How cost-effective are direct payments to organic farms for achieving environmental policy targets?

C. Schader[1], N. Lampkin[2], M. Christie[3], M. Stolze[1]

[1]Frick/CH, [2]Newbury/UK, [3]Aberystwyth/UK

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Introduction

Since 1993, the Swiss federal agricultural policy has been providing financial support for organic farming via area payments. Like other voluntary agri-environmental measures (AEM), these payments are intended as incentives for farmers to comply with defined production standards. Such payments lead to better environmental performance, as compliance with organic production standards averts negative and provides positive external effects compared to conventional or integrated farming (CRER, 2002). For instance, organic farming is largely not dependent on external inputs. This minimises the resource use of the farming system and limits the nutrient loads in the system, which in turn leads to less overfertilisation and reduced eutrophication risks involving nitrogen and phosphorus (Haas *et al.*, 2001). Besides effectiveness, against the background of limited public budgets, efficiency in delivering environmental impacts plays a fundamental role in the further development of direct payment schemes (Swiss Federal Council, 2009). The targeting and tailoring of policies to achieve maximum effectiveness with a given budget is essential (OECD, 2007). It is therefore necessary to compare both environmental effects and the societal costs of AEM with each other in order to provide a basis for economically sound policy design (Pearce, 2005).

Agricultural economists hold differing views on the cost-effectiveness of organic farming support payments. Von Alvensleben (1998) argues that the organic farming area support payments are not economically sound, as the policy goals could be achieved more efficiently using more flexible and targeted combinations of various AEM. The economic rationale behind this argument was introduced by Tinbergen (1956), who theorised that an efficient policy requires at least as many specific instruments as there are specific goals. However, the Tinbergen Rule may not apply fully in this case due to interactions between policies, conflicting goals and the limited determinability of different aspects of environmental performance. Furthermore, the multi-purpose character of organic agriculture could increase its cost-effectiveness due to its potentially lower transaction costs compared to targeted AEM (Dabbert *et al.*, 2004).

Empirical papers on this question lack. Thus, this paper aims to compare the cost-effectiveness of a) direct payments to organic farms and b) AEM, in providing environmental services. This is done, using the current Swiss agricultural policy scheme as a case study.

Methods

In this section, first the general understanding of cost-effectiveness is reviewed. Second, a brief overview of the Swiss FARMIS model is given. Third, the extensions made to FARMIS for evaluating organic farming and AEM are explained. Finally, the way of comparing organic farming as a system approach with specific AEM is described.

Cost-effectiveness of direct payments

The cost-effectiveness ratio (CE) of a policy is the relation between effectiveness, expressed in physical terms and costs, expressed in monetary terms (Pearce, 2005). Equation 1 is the basis for deriving cost-effectiveness algebraically for several policies (i) and environmental effects (j).

$$CE_{ij} = \frac{E_{ij}}{C_i} \quad \forall\, i, j \tag{1}$$

where CE_{ij} is the cost-effectiveness of policy i in relation to environmental effect j. CE is defined as a ratio of the environmental effect (E_j) of policy i and the cost (C) of policy i.
The total sector-level environmental effect can be calculated, as in Equation 2, by adding up the effects multiplied by the areas where the effects occur.

$$E_{ij} = \sum_{X} E_{ijx}\ AR_{ix} \quad \forall\, i, j \qquad (2)$$

E_{ij} is the total environmental effect of policy i on environmental category j. AR characterises policy uptake (e.g. measured in hectares) x is the index for uptake.
Alike the cumulative environmental effects, the total additional policy-related cost at sector level can be calculated using Equation 3

$$C_i = \sum_{X} ((PL_{ix} + TC_{FARM\,ix} \ + TC_{VAR_{ix}})\ AR_{ix}) + TC_{FIX_i} \quad \forall\, i \qquad (3)$$

where PL_{ix} is the payment level for policy i and area x; TC_{FARM} are the farm-level policy-related transaction costs (PRTC), TC_{VAR} the variable share of the public PRTC, and TC_{FIX} the fixed public PRTC.
The reciprocal of CER is called abatement cost (ABC) in the case of negative externalities and provision cost (PRC) in the case of positive external effects (Equation 4).

$$ABC_i = \frac{C_i}{\frac{\sum_j W_j * RE_{ij}}{J}} \quad \forall\, i \qquad (4)$$

where RE is the relative effect (expressed as a percentage) on the environmental category resulting from the policy. W_j is the weight of the each category. W can be determined according to societal preferences, or normative approaches (e.g. distance to target).
J is the number of environmental categories taken into account. Policies with a high CE will be more favourable compared to policies with a low CE for the given set of environmental categories.
Thus, cost-effectiveness of AEM can be understood as a function of a) payment levels, b) policy uptake, c) environmental effectiveness and d) public expenditure.

The CH-FARMIS model

The Swiss FARMIS Model (CH-FARMIS) is a comparative-static mathematical programming model for the Swiss agricultural sector based on positive mathematical programming (PMP) (Howitt, 1995). As an optimisation model, FARMIS attempts to model directly the decision-making process of farmers using an objective function which explicitly takes expectations and the technical production environment into account (Bertelsmeier, 2005). Farmers' responses to changes in exogenous conditions (e.g. direct payments or product prices) are thus modelled by conducting 'synthetic experiments' (Berger, 2000). In contrast to econometric approaches, FARMIS models the decision-making process directly using an objective function for each farm group subject to production constraints. 46 plant production activities and 27 animal production activities are considered in CH-FARMIS. Each activity receives farm group-specific input-output factors which determine their relative economic preferability.
Data used in the FARMIS model included: bookkeeping records (Swiss FADN) of the years 2006 and 2007 (this dataset comprised 3500 farms selected to be representative of the Swiss farming community); the Swiss farm structure survey and normative data about production technologies and prices; and data on non-renewable energy use, biodiversity

and N- and P-eutrophication from the Swiss Agriculture Life Cycle Assessments (SALCA) (Nemecek *et al.*, 2005).
The standard FARMIS modelling procedure consists of four steps: First, the farm groups are assembled on the basis of FADN data. For this study farms were grouped according to region (lowlands, hills, mountains), farm type (dairy farms, suckler cow farms, mixed farms) and farming system (organic, conventional). Due to a lack of organic farms in the FADN, a further stratification was not possible. Second, input-output data are generated specifically for the assigned farm groups. Third, the detailed model assumptions are specified according to the requirements of the research question. Fourth, the model is calibrated for the base year by running it as a linear programme with calibration constraints in order to reveal the hidden, *i.e.* not explicitly modelled, costs. Fifth, policy scenarios are calculated using the calibrated, quadratic PMP model and scenario-specific assumptions. A detailed description of the Swiss FARMIS is given by Sanders (2007) and Schader (2009).

Modelling uptake of AEM within FARMIS

The uptake of agri-environmental policies needs to be modelled differently from ordinary activities, since farmers' decisions follow a different rationale than when switching between standard activities. The Röhm-Dabbert approach (RDA) (Röhm and Dabbert, 2003) presents a more realistic model of behaviour by defining intensity levels, according to the uptake or non-uptake of an agri-environmental policy. These intensity levels are treated by the model as 'similar activities', *i.e.* activities which entail similar requirements in terms of machinery and labour input. Without the definition of similar activities, all activities are exchanged according to the standard PMP coefficients. However, in reality farmers are able to switch easily between different intensity levels without replacing all their machinery or other farm processes. In contrast, switching from, say, wheat production to grassland requires many changes on the farm, considered in the model as a farm's hidden costs. Since these hidden costs differ depending on whether farms switch from one intensity level to the other or whether they switch between activities, different PMP cost terms need to be included in the objective functions.
The income (Z) of each farm group is maximised allowing for revenues from agricultural production, direct payments, fixed and variable cost components. The first term of the objective function (Equation 9) sums up the revenues for marketed products. The second term adds up all direct cost components per activity. This encompasses various types of expenditure on seeds, crop protection, purchased fodder, veterinary services, animal medicines, primary energy, insurances, and contract work. The third term covers revenues from direct payments, while PX_{ni} specifies the grade of eligibility of the farm for a certain activity. The fourth, fifth and sixth term comprise costs for employed labour force, purchased fertilisers and rented land.
There are two types of quadratic hidden cost parameters (ω) in the extended objective function. This implies that hidden costs are split into a) a share which depends on the level of the intensity (with ω_{n1} as slope coefficient), and b) a share which depends on the level of the other intensities of a particular activity (with ω_{n2} as slope coefficient), while δ ensures the exact calibration of the intensity levels according to the empirically observed levels in the base year (Kuepker, 2004; Röhm and Dabbert, 2003).

$$
\begin{aligned}
\max Z_n = {} & \sum_j \sum_k p_{njk} Y_{njk} - \sum_i \sum_k c_{nik} X_{nik} + \sum_i \sum_k dp_{nik} PX_{nik} - \sum_u r_{nu} U_{nu} - \\
& \sum_v r_{nv} V_{nv} - \sum_l r_{nl} LAND_{nl} - \sum_i \sum_k \delta_{nik} X_{nik} - 0.5 \sum_i \omega_{ni1} X_{nik}^2 - 0.5 \sum_i \sum_w \omega_{ni2} X_{niw}^2 \qquad \forall n
\end{aligned}
\tag{9}
$$

$Y_{njk}, X_{ni}, PX_{ni}, U_{nu}, V_{nv}, LAND_{nl} \geq 0$

where:

Indices:

- n = index for farm groups
- i = index for production activities
- j = index for output products
- k = index for intensity levels
- w = index for intensity levels ≠ w
- l = index for land type
- u = index for labour
- v = index for fertilisers

Variables:

- Z = objective (profit per farm group)
- Y = sales of agricultural products
- X = level of activities
- PX = level of activities eligible for direct payments
- U = level of labour input/requirements
- V = level of fertiliser input/requirement
- LAND = level of rented UAA

Parameters:

- p = prices for agricultural products
- c = activity-specific costs
- dp = activity-specific direct payments
- r = variable costs
- δ = parameter for linear hidden cost
- ω = parameters for quadratic hidden cost (depending on the alternative intensity levels)

δ, ω_{n1} and ω_{n2} are derived according to (Kuepker, 2004). Accordingly, uptake of agri-environmental policies is modelled by defining separate sub-activities reflecting the uptake choices of farmers. Two types of grassland extensification payments, a) ‘payments for less intensive meadows’ and b) ‘payments for extensive meadows’ were modelled using the RDA. Furthermore, as an agri-environmental policy for grains and rapeseed, ‘extenso payments’ are implemented for conventional farms[1].

By contrast, organic farming area support payments (OFASP) cannot be modelled using the RDA (Schmid and Sinabell, 2006), as these specific policy instrument is not the dominant factor influencing farmers decision for conversion. Economically, conversion depends much more than for AEM on market price expectations and soft factors which have not been identified to a sufficient extent to be modelled at sector level (Bichler *et al.*, 2005; Hollenberg, 2001).

Modelling environmental effects within CH-FARMIS

Due to the complexity and the multitude of environmental impacts associated with organic agriculture, not all relevant impacts could be considered. The subsequent quantitative modelling analysis focuses on three key environmental categories (non-renewable energy use, biodiversity (expressed as habitat quality), eutrophication with N and P). This selection was based on the following criteria: a) the importance of the environmental category in the current policy debate, b) the importance of agriculture for the environmental category, c) the existence of systematic differences between organic and non-organic farming systems, d) the feasibility of modelling the environmental indicators at sector level and e) the availability of comprehensive, quantitative and widely accepted data for Switzerland.

Data for all environmental impacts was taken from Swiss Agriculture Life Cycle Assessment data (Nemecek *et al.*, 2005). All environmental indicators were related to

[1] Organic farms are eligible for these payments by definition as the restrictions are covered in any case by the organic farming standards. Organic farms therefore have a fixed uptake level of 100 % for extenso payments.

area (e.g. energy use per ha and year) as the object of evaluation were direct payments which were paid also on a hectare basis. Furthermore, it is currently methodologically not possible to relate biodiversity impacts to product level. According to the standard system boundaries for life cycle assessments, the calculations for energy use and eutrophication included impacts from inputs (e.g. purchased mineral fertilisers, pesticides and fodder). Data were linked to FARMIS predominantly via activities. Energy use for milking and purchased fodder was linked to calculated inputs and outputs quantities.

Modelling public expenditure within CH-FARMIS

Costs of agri-environmental policies are modelled from a budgetary perspective as in Marggraf (2003). Total public expenditure (PE_{TOTAL}) on direct payments is calculated by adding up the payments to the beneficiaries (PC) (Equation 13). Furthermore, variable as well as fixed transaction costs at cantonal and national level are added (TC_{VAR} and TC_{FIX}), while farm-level transaction costs are not considered, as they are meant to be compensated already by the direct payments. Data was derived from empirical data by Buchli and Flury (2005) and Mann (2003).

$$PE_{TOTAL} = \sum_{n} \sum_{i} \sum_{k} (PC_{nik} + TC_{VAR\,nik}) + TC_{FIX} \qquad \textbf{(13)}$$

where:
n = index for farm group
i = index for production activities
k = index for intensity level
PE_{TOTAL} = total public expenditure on a policy
PC = costs for payments to beneficiaries (farmers)
TC_{VAR} = variable public policy-related transaction costs
TC_{FIX} = fixed public policy-related transaction costs

Derivation of cost-effectiveness of organic farming support and AEM

As conversion to and from organic agriculture (as the equivalent to “policy uptake” regarding AEM) could not modelled explicitly in FARMIS, two different approaches had to be taken to derive RE and C for a) organic farming support was evaluated by comparing farm organic and conventional farm groups in the base year and b) AEMs were modelled by running policy scenarios in which payment levels for each AEM were set to 0.

The **cost-effectiveness of organic farming support** was evaluated from an ex-post perspective for organic farming as a system approach, rather than taking into account only the OFASP, which is responsible for only a small part of the difference in environmental performance and public expenditure.

In order to derive a value for cost-effectiveness (CE), the relative environmental effects (RE) and the absolute difference in average public expenditure (C) have to be determined. Both parameters are obtained by comparing organic with conventional farm groups in the base year, i.e. from an ex-post perspective. Either all farms of both farming systems are compared, or specific farm types or regions, in order to diminish structural differences between organic farm groups (regional or farm types) and their conventional counterparts.

The RE are expressed as hectare averages in relative terms (%) in order to avoid upscaling problems when aggregating different farm groups, and to assure consistency between the environmental indicators. RE is calculated as in Equation 14, where IND is the average state of the respective environmental impact indicator per ha in the farming system.

$$RE_{ORG} = \frac{(IND_{ORG} - IND_{CON})}{IND_{CON}} \qquad (14)$$

C is also expressed as a hectare average. The parameter was derived by subtracting the total public expenditure per ha on conventional farms (PE_{CON}) from the total public expenditure per ha on organic farms (PE_{ORG}) (Equation 15). PE_{CON} and PE_{ORG} are obtained equivalently to PE_{TOTAL} (Equation 13) with index 'n' being limited to organic or conventional farms respectively.

$$C_{ORG} = \frac{PE_{ORG}}{UAA_{ORG}} - \frac{PE_{CON}}{UAA_{CON}} \qquad (15)$$

The **cost-effectiveness of AEM** is derived by comparing the cost-effectiveness of all farms in the policy scenarios with all farms in the base year (calculations for specific farm types and regions have been made but are not presented in this paper for the benefit of brevity). In the policy scenarios, the payments for policy measures are set to 0 CHF/ha. Thus, a hypothetical situation is modelled, in which the payments which are under evaluation are abolished. In other words, empirical data on the 'treatment' and modelled data on the 'counterfactuals' (base year) were obtained.

Accordingly, the difference between the reference scenario and each policy scenario without the payment is interpreted as the additionality of the respective policy measure, as the model shows how farmers would respond, if the payment was not disbursed. The additionality consists of both a direct and an indirect component. The direct component relates directly to the policy uptake induced by the payment, while the indirect component refers to other responses from the farm groups, such as changes in stocking density or uptake of other AEM. This is presented in Equations 16 and 17.

$$RE_{ij} = \frac{(IND_{BASE_{ij}} - IND_{SCEN_{ij}})}{IND_{SCEN_{ij}}} \quad \forall i, j \qquad (16)$$

$$C_i = \frac{PE_{BASE_i}}{UAA_{BASE_i}} - \frac{PE_{SCEN_i}}{UAA_{SCEN_i}} \quad \forall i \qquad (17)$$

where IND_{BASE} and IND_{SCEN} refer to the state of the environmental indicators in the base year and scenario, respectively. The same distinction is made for public expenditure (PE) and utilised agricultural area (UAA).

Results

Cost-effectiveness of organic farming support

Across all farms, the additional public expenditure for organic farms per ha amounts to 686 CHF (Table 1). This figure varies regionally from 305.8 CHF/ha in mountain areas, 489 CHF/ha in hill areas to 537.7 CHF in the lowlands. Average per-ha costs in terms of additional public expenditure for organic farm types range from 310.5 CHF to 737.7 CHF for mixed farms, while organic dairy farms entail an additional 447.2 CHF per ha among different farm types.

Table 1 **Abatement and provision costs of organic farming by region and farm type, expressed as CHF/ha for a 1% improvement of the indicator (2006/07)**

	Indicator	Unit	Lowlands	Hill	Mountain	Dairy farms	Suckler cow farms	Mixed farms	Total farms
Cost	Public expenditure	CHF/ha	537.71	489.00	305.80	447.16	310.54	737.65	685.99
Environ-mental effects	Energy use	%*	55.25	40.85	33.21	30.44	35.99	48.92	54.39
	Habitat quality	%*	23.18	29.06	60.52	52.70	85.69	34.11	55.03
	Total eutrophication	%*	10.73	22.07	21.99	25.37	32.34	13.36	35.26
	N-eutrophication	%*	9.36	22.60	23.41	26.58	34.65	12.39	37.49
	P-eutrophication	%*	32.71	17.49	15.00	16.86	13.53	27.44	11.22
Abatement cost	Total energy use	CHF/1%**	9.73	11.97	9.21	14.69	8.63	15.08	12.61
	Habitat quality	CHF/1%**	23.20	16.83	5.05	8.49	3.62	21.63	12.47
	Total eutrophication	CHF/1%**	50.13	22.16	13.91	17.63	9.60	55.22	19.45
	N-eutrophication	CHF/1%**	57.43	21.64	13.06	16.82	8.96	59.56	18.30
	P-eutrophication	CHF/1%**	16.44	27.96	20.38	26.53	22.96	26.89	61.12

*relative difference between organic and conventional farms with conventional farms = 100 %;

**CHF/ha*1%improvement of the indicator

Source: own calculations based on Swiss FADN and SALCA data

The relative differences in environmental effects between organic and conventional farms vary by farm type and region. Energy use per ha is between 30-55% lower on organic farms than on their conventional counterparts. This is mainly due to the lower stocking rates, less purchase of concentrate feed and the ban of mineral fertilisers. The main factor for the better habitat quality on organic farms (by 23-86%) lies in the higher uptake rate of AEM, mainly extensive meadows on organic farms. Eutrophication potential per ha on organic farms is lower by 11-32% due to less fertiliser input.

The figures for total farms are often higher than for specific farm groups, because structural differences between farms are influencing the results. For instance, there is higher share of organic farms in mountain regions from total organic farms than conventional farms in mountain regions from total conventional farms. As per-ha energy use tends to be lower in mountain regions, this leads to higher relative differences between the farming systems.

Abatement/provision costs express the costs that were spent on achieving a 1 % improvement in the respective environmental indicator. With regard to regions, abatement costs for total energy use per ha are 9.2 CHF/ha, 9.7 CHF/ha and 12 CHF/ha for mountains, lowlands, and hills respectively. Regarding farm types, abatement costs range from 8.6 CHF/ha on suckler cow farms to 15.1 CHF/ha on mixed farms, while costs on dairy cow farms are 14.7 CHF/ha.

Provision costs for habitat quality vary markedly among the regions. In particular, low provision costs were calculated for mountain regions (5.9 CHF/ha) and hill regions (8.1 CHF/ha), while in the lowlands provision costs of 18.5 CHF/ha were incurred. Farm-type differences were even higher than regional differences, with 5.6 CHF/ha for mountain regions, 8.1 CHF/ha for hills and 18.5 CHF/ha in the lowlands.

Abatement costs for eutrophication range from 13.92 CHF/ha in the mountain areas to 22.2 CHF/ha in the hill areas and 50.1 CHF/ha in the lowlands. Mixed farms have the highest eutrophication abatement costs at 55.2 CHF/ha. Abatement costs on dairy farms amount to 17.6 CHF/ha followed by 9.6 CHF/ha on suckler cow farms.

Cost-effectiveness of AEM

Table 2 presents the cost-effectiveness of the measures expressed as abatement and provision costs, which is the reciprocal value of the cost-effectiveness ratio. It shows that achieving relative improvements is most expensive with extenso payments. The indicator shows that habitat-quality improvements are particularly costly. By contrast, extensive meadows achieve very low values for abatement costs of 9.3 CHF/% for energy use and 0.7 CHF/% for habitat quality. Abatement costs for eutrophication, on the other hand, are relatively high at 6.4 CHF/%.

Table 2 Abatement and provision costs of agri-environmental policy measures regarding the analysed environmental indicators

Indicator	Unit	Conventional farms				Organic farms				All farms			
		Extenso	Less intensive meadows	Exten-sive meadows	Com-bined AEM	Extenso	Less intensive meadows	Exten-sive meadows	Com-bined AEM	Extenso	Less intensive meadows	Exten-sive meadows	Com-bined AEM
Fossil energy use	CHF/%	386.3	n.d.	11.8	56.9	**631.3**	**39.8**	**n.d.**	**6.1**	383.3	n.d.	9.3	48.9
Habitat quality	CHF/%	543.0	n.d.	0.8	4.3	**859.0**	**-7.5**	**n.d.**	**1.3**	573.1	n.d.	0.7	4.1
Total eutrophication	CHF/%	130.5	n.d.	8.2	37.4	**-282.5**	**8.7**	**n.d.**	**7.2**	137.4	n.d.	6.6	33.6
N-eutrophication	CHF/%	123.1	n.d.	7.9	36.0	**-250.4**	**7.3**	**n.d.**	**6.5**	129.3	n.d.	6.4	32.2
P-eutrophication	CHF/%	373.2	n.d.	11.6	62.8	**-10'410.5**	**-21.2**	**n.d.**	**28.1**	395.1	n.d.	9.9	60.3

n.d.: cost-effectiveness of this policy is not defined, as the payment induces negative cost

Source: own calculations based on Swiss FADN and SALCA data

The combination of AEM entails higher abatement costs, as the environmental effects are only slightly higher and the costs substantially exceed those of the payments for extensive meadows.

By correspondence to the higher cost-effectiveness of combined payments on organic farms, the abatement costs are substantially lower as compared to conventional farms. With combined payments energy use could be reduced at 6.1 CHF/% as compared to 56.9 CHF/%. Provision costs for habitat quality are only 1.3 CHF/% on organic farms compared to 4.3 CHF/% on conventional farms. With regard to eutrophication, the abatement costs are 7.2 CHF/% compared to 37.4 CHF/% on conventional farms.

Cost-effectiveness of less intensive meadows was not defined, because in fact this AEM results in negative environmental effects and savings in public expenditure. This result seems irritating at first glance but is due to the cross-compliance regulation in Switzerland. Farms need to have 7% of their UAA under agri-environmental schemes and therefore less intensive meadows are an efficient way for farms to comply. If the payments would not be given, farms would tend to implement extensive meadows more frequently, which results in an improvement of environmental indicators and additional public expenditure. Uptake of extenso payments, proved to be inelastic. Even if this policy measure was abolished the model predicts only a slight intensification of grain and rape production. This inelastic response is due to the higher prices for extensively produced grains which is responsible for an often better economic performance than intensive production. This implies that there are high windfall profits entailed with extensor payments.

Comparison of organic farming with AEM

The average cost-effectiveness and average abatement costs of the three indicators was calculated as a non-weighted mean according to Equations 6-8 with $W_j = 1/J$. The highest average improvement has been found for the combined AEM and extensive meadows (7.2 %) (Table 3). The relative environmental effect of organic farming is only slightly

lower at 4.7 %. Average environmental effects of both extenso payments and less intensive meadows are insignificant.
Abatement costs are, lowest for extensive meadows at 1.8 CHF/%. The combination of AEM costs 10.1 CHF/ha per % of environmental improvement, while organic farming costs 14.2 CHF/%. Abatement costs of extenso payments are highest, at 257.9 CHF/%, while the abatement costs for less intensive meadows are not defined. The combination of AEM costs only 2.79 CHF/% when implemented on a hectare on an organic farm, compared to 10.94 CHF/% on conventional farm. The main driver for this difference in abatement cost is that organic farms tend to take up the highly effective extensive meadows to a much higher degree than conventional farms.

Table 3 Average cost-effectiveness of organic farming compared to AEM

Indicator	Unit	Organic agriculture	Extenso	Less intensive meadows	Extensive meadows	Combined AEM	Combined AEM on organic farms	combined AEM on conventional farms
Public expenditure	CHF / ha	66.58	28.24	-0.49	12.76	73.17	23.11	78.62
Average improvement	%	4.68	0.11	-0.78	7.22	7.24	8.29	7.19
Average abatement cost	CHF / %*	14.22	257.89	n.d.	1.77	10.10	2.79	10.94

* Costs per ha for improving the environmental indicators on average by 1%

Source: own calculations based on Swiss FADN and SALCA data

Sensitivity analyses were conducted regarding payment levels, policy uptake elasticity, number of policy targets and the weighting of targets against each other. In general the sensitivity analyses revealed that the main result of a comparable cost-effectiveness of organic farming support compared to the combination of individual payments is robust. Only variations in uptake elasticity revealed a significant influence on the ranking of the policy measures. If a more elastic uptake response was assumed, the model calculated a higher cost-effectiveness for the measures, while the assumption of more inelastic uptake led to lower cost-effectiveness. If the Röhm-Dabbert approach was not applied, *i.e.* assuming a standard elasticity of the policy measures, the combination of AEM would entail slightly higher abatement costs (15.5 CHF) than for organic farming.

Discussion

The present study showed that organic farming in Switzerland is able to deliver environmental services at a competitive cost compared to a combination of currently implemented agri-environmental policies. However, this study cannot deliver generalisable results on the cost-effectiveness of organic farming with respect to environmental impacts, not least because environmental effectiveness and costs depend, of course, on specific geographic and political contexts.
Methodologically, this study revealed that particularly the question of modelling uptake of AEM and conversion of organic farming need to be addressed. Econometric estimation of the PMP coefficients, as discussed by Heckelei (2002), could be a promising way to go. Furthermore, other policy options than existing AEM have to be explored. Due to the limitations of the PMP approach, different types of deriving cost-effectiveness had to be applied. This limits the comparability of the figures derived for cost-effectiveness but on the other hand allows us to take into account structural differences between organic farms and conventional farms.
Furthermore, the question regarding the means by which this support should be granted is a different one. Different combinations of measures could be more cost-effective than the

current system of OFASP. In addressing this question, however, the support for organic farming becomes a policy goal in itself. According to Elliott *et al.* (2003), the main rationale for such a policy is the provision of environmental public goods and compensation for market failure. International evaluation studies of organic farming schemes (CRER, 2002) and organic action plans in Europe (Lampkin *et al.*, 2008) suggest a wide portfolio of measures, which could develop mutually synergetic effects with current support schemes both in Switzerland and elsewhere.

Conclusions

Direct payments to organic farms proved to be a competitive instrument complementary to single agri-environmental policies, showing a stable effectiveness across all regions and farm types and an even effect across all analysed impact categories in the specific case analysed in this study. Furthermore, mutually enhancing interactions with the policy measure ‘payments for extensive meadows’ were found.

However, this study cannot provide the basis for advice regarding the choice of policy instruments for supporting organic farming, since OFASP were not specifically evaluated: Instead, the total surplus direct payments to organic farms compared to conventional farms were considered. Other policy measures, e.g. conversion payments, investment support, compensation for inspection costs, input taxes on mineral fertilisers or pesticides, or tax exemptions for organic farms could be alternative, better-performing options. Furthermore, the results of this paper suggest a regional or farm type-specific differentiation of payment levels, since both the costs and environmental effects of organic farming differed between the groups analysed. The approach developed could be used to analyse the potential for such a differentiation.

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References

Berger, T. (2000), 'Agentenbasierte räumliche Simulationsmodelle in der Landwirtschaft. Anwendungsmöglichkeiten zur Bewertung von Diffusionsprozessen, Ressourcennutzung und Politikoptionen', *Agrarwirtschaft*, Sonderheft 168.

Bertelsmeier, M. (2005), 'Analyse der Wirkungen unterschiedlicher Systeme von direkten Transferzahlungen unter besonderer Berücksichtigung von Bodenpacht- und Quotenmärkten. Dissertation', *Schriftenreihe des Bundesministeriums für Verbraucherschutz, Ernährung und Landwirtschaft: Reihe A: Angewandte Wissenschaft H.510*, Hiltrup.

Bichler, B., Lippert, C., Häring, A.M. and Dabbert, S. (2005), 'Die Bestimmungsgründe der räumlichen Verteilung des ökologischen Landbaus in Deutschland', *Berichte über die Landwirtschaft*, 83, 1, pp. 50-75.

Buchli, S. and Flury, C. (2005), 'Policy related transaction costs of direct payments in Switzerland', *Workshop on policy-related transaction costs, 20-21 January 2005*, Paris, Organisation for Economic Co-Operation and Development (OECD).

CRER (2002), 'Economic evaluation of the Organic Farming Scheme: Final report to the Department of Environment, Food, and Rural Affairs', Cambridge, Centre for Rural Economics Research, Department of Land Economy, University of Cambridge.

Dabbert, S., Häring, A.M. and Zanoli, R. (2004), *Organic farming: policies and prospects*, London, Zed Books.

Elliott, J., Temple, M.L., Clinton, S., Tiffin, A.L., Rees, E. and Standen, J. (2003), 'Evidence assessment to inform the review of the organic farming scheme. Report to Department for Environment, Food and Rural Affairs', ADAS Consulting, University of Reading, Department of Agricultural and Food Economics.

Haas, G., Wetterich, F. and Köpke, U. (2001), 'Comparing intensive, extensified and organic grassland farming in southern Germany by process life cycle assessment', *Agriculture, Ecosystems and Environment*, 83, pp. 43-53.

Heckelei, T. (2002), 'Calibration and estimation of programming models for agricultural supply analysis - Habilitationsschrift', *Agricultural Faculty*, Bonn, University of Bonn.

Hollenberg, K. (2001), *Auswirkungen einer Umstellung der Landwirtschaft auf ökologischen Landbau*, Kiel, Vauk.

Howitt, R., E. (1995), 'Positive mathematical programming', *Journal of Agricultural Economics*, 77, 2, pp. 329-342.

Kuepker, B. (2004), 'Assessing the impact of decoupling on farmers' acceptance of environmental measures to reduce nitrogen input in cotton production: a case study for the region Thessaly, Greece', *in* Jayet, P.A. and Kleinhanss, W. (eds.), *Work package 5, Deliverable D8.3. Possible options and impacts of decoupling within Pillar-II of CAP*, Grignon, Braunschweig, GENEDEC, pp. 43-62.

Lampkin, N.H., Schmid, O., Dabbert, S., Michelsen, J. and Zanoli, R. (2008), 'Organic action plan evaluation toolbox (ORGAPET). Final output of the ORGAP research project (www.orgap.org) for the European Commission ', Aberystwyth, Frick, Institute of Biological, Environmental and Rural Sciences, Aberystwyth University, UK and Research Institute of Organic Agriculture (FiBL), Frick, CH.

Mann, S. (2003), 'Die Kosten der Ökomassnahmen in der Schweizer Landwirtschaft', *Agrarwirtschaft und Agrarsoziologie*, 1/03, pp. 103-130.

Marggraf, R. (2003), 'Comparative assessment of agri-environment programmes in federal states of Germany', *Agriculture, Ecosystems and Environment*, 98, pp. 507-516.

Nemecek, T., Huguenin-Elie, O., Dubois, D. and Gaillard, G. (2005), 'Ökobilanzierung von Anbausystemen im Schweizerischen Acker- und Futterbau', *FAL Schriftenreihe No. 58*, Reckenholz, Eidgenössische Forschungsanstalt für Agrarökologie und Landbau (FAL).

OECD (2007), 'Policy design characteristics for effective targeting', *in* Working Party on Agricultural Policies and Marktes (ed.), Paris, Organisation for Economic Co-operation and Development (OECD), AGR/CA/APM(2005)32/FINAL.

Pearce, D. (2005), 'What constitutes a good agri-environmental policy evaluation?', *Evaluating Agri-Environmental Policies. Design, practice and results*, Paris, Organisation for Economic Co-operation and Development (OECD).

Röhm, O. and Dabbert, S. (2003), 'Integrating Agri-environmental programs into regional production models: an extension of positive mathematical programming', *Amer. J. Agr. Econ.*, 85, 1, pp. 254-265.

Sanders, J. (2007), 'Economic impact of agricultural liberalisation policies on organic farming in Switzerland', *Institute of Rural Sciences*, PhD thesis, Aberystwyth, University of Wales.

Schader, C. (2009), 'Cost-effectiveness of organic farming for achieving environmental policy targets in Switzerland', *Institute of Biological, Environmental and Rural Sciences*, Ph.D. thesis, Aberystwyth, Aberystwyth University, Wales. Research Institute of Organic Farming (FiBL), Frick, Switzerland.

Schmid, E. and Sinabell, F. (2006), 'Modelling organic farming at sector level - an application to the reformed CAP in Austria', *International Association of Agricultural Economists Conference, August 12-18, 2006*, Gold Coast, Australia, International Association of Agricultural Economists (IAAE).

Swiss Federal Council (2009), 'Weiterentwicklung des Direktzahlungssystems - Bericht des Bundesrates in Erfüllung der Motion der Kommission für Wirtschaft und Abgaben des Ständerates vom 10. November 2006 (06.3635)', Bern, Schweizerischer Bundesrat.

Tinbergen, J. (1956), *Economic policy: Principles and design*, Amsterdam, North Holland.

von Alvensleben, R. (1998), 'Ökologischer Landbau aus Sicht der Umweltökonomie', Berlin, AGÖL-Tagung, 23.1.1998.