Two systems stand out from all the others by virtue of their greater flexibility (target public, crop affected, application technique) and their adaptability (function logic, type of interpretation). These systems seem *a priori* to be more interesting for introduction in Switzerland.

However, none of the systems is suitable for direct application in Switzerland, because none of them meet all requirements. In any case, adaptations are necessary for the introduction of any system. It is planned to adapt one of the existing foreign information systems to Swiss requirements and to gain practical experience with it.

4.3 Indicators for agricultural and environmental policy

Measures to reduce risk and control results require more precise knowledge about the use of PPPs. In order to calculate risk indicators, it is necessary to know when, where and what PPPs were used and in what quantities. EUROSTAT has therefore founded a project in conjunction with the OECD to harmonise collection of use data. A task force from countries which already have practical experience with collection of such data (GB, USA, NL and F) has drawn up guidelines on the subject. Data collection is based on the basic principles as mentioned below.

- Data collection on the use of PPPs must take account of the following parameters:
  - products used and crops treated;
  - dose, amount of product and area treated;
  - time of treatment;
  - aim and purpose of application.
- Data collections for the most important crops must be repeated at regular intervals.

[20] Witz. N., *"Evaluation des systèmes d'aide à la décision pour le choix des produits phytosanitaires en fonction du risque pour l'environnement"*, SGP (1999).

- Tested collection methods (e.g. United Kingdom's approach) must be applied.

Data collection in Switzerland must be comparable with those of EU countries. They must therefore be in line with the OECD guidelines[21] published in 1999. The most appropriate collection method for Switzerland is determined on the basis of current studies on the *"Evaluation of Ecological Measures and Stock Rearing Programmes"* and the experience of other countries.

Based on the application data, so-called risk indicators can be calculated using models which include the environmental risk of the various PPP applications. These act as the basis for agricultural and environmental policy decision making and for the necessary control of results.

The indicators developed to date differ with regard to:

- the purpose for which they were developed (advice, political decision making or control of results);
- the operational level at which they are targeted (farm level, regional or national level);
- degree of detail and number of variables included (chemical properties of the PPPs, application methods, environmental properties);
- base data which were available or were used.

In Germany, the *Federal Biological Research Centre for Agriculture and Forestry* calculates the risk potential of the different PPPs, in order to identify particularly problematic products. It takes into account the fate (degradation and mobility) and ecotoxicity of the products. The Dutch *Institute CLM* assesses the PPP risks for the Netherlands by multiplying the amount sold in kg of active ingredient per product by an environmental pollution index.

This produces an instrument which can be used to deduce the reduction in environmental pollution from the reduction in the quantity of PPPs used. France, under the leadership of the *Institut français de l'Environnement (ifen)*, has divided the PPPs used into risk classes according to the risk for water bodies for the different catchment areas *(bassins versants)* and based on these has laid down priorities for targeted monitoring programmes. In this way, cost and benefit of residue analysis in rivers and in groundwaters could be optimised.

As already mentioned (cf. *Chap. 3.3)*, the EU and OECD are also currently developing models for calculating risk indicators for PPPs. They intend later to apply comparing factors to the utilisation data according to the environmental risk of the different products and use this indicator as a better basis for making decisions and controlling results.

Such indicators are intended to serve the course of the total calculated risk from PPP application for different areas over a certain period of time. At a workshop in Braunschweig in June 1999[22], risk indicators drawn up by an international group of experts for the environmental sector water *(Aquatic Risk Indicators)* were presented

21 OECD, *"Guidelines for the Collection of Pesticide Usage Statistics within Agriculture and Horticulture"*, Paris (1999).

22 c.f. *"2nd OECD Workshop on Pesticide Risk Reduction"*, Braunschweig, 1–3 June 1999; http://www.oecd.org/dataoecd/32/40/2078023.pdf

and discussed. The workshop came to the conclusion that indicators can be a valuable tool for governments in order to:

- identify problem areas where risk reduction is necessary;
- monitor the results of PPP policy and action programmes;
- communicate the aims and results of PPP policy and action programmes;
- obtain information on aggregated risk with the application of different PPPs;
- compare the risks of different PPPs in different situations;
- obtain information for other types of indicators, such as indicators on the progress of IP.

This workshop also confirmed that the indicators developed meet the criteria of the OECD *Joint Working Party for Agriculture and Environment,* and are:

- **policy relevant** because they respond to risk reduction measures;
- **measurable** because they use data that exist;
- **analytically sound** because the results can be interpreted in a meaningful way, using knowledge of PPP toxicity, fate and use;
- **usable at different levels of aggregation** because they were so designed.

However, comparison of the different models has also shown certain problems in the application of such indicators. Due to the differing sensitivity to various base data, the deduced values may also differ considerably from each other.

Another problem is that the data available are incomplete. The availability of use data is crucial. The workshop therefore came to the conclusion that these indicators cannot yet be used at the present time and that their scientific acceptance, explanatory power and applicability must first be investigated.

4.4 PPP use as an indicator for environmental pollution

In order to estimate the risk, the use of PPPs must be determined according to OECD guidelines. This is only possible with regular data survey on the quantity of PPPs used, the type of application, and the place and time of application. IP farmers must keep a logbook on such data. However, so far the data have not been summarised and evaluated. Therefore, detailed application statistics and calculations of the environmental risk based on them do not exist, which means that trends showing the environmental risk associated with PPP use in recent years cannot be determined either.

The only available data in Switzerland are the total quantities of PPPs sold, which have been collected by the SGCI[23] since 1988 and published annually. These statistics contain figures on the total revenue and quantity of chemical groups sold in CHF and tonnes (cf. *Chap. 6.2, Tab. 3* and *Annex).*

However, the alteration in the annual quantity consumed would only give an indication about the development of environmental pollution if roughly the same products had been used over the period considered. This is not the case, however. The noted

23 SGCI = Schweizerische Gesellschaft für chemische Industrie *[Swiss association for chemical industry]*.

reduction in quantities sold is partly the result of the fact that older active ingredients have been replaced by more modern ones, which achieve the same effect with a much smaller quantity. The conclusion *"less PPP means less environmental pollution"* is therefore not acceptable.

More detailed application data in accordance with OECD guidelines should therefore be gathered in future. Data survey must be based on a statistically representative selection of farms. The total consumption data extrapolated from such surveys should then be compared with the sales data of the SGCI to test plausibility.

4.5 Risk profiles of PPPs as indicators for environmental pollution

An indicator based on a scientifically based and internationally agreed concept of data survey and risk analysis is currently being evaluated in Switzerland (cf. *Chap. 3.3).* It is to be used to express pollution trends of selected PPPs. The aim of this indicator is to:

- allow the authorities concerned to quantify the risks which are associated with the use of PPPs and, considering the benefits of PPPs, to draw up measures to reduce their use;
- allow the introduction of a modern system for advice (and self-supervision) in agricultural practice;
- allow comparison of agricultural production systems with regard to their environmental impact;
- provide bases for agricultural and environmental policy decision making.

The indicator is based on the risk profile of the PPPs used. Determination of such risk profiles for PPPs is based on three scientifically accepted principles used in the approval procedure:

- When determining the risk associated with the use of a respective PPP, its toxicity, the quantity used (dose) and its fate must all be considered simultaneously. Toxicity and fate are substance-specific properties of a product. The needed quantity applied is determined by the desired biological effect which the PPP is intended to provide. Quantity used and fate are responsible for the exposure or pollution load of the environment. In brief:

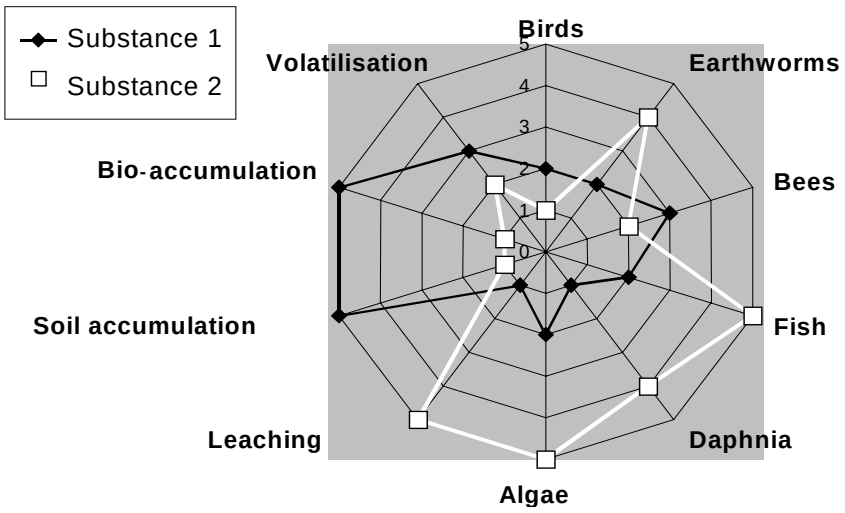
  $$\text{Risk} = \text{toxicity} * \text{exposure}$$

  or according to Paracelsus *"... it is only the dose which makes a thing a poison"*.
- If, when used properly, the concentration of a certain PPP in the environment is much lower than the concentration at which the first detrimental effects are observed, this PPP may be more environmentally compatible than another one where the environmental concentration and damage threshold are nearer to each other.
- The environmental effects of a PPP must be considered individually according to the environmental sector (soil, water, air) and the organisms to be protected (animals, plants, soil organisms etc.) and assessed as a whole. This is because individual favourable environmental properties of a PPP in a particular area, such as their leaching behaviour, often necessarily mean more unfavourable properties in another regard, such as accumulation in the food chain. Consequently, the envi-

ronmental risk of a PPP cannot be assessed with a single overall figure, but only in a differentiated way with the proper expert knowledge.

Based on these principles, each PPP can be assigned a risk profile and this can be presented as a graph. The environmental compatibility of a PPP is evaluated in this type of profile according to its impact on internationally recognised indicator organisms and according to its behaviour in the environmental sectors. *Figure 1* compares an example for the risk profiles of two hypothetical PPPs.

Figure 1: **Hypothetical risk profiles of two PPPs: the properties of the PPP active compounds can be illustrated and compared on the basis of a risk profiles.**



In order to quantify the total risk associated with PPP use, the risk profiles of the individual PPPs now have to be assessed with the quantity applied and summed up. If this calculation is repeated over a series of years, the development over time of the risk of environmental pollution from PPPs is gained, which can also be shown as a graph and as a group of annual total profiles which is easily interpreted (cf. *Fig. 2).* These profiles produce the risk indicator for the PPPs used.

The nearer the profile rests to the origin, the lower the risk of environmental pollution due to PPP use. The lower the value of the indicator, the better the improvement in the risk situation for a particular type or organism. A rise (distance from the origin) corresponds to an increase in the environmental risks, the causes of which could be discovered and corrected.

The product data used in this procedure, such as toxicity, quantity applied, degradation rate etc., can be obtained from the files which have to be submitted to the approval authorities with the application as part of the approval procedure for PPPs.

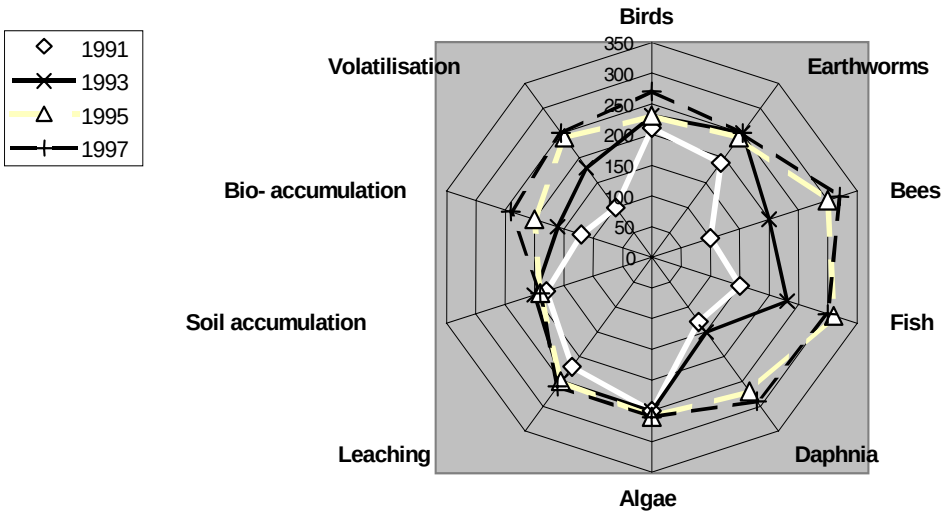


Figure 2: Hypothetical development over several years of the risk of PPPs used; the development of the profiles can be shown as risk indicator per area and year by summing all the risk profiles of the PPP active ingredients used.

Furthermore, the preparation of product profiles allows better advice for users of PPPs. The profiles of the PPPs, which are approved for controlling certain harmful organisms, can also be compared with the environmentally relevant conditions of a farm (e.g. soil properties, groundwater protection zones, rivers, nature conservation areas), and in this way the most appropriate PPP can be selected. This contributes to precautionary reduction of environmental pollution from PPPs.

In the course of implementation of this indicator, the needed databases are currently being established, containing firstly verified product data from the approval procedure and secondly, regional and national PPP sales figures. Although information on sales can only be used to provide an approximate estimate of quantity applied, this information is easier to procure and therefore acts as a sensible interim solution until the actual use data are available.

This highly informative indicator will only attain its full effectiveness for risk management when it can be used to help trace the risk development over several years. Then well-founded and effective measures to reduce risk can be taken.

4.6 Method of PPP application as an indicator for environmental pollution

The risk profile of PPPs described above is based on the environmentally relevant properties of the individual active compounds. However, the way in which the PPPs finally enter the environment is not taken into account in this calculation. In principle, it is assumed that all PPPs are used in accordance with *"good agricultural practice" (GLP).* It is clear that incorrect application pollutes the environment to a greater extent, but that very specific application considerably reduces the risk to the environment. Apart from progress in products quality and in reduction of quantities applied, improvements must also be sought in application and in general precau-

tions. A basic prerequisite for this is good experts training. In Switzerland, therefore, professional use of PPPs is made dependent on holding a technical permit.

When applying PPPs, the environmental risk may considerably be reduced particularly by taking the following measures:

- Compliance with the general precautionary measures when preparing the spray mixture, maintaining and cleaning the spraying equipment and storing and disposing of PPPs;
- Selection of the optimal treatment time taking account of weather conditions (wind, temperature, humidity);
- Leaving as wide as possible an untreated buffer strip (safety width >3 m alongside water bodies, hedges, woodland etc.);
- Selection and correct adjustment of appropriate equipment (e.g. use of recycling equipment, cf. *Chap. 2.4).*

Both the OECD and the EU are trying to take account of the risks associated with application in the development of models for PPP risk indicators (cf. *Chap. 4.3).* However, here the question arises: does one want a complex analysis which is as comprehensive as possible, but which is unwieldy and difficult to communicate, or does one want a simpler analysis which concentrates on the essential points and is relatively convenient and transparent? In both cases evaluation of results by experts is necessary in order to avoid false interpretations.

5 Environmental monitoring to evaluate PPPs used

5.1 Preliminary remarks

Regular monitoring of PPP concentrations in the environment is associated with major technical and financial expenditure. Thus, systematic and statistically representative data surveys for the whole of Switzerland can hardly be justified. Moreover, data from use surveys are not yet available. The pollution status can therefore only be characterized on the basis of random measurements.

The aim of indicators is to trace the development of environmental pollution caused by PPPs and the resulting risk at a reasonable cost. However, indicators cannot be considered as actual pollution loads. It is necessary to validate the models by recording PPP concentrations in the environment and biodiversity. Such monitoring programmes, however, are very costly and can only be applied on a random and supplementary basis.

The OAGR evaluates the impact of agricultural policy in the following areas: natural species diversity, environmental pollution from fertilisers and PPPs, welfare of animal husbandry, economic situation of farms.[24] In the subject of PPPs, it should be established whether there is a change in environmental pollution due to PPPs used in agriculture.

[24] OAGR, *"Evaluation der Ökomassnahmen und Tierhaltungsprogramme",* Concept report (May 1998).

5.2 Assessment of groundwater pollution

The present state of knowledge about PPP pollution of groundwater in Switzerland is based on very fragmentary data. Genuine groundwater data, which would characterize the state of groundwater reserves in Switzerland in general, are rare due to the high monitoring costs. It is generally much more common that only the most important drinking water catchment sites are analysed for individual PPP residues as part of public monitoring of foodstuffs.

These are mostly isolated data in terms of time (one or two analysis per year) and location – drinking water catchment sites represent only a limited proportion of groundwater. The PPP active ingredients analysed are usually selected on the basis of the expected global quantities of individual active ingredients used, the vulnerability of the groundwater reserves to contamination by PPPs (if this is known at all), the available monitoring methods and according to the analytical capabilities of the laboratory.

Groundwater analysis are usually only carried out when pollution has taken place and seldom as a preventive measure. For example, in Canton Freiburg in 1979, atrazine residues were found for the first time more or less by chance in a drinking water catchment site next to a railway line. This discovery gave rise to additional investigations.

Some cantons then began a targeted investigation of their drinking water catchment sites for PPP residues. Initial results showed that the herbicide atrazine is the most frequent PPP detectable in relevant concentrations. For a long time it was the most used herbicide, has a medium degradation rate, medium mobility and is now easily detectable with current monitoring techniques. This is why investigations mainly concentrated on atrazine and its degradation products and still do.

Since investigations and in particular their evaluations are not yet carried out systematically, they are only indicative but not really representative. It will only be possible firstly to record systematically the long-term development of groundwater quality, which is in the national interest, and secondly to study particular problems (e.g. PPP pollution) by means of targeted campaigns when the "*Nationale Netz zur Qualitätsbeobachtung des Grundwassers" (NAQUA)*[25] [National Network for Monitoring the Quality of Groundwater] is operational.

5.3 Assessment of surface waters pollution

PPP pollution of surface waters has so far only been systematically recorded in isolated cases. Surveys by the *Commission internationale pour la protection des eaux du Léman, CIPEL* [International Commission for Protection of the Waters of Lake Geneva] in the catchment area of Lake Geneva and analysis by the Water Protection Office of Canton Berne showed that it is primarily smaller rivers in typical arable farming areas that exhibit high PPP peak pollution loads during application periods.

25 SAEFL, *"Das nationale Netz zur Qualitätsbeobachtung des Grundwassers – NAQUA"* (1998).

Very little research has been performed into the impact of this pollution on aquatic ecosystems. Studies from Germany[26], however, indicate that normal insecticide application practices can cause great damage to river biological communities (e.g. species reduction from 11 to 3).

The impact of ecological measures on inputs of PPPs into surface waters from 1995 to 2005 is being studied as part of the evaluation concept of ecological direct payments under Article 72 ff. LAgr. Surveys concentrate on lakes with average water lag times and on their catchment areas. The annual total load of certain PPPs is to be determined by means of monitorings in lakes. It is also to be established how input develops over time. A cause/effect analysis is to be carried out by recording both the agricultural and non-agricultural input of PPPs in catchment areas of certain lakes and by checking or comparing these data with the lake data.

Analysis of river waters are only of limited suitability for estimating total loads as a result of the large variation in PPP concentrations (cf. *Chap. 6.4)*. On the other hand, groundwater is not suitable as an indicator for short-term reduction in pollution due to the long regeneration period, and peak pollution loads in rivers cannot be obtained using monitoring in lakes.

5.4 Assessment of soil pollution

When herbicides are applied, the bulk of active ingredients arrives directly on the soil and in the case of fungicide or insecticide application, the proportion is on average 20–50%. Every year arable soil in Switzerland is exposed directly or indirectly to a total load of different PPP active ingredients in the order of 1,600 tonnes, not counting the additives in the formulations. Despite this, very few studies have so far been carried out into soil pollution and the impact of PPP application on the soil ecosystem. Relatively systematic measurements are only available for soil pollution in vineyards from non-degradable copper (cf. *Chap. 6.5).* Many countries as well as the OECD therefore attribute great importance to drawing up indicators for the terrestrial ecosystem.

5.5 Assessment of air pollution

The presence of PPPs in the air is not studied in Switzerland. However, products suspended in the air can be deposited in water. Analysis of S-triazines in mountain lakes and in rain water can be used to determine whether herbicides have been transported in the air. The *Agroscope* FAW investigates the level of herbicides in lakes and uses the water of some mountain lakes as a control. The EAWAG[27] analyses PPPs in rain water (cf. *Chap. 6.6*).

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26 Schulz R., *"Insektizid-Auswirkungen auf Fliessgewässer-Lebensgemeinschaften"*, UWSF – Z. Umweltchem. Ökotox., 10, (2), 123–127 (1998).

27 EAWAG = Swiss Federal Institute for Environmental Science and Technology, CH-8600 Duebendorf.

5.6 Assessment of the impact on biodiversity

As part of the OAGR evaluation, the *Swiss Federal Research Station for Agroecology and Agriculture (Agroscope* FAL), is studying the impact on the species diversity of flora and fauna of ecological compensation areas. The use of PPPs is strictly prohibited in these areas. Studies on agricultural crops grown using different farming methods are not part of the concept. For this reason, no direct information on the impact of PPPs on biodiversity can be expected from the OAGR evaluation.

Pollution of the environment and the risk resulting from it cannot be measured without great expense and cannot be deduced easily. The method for assessing pollution load and risk is complex. That is why *"indicators"* are now being developed in various countries and within the OECD. These indicators represent auxiliary quantities intended to make it possible to estimate changes in the environmental risk based on selected, environmentally relevant data, and to show the effect of risk reduction measures. Such indicators can be applied in various areas, for example in agricultural advisory services.

Switzerland has no detailed statistics on pesticide use. This means no trends in the environmental risk associated with the use of PPPs in recent years can be established. Knowledge about the use and concentrations of PPPs in the environment is an important basis for assessment of the environmental risk. However, at present this knowledge is only very fragmentary.

6 Summary assessment of the PPP situation in Switzerland

6.1 Development of extensively managed areas

The agricultural land (AL) managed according to the *"Extenso-Programme"* for cereals and oil seed rape increased by 17,927 ha (27 %) between 1992 and 2000. The AL of cereals cultivated in this way makes up 44 per cent (in the year 2000) of the total cereal acreage (in 1997 it was 49 %). Measured by the area of open arable land in 2000 (292,548 ha), the extensively managed cereal and rape acreage is running at 29 per cent *(Tab. 1)*.

This means that no fungicides, insecticides, growth regulators or chemical stimulators of natural resistance were applied on just under half the cereal acreage and slightly less than a third of the area of open arable land.

Since apart from the perennial special crops, the bulk of PPPs are applied to open arable land, the effect of this risk reduction measure seems evident. In view of the withdrawal of state price support and the collapse of prices, the Extenso-Programme should remain at least as attractive in future as in the period 1992–2000.

Table 1: Development of extensively managed areas and ecological compensation areas entitled to contributions (ha)

Farming	1992	1993	1995	1996	1997	1998	1999	2000	
								ha	%al
extensive cereal cultivation	65'650	72'950	80'627	79'410	91'556	86'435	84'193	80'235	7.5
extensive rape cultivation since 1997	–	–	–	–	4'055	4'967	3'568	3'342	0.3
green fallow	960	2'450	2'134	2'585	3'577	3'805	1'923	closed	–
wildflower fallow	–	–	79	154	265	380	746	1'315	0.1
rotation fallow since 1999	–	–	–	–	–	–	328	1'019	0.1
conservation strips since 1999	–	–	–	–	–	–	59	48	0.0
extensively used grassland on set-aside arable land	630	1'100	2'804	4'805	6'841	8'245	5'877	5'712	0.5
extensively used grassland, hedges, copses, litter meadows	–	19'319	23'274	31'421	37'299	37'999	41'144	44'659	4.2
not intensively used grassland	28'330	31'040	32'547	38'485	41'486	42'344	40'388	40'106	3.7
standard-orchard fruit trees (in millions of trees)	–	1.9	2.2	2.4	2.5	2.5	2.5	2.5	–

Ecological compensation areas (ECA) are constantly being extended. In 2000 the areas entitled to contributions corresponded to 8.7 per cent of Swiss agricultural land (AL). The statistics given in *Table 1* only refer to the ECA entitled to contributions. In fact, these are mainly those areas which are of interest with regard to reducing the risks associated with PPPs, because they are on AL, that is on areas which might otherwise be treated with PPPs. Even if it is difficult to quantify precisely the impact of these areas on environmental pollution from PPPs, it can still be said that the increase in these areas contributes to the reduction in PPP application and therefore also to the reduction in the risks associated with these products.

An important IP condition prescribes that an extensive grassland strip at least 3 m wide should be laid alongside surface waters, hedges and copses and edges of woodland. These strips have various ecological functions, including acting as a buffer zone for these vulnerable areas and reducing the risk of pollution from PPPs and other pollutants. To a certain extent, they implement the provisions contained in Annex 4.3 of the *Ordinance relating to Hazardous Substances (OHS).*

It is difficult or even impossible to determine the effect of the rules of IP and organic farming with regard to PPP risk reduction. This is mainly due to the holistic nature of these two types of cultivation. The conditions laid down with regard to crop percentages, for example, have an impact *inter alia* on the health of the plants (they require less treatment) and on the soil structure (leaching of fertilisers and PPPs is reduced).

On the other hand, the advantages gained by following these rules more closely can be qualitatively estimated by dividing chemical treatment into three phases:

- *Decision in favour of treatment:* only as required (no treatment calendar), taking account of the damage threshold, when there is immediate danger to crops (warning, prediction) and only when natural mechanisms are insufficient;
- *Product selection:* list of approved products (cf. *Chap. 2.2)*, more restrictive lists and limitation of application by professional organisations (partly linked to the label, crop-specific, consideration of resistance, compatibility with beneficial animals, local conditions etc.), limitation of choice and application anchored in the rules of IP and BIO, i.e. organic farming;
- *Application technique:* obligatory inspection of equipment every four years; not linked to IP: obligatory training (technical permit) for users, instructions for use on the labels.

The whole system is generally orientated towards better handling of PPPs. However, the rules must be constantly adapted in line with technical progress and the requirements of enforcement. Studies relating to consideration of the environmental risk show that great advances could still be made in this area.

The qualitative description of increased participation in the various programmes (*Tab. 1* and *2)* and the change to PEA (obligatory for IP) indicate that the system is moving in the desired direction. However, in order to answer the question of whether the intended effect and aims are also being achieved quantitatively, additional indicators are necessary which also include the environmental risk (as described in *Chap. 4*) and allow comprehensive system analysis.

Table 2: Development of areas which are managed according to the rules of integrated production (IP) or organic farming (BIO); ha.

	1993	1994	1995	1996	1997	1998	1999	2000 ha	2000 (% AL)
IP/PEA	179'152	298'297	364'414	646'282	784'562	833'530	895'499	919'743	85.8
BIO	18'908	21'223	28'350	53'982	66'885	72'466	78'454	82'822	7.7

In Switzerland, participation in the programmes for integrated production in accordance with the *Ordinance relating to Direct Payments (ODP)* has increased from around 17 per cent in 1993 to around 86 per cent in 2000. In the year 2000, 7.7 per cent of agricultural acreage was being farmed organically *(Tab. 2).*

6.2 Reducing PPP application

The market statistics of the SGCI (cf. *Tab. 3* and *Annex)* show that the quantity of PPP active ingredients sold between 1990 and 2000 fell by 31 per cent from 2,283 to 1,577 t. As already mentioned, this is due on the one hand to the measures described in *Chapter 2* as part of agricultural reform (e.g. extensively farmed cereals, withdrawal of price guarantees, ecological direct payments).

On the other hand, new PPPs have been developed in recent years, which achieve the same effect with a considerably smaller quantity of active ingredient. Traditional herbicides such as atrazine for example must be applied at the rate of around kg/ha, whereas quantities of a few grammes per hectare are sufficient for modern sulphonylureas. As already mentioned in *Chapter 4.3*, the quality of the product range also gives indications of the environmental pollution.

The PPP quantities are listed by active ingredient group in *Annex* and *Table 3*. They show that the use of products of plant or biological origin has clearly increased, whilst quantities have fallen or remained constant for all other categories. However, the use of PPPs cannot be reduced at will without incurring losses in yield or quality.

As already mentioned (cf. *Chap. 4.4)*, environmental risk cannot be deduced from the quantity of PPPs sold. A risk analysis must be based at least on the application of the individual active ingredients in the different crops, as is already possible in some EU countries[28].

Table 3: Statistics on sales of PPPs 1990 to 2000 (in t active ingredients).

Biocide group	**1990**	**1992**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Insecticides / acaricides	390	269	246	186	209	186	182	188	184
of which of plant/ biological origin	1	10	9	2	22	19	24	42	42
Herbicides	824	750	668	657	625	598	599	612	653
Fungicides/ seed dressings	988	953	973	949	891	840	764	708	720
Growth regulators	79	49	33	34	22	20	18	18	19
Rodenticides	2	<1	<1	<1	<1	<1	<1	<1	<1
Total	**2'283**	**2'022**	**1'921**	**1'827**	**1'748**	**1'644**	**1'563**	**1'527**	**1'577**
%	**100**	**89**	**84**	**80**	**77**	**72**	**68**	**67**	**69**
Turnover in million CHF	137	133	134	131	128	121	120	123	125

(Source: SGCI, 1998 to 2000).

According to SGCI figures, 20 active ingredients (AI) are responsible for 68.5 per cent of the total quantity amounting to 1,577 tonnes in 2000, of which the inorganic fungicides copper and sulphur, which are also used in organic farming, make up as much as 17 per cent and the AI mineral oil and rape seed oil, used as insecticides, 8 per cent. The fungicides aluminium phosethyl, captan, chlorothalonile, cyprodinile, folpet and mancozeb account for a further 17 per cent. The remaining 26.5 per cent are made up of the herbicides atrazine, dinoseb, glyphosate, isoproturon, MCPA,

28 cf. EUROSTAT: *"The use of pesticides in the EU"*, ISSN 1017-5857.

mecoprop-P, metamitron, metolachlor, pendimethaline and prosulphocarb. The herbicide glyphosate shows the greatest increase compared with 1995. Sales rose 146 per cent within five years from 67 t to 165 t. This makes glyphosate the second most frequently used active ingredient after sulphur and ahead of mineral oil.

A reduction in the total quantity of PPPs sold cannot be directly equated with a decrease in the environmental risk. For a differentiated assessment of the risk to the environment of the PPPs applied it is necessary to know the application rate of the individual active ingredients and their environmentally relevant properties..

6.3 Pollution of groundwater

The degree of testing of groundwater for PPP residues and their degradation products varies enormously in Switzerland both regarding the sampling density and the spectrum of active ingredients tested, according to surveys by the *Centre d'Hydrogéologie de l'Université de Neuchâtel*. Groundwater was not tested at all for 176 of the 238 (1989/90) chemical/synthetic PPPs approved for agriculture nor for almost all degradation products (exceptions: desethylatrazine, desisopropylatrazine, AMPA and DDT degradation products).

Single substance analysis carried out by the canton chemists in 1988/89 (>17,000 analysis on a total of 80 chemical-synthetic PPP active ingredients) showed that around 10 per cent of approved PPPs, or more than a third of active ingredients tested, could already be found in groundwater:

- Atrazine
- Bromacil
- Desethylatrazine (degradation product)
- Dichlobenil
- Diuron
- Fenpropimorph
- Glyphosate (uncertain)
- Isoproturon
- Metalaxyl
- Metamitron
- Metazachlor
- Methabenzthiazuron
- Metobrumuron
- Metolachlor
- Metoxuron
- Metribuzin
- Prometryn
- Propazine
- Simazine
- TCA
- Terbuthylazine
- Trietazine
- Trifluralin
- Vinclozolin

The measured values of some active ingredients or degradation products exceeded the quality requirements for groundwater (0.1 µg/l)[29] or the Swiss tolerance value for drinking water (0.1 µg/l).

29 Water Protection Ordinance of 28 October 1998 (Ann. 2 Nr. 22 Para. 2; SR 814.201).

The following active ingredients and degradation products were found in not directly comparable studies in 1995/96:

- Ametryn
- Atrazine + metabolite
- Bromacyl
- Brompropylate
- Chlortoluron
- Deltamethrin
- Diuron
- Isoproturon
- Metolachlor
- Metribuzin
- Pendimethalin
- Prometryn
- Propazine
- Simazine
- TCA
- Terbutryn
- Terbuthylazine

Groundwater reserves used for drinking water are only monitored in a reasonably systematic manner for the two herbicides atrazine and simazine. As expected, therefore, atrazine is the most analysed PPP active ingredient, with approximately 800 to 1,350 samples being analysed each year. In 1988, 51 per cent and in 1989 42 per cent of groundwater samples analysed revealed atrazine concentrations which exceeded the required quality levels for groundwater. Atrazine could be detected in over 70 per cent of samples.

Simazine residues exceeded the groundwater requirements or the drinking water tolerance value in nearly 10 per cent of samples and were detected in 34 per cent (1988) and 43 per cent (1989) of samples.

Although the quantity of atrazine used throughout Switzerland almost halved between the two test periods, 66 and 59 per cent of samples analysed were still polluted with atrazine in 1995 and 1996, respectively. However, a more detailed analysis of the PPP concentrations recorded in the various cantonal measuring programmes is not practical because the samplings were neither systematic nor representative.

Although as a whole these results show the actual existence of PPP pollution of groundwater in Switzerland, they do not however allow either a precise assessment of total PPP pollution of groundwater or of drinking water exploited from groundwater. On the one hand, samples are taken more frequently at polluted sites, which leads to an overestimation of positive PPP findings, on the other, most of the cantonal laboratories test drinking water, but not the groundwater reserves from which it comes. Due to the closure of polluted drinking water catchment sites, this leads e.g. to an apparently better pollution situation compared with the actual condition of the groundwater. The problem is compounded because relevant routine detection methods were not available for all PPPs.

6.4 Pollution of surface waters

In 1992/93, the *Water Protection Office of Canton Berne* tested 26 rivers for 22 pesticides.[30] The herbicides atrazine, simazine, terbuthylazine and pendimethalin were found together with the atrazine degradation product (desethylatrazine) and the insecticide carbofuran. Due to these findings, in 1994 monthly samples from six water bodies were tested for the active ingredients which had already been found, and for the herbicides metolachlor and metamitron (cf. *Tab. 4).*

Table 4: Maximum concentrations of PPPs in rivers in Canton Berne (Water Protection Office, 1995).

Active ingredient	Type	Applications	Max. concentration (μg/l)
Atrazine	Herbicide	Maize	0.3
Simazine	Herbicide	Maize, fruit, vines, forestry	0.1
Terbuthylazine	Herbicide	Maize, potatoes, paths/-municipal squares	1.0
Metamitron	Herbicide	Sugar beet	2.2
Metolachlor	Herbicide	Maize, sugar beet	2.6
Pendimethalin	Herbicide	Cereals, potatoes, vegetables	0.2
Carbofuran	Insecticide	Maize, sugar beet	0.8

The PPP pollution of rivers clearly correlated with agricultural use in the catchment areas. The maximum concentrations measured are in the impact range of the most vulnerable species (mainly algae). Negative impacts of the measured maximum concentrations on aquatic communities cannot therefore be excluded. The values also exceed the quality requirements for rivers of 0.1 μg/l.[31]

PPP concentrations fluctuate markedly over time. Within a few hours, more than half the annual load of a substance can be transported. The EAWAG established on the basis of atrazine that the amount of atrazine applied in the catchment area and the rain intensity after application are the decisive defining values for the annual input into lakes.[32] As part of the evaluation from 1998 onwards, the connections between agricultural and non-agricultural application of PPPs as well as the pollution load of rivers and the concentration in lakes are recorded in an comprehensive study of entire lake catchment areas. This is intended to identify sources and causes of PPP pollution of water bodies.

30 Würsch D., *"Pestizide in Fliessgewässern des Kantons Bern"*, GSA-Report, Berne (1995).

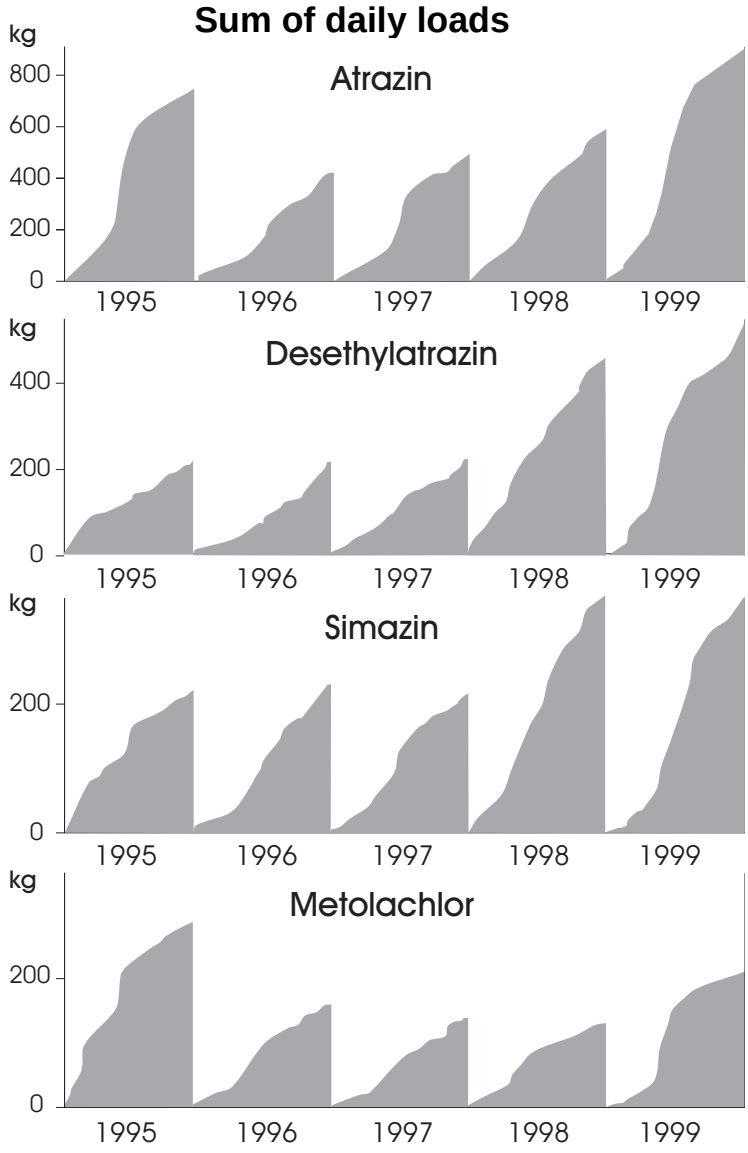
31 Water Protection Ordinance of 28 October 1998 (Ann. 2 Nr. 12 Para. 5; SR 814.201).

32 OAGR, *"Evaluation der Ökomassnahmen und Tierhaltungsprogramme"*, 2nd Interim Report, 167 pp. (June 1999).

The PPP pollution load of rivers has to date only been measured at a few sites in Switzerland because of the high costs of sampling and analysis. The Rhine is studied by means of an extensive monitoring programme run within the context of the warning and alarm system of the *International Commission for the Protection of the Rhine against Pollution (ICPR).* At the monitoring station Weil am Rhein bulk samples were tested for 72 PPPs every three days in 1995 and this has been performed every day since 01.01.1996.

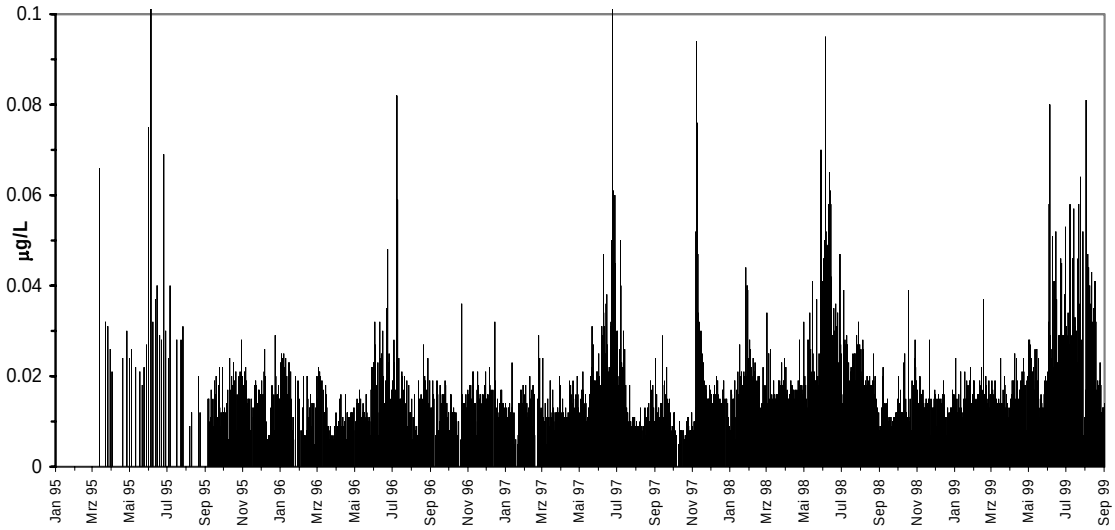
A simple illustration of the pollution load is given by the sums of loads for individual years (cf. *Fig. 3)* and the variation in PPP concentration during a single year (cf. *Fig. 4).* These show no decrease in the pollution load or the evident connection between PPP application in agriculture and PPP concentrations in rivers, particularly in the case of triazines and the substitute product metolachlor.

Figure 3: Annual PPP load in the Rhine (ICPR Measuring programme 1995–1999).



Because concentrations in the Rhine at Basle are very small, the sampling and analysis errors are very large; moreover, an observation period of five years is too short to establish clear trends. The assessment must also take account of the hydrological situation, because the volume of water flowing is included in the load calculation. The monitoring confirms that pesticide run-off is larger during high water peaks.

Figure 4: Atrazine concentration in the Rhine (ICPR Measuring programme 1995–1999).



Between 1995 and 1997, the *CIPEL (Commission Internationale pour la Protection des Eaux du Léman – International Commission for Protection of the Waters of Lake Geneva)* carried out more extensive measurements of PPP pollution loads in rivers in the catchment area of Lake Geneva.

The CIPEL studies produced the following results:[33]

- Three herbicides (atrazine, simazine and terbuthylazine) were detected in all rivers and throughout almost the entire test period (concentration >0.1 µg/l). Chlortoluron and diuron were found in the waters in the border area between Geneva and France. The insecticide chlorpyriphos, which is relatively toxic for fish, and the herbicide metoxuron were found sporadically in the Arve (cf. *Tab. 5).*
- The period with the highest PPP pollution loads in the rivers coincides with the period of most intensive PPP application in agriculture – except for an occasional slight delay.

33 CIPEL, *"Rapports sur les études et recherches entreprises dans le bassin lémanique"*, Campagne, Lausanne (1996).

These observations are also confirmed by a broad-based study published recently by the *Institut français de l'environnement (ifen)*[34]. Approximately 100 PPP active ingredients could be detected in varying concentrations in French waters. However, the main pollution load stems from a dozen active ingredients, among which triazine herbicides are found particularly frequently. It was primarily surface waters which were polluted.

Table 5: Observed maximum PPP concentrations in rivers in the catchment area of Lake Geneva.

River	Simazin	Atrazin	Terbutyl-azin	Chlor-toluron	Diuron	Parathion und Chlorpyriphos	Desethyl-atrazin
Rhone	•	•	•	●	•	•	•
Venoge	●	⬤	•	•	•	•	●
Grand Canal	●	●	•	•	•	•	●
Chamberonne	●	●	⬤	•	•	•	•
Hermance	⬤	⬤	⬤	•	⬤	•	●
Lutrive	•	●	●	•	•	•	•
Boiron	●	●	●	•	•	•	●
Foron de Sciez	•	•	•	•	•	•	●
Arve	•	•	•	•	•	●	•
Allondon	●	●	⬤	•	●	•	●
Aire	●	⬤	●	⬤	⬤	•	●
Laire	⬤	⬤	●	●	•	•	●

• not detectable or < 0.1 µg/l

● between 0.1 and 1 µg /l

⬤ > 1 µg/l

(Source: CIPEL 1996).

[34] ifen, *"Les pesticides dans les eaux, usage, origines, pertinence du suivi – Etat 1997"*, Orléans Cedex, France (1998).

PPP concentrations in smaller rivers vary widely with time. Within a few hours more than half the annual load of a substance can be transported. In Switzerland, there are no comparative measurements over several years which would allow general statements to be made about the development of PPP pollution in water. Most series of measurements which were taken regularly over a longer period are restricted to a few active ingredients (mainly atrazine). Although a decrease in the pollution load can be detected for atrazine, it cannot be concluded from this that there is a decrease in the total pollution load. That would require broad-based, standardized and correspondingly costly series of analysis, covering the most important active ingredients and water bodies.

6.5 Soil pollution

Large quantities of copper were used as a fungicide particularly in the early stages of chemical plant protection and this led to accumulation in the soil in viticulture, hop-growing and to a lesser extent in potato-growing. Extrapolations based on large numbers of studies showed that the recommended value for copper of 40 mg/kg soil laid down in the Ordinance relating to Impacts on the Soil (OIS)[35] is sometimes massively exceeded on over 40,000 ha of land once used for viticulture.[36] It can be assumed, therefore, that the fertility of these soils has been greatly damaged and that consequently unrestricted use, for example as land for vegetable cropping or grazing sheep, is no longer possible.

Long-term effects of PPP application can also be deduced from the DOK trial conducted by agricultural research stations. This compares conventional, integrated and organic cultivation methods over a period of over 18 years.[37] Organic methods show a 30–70% higher earthworm biomass. In addition, microbiological tests revealed a 20–30% greater biomass, and the activity of microorganisms in the organic plots was between 30 and 70% higher.

Mycorrhiza fungi, for example, have also increased with the organic methods. As root symbionts, they help to improve the supply of phosphorus and water to the plants. Not only was the incidence of ground beetles almost twice as high in the organic wheat fields as in the conventionally farmed plots, but more species could also be found (cf. *Chap. 6.7).* These findings indicate possible effects of PPP application on soil fertility as defined in the OIS.

35 SR 814.12

36 Studer K., Gsponer R., Desaules A., *"Erfassung und Ausmass der flächenhaften Kupferbelastung in Rebbergböden der Schweiz"*, Schriftenreihe FAC no. 20 (1995).

37 Pfiffner L., Besson J.-M., Niggli U., *"DOK-Versuch: Vergleichende Langzeit-Untersuchungen in den drei Anbausystemen biologisch-dynamisch, organisch-biologisch und konventionell"*, Recherche agronomique en Suisse, Cahier spécial *DOC*, no. 1 (1995); see also SCIENCE Vol. 296, 31 May 2002, pp. 1694-97.

The bulk of PPPs used eventually enter the soil (in the case of herbicides up to 100 per cent). The long-term effects on the living organisms in soil have not yet been adequately studied. The development of indicators to estimate the impact of PPPs on soil fertility therefore has a high priority.

6.6 Air pollution

The presence of PPPs in the air can be detected by their inputs into mountain lakes or via rain-water. Samples from mountain lakes contain traces of triazines, especially atrazine. These herbicides must therefore have been transported in the air *(Buser 1990)*[38]. Volatilisation, the transport of fine soil particles by the wind and atmospheric transport are the main causes of this phenomenon.

The results of more recent precipitation studies by the EAWAG indicate in some cases considerable PPP pollution of the atmosphere. The following PPPs or degradation products were detected in rain-water between February and October 1996:

- 2,4-D
- Atrazine
- Dimethenamide
- Metalaxyl
- Metolachlor
- Propazine
- R-Mecoprop
- Simazine
- Terbuthylazine
- Alachlor
- Desethylatrazine
- MCPA
- Metazachlor
- Propachlor
- R-Dichlorprop
- S-Dichlorprop
- S-Mecoprop

Maximum average concentrations of 0.9 µg/L per precipitation event or annual loads of 13.9 µg/m^2 were measured for atrazine, of 0.2 µg/L or 5.9 µg/m^2 per year for alachlor and of 0.1 µg/L or 5.1 µg/m^2 per year for R-dichlorprop. The highest pollutant levels are measured in the same months in which the relevant PPPs are applied. However, despite the relatively high PPP levels in precipitation water (drinking water tolerance value 0.1 µg/L), the resulting groundwater pollution potential is not relevant compared with direct input from PPP application in the field.

6.7 Impact on biological diversity

PPPs are used mainly to control harmful organisms (pests, pathogenic organisms, weeds) which damage agricultural crops. The application of PPPs therefore directly affects the diversity of fauna and flora within the crops or in neighbouring areas.

38 Buser H.R., *"Atrazine and other s-triazine herbicides in lakes and in rain in Switzerland"*, Environ. Sci. Technol., 24/7 (1990).

The number of PPP applications varies according to the cultivation system. Based on a specific example, *Fried et al. (1998)*[39] show that compared with an intensive cultivation system, applications of herbicides can be reduced by nearly 55 per cent in IP and by 100 per cent in BIO (organic farming). In the case of fungicides, the reductions amount to ca. 50 per cent in IP or 60 per cent in BIO. For insecticides, the number of applications fell by 15 per cent in IP and by 65 per cent in BIO.

It is established in the same study that the different cultivation systems also have an impact on earthworm populations. The largest number of earthworms was observed on plots with IP (143 individuals/m²) and BIO (133 individuals/m²). Noticeably fewer earthworms were found on traditionally cultivated plots (107 individuals/m²). This is very probably due to the more extensive and frequent application of PPPs, which possibly have a toxic effect on earthworms. However, the example is not representative.

Pfiffner et al. (1995)[40] compare the impact of three cultivation systems (biodynamic, organic-biological and traditional farming) on the diversity of fauna and flora. The organic systems show larger populations of different companion plants. The diversity of flora is therefore greater on these areas. As far as fauna is concerned, the application of insecticides and fungicides is probably a direct cause of a reduction in beneficial animals living above ground (predators). Fungicides like herbicides can also indirectly cause high mortality of springtails and ground beetles because they have a negative effect on the food of plant-eating insect fauna and consequently also on polyphagous predators. Several studies have shown that even low populations of so-called companion plants have a positive effect on predator populations.

Genini (2000)[41] has studied the interactions between viticulture and fauna in the neighbouring natural habitats (cf. *Tab. 6)*. He showed that the species diversity of hymenoptera and diptera in the natural habitats is greater than in the vineyards. However, this is not true for ground beetles, ants and spiders. According to the study, the diversity index in organically cultivated vineyards is generally higher than in those with integrated production.

Plant protection products generally have a negative impact on biodiversity. However, cultivation methods which use selective plant protection products in a particularly targeted way are less damaging to the diversity of flora and fauna.

39 Fried P., Dubois D., Zihlmann U., Tschachtli R., Malitius O., *"Comparison of tree arable farming systems at Burgrain in Central Switzerland, 1991–1998"*, Sustainable agriculture for food, energy and industry, James & James (Science Publishers), pp. 618–626 (1998).

40 Pfiffner L., Besson J.-M., Niggli U., *"DOK-Versuch: vergleichende Langzeit-Untersuchungen in den drei Anbausystemen biologisch-dynamisch, organisch-biologisch und konventionell"*, Recherche agronomique en Suisse, Cahier spécial DOC, no. 1 (1995).

41 Genini M., *"Antagonistes de la cicadelle verte et des vers de la grappe dans le vignoble valaisan et les milieux environnants"*, Revue suisse Vitic. Arboric. Hortic., 32/3, (2000) and *"Faune épigée de la vigne et des milieux environnants"*, Revue suisse Vitic. Arboric. Hortic., 32/5 (2000).

Table 6: Diversity index for bees, wasps etc., spiders and ants in vineyards and neighbouring natural habitats for BIO (organic), IPCo (integrated production and confusion technique against grape berry moth) and IP plots.

Bees, wasps etc.				
	Miège		Châteauneuf	
	BIO	IPCo	IPCo	IP
Natural environs	79	88	64	74
10 m inside vineyard	80	77	73	64
50 m inside vineyard	69	80	-	-

Spiders				
	Miège		Châteauneuf	
	Bio	IPCo	IPCo	IP
Natural environs	83	89	90	63
10 m inside vineyard	90	79	64	73
50 m inside vineyard	92	79	63	-

Ants				
	Miège		Châteauneuf	
	Bio	IPCo	IPCo	IP
Natural environs	89	75	67	72
10 m inside vineyard	96	57	75	28
50 m inside vineyard	90	119	47	-

A specific example shows how the targeted selection and application of PPPs can conserve biodiversity and therefore reduce the risk to the environment:

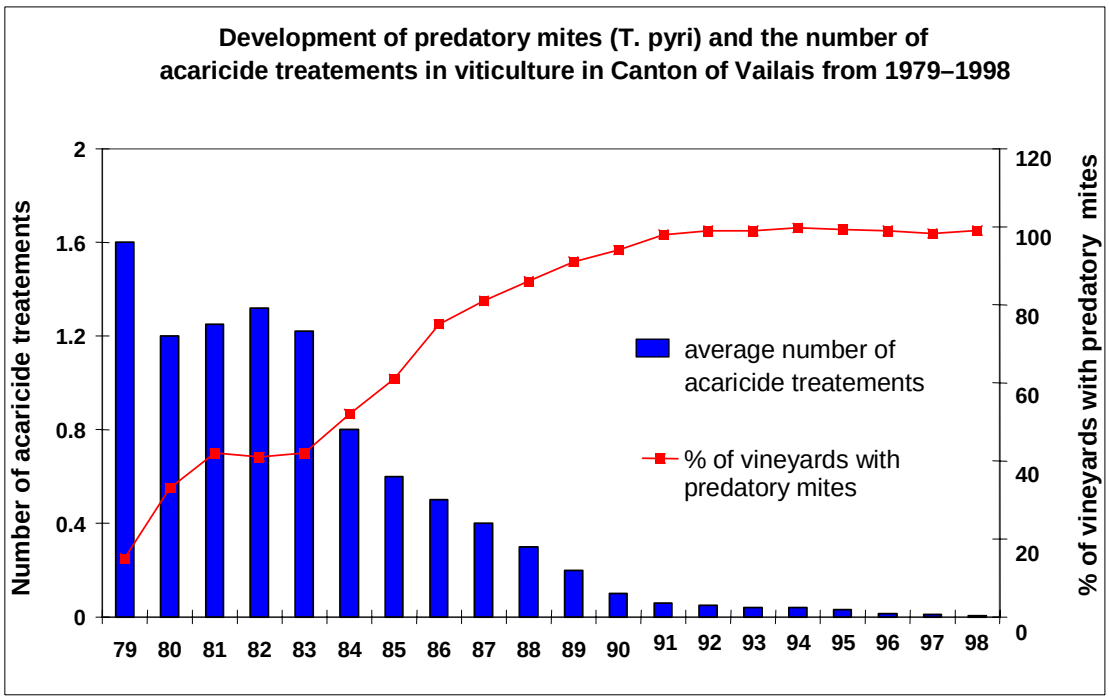
At the end of the 1970s, vineyards in the Valais had to be treated with acaricides once or twice a year on average, in order to protect them against harmful spider mites (European red mite *Panonychus ulmi* and twospotted spider mite *Tetranychus urticae*; *cf. Fig. 5)*. However, research findings showed that many of the PPPs used also damaged the beneficial predatory mites (*Typhlodromus piri).* Predatory mites therefore disappeared from many vineyards. As a result of these findings, fungicides, insecticides and acaricides were divided into so-called *predatory mite classes* according to how harmful they are to predatory mites. PPPs which had no negative

effects were classified as *"neutral" (N)*, those which caused medium or great damage to predatory mite populations were classified as *"medium harmful" (M)* and *"toxic" (T)*.

Since the beginning of the 80s, only PPPs which do not harm beneficial animals and are not toxic to predatory mites have been used in IP in viticulture. At the same time, predatory mites were reintroduced into many vineyards. Consequently, populations of predatory mites rose sharply so that it was increasingly possible to cease using acaricides against harmful spider mites. This example shows that with selective plant protection, less PPP has to be used because the natural regulatory mechanisms remain intact.

It can be assumed that selective PPPs which do not damage beneficial animals also do less harm to various indifferent species, which are neither beneficial nor harmful to agriculture. The use of these PPPs in IP or in BIO therefore conserves biodiversity. This is also shown in the studies by *Genini*[42].

Figure 5: The use of PPPs which do not harm beneficial animals makes it possible cease using acaricides in viticulture in Valais.



(Source: Cantonal PPA of VS).

42 Genini M., *"Antagonistes de la cicadelle verte et des vers de la grappe dans le vignoble valaisan et les milieux environnants"*, Revue suisse Vitic.Arboric.Hortic., 32/3 (2000), and *"Faune épigée de la vigne et des milieux environnants"*, Revue suisse Vitic.Arboric. Hortic., 32/5 (2000).

Measures introduced as part of agricultural reform have led to a reduction in the quantity of PPPs used. Data on concentrations in the environment are only available for certain sites and for individual, very common and easily measured active ingredients. Restrictions on use lead to a decrease in concentrations and thus to a reduction in environmental pollution as is shown by the results of series of analysis of atrazine in water bodies. However, in order to be able to assess the general pollution situation and the total risk, pesticide use data must be known and comprehensive series of surveys must be available on the pollution of soil, water and air for the environmentally relevant active ingredients.

There is a lack of such data in Switzerland and they must therefore be specifically collected in future.

Unfortunately, non-selective products are used all too often in agriculture because they are considerably cheaper. The use of PPPs which do not harm beneficial animals should therefore be encouraged for targeted use in IP. Comprehensive data collection is necessary for reliable statements on the contribution such programmes make to conservation and promotion of biodiversity. Biodiversity monitoring (BDM) must therefore be used to observe and evaluate species diversity over several years in agricultural areas which are representative for Switzerland.

7 Need for resources to improve the data situation

7.1 Preliminary remarks

In order to fill the indicated gaps in data and to be able to assess the development of risk related to the use of PPPs, relevant resources must be available.

7.2 Collection of use data

From experience, data must be collected from 1,000–1,500 farms per year in Switzerland for a representative survey of PPP application. Collection of the data can be carried out as part of the proof of ecological achievement (PEA) for direct payments. The cropping calendar and additional inquiries form the basis. Estimates of the time required: 500 working days (WD) each year for the data collection, 150 WD for evaluation, publication and information and a further 100 WD for development and adjustment of the programmes. In total, therefore, the application surveys require about 750 WD per year.

7.3 Database and development of risk indicators

In addition to application data, the product properties of PPPs must also be available in an appropriate database in order to calculate reliable risk indicators. Such a database should be established as far as possible within the framework of international

collaboration. The procurement costs are estimated to be CHF 400,000. Development of appropriate risk indicators will require an estimated 200 WD per year. Operation and use of the database for risk assessment will require about 50 WD per year.

7.4 Information and advice

Continuous updating and following up of special data sheets requires a labour cost of approximately 100 WD per year. Development, adaptation, maintenance and application of an information system based on risk indicators requires around 400 WD per year.

7.5 Targeted environmental monitoring (water, soil, air)

Representative, statistically supported environmental monitoring covering the most important PPPs would be beyond means. The cost of regular analysis of the different active ingredients in groundwater, various surface waters, soil and air would be disproportionately high. Current estimates of the cost of analysis of an active ingredient in a random sample are CHF 150–1,500. Monitoring of PPP pollution must therefore be limited to random sampling and can only serve to check the different risk estimates and input pathways. A minimum programme for checking environmental pollution can be provided with CHF 600,000–800,000 per year.

8 Conclusions

This report gives a review of the existing environmental and agricultural policy instruments and summarizes the possible impact on environmental pollution and risks associated with the use of PPPs. It also describes the data basis currently available for assessment, highlights the existing deficiencies and suggests improvements for control of results. This report answers questions concerning the need for, and expedience of, incentive taxes on PPPs. It comes to the following conclusions:

- The approval obligation for PPPs corresponds to the precautionary principle and is an important basis for assessing and reducing the risks connected with these substances. The approval procedure is a preventive measure. According to the state of scientific knowledge, a product is only approved if, when used properly, it does not endanger the environment nor persons.
- Since the motion of CERPE-S was proposed in 1994, both agricultural policy instruments within the new agricultural policy (AP 2002) and provisions under environmental law have been further developed. Specifically, *proof of ecological achievement (PEA)* was introduced as a condition for receiving direct payments, and in environmental legislation (Art. 62a Water Protection Law; LWP), a further instrument was created for remediation of polluted waters.
- With a view to improved competitiveness, the new agricultural policy aims to lower the prices of agricultural products. As a result, farmers are also reducing

their production costs and this increases their economic interest in more sparing use of PPPs. In this way, economic aims reinforce ecological aims.

- The direct payments linked with PEA, which now apply to 94 per cent of the agricultural land (in the year 2000), and the ecological contributions for ecological compensation, extensive production of cereals and oil seed rape and for BIO are appropriate instruments for further reducing the environmental risk. In addition, improvement of training and advisory services contributes to targeted and appropriate use of PPPs.
- The measures introduced as part of agricultural reform have led to a 30 per cent reduction in the quantity of PPPs sold since 1990. However, this reduction in quantity cannot be equated with a corresponding risk reduction because in the final analysis the toxicity and fate of each of the PPPs used are decisive for the environmental pollution load.
- Environmental risk and the resulting pollution of the environment cannot be easily deduced or analysed. The procedure for assessing risk and pollution is complex. That is why "risk indicators" based on environmentally relevant data are currently being developed in various countries and within the OECD. Switzerland is also participating in these projects.
- The risk indicators represent valuable auxiliary parameters for estimating the risk to the environment. They make it possible to identify problem situations and to set priorities for solving them. They can also support advisory services.
- Knowledge about when, where and which PPPs are used represents an important basis for calculating these indicators. In Switzerland, use data are already collected within the framework of integrated production. These have to be analysed so that the environmental risk associated with PPP use can be estimated in future.
- Apart from data on the use of PPPs, monitored concentrations in the environment, namely in soil, water and air, are important parameters for quantifying environmental pollution and risks. As the results of series of atrazine analysis in different water bodies show, restrictions on the use of individual active ingredients result in a decrease in concentrations and thus in a reduction of the environmental pollution caused by them. However, data on concentrations in the environment only exist for a few, very common and easily measured active ingredients. Representative data collections in terms of both time and location are therefore only available to a limited extent. They do not permit any general statements to be made regarding the development of the general pollution load due to all PPPs used. It is known merely that PPPs can be found in all sectors of the environment and that there is a sharp increase in concentrations mainly during or shortly after application periods.
- In order to be able to assess the general environmental pollution load and the total risk, regional surveys on the use of individual active ingredients and targeted series of analysis on the pollution load of soil, water and air due to environmentally relevant active ingredients are necessary. There is a lack of such detailed data in Switzerland and they must therefore be collected in future.
- Knowledge about the impact on biodiversity and on ecosystems as a whole is also very fragmentary because biodiversity monitoring (BDM) in Switzerland only covers surveys of ecological compensation areas. In order to improve the

data basis, species diversity must be monitored and evaluated over several years in agricultural areas which are representative of Switzerland.

- Various EU countries have an incentive tax or a financing tax on PPP turnover. The latter is mostly earmarked for use in financing the approval procedure, market control or collection of application data.
- No country has yet imposed incentive taxes differentiated according to the environmental risk of the individual PPPs, because division into different risk classes is not easy due to complex interrelations. France introduced this kind of differentiated tax for the first time in the year 2000. An undifferentiated tax only achieves satisfactory control with very marked price increases. An incentive tax differentiated according to environmental risk of the products, on the other hand, is more effective.
- Most OECD countries have special programmes for reducing the risks from PPPs. In the OECD and the EU, intensive efforts are also being made to harmonize these programmes so that assessment results can be compared. However, the environmental risk of PPP applications must be defined and estimated using as uniform a method as possible.
- In order to be able to show the effect of environmental policy and agri-ecological measures, use data must be systematically analysed and assessed with appropriate indicators. In this way, priorities can be set for measuring PPP concentrations in the environment, and the environmental pollution load and the risks of PPPs can be quantified. At the same time, this information can be used to set targets for a Swiss action programme to reduce the risks of PPPs.

The environmental policy and agri-ecological instruments currently available are essentially appropriate for reducing the risk associated with the use of plant protection products. However, the available data do not permit a conclusive assessment of the effect. The decision-making bases for estimating the environmental pollution load and the risks must be improved by means of an appropriate action programme. The success of measures is reassessed after a recommended interval as part of the evaluation reports on agri-ecological progress published by the OAgr and of general environmental monitoring by SAEFL.

9 Action programme for PPP risk reduction and need for resources

- **Action programme:**

  In order to be able to make a reliable assessment of the effect of environmental and agricultural policy measures (cf. motion CERPE-S), data on the use of PPPs are to be collected in a representative and transparent way in future. The risk associated with the PPP applications will be determined using appropriate indicators, which are based on relevant regional or local monitoring. The results will also serve as a basis for targeted monitoring of environmental pollution from PPPs and for advice regarding targeted selection and application of PPPs. The action programme is based on existing studies by both agencies.

  Targets for reducing the environmental risks from PPPs will be set jointly by SAEFL and OAGR – in collaboration with interested and affected parties.

- **Resources:**

  The annual cost of recording the use of PPPs and the associated environmental risk together with the corresponding additional advice is estimated to be CHF 1.9 million per year, taking account of current studies by both agencies. These costs will be allocated from the budgets of SAEFL and OAGR by means of relevant setting of priorities, so that no extra expenditure will be incurred for the Confederation.

Annex to PART III – *PLANT PROTECTION PRODUCTS*

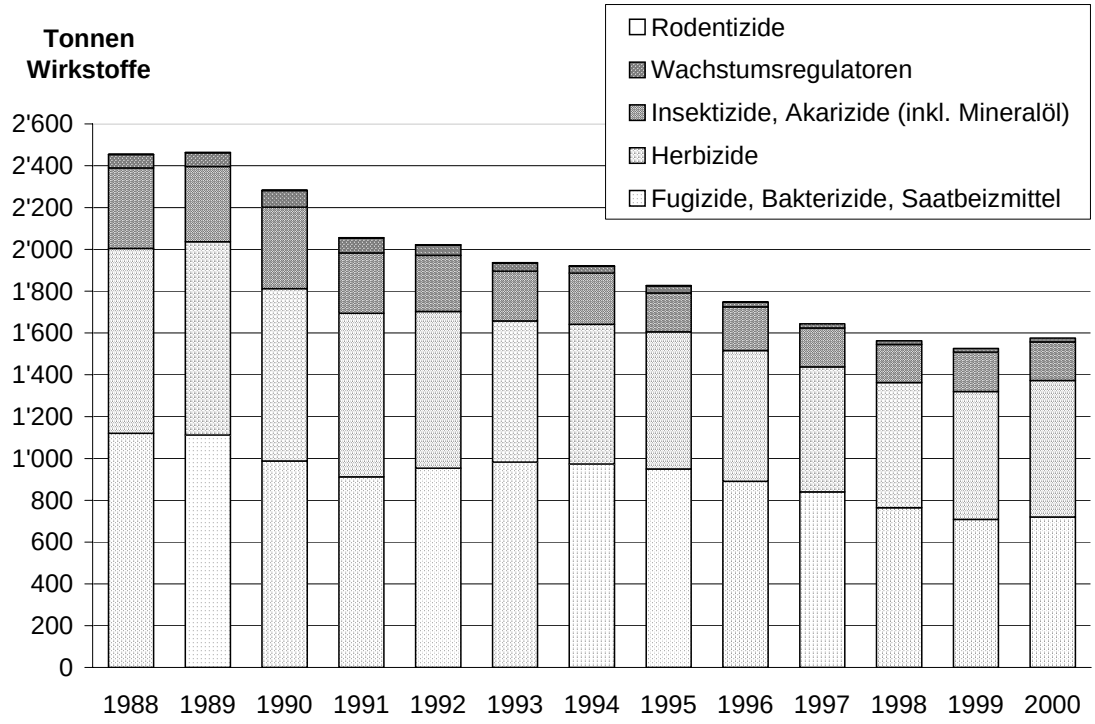
Plant protection products (PPPs) – market statistics 1988–2000

Statistics for Switzerland and the Principality of Liechtenstein

Data on the market for plant protection products (PPPs) has been compiled by the *Swiss Society of Chemical Industries (SGCI).* It is based on data collections from the firms Bayer (Switzerland), Leu & Gygax, Syngenta (formerly Novartis), OMYA (formerly Plüss-Staufer) and Siegfried Agro. The figures reflect approximately 90–95 per cent of the total market volume. The turnover figures correspond to the actual figures and are not adjusted for inflation.

All data refers to the market for plant protection products (PPPs) in Switzerland and the Principality of Liechtenstein.

Graph 1: Sales of PPPs in Switzerland in tonnes of active ingredients by biocide groups *(source: SGCI, 1998–2000).*

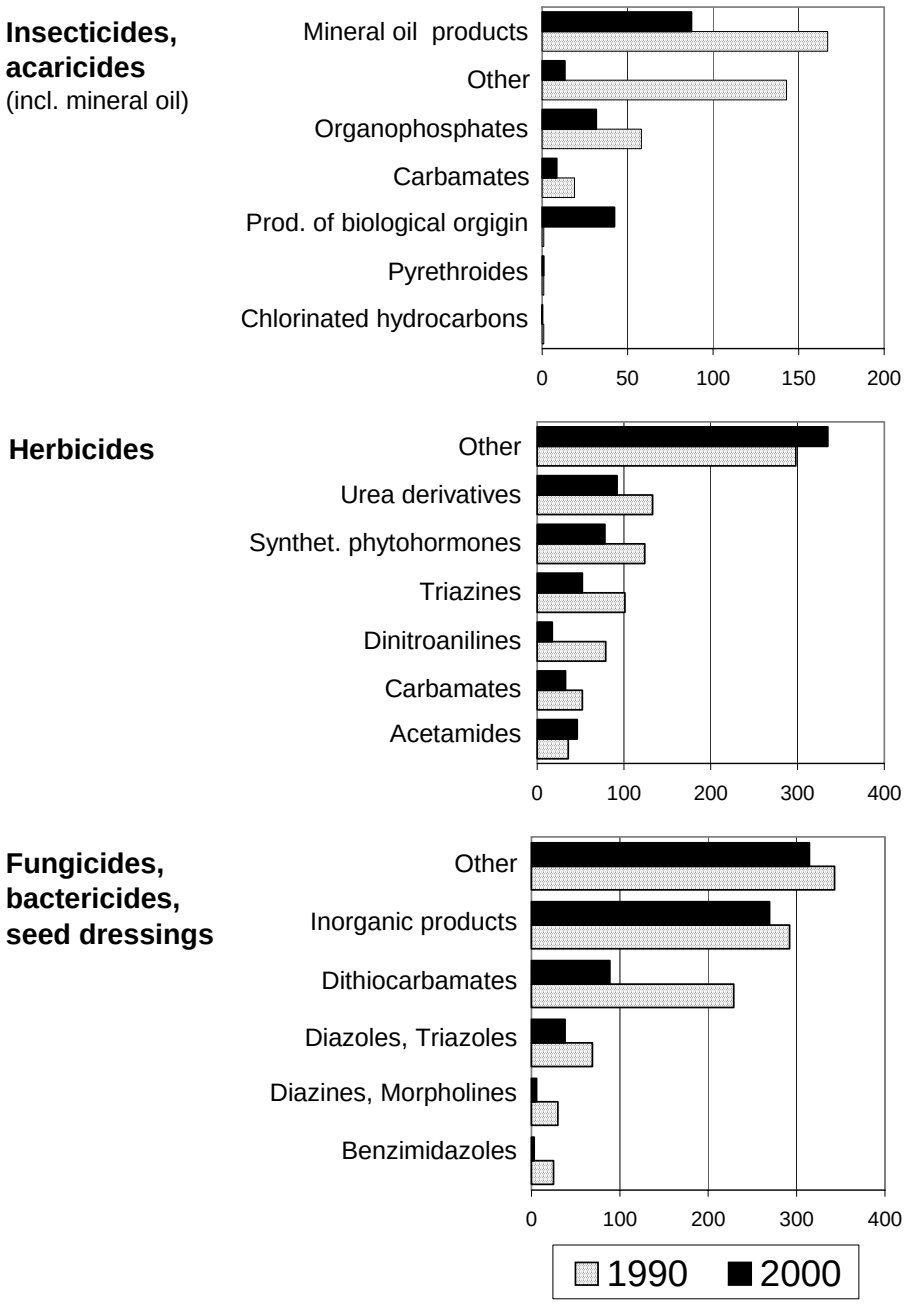


[Translation: Tonnen Wirkstoff = *tonnes of active ingredients;* Rodentizide = *rodenticides;* Wachstumsregulatoren = *growth regulators;* Insektizide, Akarizide (inkl. Mineralöl) = *insecticides, acaricides (including mineral oil);* Herbizide = *herbicides;* Fungizide, Bakterizide, Saatbeizmittel = *fungicides, bactericides, seed dressings]*.

Graph 2: Sales of PPPs in Switzerland in tonnes of active ingredients by chemical groups *(Source: SGCI, 1998–2000).*

Chemical group		90	92	94	95	96	97	98	99	00
Insecticides	Chlorinated hydroc.	1	1	1	<1	<1	1	<1	<1	<1
	Organophosph.	58	60	48	45	44	41	36	31	32
	Carbamates	19	17	14	10	10	8	9	8	9
	Pyrethroides	1	1	<1	<1	<1	1	1	1	1
	Biological prod.	1	10	9	2	22	19	24	42	42
	Other	143	38	38	36	33	28	24	13	13
	Mineral oil	167	141	135	91	98	88	88	93	87
Herbicides	Synth. phytohorm.	124	92	109	97	87	83	80	81	78
	Triazine	101	93	75	70	62	65	67	53	52
	Acetamide	36	45	25	25	22	31	41	49	46
	Carbamate	52	53	52	55	57	42	29	37	33
	Dinitroaniline	79	55	24	35	25	22	22	21	17
	Urea derivatives	133	112	109	118	113	99	98	97	91
	Other	298	299	275	257	259	256	262	274	336
Fungicides Seed dressings	Inorganic prod.	292	337	382	347	355	351	311	267	269
	Dithiocarbamates	229	199	171	170	145	109	101	88	89
	Benzimidazoles	25	11	7	8	4	3	3	3	3
	Diazole, Triazole	69	56	61	56	53	43	37	34	38
	Diazine, Morpholine	30	31	30	31	33	13	14	8	6
	Other	343	319	323	337	300	321	300	308	314
Growth regulators		79	49	33	34	22	20	18	18	19
Rodenticides		2	<1	<1	<1	<1	<1	<1	<1	<1

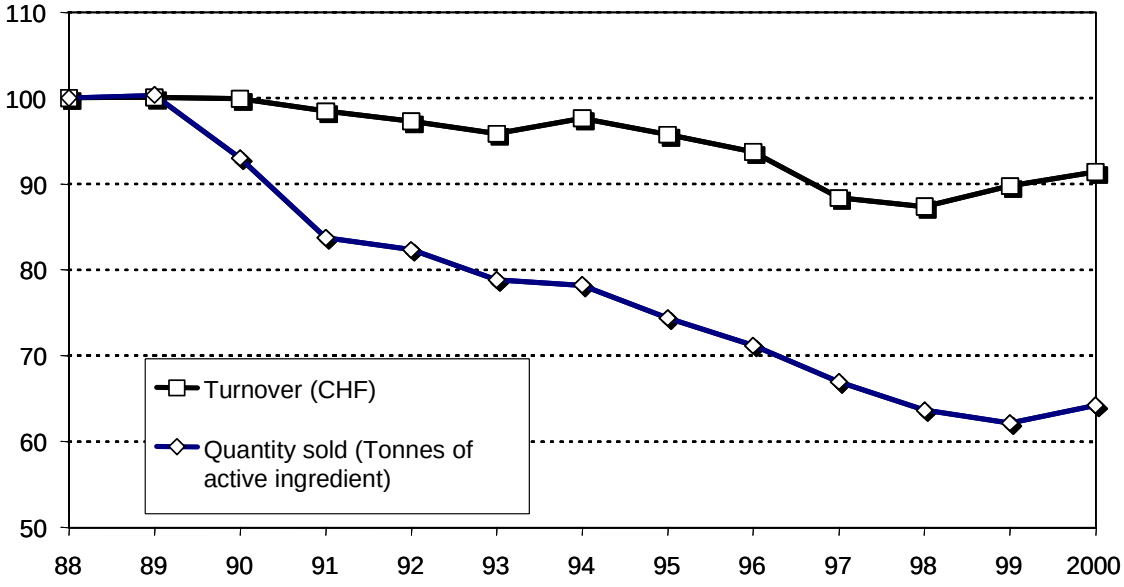
Graph 3: Sales of PPPs in Switzerland by chemical groups 1990/2000
(Source: SGCI, 1998–2000).



Graph 4: Turnover of PPPs in Switzerland in CHF million by crops 1988–2000 *(source: SGCI, 1998–2000).*

Crops	88	90	92	94	95	96	97	98	99	00
Cereals	48.5	49.7	45.5	43.3	41.4	39.5	34.5	34.3	36.3	37.2
Potatoes	10.1	10.6	11.6	11.9	10.4	9.6	9.1	8.5	8.6	9.3
Maize	6.9	7.6	8.5	10.5	10.2	9.3	8.6	8.6	8.9	9.3
Oil seed rape	5.0	4.9	5.5	5.4	5.3	5.0	5.6	5.9	5.7	5.1
Sugar beet/ fodder beet	9.7	8.7	8.7	9.5	9.3	9.3	9.1	9.5	9.2	9.1
Other field crops	2.2	2.7	2.3	2.0	2.2	3.0	2.2	2.4	2.4	2.7
Fruit-growing	16.5	15.6	15.0	13.9	14.3	14.5	14.3	13.8	13.3	13.4
Viticulture	21.4	21.2	20.9	22.1	22.6	22.9	22.6	21.5	24.0	24.2
Vegetables	7.4	7.6	7.3	6.7	6.8	6.8	7.6	6.7	6.6	7.3
Horticulture, berries, ornamental plants	5.6	5.2	5.3	5.4	5.0	4.9	4.9	5.3	5.2	4.8
Other Crops	3.7	3.1	2.7	3.1	3.7	3.7	2.9	2.8	2.7	3.0
Total	**137.0**	**136.9**	**133.3**	**133.8**	**131.2**	**128.4**	**121.1**	**119.3**	**123.9**	**125.4**

Graph 5: Relative development of turnover in CHF and quantity of PPP active ingredients sold in tonnes in Switzerland
(index basis: 1988 = 100).



Source: SGCI, 1998–2000.

PART IV: REPORT ON THE REDUCTION OF ENVIRONMENTAL RISKS OF FERTILISERS AND PLANT PROTECTION PRODUCTS, WHICH THE SWISS FEDERAL COUNCIL ADOPTED ON 21 MAY 2003

(Answer to motion 94.3005 UREK-S[1])

[1] UREK-S Commission for environment, space planning and energy of the Council of States (Senat).

on Motion no. 94.3005

Swiss Federal Council report[1] on the reduction of environmental risks of fertilisers and plant protection products

of 21 May 2003

Mr Presidents,
Ladies and Gentlemen,

In compliance with motion 94.3005 of UREK-S "Introduction of incentive taxes on mineral fertilisers, surplus manure and plant protection products" of 27 January 1994, we hereby present this report for your information.

Yours sincerely,

21 May 2003

On behalf of the Swiss Federal Council

President of the Confederation: Pascal Couchepin
Chancellor of the Confederation: Annemarie Huber-Hotz

1 Published in the federal Bundesblatt, no. 26, p. 4802–4810, 8 July 2003.

Report

1 Task and aims

1.1 Initial situation

With Motion 94.3005 of 27 January 1994, the *Commission for Environment, Regional Planning and Energy of the Council of States (UREK-S)* charged the Federal Council to lay before parliament within five years a bill on the introduction of incentive taxes on mineral fertilisers, regional surplus manure and plant protection products (PPPs). This is in case the recently introduced environmental and agricultural policy instruments to promote environmentally compatible agriculture fail to have the intended effect. Otherwise the Federal Council is charged with presenting to parliament a report which shows that the instruments already introduced are having the intended effect.

This report is in response to this motion.[1] The technical information is based on numerous national and international studies as well as documents by the Confederation, cantons, agricultural research stations (Agroscope) and university institutes. It takes account of the provisions laid down in legislation covering environmental protection, water protection and agriculture relating to the use of fertilisers and PPPs, and relevant implementation aids. It also includes current developments in agriculture and further development of Federal Council agricultural policy 2007 (AP 2007).

Agri-ecological framework conditions have improved significantly since 1994. Further to the referendum of 9 June 1996, agricultural legislation was revised under the motto "more market – more ecology".[2] Incentives for ecological farming were reinforced. The quantity of environmentally hazardous agrochemicals used has fallen noticeably since then (e.g. mineral fertilisers, PPPs). The forthcoming agricultural reform (AP 2007) is intended to consolidate the reforms introduced with agricultural policy 2002 (AP 2002).

Moreover, with an amendment to the Water Protection Law (LWP)[3], parliament has created the possibility of remunerating more extensive, regional measures in agriculture, which prevent run-off and leaching of substances, mainly fertilisers and PPPs (cf. Art. 62*a* LWP). This is mainly intended to reduce nitrate pollution of groundwater and phosphorus pollution of surface waters. This is to be achieved primarily by environmentally-friendly land use management and adjustment of livestock numbers to the proven agricultural land approved for fertiliser application (LFA) for each farm.

1 The full version of the report can be obtained from the Swiss Agency for the Environment, Forests and Landscape (SAEFL).
2 BBl **1996** IV 1
3 SR **814.20**

1.2 Aims

A distinction must be made between long-term ecological targets under environmental law and agri-ecological stage targets under agricultural law:

- *long-term ecological targets* define the sustainable level of environmental protection, which is defined by the longer-term acceptable pollution load capacity of ecosystems. Progress and status of environmental measures under legislation on environmental protection, water protection and nature conservation are measured against these ecological targets.
- *agri-ecological stage targets* define the aims to be achieved in the agricultural sector within a specified period. The framework conditions provided by federal agricultural policy and environmental law should make it possible for agriculture to achieve these. This is checked in the context of the Federal Office for Agriculture's (OAGR) evaluation periods of several years in accordance with the Ordinance relating to the Assessment of Sustainability in Agriculture of 7 December 1998 (SR *919.118*).

The agri-ecological stage targets for the period up to 2005 have been defined by the Federal Council as follows in the proposal for the further development of agricultural policy (agricultural policy 2007)[4]:

Agri-environment sector	**Measured quantity**	**Basis**	**Stage targets 2005**
Total ecological compatibility	Annual N-balance	96,000 t N_{tot} (1994)	Loss potential 74,000 t N_{tot}
	Annual P-balance	20,000 t P (1990)	Reduction of P surplus to 10,000 t P
Agricultural practice	Annual quantity of PPP used	ca. 2,200 t active ingredients (1990/92)	Reduction to 1,500 t active ingredients
Impact on the environment	NH_3 emissions	53,500 t N (1990)	Reduction by ca. 4,800 t N
	Biodiversity	ca. 1,080,000 ha AL (1990/92)	65,000 ha ecological compensation areas in lowland regions
	Nitrate	-	90% of catchment sites are below 40 mg/l
Influence of society on development of agriculture	Use of agricultural land (AL)	ca. 1,080,000 ha AL (1990/92)	98% farmed in accordance with proof of ecological achievement criteria or organic farming principles

4 BBl **2002** 4721

The Federal Office for Agriculture (OAGR) together with the Swiss Agency for the Environment, Forests and Landscape (SAEFL) and other interested agencies intends to develop further these agri-ecological stage targets for 2005 with regard to the continuation of AP 2007.

2 Developments in the case of fertilisers

2.1 Present situation

Fertiliser statistics and many emission measurements and calculations show that consumption of mineral fertilisers has fallen markedly in recent years. Mineral fertilisers are usually only used as single element fertilisers, i.e. as pure nitrogen or phosphorus (N or P) fertilisers, to supplement manure (slurry, solid manure), which must be used first.

The main reasons for this reduction are financial considerations and more targeted fertiliser application practice, which takes account of environmental compatibility (nutrient balancing).

Studies by the ETH Zurich[5] [Swiss Federal University of Technology] revealed that environmentally relevant N-pollution from agriculture fell overall between 1994 and 1998. However, the development is not uniform; it depends to a great extent on the structure and production methods of individual agricultural holdings. Falling N-losses are noticeable particularly in lowland regions. In mountain regions, on the other hand, losses are still rising slightly.

The reduction in ammonia emissions from livestock farming is still insufficient. This gaseous N-compound, which is transported over large distances in the air, is considered to be hazardous to the environment (impacts to natural conservation plant communities and forests).

Input of N and P into the environment caused by agriculture has therefore dropped. The possibilities of reducing the quantities of mineral and recycling fertilisers used have been successfully exhausted, particularly in the case of P; the agri-ecological stage target has been reached for these types of fertilisers.

However, this situation does not yet apply for farm manures. Many years of enforcement experience in areas with high numbers of livestock – i.e. in the agricultural catchment areas of lakes in the Swiss Plateau in the cantons of Aargau, Lucerne, Zug and Zurich – have shown that in the case of surplus manure, it is still not possible to make any substantial progress towards solving this regional environmental problem in agriculture. Although considerable improvements have been made in remediating storage facilities for farm manures (new slurry pits), mainly on the basis of water protection legislation, adjustment of livestock numbers to the agricultural land suitable for fertiliser application (LSA), and also reduction of excessive P-accumulation in the soil, are still unresolved problems.

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5 IAW-ETHZ, Institute of Agricultural Economics of the Swiss Federal Institute of Technology, Zurich, *"Technischer Bericht über die Auswirkungen der Agrarreform auf das Stickstoffverlustpotenzial der Landwirtschaft in der Zeit von 1994–1998"*, 82 pp., abbreviated version (September 1999).

Manure contains nitrogen (N) and phosphorus (P), plus other nutrients and trace elements, which affect plants but are scarcely relevant for the environment. The P-flux is generally considered for the quantitative assessment of regional surplus manure. This can be more reliably recorded and described than the N-flux.

Ecological N-target values as well as stage targets for N-emissions were set both nationally and internationally for N-pollution. Some of these target values are the subject of international agreements, which are also binding for Switzerland.

Studies show:

– In the case of P, the target value set by the OAGR in the report on the evaluation of ecological measures and livestock keeping programmes[6] (halving the P-surplus of ca. 20,000 t in 1990 – with an annual consumption of mineral fertilisers of ca. 17,000 t) will be reached by 2005. Proportionately, the P-surplus in fertiliser application is currently still 8,000 t P. Enforcement of the environmental regulations and agricultural legislation in this regard is therefore successful (cf. Ordinance relating to hazardous substances, OHS[7]; Ordinance relating to direct payments, ODP[8]).

  Continued efforts in cantonal enforcement of the applicable federal laws are needed particularly in heavily polluted areas with high numbers of livestock (animal fattening regions) with high P-accumulation in fertilised soils. Relevant, more extensive, regional measures should be introduced on the basis of Article 62*a* LWP and should then be quickly, effectively and transparently enforced.

– In the case of N, the agri-ecological stage target for 1998 – a reduction in N-losses compared with 1994 of 14, 000 t – has clearly not been reached. The reduction was only 7,000 t N. Despite agri-ecological measures, the target set in AP 2002, namely a total reduction of 22, 000 t N compared with 1994, was clearly not achieved in 2002.

2.2 Conclusions regarding incentive taxes

After weighing up all the technical aspects and in view of the wording of the motion 94.3005 UREK-S, the question of whether incentive taxes are an appropriate measure at the present time can be clearly answered in the negative for mineral fertilisers.

Incentive taxes on surplus manure, on the other hand, would be necessary in principle.

However, since the motion by UREK-S of 27 January 1994 was proposed, further measures have been introduced under Article 62*a* LWP in regions vulnerable to water pollution. These are currently being implemented at great financial and technical expense by farmers participating in the programme. The ecological effect

6 Evaluation of Ecological Measures and Animal Husbandry Programmes, 2nd Interim Report, June 1999, Chapter 5, p. 78, Fig. 21 and 22.

7 SR **814.013**

8 SR **910.13**

of this programme, which is only in its early stages, cannot yet be definitively assessed. However, it is expected to achieve the first results in solving the problem of regional surplus manure.

In view of the present agricultural policy climate, more consistent implementation of existing environmental and agri-ecological regulations under the ODP together with incentive measures under Article 62*a* LWP is therefore proposed as an alternative to incentive taxes.

Agricultural animal husbandry in vulnerable areas must be more closely related to the farm's own and leased agricultural land suitable for fertiliser application – particularly when examining applications for new buildings. The farmer's own management responsibility must also be reinforced (target for land use management of traditional farms; cf. Art. 2 Law on Agriculture, LAgr, and Art. 6 ODP). On the basis of estimates by SAEFL, based on data from the Federal Office of Statistics (FOS), it should be possible in future to reduce surplus manure from the current 1,700 t P by about one third. This should simplify enforcement of water protection legislation and at the same time should tend to shift pig fattening to traditional farms most of which have their own agricultural acreage approved for fertilisation.

2.3 Greater commitment by the Confederation and Cantons to fertiliser application, land use management and air pollution control

Action is needed in the following areas:

- *for phosphorus:* in areas with high numbers of livestock, it is essential that the high accumulation of soils fertilised with P be taken into account when calculating and implementing the whole farm balanced nutrient budget or the whole farm nutrient budget (cf. individual farm site potential and fertiliser application plans under ODP). Whenever possible, manure must be used in accordance with fertiliser application plans (cf. e.g. programme in Canton Fribourg). The water protection provisions must be consistently implemented especially on farms with surplus manure, i.e. manure must be stored and utilised in a way which is compatible with the environment. Livestock numbers must be adjusted in line with the agricultural land suitable for fertiliser application, which should be situated at a reasonable distance from the farm locality.
- *for nitrogen:* in order to reach the agri-ecological target of a reduction in N-losses totalling 22,000 t N, further efforts are essential. However, for reasons of sustainable environmental protection, the annual environmentally relevant N-losses would have to be halved in the longer term i.e. from 96,000 t N in 1994 to 48,000 t N. Measures within the framework of currently applicable provisions under environmental law and agricultural policy are:
  a. fertiliser application and land use management according to the individual farm site potential of the locations especially in vulnerable areas;

b. enforcement of precautionary limitation of emissions in accordance with the Air pollution control ordinance (OAPC)[9] to reduce ammonia emissions from agriculture, and cantonal action plans under the OAPC to reduce excessive N-pollution.

Favourable framework conditions must be created for this (incentive strategy, promotional programme for low-emission technologies).

The effect of such further regional measures will have to be reported as part of the annual agricultural reports on agri-ecological progress published by the OAGR and based on general environmental monitoring arranged by SAEFL.

2.4 Transparency in enforcement and controls

In future, environmental pollution from N and P due to agricultural activities must be better recorded in the control of such activities and transparently documented both for the whole of Switzerland and regionally.

Existing federal enforcement aids for agricultural environmental protection (fertiliser application, utilisation of soils, livestock farming) must be reviewed in accordance with the environmental legislation in force and, based on enforcement experience, must be adjusted in line with present and foreseeable requirements by 2005 in conjunction with the cantons.

3 Developments in the case of plant protection products (PPPs)

3.1 Present position

The available statistics and surveys on sales and use of PPPs essentially indicate that the environmental policy and agri-ecological instruments currently available are appropriate for reducing the risk associated with the use of PPPs. However, they do not allow any satisfactory assessment of their impact.

In order to be able to make a more reliable assessment of the effect of environmental and agricultural policy measures, as required by the UREK-S motion, in future

- the use of PPPs must be recorded in a representative way,
- the associated development of the environmental risk must be estimated by means of appropriate indicators, and
- targets to reduce the quantitative and qualitative environmental risks must be laid down in agreement with interested parties.

Risk indicators are also useful for targeted monitoring of environmental pollution from PPPs and for advice regarding specific selection and application of PPPs (cf. Art. 70 Para. 2 Let. f LAgr).

9 SR **814.318.142.1**

Risk assessment and risk management are continuing to develop internationally. Switzerland must also support this development. Detailed surveys on the various uses of PPPs and targeted representative measurements of environmental pollution are the most important continuing measures. These allow both an estimate of the general pollution situation and risks, and better control of results conducted according to current benchmarks.

The costs of these continuing studies could – according to the polluter pays principle – be covered by a financing tax on PPPs sold (as is performed in the United Kingdom for example). However, such a tax would not have any incentive effect.

The latter could be achieved, on the other hand, with taxes scaled according to environmental pollution and risk of the PPPs, without making the average production costs substantially higher.[10] The difficulty, however, lies in assigning the individual active ingredients to different risk classes, which are decisive for setting the level of the tax. So far it has not been possible to agree on such a classification.

That is why the possibilities of direct payments with the proof of ecological achievement (PEA) should first be fully utilized and the necessary funding for continuing measures from 2003 procured from the general budget.

3.2 Result

The present environmental and agricultural policy instruments are essentially appropriate for reducing the environmental risk associated with the use of PPPs. There is therefore no need for incentive taxes on PPPs.

The data collection necessary for control of results, development of risk indicators and agri-ecological stage targets for risk reduction are laid down in a PPP Action Programme. International experience and the concerns of interested parties are taken into consideration.

The effect of the proposed measures and the Action Programme will be reassessed by OAGR and SAEFL after a recommended interval. The success of the proposed measures will be reported by the OAGR in its agricultural reports on agri-ecological progress and by SAEFL as part of general environmental monitoring.

4 Conclusions

Numerous studies and previous experience with the new agricultural policy lead to the following conclusions:

a. Incentive taxes will not be introduced on mineral fertilisers, surplus manure or plant protection products. The environmental risk associated with the application of these substances can be effectively reduced by means of consistent implementation and application of the existing environmental and agricultural policy instruments.

10 Bidaux A., Gaillard R. and Lehmann B., “Etude de divers modèles de taxes d’incitation différenciées portant sur les pesticides utilisés en agriculture”, ETHZ study commissioned by SAEFL (1992).

b. An incentive tax would be justified on ecological grounds only in the case of surplus manure. However, this problem is to be tackled with the set of specific promotion instruments laid down in Article 62*a* LWP.

c. Excessive ammonia emissions from agriculture are to be reduced by stricter measures as part of enforcement of the Air pollution control ordinance (OAPC), and by better adaptation of fertiliser application and individual farm site potential in vulnerable areas.

d. In the case of plant protection products, the data collections necessary for control of results, development of risk indicators and stage targets for risk reduction are to be specified in an action programme.

e. The OAGR shall provide information on the success of the measures taken to reduce the environmental risks described here in its agricultural reports. It shall consult SAEFL.