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Lessons learned and policy implications from 20 years of Swiss agricultural policy reforms: A review of policy evaluations

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Abstract. Learning from the experiences of other countries can support efforts to improve agricultural policies. Switzerland provides an interesting case because its policy is exceptionally targeted towards the establishment of sustainable production systems. We describe the history and the current state of Swiss agricultural policy, review evaluations of policy reforms, summarise their impact and outline the lessons learned for policy developments in other countries. We discuss four implications: i) some goals have been met, albeit at a high cost, and so, increasing efficiency of policies is key; ii) there is a need for more coherence and coordination regarding the different policy programmes (i.e. in the sense of a 'food system policy'); iii) cross-compliance measures (i.e. minimum standards for receiving support) have an important leverage effect; and iv) policy differentiation (e.g. by spatial targeting) and increasing farmers' discretion over how to achieve goals (e.g. by implementing results-based payments) are key for future policies.

Keywords: agricultural policy, comparative studies, policy comparison, policy evaluation, agriculture and food policy, farm support.
JEL codes: Q01, Q18, Q57.

1. INTRODUCTION

Agricultural policies are essential in achieving a sustainable and resilient farming sector. Agricultural policy goals and instruments have high heterogeneity across nations, which reflects the different historical developments of and fundamental differences in societal needs with regard to agricultural policies worldwide (Swinnen, 2018). Policy learning from the experiences of other countries provides an important entry point for improving agricultural policymaking. Switzerland, which is geographically situated in the heart of Europe but not part of the European Union or the European Common Agricultural Policy (CAP), provides an interesting case for policy learning.

Agricultural policy in Switzerland is characterised by its strong governmental support. The producer support estimate for Swiss agriculture is about 50%, which implies that half of farmers' gross receipts are based on public

support (OECD, 2022). The total amount of governmental spending is approximately 4 billion Swiss francs (CHF)[1] per year for about 50,000 farms and a total agricultural area of 1.04 million hectares (FOAG, 2022b). The total cost for taxpayers and consumers in 2022 amounts to roughly CHF130,000 per farm per year, or about CHF6000 per hectare of agricultural land per year.

In addition, Swiss agricultural policy has been a forerunner in environmental and animal welfare programmes. In 2022, about 40% of direct payments to Swiss farmers are targeted towards biodiversity conservation, landscape maintenance, sustainable production systems and animal welfare. Swiss agriculture's high level of support for environmental and animal welfare programmes, and its unique policy interventions in Europe, provides a valuable example for policy learning. This is especially so, given the plans to improve environmental performance in the CAP (e.g. via the Farm to Fork strategy; (e.g., Schebesta & Candel, 2020) and by the UK as it tries to make its agricultural policies "greener" (e.g., Gravey, 2019).

In this paper, we present and analyse the goals and instruments of Swiss agricultural policy. We also describe the historical development and implementation of the policy and outline its effectiveness by reviewing policy evaluations over the last 20 years. We discuss the lessons learned from Swiss agricultural policy to provide insight for other countries, including not only the positive aspects that should be followed but also the negative ones that are better avoided. On this basis, we derive the implications of Swiss agricultural policy development that may have promise in other farming contexts and environments.

The design and development of Swiss agricultural policy has previously only partly been described (e.g., Curry & Stucki, 1997; El Benni & Lehmann, 2010; Mann, 2003; Mann & Lanz, 2013; Schmid & Lehmann, 2000). In its latest review of Swiss agricultural policy, in 2015, the OECD focused on recommending how to develop further existing policies on a strategic level (OECD, 2015). Since then, no overview has been provided of the most recent reform steps that aim to make Swiss agriculture more ecologically sustainable. Other agricultural policy reviews and comparisons, such as those between the EU and the US (Baylis, Peplow, Rausser, & Simon, 2008; Blandford & Matthews, 2019) and between the CAP and individual countries, such as the UK after Brexit (e.g., Roederer-Rynning & Matthews, 2019), have provided insightful descriptions of ongoing policy changes. In this context, countries that want to support more environment- and animal-friendly multifunctional agricultural sectors can gain insights from the experiences drawn from Switzerland's highly complex agricultural policy (e.g. 104 different direct payment measures are currently implemented), its specific policy programmes and their synergies and trade-offs.

Our analysis presents and discusses the lessons learned from Swiss agricultural policy approaches and provides implications for potential agricultural policy development in Switzerland and other (European) countries. Our contribution focuses on three aspects that extend the current literature on agricultural policy learning. First, we present details and experiences of a wide range of instruments within a multifunctional agricultural landscape and review a (almost) complete set of existing agricultural policy measures that have been applied. Such a comprehensive analysis provides a unique perspective on the fact that agricultural policy is more than the sum of its parts. Second, the recent shift in Swiss agricultural policy towards environmental and animal welfare goals and tailored policy instruments may be exemplary for future European agricultural policy development (Schebesta & Candel, 2020).[2] Despite such efforts, Switzerland is currently observing an increase in societal discourses that have revealed gaps between societal demand for what agricultural and food systems should deliver, especially in terms of environmental performance and animal welfare, and what the current policies allow them to reach (e.g. Huber & Finger, 2019). It is likely that this is also emerging in other countries. Third, Switzerland covers a large gradient of natural environments, from Alpine regions to hilly landscapes and highly productive plains, and thus represents an interesting case for analysing the potential of differentiated policy measures within an agricultural policy mix. The results from our analysis provide important entry points for the discussion of policy instruments and the transformation of food and agricultural policies not only for Switzerland but also for other countries.

The remainder of this paper is structured as follows. We begin by describing the historical development of Swiss agricultural policy. In the second section, we provide an overview of the current goals, programmes, and instruments of Swiss agricultural policy. In the third section, we provide an overview of the goals achieved from the different policies and discuss the effectiveness and efficiency of the various policy measures, based on a review of Swiss agricultural policy evaluations. We then synthesise the impact of the different policies, dis-

[1] Numbers refer to the year 2021. In 2023 1 Swiss franc (CHF) equals ca. 1.05 euro and 1.11 US dollar.

[2] We do not provide an explicit comparison between Swiss agricultural policy and the CAP beyond a short description of their historic development (see the supplementary material)

cuss the lessons learned and present the implications for policy-making and potential learnings to other country-specific agricultural policies.

2. HISTORICAL DEVELOPMENT OF SWISS AGRICULTURAL POLICY TO DATE

2.1. Protective policies in the twentieth century

Governmental regulation of the Swiss agricultural sector started at the beginning of the twentieth century. The evolution of a new "food regime" at the start of the previous century, when farmers were increasingly integrated into the industrialising world and dependent on trade as well as mechanical and chemical inputs (Tauger, 2020), had triggered various laws aiming to protect Swiss farmers from low producer prices due to imports, reduce their debt and maintain their production capabilities. After the world wars, a new constitutional article defined a liberal economic policy in Switzerland – albeit with the exception of the agricultural sector. This "exceptionalism" provided a new legal basis for protective policies. The subsequent 35-year phase (1950–1985) was characterised by protective market regulations for grain, milk and sugar, during which Switzerland became the greatest supporter of agriculture worldwide (Huber & Finger, 2019). The producer support estimate PSE – that is, the transfer from taxpayers and consumers to farmers – was at about 75% in the mid-1980s. This implies that three-quarters of agricultural gross receipts came from either market protection or other forms of price support (OECD, 2015).

2.2. The era of decoupling

The flipside of this massive support until the beginning of the nineties was that the Swiss government spent almost CHF 2 billion to guarantee high farm-gate prices and sell production surpluses from domestic overproduction on international markets, while increasing environmental awareness brought to light the severe environmental problems of this highly intensive production system. At the same time, the negotiations in the Uruguay round of the General Agreement on Tariffs and Trade, and the subsequent foundation of the World Trade Organization (WTO), placed additional pressure on Swiss border protection measures and level of support for producers. This domestic and international pressure led to a major change in Swiss agricultural policy in the 1990s as Switzerland adapted its federal constitution to public and international demands and income and price policies were decoupled. This decoupling was implemented in two successive reform steps. The first of these was in 1992, when Switzerland rejected economic integration with the European Union but decided to pursue a route of agricultural policy reform combined with bilateral agreements, especially with other European countries (El Benni & Lehmann, 2010). Price support was reduced, and decoupled direct payments were introduced for all farmers without geographical restrictions. In addition, farmers could voluntarily apply to a so-called integrated production programme,[3] for which additional payments were provided (Finger & El Benni, 2013).

With the next reform step, in 1999, price guarantees (e.g. for crops and milk) were abolished. Governmental spending was converted into direct payments, and tariff-rate quotas were introduced that complied with WTO rules. Direct payments were divided into general (lump-sum area payments) and ecological direct payments. To be eligible for these direct payments, cross-compliance measures were introduced that guaranteed a minimum environmental and social standard across all farms. Farmers located in hilly and mountainous regions additionally received payments to compensate for unfavourable production conditions and thus maintained production and concurrent landscape maintenance in remote mountain areas. While the first reform step, in 1992, was legally based on two articles, 31a and 31b, newly introduced into agricultural law, the regulatory change in 1999 was based upon the new Article 104 of the federal constitution, which had been accepted in a public vote in 1996.

Article 104 (see the box in the online supplementary material A) defined multifunctionality as the underlying justification for public support of agriculture (Hediger, 2006) and led to a stable political phase between 1999 and 2015. Decoupling shifted the financial burden for agricultural support from the consumer (via consumer prices) to the state, and thus the taxpayer (via tax money used for direct payments). Switzerland's new constitutional article explicitly foresaw a periodic examination of the agricultural policy strategy. The annual federal budget for the agricultural sector, amounting to around CHF 4 billion (approximately 7% of total governmental spending) had to be approved every four years by the Swiss parliament.

This recurrent review of the Swiss agricultural policy led to four consequent reform steps named after the targeted years of the reforms (AP02, AP07, AP11 and

[3] In addition, farmers founded the private food label organisation Integrated Production (IP Suisse) with the goal to align agricultural production with environmental principles such as farm nutrient balance, diversified crop rotation, soil protection and the targeted application of pesticides.

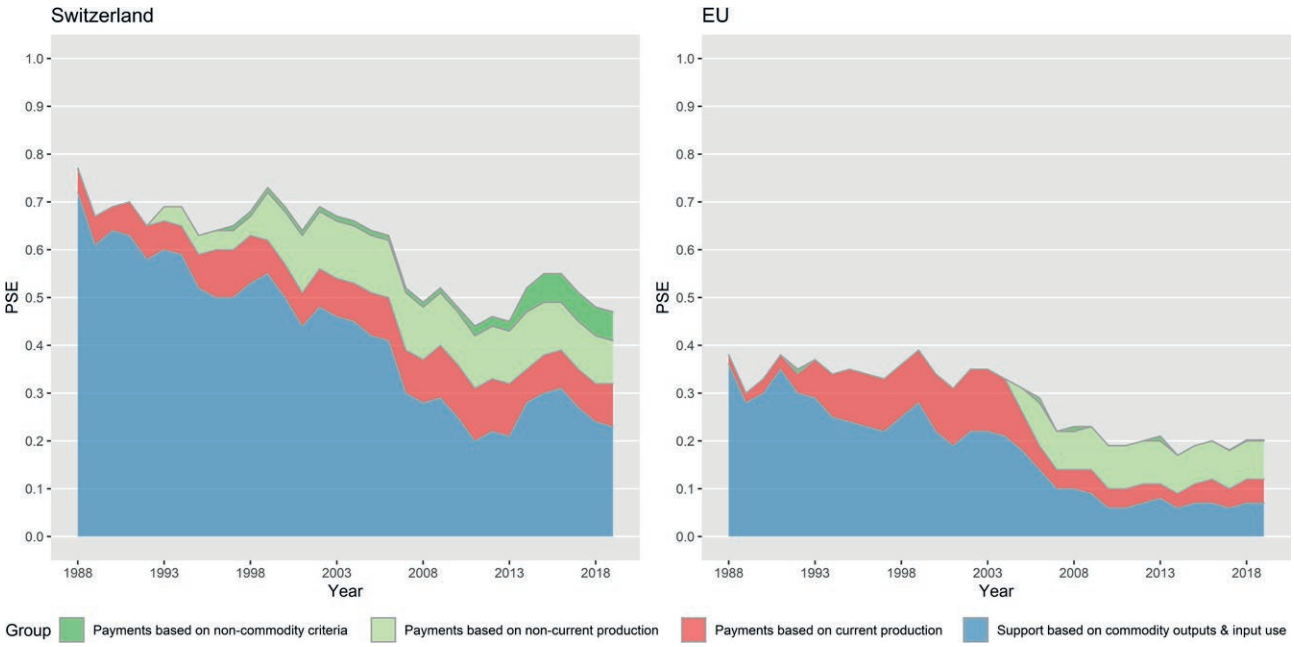

Figure 1. Comparison of producer support estimates (PSE) between Switzerland and the EU. Data from OECD (2022). The different colours refer to the gradient of coupling between the policies and agricultural commodity output. The instruments represented in green are fully decoupled from agricultural production (e.g. a biodiversity conservation programme). Light green refers to support that is not linked to current output (e.g. area-based payments for landscape maintenance). Red refers to payments coupled to production (e.g. area-based payments for a specific crop, such as sugar beet). Blue refers to support that is coupled to commodity outputs or input use.

AP14–17). Policy developments in this period were in line with the reform agenda, including various deregulation and liberalisation steps, e.g. the bilateral trade agreement on cheese with the EU and abolition of milk quotas (El Benni & Lehmann, 2010). During this time, the development of agricultural policy was dominated by the administration and the executive (Hirschi, Widmer, Briner, & Huber, 2013). Overall support and protection decreased slightly, and the producer support estimate amounted to about 50% in 2021, compared to around 18% in the European Union (see Figure 1).

2.3. Increasing societal pressure triggers more environmental sustainability and animal welfare

In Switzerland, citizens can influence public policy via plebiscites. Popular initiatives allow any citizen to launch a proposal to revise the Federal Constitution. In the period from 2016 to 2022, ten popular initiatives were launched that addressed agricultural policy issues, including food security, food sovereignty, speculation on foodstuffs, fair-trade and animal welfare and pesticides. As a result of these, two opposite societal concerns collided. On the one hand, farmers' organisations wanted to re-introduce protective measures (e.g. stricter import restrictions, higher governmental market control); on the other, Swiss citizens criticised the fact that agriculture had not been meeting its environmental and animal welfare goals. The increase in popular initiatives represented a shift from a government-driven process towards "grass-roots initiatives" that had been developed and articulated outside, or in addition to, the legislative and executive processes. This phenomenon revealed an increasing gap between societal demand and the policies and plebiscites, which could be seen as a barometer of the changes in societal preferences for agriculture and related policies (Huber & Finger, 2019). While nine out of ten popular initiatives had been rejected by Swiss voters, they still had a considerable impact on the development of Swiss agricultural policy by putting environmental issues at the top of the agenda (Finger, 2021; Schmidt, Mack, Möhring, Mann, & El Benni, 2019). The pressure led, for example, to the introduction of a new constitutional article (104a) in 2017 that evolved from a counter proposal to a popular initiative that extended the role of agricultural policy towards a more comprehensive "food system policy". Moreover, even though the latest reform process in Switzerland had been delayed (AP22+), the public pressure had still led to a strengthening of agricultural laws on pesticide use and nitrogen policies. More precisely, from 2023 onwards, agricultur-

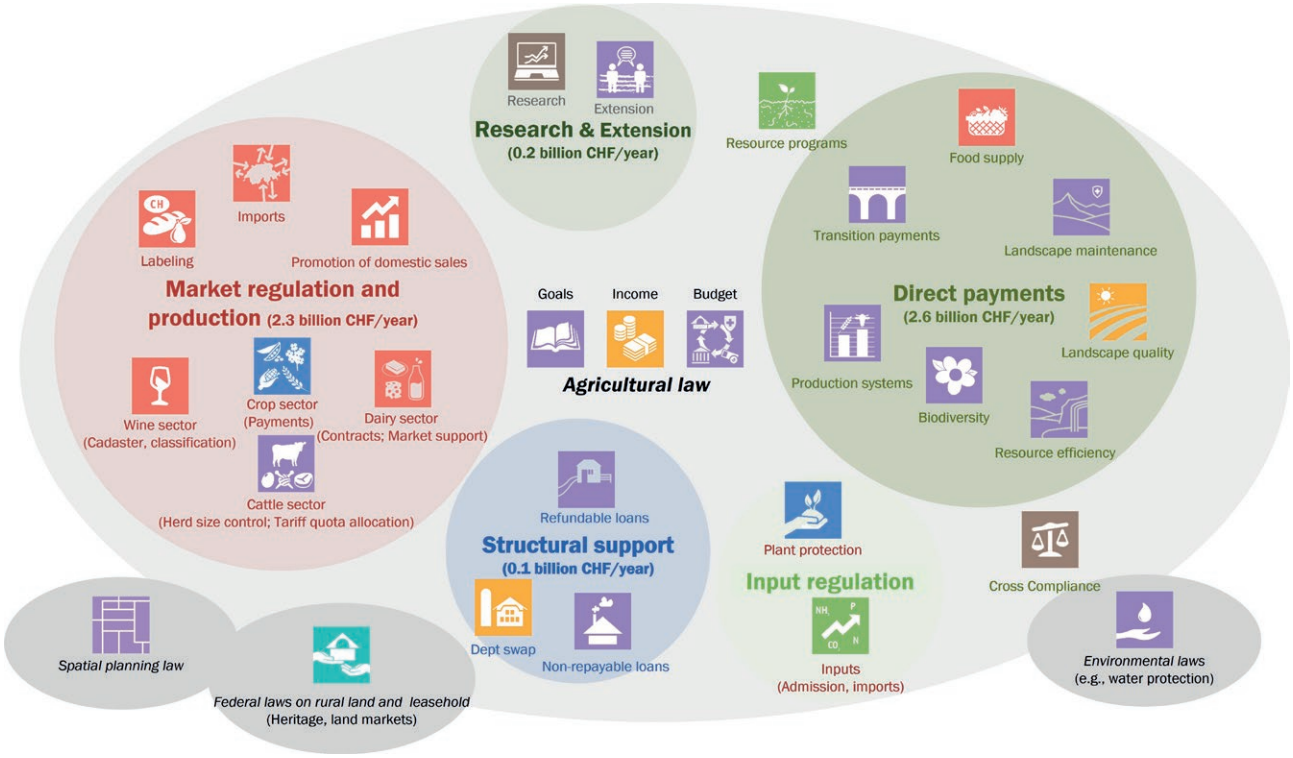

Figure 2. Overview of Swiss agricultural policy, including major legal fundamental agricultural law, federal law on rural land, law on leasehold, spatial planning law and environmental law (grey circles). Financial support to farmers is mainly provided through the agricultural law, whereas the other laws include command-and-control regulations. Major instrument categories within Swiss agricultural law are the direct payment system (green), input regulation (light green), research and consulting (dark green), market regulation and production (red) and structural support (blue). Icons reflect the major policy programmes in these areas. The numbers in CHF are monetary transfers from consumers and taxpayers to farmers per year, which have been stable since 2010. The figure has been adapted from Huber (2022). Please note that the bubbles are for illustrative purpose only and do not represent the (monetary) size of the respective law area.

al policy aims to reduce nitrogen and phosphorus surpluses by 20% until 2030, and the risks associated with the use of plant protection products should be halved by 2027 (FOAG, 2023).[4]

Swiss agricultural policy and the CAP have very similar roots and goals, and they developed on par with respect to the decoupling of income and price policies (see online supplementary information B). However, Swiss agricultural policies have on average gone further than those of the EU with respect to aspects of environmental and animal welfare (see e.g., Metz, Lieberherr, Schmucki, & Huber, 2020; Pe'er et al., 2014). The question is whether and how other countries could learn from the Swiss experience to better consider environmental challenges in agricultural policymaking (Alons, 2017; Pe'er et al., 2020).

3. CURRENT PROGRAMMES AND INSTRUMENTS IN SWISS AGRICULTURAL POLICY

Swiss agricultural policy is a sectoral policy at the federal level. The main regulations are concentrated within a few laws with little linkage either to each other or to cross-sectoral policy areas such as regional, environmental and climate policy (Figure 2). In the following, we summarise the overarching goals of Swiss agricultural policy and describe its interventional logic. We then present two key policy instruments of the agricultural law, namely direct payments, and market regulation. Details of the other policy programmes in the agricultural law (that is structural support, input regulation and research and education) are presented in the online supplementary material C.

3.1. Policy goals and interventional logic

The goals of the Swiss agricultural policy are derived from the federal constitution (see online supplementary

[4] These targets are, however, still discussed in the ongoing political process of the AP22+.

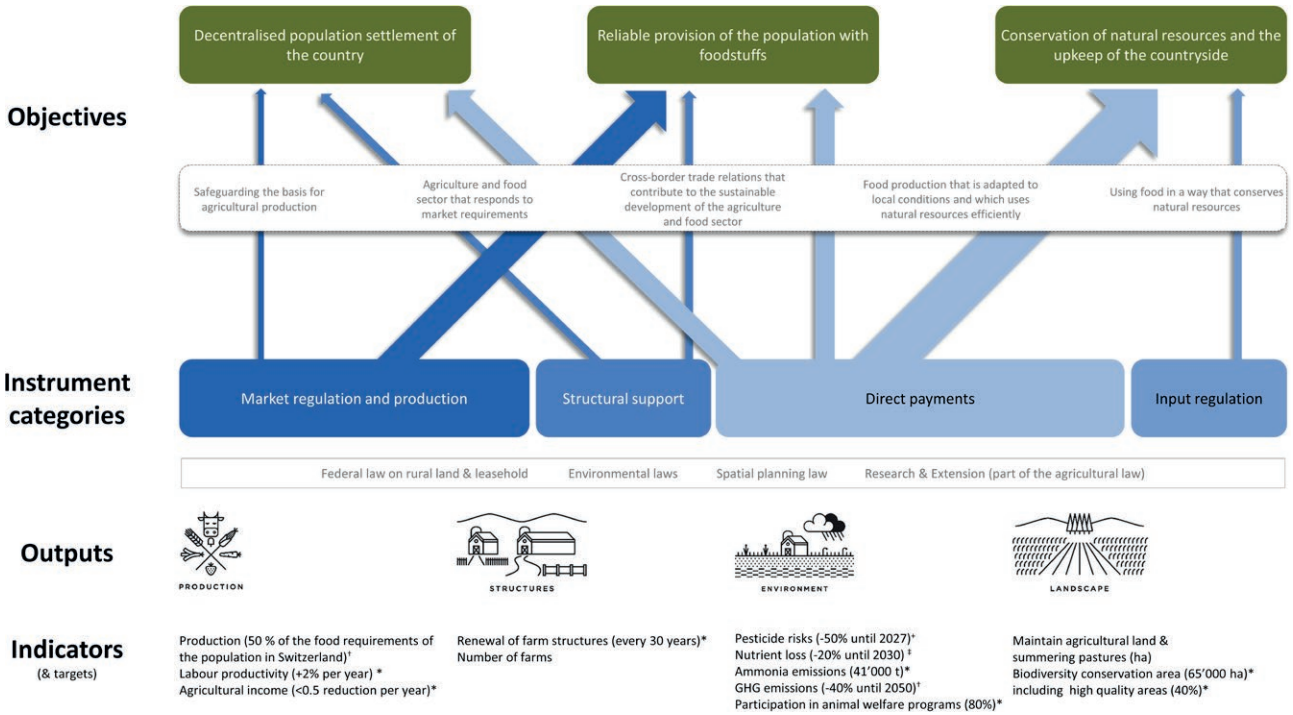

Figure 3. The basic intervention logic summarising the different and overlapping links between the policy goals, main instrument categories, outputs, and indicators in the Swiss agricultural law. The goals of Article 104 are in green; the additional goals of Article 104a are in the white dashed box; instruments with higher impacts on production are in darker blue. Other laws as well as research and extension are depicted as basis or supporting categories. Sources for indicators and target values: ‡FOAG (2022a); +FOAG (2023); †FOAG, BLV, and BAFU (2023) *FC (2020) with reference to the year 2021. Please note that the bars and arrows are for illustrative purpose only and do not represent the (monetary) size of the respective instrument. Formulation of the goals are taken from the original translation of the Federal Constitution of the Swiss Confederation (admin.ch).

material A). There are two key elements: First, the article defines the multifunctional role of agriculture; that is, the agricultural sector should contribute towards a) the reliable provision of foodstuffs to the population, b) the conservation of natural resources and upkeep of the countryside and c) the decentralised population settlement of the country. This implies that the agricultural sector not only has a role as a producer of food but also as a steward of the environment and a key player in rural development. Second, the constitution states that these goals should be achieved by means of a sustainable and market-orientated production policy. In principle, this reflects the main intervention logic[5] (see Figure 3) and the idea of decoupling income and price support in the agricultural sector; that is, market prices should be based on the principle of economic freedom, whereas the confederation can supplement incomes by means of direct subsidies. It is important to note, however, that market-orientated production does not imply fully liberalised and deregulated markets. To fulfil the goal of ensuring food supplies, Swiss agricultural policy directly and indirectly supports market prices, the competitiveness of the agricultural sector and farm structures and rural infrastructure.

Article 104 of the Federal Constitution also predefines four categories of instruments that should be used to achieve these goals (see Figure 3). These main policy categories are i) direct payments to support methods of production that are specifically natural and animal friendly; ii) market regulation to protect farm gate prices and declare the production origin and quality of foodstuffs; iii) structural support (i.e. the provision of investment aids and regulation of the consolidation of agricultural property holdings); and iv) input regulation to protect the environment, e.g. against the excessive use of fertilisers, pesticides and other inputs. The article also provides the basis to support agricultural research, counselling, and education, providing the basis of the Swiss agricultural knowledge system (Obrist, Moschitz, Home, & 2015). Finally, the article provides links to other impor-

[5] An intervention logic links the objective that needs to be met with the policy options that exist.

tant laws, such as the Federal Law on Rural Land and Leasehold and the Environmental Law. The output indicators and the targets of the different policies are set out in various reports of the Federal Office for Agriculture (FOAG, 2022a) and/or the Federal Office for the Environment (BAFU & BLW, 2016), although they are constantly debated and revised as part of political processes.

Article 104a, which was introduced in 2017 through a public vote, strengthens the role of food security formulated in the original 104; that is, it states that the confederation should safeguard the basis for agricultural production by maintaining the extent of agricultural land and guarantee that food production is adapted to local conditions. In addition, the new article also specifies the role of trade in securing food availability by stating that cross-border trade relations should contribute to the sustainable development of the agriculture and food sector. Finally, the article also states that food should be used in a way that conserves natural resources (related to food waste, as an important policy goal).

The clear setting of the linkage between the objectives and instruments shows that Swiss agricultural policies are strongly anchored in the Federal Constitution. The fact that the Swiss public can suggest directly amending the constitution by popular initiatives, and that this democratic tool has been increasingly used in recent years, means that the Swiss constitution can be seen as a "social contract" between the agricultural sector and the rest of the society (see e.g., Feindt et al., 2019).

This brings a high level of legitimacy to the decision-makers on Swiss agricultural policy. On the flipside, the federal constitution is a reservoir of conflicting goals[6] that have led to many practical trade-offs in the implementation of agricultural policy programmes and instruments, as well as their intended outcomes. This is also shown in the basic intervention logic (see Figure 3), illustrating the many overlapping links between the main objectives in the constitution and the four policy categories.

3.2. Direct payments

At the heart of decoupling income and price policies, as well as incentivising the uptake of more sustainable farming practices, is the substitution of price regulations with direct payments that remunerate farmers for their multifunctional role in society. The Swiss agricultural direct payment system has two conceptual pillars. First, payments are conditional on cross-compliance measures. This implies that a farm is only eligible for direct payments if it fulfils minimum environmental requirements (in the so called "proof of ecological performance") and those of individual farmers (e.g. age, education; see online supplementary material C1 for a detailed description of these standards).

Second, the conceptual design of the current direct payment system is inspired by the so called Tinbergen rule, which states that each individual instrument should address a single goal (Mann & Lanz, 2013). This implies that there exists a direct payment programme for each specific goal of Swiss agricultural policy, namely i) ensuring food supply, ii) the maintenance of cultural landscapes, iii) the promotion of landscape quality, iv) increasing resource efficiency, v) biodiversity conservation and vi) the development of environmental- and animal-friendly production systems. The conceptual alignment of the Swiss direct payment programme with the Tinbergen rule aims to ensure that the schemes within the corresponding programme are well-targeted to agricultural policy goals (e.g., S. Wunder et al., 2018). An overview of these payment schemes, and their budgets can be found in Table 1.

In addition to the targeting, each of the programmes may consist of different direct payment schemes and measures, which allows the corresponding direct payments to be "tailored" to production regions, farm types or landscape elements, which should ensure the additionality[7] of the policy (e.g., Guerrero, 2021). For example, the development of a nature- and animal-friendly production system contains payments for organic farming, crop production with restricted use of pesticides, animal welfare and reducing concentrated feed in milk and meat production. Each of these schemes, in turn, consists of different measures (i.e. payments tailored to crops or livestock units). Overall, the Swiss direct payment system consists of 104 different payments.[8]

The design and legal development of direct payments is driven by national authorities, while the responsibility for their administration (control, pay-out, cuts etc.) lies within the Swiss cantons. Thus, the subsidiarity of Swiss agricultural policy is rather low.

3.3. Market Regulation

Market regulations in Switzerland are based on the following four pillars: i) the regulation of imports, ii) the

[6] Switzerland does not have a constitutional court, and conflicting articles may be added to the constitution.

[7] Additionality implies that the direct payment improves environmental outcomes compared to the baseline (e.g., business as usual).

[8] Note that these payments are often characterised by complex substructures and conditions, so the complexity is even higher than the 104 payment schemes.

Table 1. Overview of direct payments in Swiss agriculture (as of 2022).

Objective	Payment for…	No. of measures	Measures tailored to…	Design	Budget (million CHF)	Share (2021)
Ensuring food supply	Producing food on agricultural land	8	Production zones (decreasing with altitude); lower payments for areas under the biodiversity scheme; additional payment for crop rotation area	Action-based scheme (payment per ha of agricultural land)	1078	39%
Landscape maintenance	Cultural landscapes	5	Production zones (increasing with altitude; zero for lowlands)	Action-based scheme (payment per ha of agricultural land)	140	5%
	Steep slopes and very steep slopes	7	Different gradients of steepness (and specific payments for grapes)	Action-based scheme (payment per ha of agricultural land)	149	5%
	Summering pastures	6	Specific animals (cattle v sheep) and differentiating between farms that send or receive animals for summering	Action-based scheme (payment per livestock unit living 100 days on summering pastures)	239	9%
Biodiversity conservation	Areas that support biodiversity maintenance	17	Production zones and type of biodiversity element or measure (e.g. less intensively used grassland, flowering fallows, trees)	Action-based scheme (payment per ha; elements like trees are converted on a ha basis)	159	6%
	Areas that support biodiversity of high quality	17	Production zones and biodiversity elements. No payments for measures on cropland	Result-based scheme (payment per ha for a certain quality, i.e. minimal number of rare species found)	163	6%
	Agglomeration bonus	6	Production zones and biodiversity elements	Collaborative payment scheme (payment per ha)*	113	4%
Landscape quality	Landscape quality	4	Project goals (i.e. ecological elements or land-use types)	Collaborative payment scheme (payment per ha or livestock unit on summering pastures)*	147	5%
Sustainable production systems	Organic agriculture	3	Crops (vegetables and grapes, other crops and grassland)	Action-based scheme (payment per ha)	67	2%
	Extensive production of cereals	1	-	Action-based scheme for crop production without pesticides, except for herbicides (payment per ha)	36	1%
	Grassland-based milk and meat (GMF)	1	-	Action-based scheme that restricts the concentrated use of roughage-consuming animals and the proportion of maize silage from arable land (payment per ha of grassland)	112	4%
	Animal-friendly housing systems	3	Animal type (pigs, poultry, cattle and sheep/goats)	Action-based scheme (payment per livestock unit)	98	3%
	Animals under free-range production systems	7	Animal type	Action-based scheme (payment per livestock unit)	198	7%
Resource efficiency	Agricultural practices	19	Agricultural practices (direct sowing, precision agriculture techniques, wash-up systems in pesticide applications, reduced nitrogen in feed for pigs)	Action-based scheme (payment per ha or livestock unit)	43	2%
Total		104			2'732	100%

*Farmers receive a bonus payment on top of the action-based payment if they designate land for conservation that is in close proximity to neighbours' conservation areas. Eligibility depends on the project (defined by farmers, cantons, farm advisors and members of ecological planning firms). Data are from OECD PSE (OECD, 2022). For details of the different payments, refer to the online supplementary material C2. Note that in 2023, there have been further adjustments in direct payment schemes (e.g. Mack, Finger, Ammann, & El Benni, 2023).

Table 2. Overview of total financial support (border protection and governmental spending) for Swiss farmers.

Objective	Instrument	Targeted or tailored to…	Support (million CHF)	Share PSE (2021)
Market price support	Tariffs and tariff rate quotas	Wheat, barley, maize, rapeseed, milk, beef, pig meat, poultry, sheep meat, eggs, other	2447*	41.5%
Multifunctionality (including environmental goals)	Direct payments	See Table 1	2732	46%
Competitiveness	Milk price supplement for cheese production	Milk used to produce cheese	201	9%
	Payments for non-silage feeding of cows	Milk used to produce raw milk cheese	32	
	Payments for commercial milk	Milk used for export products (chocolate, biscuits)	149	
	Area payments	Oilseed cultivation, sugar beet, leguminous crops, grains	77	
	Concession energy prices		65	
Increase demand for domestic products	Promotion of domestic agricultural products	Advertisement of domestic product categories (milk, meat, fruits, vegetables)	67	1%
Structural support	Refundable loans	Stables, young farmer programme, farm diversification	32	2%
	Non-repayable loans	Stables, residential buildings	3	
	Development and maintenance of infrastructure	Water and road infrastructure, ameliorations, regional projects to support local value chains	84	
Support of resource efficiency and sustainability	Payments for innovative projects (resource programmes)	Different agricultural practices or technologies	25	0.5%
Total**			5914	100%
Governmental spending thereof (i.e. federal budget)			3402	58%

Data source: OECD (2022) *Price support measured in OECD indicator (i.e. market price support); that is, annual monetary value of gross transfers from consumers to agricultural producers arise from policy measures and create a gap between domestic producer prices and the reference prices of a specific agricultural commodity measured at the farm-gate level. **Not considered: Transition payments (expiring in 2023; CHF67 million). Total producer support estimate in 2021: CHF6008 (OECD, 2022). Additional governmental support, namely support by cantons (~CHF200 million), research and extension (~CHF227 million) and social contributions (~CHF60 million); cost of public stockholding (~CHF50 million); and administrative costs (~CHF60 million). Total governmental spending: ~CHF4.1 billion. For further details of the different policy programmes, refer to the online supplementary material on C3 (market regulation), C4 (structural support), C5 (input regulation) and C6 (research and extension).

legal principles for the regulation of domestic markets, iii) the regulation of labels and promotion of domestic sales and iv) the specific support of sensitive product markets (crop, wine, cattle, and dairy). These policies create a highly regulated market environment for Swiss farmers and other market actors. In the following, we describe the key policies in each of the four domains.

Border protection was and still is one of the most important instruments in Swiss agricultural policy. With the exception of the free trade agreement for cheese between the European Union and Switzerland (see Finger, Listorti, & Tonini, 2017; Irek, 2022), the import of agricultural products is restricted by tariffs and governed by tariff-rate quotas. Consequently, almost 40% of the total support for Swiss farmers (as measured by the producer support estimate) stems from market price support (see Table 2).

In contrast to imported food, Switzerland does not regulate domestic production under public law. However, it provides a legal basis for private regulations via stakeholders in the food value chain. The federal government delegates market regulations to the members of different food value chains, including producer organisations, food processors, traders, and retailers. These interest

organisations (so-called "branch organisations") have the right to determine production volumes, target prices and market-clearing measures. The purpose of these "branch organisations" is to countervail market power abuses by input suppliers, the food industry and retailers and guarantee secure food availability for consumers.

The government also provides a legal basis for the labelling of agricultural products, such as with respect to type of production (organic) or origin (mountain or Alps) and the protected designation of origin (i.e. Appellation d'origine protégée, AOP, and Indication géographique protégée, IGP). These geographical indications allow typical specialties from defined areas to be protected and differentiated and support their competitiveness in domestic and foreign markets (Maye, Kirwan, Schmitt, Keech, & Barjolle, 2016).

Finally, the Swiss government directly regulates and supports specific markets. For example, it subsidises raw milk production that is used for cheesemaking (Finger et al., 2017) and funds compensation payments for milk and cereal production for export commodities. This reduces the costs of domestic food processors in highly competitive markets (cheese, chocolate, biscuits etc.). The government also subsidises the production of specific crops (payments for single crops) to increase their availability on domestic markets with payments per hectare. These crops include sugar beets, oilseeds, fodder crops and pulses for human consumption.

4. EFFECTIVENESS OF SWISS AGRICULTURAL POLICY: WHAT IS THE EVIDENCE?

In this section, we summarise the achievements of these regulations with respect to the economic, ecological, and social aims formulated in the constitution, focusing on the main output indicators (see Figure 3). We rely on a review of agricultural policy evaluations in Switzerland during the last 20 years. Our review is based on a systematic search of two sources. First, we systematically searched for agricultural policy evaluations in the Administration Research Actions Management Information System (ARAMIS) of the Swiss federal government. ARAMIS is a database in which the evaluations of the federal administration are stored. We searched the database using the search term 'agricultural policy' and found 105 studies from 2002 to 2022. We screened these studies and excluded projects and reports that did not i) focus on agriculture; ii) specifically address a policy instrument (e.g. basic research projects) or iii) evaluated correlations between land-use types e.g. extensively managed grasslands and ecological indicators e.g. bird index without focusing on a specific policy program or measure[9]. We found 16 relevant evaluations. Second, we searched for scientific publications that evaluate Swiss agricultural policy instruments. This search in Google Scholar resulted in additional 17 studies. In total, we included 33 evaluations in our review (see Table 3).

4.1. Economic performance: production and income

With respect to the production and economic goals of the Swiss agricultural policy, the outcomes have been mixed. On the one hand, the share of domestic food production of total consumption, (i.e. the degree of self-sufficiency) has been constant[10], with some fluctuations, over the last 20 years, despite a growing population (~20% in this period). Labour productivity has been steadily increasing, driven mainly by farm structural change and constant re-investment in farm structures and production infrastructure. The corresponding policy targets (i.e. calorie production, productivity increase and re-investment) have been met.

Farm incomes have also increased on average during the last 12 years (i.e. the period between 2010 and 2022). Key elements of this income development are border protection and farm size growth, increasing income from per-hectare direct payments. With respect to border protection, tariff rate quotas are the main instruments, which are highly effective in maintaining high farm-gate prices, as shown in different studies e.g. for meat and vegetables, (Loi et al., 2016) or for dairy products, (Hillen & von Cramon-Taubadel, 2019). In addition, the direct payments have become an important source of agricultural income, especially in rural and mountainous regions. Average direct payments amount to CHF2700 per hectare of all agricultural land in 2021.[11] While these payments are targeted towards public goods from agricultural production, they create windfall effects (i.e. increased income), an important and intended side-effect of the direct payment system in Switzerland. In particular, payments for ensuring food supplies, which comprise more than one-third of all direct payments, have a high income transfer effect (A. Möhring & Mann, 2020).

On the other hand, the massive support of agricultural production and farm incomes increases economic inef-

[9] Please note that we still cite some of these studies in the discussion.

[10] Average net self-sufficiency between 2015 and 2020 was 58%. Net self sufficiency i.e. self-sufficiency corrected for fodder imports, was on average 51%.

[11] Total support per ha of agricultural land (i.e., including border protection) amounts to ~CHF6000 (see Introduction). Thus, direct payments alone correspond to roughly 46% of the support (see also Table 2).

Table 3. Policy evaluation studies in Switzerland 2002–2022.

	Evaluation	Instrument	Key findings	Method	Source
1	Biodiversity programme	Payments for biodiversity	Payments increased the biodiversity conservation area. The combination of action- and results-based schemes increased not only average effectiveness but also windfall gains. Payments resulted in a positive return of investment (for the public).	Causal identification (difference in difference approach)	Wuepper and Huber (2022)
2	Biodiversity programme	Payments for biodiversity	Biodiversity promotion areas generally have a greater diversity of species and habitats than control areas. Quantitative targets (i.e. ha enrolled in the program) are met. Quality of biodiversity area (e.g. number of species) are not met, especially in the lowlands.	Monitoring of biodiversity, indicator assessment, regression analysis	E. Meier et al. (2021)
3	Resource programme	Resource programme (RP) and resource efficiency payments (REPs)	The RP is generally well received by those involved. However, the orientation of resource efficiency contributions lacks a clear focus on the impact of the measures promoted. This calls the subsidy into question. RP is more efficient than REPs.	Assessment of legal and governmental documents	EFK (2021)
4	Biodiversity programme	Agglomeration payments	The collaborative development of agglomeration projects is beneficial to increase the weight given to biodiversity by connecting conservation sites in the planning process of bonus payment schemes.	Spatial regression analysis	Huber et al. (2021)
5	Protection of domestic food via labelling	'Swissness' regulation	The Swissness regulation (i.e. regulation of minimal standards to label a product "from Switzerland") did not affect demand or supply of domestic agricultural products.	Assessment of legal and governmental documents, expert survey	Feige, Rieder, Annen, and Roose (2020)
6	Sustainable production system	Support for grassland-based milk production (GMF)	The GMF programme reduces the use of concentrated feed. No short-term effect on ecological outcomes was found. Economic outcomes improved with the programme.	Agent-based simulation model SWISSland	Mack and Kohler (2019)
7	Market integration and efficiency of seasonal tariff rate quotas	Tariff rate quotas (TRQs)	TRQs are effective in protecting domestic production against competing imports but lead to inefficiencies and create rents for importers.	Regression analysis (parity bounds model)	Hillen (2019)
8	Protecting the Swiss milk market from foreign price shocks	Border protection	Prices of tariff-protected dairy products are influenced by price developments in neighbouring countries. This could not be observed for the liberalised cheese market. The qualitative differentiation of Swiss products contributes more to reducing international price pressure than public border protection.	Price transmission analysis	Hillen and von Cramon-Taubadel (2019)
9	Border protection and downstream industries	Border protection	The high market power of up- and downstream industries results in mark-ups for agricultural inputs. More competition, less border protection and regulatory oversight could increase efficiency along the value chain.	Expert assessment	Wey and Gösser (2019)
10	Biodiversity programme	Payments for biodiversity	The biodiversity programme has had an effect, but shortcomings remain (especially with respect to the quality of the biodiversity areas). Implementation of the programme has been satisfactory, albeit with a high administrative burden. Education and training of farmers should be reinforced to increase effectiveness. Coherence with other policy measures should be checked.	Correlational analysis, interviews, case studies	Fontana et al. (2019)

(Continued)

Table 3. (Continued).

	Evaluation	Instrument	Key findings	Method	Source
11	Food supply support	Payment for food supply	Payments for food supply contribute effectively to calorie production and increase farm incomes. Efficiency could be improved by focusing payments on selected crops and fertile soils. The effectiveness of the instrument critically depends on the definition of food security.	Agent-based simulation model SWISSland	A. Möhring, Mack, Zimmermann, Mann, and Ferjani (2018)
12	Biodiversity programme	Agglomeration payments	There was high participation of farmers. The agglomeration bonus, however, did not allow the proportion of qualitatively valuable biodiversity conservation areas to increase (across all production regions). Complex administration was one important barrier.	Interviews, case studies	Jenny, Studer, and Bosshard (2018)
13	Production support of milk	Payment for milk processed into cheese	About two-thirds of the payments made benefit milk producers. The payment directly affects cheese production and exports but also has indirect effects on other dairy products. The findings suggest a net welfare gain from elimination.	Vector autoregressive model, CAPRI (partial equilibrium model)	Finger et al. (2017)
14	Ecological direct payments	Payments for biodiversity and landscape	There is large heterogeneity in provision costs for environmental services. Targeting and tailoring have the potential to increase the efficiency of the current direct payment system.	Cost accounting, interviews, case studies	Huber, Flury, Meier, and Mack (2017),
15	Sustainable production system	Support for grassland-based milk production (GMF)	The GMF programme reduces nitrogen surpluses, although the effect is very small. An increase in payments would have little additivity.	Agent-based simulation model SWISSland	Mack and Huber (2017)
16	Reduction in nitrogen surpluses	Instruments for the evaluation of nitrogen	Single policy instruments (meat tax, fertiliser tax etc.) are not sufficient to reach the targeted reduction in nitrogen surplus. A coherent policy mix is needed.	Agent-based simulation model SWISSland	Schmidt et al. (2017); Schmidt, Mack, Mann, and Six (2021); Schmidt, Necpalova, Mack, Möhring, and Six (2021)
17	Policy evaluation of tariff rate quotas	Border protection (TRQs)	TRQs partly reach their policy objectives, and the policy can therefore be considered to have been partly effective. However, the policy is clearly inefficient. In addition to the volume of the TRQs and the size of the out-of-quota duty, TRQ administration methods also have an important role in this respect.	Econometric time series analysis	Loi et al. (2016)
18	Evaluation of landscape quality payments	Landscape quality payment (LQP)	LQPs have proven to be an effective tool to pay for maintaining and promoting landscape quality. However, there are considerable windfall gains by farmers for measures that they would nevertheless have applied.	Case studies, expert workshops	Steiger, Lüthi, Schmitt, and Schüpbach (2016a)
19	Rural development (vitality and attractiveness of rural landscapes)	Rural development instruments	There was a positive correlation between municipalities with strong agriculture and vitality. Attractiveness showed only a weak negative statistical correlation. The study underlined the importance of agriculture and agricultural policy for rural areas.	Correlational analysis, expert assessment	Suter et al. (2016)
20	Investment aid	Investment support	Between a quarter and a third of the subsidised investment projects would have been implemented in exactly the same way even without the investment assistance; in this respect, they had no impact.	Assessment of legal and governmental documents	EFK (2015)

(Continued)

Table 3. (Continued).

	Evaluation	Instrument	Key findings	Method	Source
21	Measurement of farm size	Farm size regulations (standard labour force, SAK)	The SAK system was shown to be effective when used as an entry criterion through a threshold or as an administrative delimitation measure. However, when used as the sole selection criterion, the SAK system must be rated more critically.	Interviews, expert workshops, case studies	Huber, Meier, and Flury (2014)
22	Effects of agricultural policy reforms and farm characteristics on income risk	Direct payments	Agricultural policy reforms have decreased the variability of farm revenues and household incomes in Switzerland. Hence, the change from market support to decoupled direct payments reduces the income risk of Swiss farmers.	Econometric analysis of accountancy data	El Benni, Finger, and Mann (2012)
23	Investment aid in rural development	Investment aids	Investment aid contributes to the improvement of economic conditions in rural areas, and especially in mountain areas. This effect, however, is only moderate, considering the population of all processing enterprises.	Interviews, expert workshop, case studies	Flury, Gerber, Giuliani, and Berger (2012)
24	Support of summering pastures	Payments and regulations	The regulations for summering pastures are effective. Payments for summering pastures increase the utilisation of the Alps. However, the overall costs of summering may increase due to additional labour and infrastructure needs.	Farm survey, descriptive analysis of census data, expert assessment, agent-based modelling	Lauber, Calabrese, Von Felten, Fischer, and Schulz (2011)
25	Social protection	Investment aids	Instruments are effective. However, only very few farms need them, and thus, the efficiency of the programme is low, given its high administrative burden.	Expert interviews and assessment	Flury and Peter (2011)
26	Ordinance for ecological quality	Payment scheme	Action-based payments were found to have low effectiveness. A replacement with regionally tailored results-based payments was suggested.	Expert assessment, interviews, case studies	Mann (2010)
27	Agri-environmental policy	Cross-compliance standards	The evaluation of the 'proof of ecological performance' with respect to nitrogen (N) and phosphorus (P) showed an overall reduction of diffuse N and P pollution from agriculture. However, the targets (-33% N and -50% P) were not met.	Correlational analysis	Herzog, Prasuhn, Spiess, and Richner (2008)
28	Farm structural change	Regulation of farm succession	The ongoing development of size structure is so slow that it restricts the potential reduction of production costs, which would be important to increase the competitiveness of the farming sector.	Markov-chain simulation	B. Meier, Giuliani, and Flury (2009)
29	Policy-related transaction costs of direct payments in Switzerland	–	An assessment of policy-related transaction costs in the Grisons and Zurich cantons showed that these costs amount to 1.8 % and 2.8 % of the overall payments, respectively. Thus, the direct payments system is characterised by relatively high transfer efficiency.	Interviews, case studies	Buchli and Flury (2006)
30	Conception of the Swiss direct payment system	Direct payments	The experience from decoupling shows that structural change in agriculture is buffered, that the ecological quality of Swiss landscapes is maintained or enhanced and that individual programmes are partly effective.	Expert assessment	Mann (2003)
31	Effect of direct payment system	Direct payments	Direct payments have had their intended effect. Area-based payment increases and stabilises farm income.	Correlational analysis, sector supply model	Mann and Mack (2004)
32	Decentralised settlement of the country	All instruments	The federal government could spend around CHF700 million less each year on the goal of decentralised settlement. This implies that the current agricultural policy is not sufficiently effective with regard to targeting decentralised settlement and social goals.	Correlational analysis, benchmarking	Rieder, Buchli, and Kopainsky (2004)
33	Evaluation of market support (milk, meat and eggs)	Border protection	Border protection has proven effective in protecting the local grain, dairy and meat markets. No effect had been found for the egg market.	Econometric analysis (equilibrium displacement model)	Koch (2002)

ficiencies along three axes. First, border protection creates high costs for domestic consumers and intermediaries, reducing consumer choice and economic welfare (Gray, Adenäuer, Flaig, & van Tongeren, 2017; Hillen, 2019).

Second, the Swiss tariff rate quotas are economically inefficient, in the sense that they increase prices along the whole value chain and not only at the farm-gate level (Loi et al., 2016); they also create rents to downstream actors that would not exist in the absence of the policy (Hillen, 2019). In this context, studies have shown that there could be considerable market power among retailers. An empirical study after the first agricultural reform step in the early 1990s indeed found indications of asymmetric price transmission between produce and retail prices in the pork market (Abdulai, 2002) implying that downstream market actors have market power. An analysis focusing on dairy and cheese production between 2004 and 2018, however, did not find such asymmetric price transmissions from producer to consumer (Hillen, 2021). Even though a direct comparison between these studies is not possible, one potential reason for the absence of asymmetric price transmissions in more recent studies may have been the establishment of "branch organisations" that regulate domestic markets on a private law basis and that lead to very specific levels of protection for products of different types and quality, which reduces asymmetric price transmission (Esposti & Listorti, 2018; Hillen, 2021).

Third, the regulatory environment also slows resource allocation within the sector to more profitable farms. In fact, the governmental support of approximately CHF4 billion is higher than the net sectoral income of roughly CHF3 billion. This implies that capital invested by the government into agriculture does not fully trickle down to the farmers. This is, among others, since farmers are compensated for the (often costly) provision of ecosystem services, but it may also reflect that efficiency gains could be achieved by re-allocating governmental spending. Overall, the high regulatory environment maintains production levels in Swiss agriculture and ensures a certain level of sectoral income at the expense of low competitiveness and high input and consumer prices (Gray et al., 2017).

4.2. Environmental performance: landscape maintenance, biodiversity, resource efficiency and animal welfare

A key characteristic of Swiss agricultural policy is that almost 40% of governmental spending is for voluntary agri-environmental direct payment programmes supporting landscape maintenance, biodiversity conservation and sustainable production systems, including programmes for low-input use, animal welfare[12] and organic agriculture. In addition, there are important cross-compliance measures for the receipt of direct payments. The introduction of these measures clearly reduced some of the negative environmental effects of the agricultural sector and supported positive ones (e.g., Herzog, Jacot, Tschumi, & Walter, 2017). The environmental goals addressed by these payments have been assessed across the following six categories: biodiversity, landscape, greenhouse gas emissions, nitrogen and phosphorus as well as pesticides[13] (BAFU & BLW, 2016).

Biodiversity: There has been an increase in areas for biodiversity conservation, which has positive associations with flora and fauna. This was observed by several scientific field studies focusing on different taxa, such as vascular plants (Aviron et al., 2008; Herzog et al., 2005; Kampmann et al., 2008; Kampmann, Lüscher, Konold, & Herzog, 2012; Knop, Kleijn, Herzog, & Schmid, 2006), arthropods (Albrecht et al., 2010; Aviron et al., 2008), mammals (Zellweger-Fischer, Kéry, & Pasinelli, 2011) and birds (Birrer et al., 2007; Engist, Finger, Knaus, Guélat, & Wuepper, 2023; Zingg, Grenz, & Humbert, 2018; Zingg, Ritschard, Arlettaz, & Humbert, 2019). In addition, flower strips and other ecological elements have had a positive effect on biodiversity and pest management, as shown by different field and experimental studies (Herzog et al., 2017; Tschumi et al., 2016; Tschumi, Albrecht, Entling, & Jacot, 2015).

It is important to note that the Swiss direct payment programme to support biodiversity targets quantitative and qualitative goals (see Mack, Ritzel, & Jan, 2020). Areas enrolled in the biodiversity programme fulfil the quantitative target of 7% of the utilised agricultural area. Of these areas, more than 75% are also enrolled in agglomeration projects. This implies that the quantitative goals (measured in ha) are being met. However, the ecological quality of these areas is still insufficient to reverse or halt biodiversity decline in Switzerland (E. Meier et al., 2021) and that biodiversity is still not in a good state. For example, Engist et al. (2023) showed that there are fewer and less diverse birds in Switzerland than in neighbouring countries. In addition, the biodiversity programme also creates windfall gains for farmers (Wuepper & Huber, 2022).

Landscape: The maintenance of Swiss agricultural landscapes is threatened by two main factors: i) land

[12] Participation in animal welfare programmes is high. For example, in 2020, 60% of animals were kept in animal-friendly housing systems and 80% were under free-range production systems.

[13] Soil protection is an additional goal in Swiss agricultural policy. However, no monitoring programme has been implemented, and the goal achievement cannot be analysed.

abandonment in mountain regions and ii) the loss of agricultural land to settlement expansion in the lowlands. The explicit goal of the direct payments for landscape maintenance is to reduce annual land abandonment by 1400 hectares, or roughly 20% of the current rate. However, land abandonment is not monitored on a regular basis, and thus, an evaluation of the measures remains difficult. The introduction of the payments, however, stabilised the number of animals sent to summering pastures, despite predictions that the reduction would continue (Herzog & Seidl, 2018; Schulz, Lauber, & Herzog, 2018). Land abandonment is therefore much less eminent, compared to in other European mountain regions (Schirpke, Tasser, Leitinger, & Tappeiner, 2022). Finally, the evaluation of the landscape quality payments implied that farmers realise windfall gains with little environmental additionality (Mann et al., 2023; Steiger, Lüthi, Schmitt, & Schüpbach, 2016b).

Greenhouse gas emissions: The amount of greenhouse gas emissions reduced by 11.5% with the introduction of the direct payment system (7.3 million t CO2eq to 6.5 million t CO2eq). The main reasons for this were a reduction in the animal herd and decreasing inputs of mineral nitrogen (Leifeld & Fuhrer, 2005) after the introduction of the cross-compliance standards. Since then, emissions have remained stable, despite the goal to reduce agricultural greenhouse emissions by 40% by 2050 compared to the emission level in 1999 (FOAG et al., 2023).

Nitrogen and phosphorus: The introduction of cross-compliance measures for all Swiss farms reduced the nitrogen and phosphorus pollution of ground and surface water in the first years of the new policy at the beginning of the century (Herzog et al., 2008; Kupper, Bonjour, & Menzi, 2015). Thus, increasing environmental standards for all farms has had a major effect on the overall ecological performance of the agricultural sector. The main leverage came from the regulation that all farms should comply with the balanced use of nutrients (i.e. the annual nitrogen and phosphorus balance needs to be lower than 110% of crop requirements) to receive direct payments. However, from the initial reduction until about 2005, phosphorus and nitrogen surpluses remained constant. By 2020, the total nitrogen surplus amounted to more than 80,000 t. In certain regions in Switzerland with high animal density (see e.g. Spörri, El Benni, Mack, & Finger, 2023), the aerial deposition of nitrogen had risen to above 40 kg per ha per year (Reutimann, Ehrler, & Schäppi, 2022). Beyond the implementation of cross-compliance measures, political efforts to reduce nutrient load in Swiss agriculture have been less successful. For example, the grass-based milk and meat production scheme, which aims to reduce the use of concentrate in roughage-consuming animals, did not reduce nitrogen surpluses but created windfall gains for participating farms (Bystricky, Bretscher, Schori, & Mack, 2023; Mack & Huber, 2017; Mack & Kohler, 2019). The increased share of sustainable production practices such as organic production (Necpalova et al., 2018; Nemecek et al., 2011; Schader et al., 2013; Zimmermann, Baumgartner, Nemecek, & Gaillard, 2011) has also not substantially decreased nutrient load at the sectoral level. The next policy reform targets a reduction of 20% of phosphorus and nitrogen surpluses in Swiss agriculture by 2030, compared to the mean emission levels between 2014 and 2016.

Pesticides: At the beginning of this century, Swiss agricultural policies did not focus explicitly on the risks from pesticides, despite their broad application in all major Swiss crops (de Baan, Spycher, & Daniel, 2015). Policy goals for groundwater pollution (i.e. maximum of 0.1 µg of pesticides per litre of groundwater) have been achieved in the majority of monitoring locations (FC, 2017). In contrast, pesticide loads in small surface water bodies were found to be often above the legal thresholds (Spycher et al., 2018). This triggered societal and political debates and finally new political initiatives such as a national action plan and new direct payment programmes that also included public-private cooperation (e.g., Mack et al., 2023; N. Möhring & Finger, 2022; Schaub, Huber, & Finger, 2020). However, the monitoring and evaluation of these efforts remains a challenge, e.g. due to data availability regarding detailed pesticide use (similar to the EU e.g., Mesnage et al., 2021) and the complex assessment of health and environmental impacts (N. Möhring et al., 2023). The most recent policy goal is to reduce the risks from pesticides by 50% by 2027, compared to the situation in 2012–2015 (Finger, 2021; Mack et al., 2023).

4.3. Social sustainability dimension: decentralised settlement, family farming, income security, administrative burden

Despite farm structural change, agriculture is still an important pillar of Swiss rural economies, especially in the mountain regions (Ecoplan & HAFL, 2016; Flury, Huber, & Tasser, 2013; Rieder et al., 2004). New policy instruments focusing on investment support along the whole rural value chain successfully support the economic viability of many farms (Flury, Abegg, & Jeannerat, 2017). More importantly, while there is a continued discussion about what family farms imply (Guarín et al., 2020), the existing policies support continuous re-investment in farm structures. The mean

Table 4. Assessment of policy reforms, policy implications and lessons learned from Swiss agricultural policy.

Evaluations*	Assessment (what has worked and what not?)	Lessons learned	Implication for future reforms
[7], [8], [11], [13], [17], [22], [31], [33]	Stabilisation of farm gate prices and farm incomes	Policy is effective with respect to maintain farmers' livelihoods. Border protection and direct payments have a high-income transfer effect.	Increases in efficiency needed
[5], [7], [8], [11]	Self-sufficiency maintained despite growing population; production targets (in calories) are met	The farming sector can steadily improve productivity.	
[20], [21], [28], [32]	Slowing of structural change	Public policy maintains small-scale farming structures.	
[1], [5], [7], [8], [9], [13], [16], [17], [31], [33]	High costs for consumer and/or taxpayers	There is low efficiency in public support.	
[19], [21], [24], [25], [31], [32]	Rural viability is maintained, but only with high public spending		
[3], [19]	Many environmental goals with unclear target values or indicators	There is a lack of focus on funding.	Coherence required
[14], [16], [30]	Trade-off between production (in calories) and environmental targets (N, P, GHG etc.)	There is the potential to re-allocate funds (i.e. public funding for public goods).	
[20], [21], [23], [25]	Continuous re-investment in farm structures	Re-investment needs to be aligned with environmental goals.	
[7], [9]	Rents for up- and downstream actors	There is a need for coordination between market and policy interests.	
[6], [16], [27], [30]	Nitrogen, phosphorus and greenhouse gas emissions stable after an initial decrease with policy reform	Forcing farmers to comply with minimal standards has a leveraging effect on the results indictors.	Strengthening cross-compliance
[6], [15], [27], [30]	Environmental targets (i.e. pesticide load or greenhouse gas or ammonia emissions) not met	Increasing standards can help to achieve environmental targets.	
[1], [4], [10], [14], [18], [26], [30]	Biodiversity programme contributes to halting biodiversity loss	Existing targeting and tailoring provide the basis for effective biodiversity conservation.	Supporting differentiation
[1], [2], [10], [12], [24], [26]	Most environmental targets are only met quantitatively (i.e. output indicators) and not qualitatively (i.e. result indicators)	Further efforts are needed to improve the quality of existing biodiversity conservation areas.	
[1], [11], [15], [18], [26]	Programmes supporting environmentally friendly farming create windfall effects	A shift to results-based payments (i.e. increasing farmers' discretion) could increase the efficiency of the programmes.	
[3], [4], [12], [29]	High administrative burden	Digitalisation is needed to reconcile administrative burden and differentiation of policy incentives.	

*The numbers refer to the evaluation sources in Table 3 i.e. [1] Wuepper and Huber (2022); [2] Meier et al. (2021); [3] EFK (2021); [4] Huber et al. (2021); [5] Feige, Rieder, Annen, and Roose (2020); [6] Mack and Kohler (2019); [7] Hillen (2019); [8] Hillen and Von Cramon-Taubadel (2019); [9] Wey and Gösser (2019); [10] Fontana et al. (2019); [11] A Möhring, Mack, Zimmermann, Mann, and Ferjani (2018); [12] Jenny, Studer, and Bosshard (2018); [13] Finger et al. (2017); [14] Huber, Flury, Meier, and Mack (2017); [15] Mack and Huber (2017); [16] Schmidt et al. (2017), Schmidt, Mack, Mann, and Six (2021), Schmidt, Necpalova, Mack, Möhring, and Six (2021); [17] Loi et al. (2016); [18] Steiger, Lüthi, Schmitt, and Schüpbach (2016); [19] Suter et al. (2016); [20] EFK (2015); [21] Huber, Meier, and Flury (2014); [22] El Benni, Finger, and Mann (2012); [23] Flury, Gerber, Giuliani, and Berger (2012); [24] Lauber, Calabrese, Von Felten, Fischer, and Schulz (2011); [25] Flury and Peter (2011); [26] Mann (2010); [27] Felix Herzog, Prasuhn, Spiess, and Richner (2008); [28] B. Meier, Giuliani, and Flury (2009); [29] Buchli and Flury (2006); [30] Mann (2003); [31] Mann and Mack (2004), [32] Rieder, Buchli, and Kopainsky (2004); [33] Koch (2002).

farm size in Switzerland is 21 hectares (FOAG, 2022b). The dualistic development of farm structures (i.e. an increase in very large and small farms combined with a decrease of mid-sized farms) is much less pronounced in Switzerland than in other countries (Bokusheva & Kimura, 2016).

In addition, the restrictive law on rural land has two important implications. First, farm succession in Switzerland is almost exclusively restricted to the descendants of farmers. Second, farms are kept among families to profit from fiscal rewards, zoning decisions or advantages related to living outside the building zone. Thus, most farms that leave the sector are small and at the end of the generational cycle (e.g., Zorn & Zimmert, 2022). Overall, the regulations with respect to structural changes in Swiss agricultural policy have led to high investment on a sector level, despite small farm structures and highly regulated land markets, with the consequence being the family-based and continuous, rather than dualistic, development of farm structures.

While income inequality in Swiss agriculture has increased as a consequence of the decoupling of price and income policies (especially between lowlands and hilly and mountain regions), the introduction of the direct payment system has positively influenced income stability by decreasing the variability of farm revenues and household income in Swiss agriculture (El Benni & Finger, 2013; El Benni, Finger, & Mann, 2012; El Benni, Finger, Mann, & Lehmann, 2012). Even though direct payments also aim to support farm incomes, the income goals of agricultural policies cannot be considered to have been achieved, and off-farm income is an indispensable diversification strategy of Swiss farm households (El Benni & Schmid, 2021). Despite ongoing discussions about the interpretation and measurement of farm incomes (Finger & El Benni, 2021), the strong governmental support has secured stable farm incomes in Swiss agriculture over recent decades. In this context, Zimmert and Zorn (2022), using a spatial regression discontinuity design, showed that direct payments increased family farm employment. The analysis pointed to not only the economic but also the social side-effects of the current direct payment system because the additional labour force often consists of non-salaried female household members. Without a wage, these family members are not sufficiently protected socially, an issue that should gain importance in the discussion on the further development of agricultural policy.

Finally, a flipside of the enforced conditionality of the Swiss direct payments system is that a high administrative burden is placed on both the farmers and the government (Mack, Ritzel, Heitkämper, & El Benni, 2021; Ritzel, Mack, Portmann, Heitkämper, & El Benni, 2020). While the actual costs of monitoring and implementing agricultural policies are less than 5% of the total budget for agriculture, farmers perceive administration to be a burden (El Benni et al., 2022; Mack, Kohler, Heitkämper, & El-Benni, 2019).

5. DISCUSSION: LESSON LEARNED AND IMPLICATIONS FOR FUTURE POLICY DEVELOPMENT

In this section, we discuss findings from our review with respect to the general lessons learned from Switzerland's experience and the following four implications that may provide entry points for the discussion of specific policy design features that would be transferable also to other countries. First, the economic and social goals have largely been met, but the costs for consumers and taxpayers are high (approximately CHF130,000 per farm per year, or ~CHF6,000 per hectare of agricultural land per year). Thus, increasing the efficiency of Swiss agricultural policy is key. Second, programmes and instruments need to be more coherently embedded in the food and agricultural sector not only to reconcile the economic and environmental goals but also to improve collaboration along the value chain. Third, standards for all farms have increased the overall ecological performance of the agricultural sector. Strengthening of cross-compliance measures has the potential to provide valuable leverage and support to the agri-environmental fields that fail to meet their targets. Fourth, differentiating targets (e.g. in space) and increasing farmers' discretion over how to achieve goals provide promising approaches to realise the premise of public funding for public goods.

5.1. Increasing efficiency

One of the key preconditions for the Swiss policy system is its restrictive border protection and generous governmental budget for agriculture. High farm-gate prices and large funds for direct payments have created a system that effectively supports the achievement of some policy targets, such as a food supply, landscape maintenance and contribution to decentralised settlement. The support has also allowed the farming sector to steadily increase labour productivity and to re-invest in small-scale infrastructure (maintaining family-based, peasant farm structures).

However, the efficiency of the system is low, including the payments for ensuring that food supplies are effective in increasing calorie production and for maintaining arable land for crop production (A. Möhring et al., 2018). Up to 25% of these payments could be saved if criteria other than the number of calories produced were considered (e.g. maintaining productive land without calorie targets; (A. Möhring & Mann, 2020). Also, the targeting and tailoring of policies has led to windfall gains for farmers. The design of a biodiversity programme combining different schemes, for example, creates larger windfall effects (Wuepper & Huber, 2022).

This implies that if the programme has additional environmental benefits, the implementation of the corresponding direct payment comes with high public costs. The restricted farm structural change also implies that farms with low competitiveness remain in the sector (Suter et al., 2016).

Thus, increasing efficiency and reducing the windfall effects of agri-environmental instruments would permit funds to be reallocated to more effective instruments and thus boost the environmental impact of agricultural programmes. In its latest assessment of Swiss agricultural policy, the OECD recommended that Switzerland further liberalise its border protection and reduce trade barriers while also reducing the overall level of general direct payments (OECD, 2015). This should allow farmers to respond to market signals, increase their competitiveness and bring about greater efficiency in the Swiss policy approach. How to align market liberalisation and the support of peasant farm structures or the contribution to decentralised settlement in this context is an important topic for future research.

5.2. Improving coherence

The acceptance of conflicting goals and trade-offs in agricultural policy-making creates challenges for policy coherence (Coderoni, 2023; Eyhorn et al., 2019; Mann & Kaiser, 2023). Trade-offs are inherent in the agricultural and food system, and there is no simple strategy that would allow all positive and negative externalities from agricultural production to be disentangled. The key challenge in Swiss agricultural policy is the conflicting goals that lead to trade-offs. This involves, for example, the production goals (measured in calories or degree of self-sufficiency), the maintenance of decentralised peasant farm structures and the environmental targets (reductions in emissions and the support of biodiversity conservation areas). Given the current inefficiencies in supporting the agricultural sector, reallocating funds, and stronger focusing on the principle of "public funding for public goods" could alleviate the trade-offs between these goals (e.g., Bateman & Balmford, 2018; S. Wunder et al., 2018). This includes, for example, that instruments that promote production include sustainability standards or that support investment should be aligned to environmental or animal welfare goals. A better alignment of policies would not make the inherent trade-offs disappear, but it could certainly improve the efficiency of the public money spent on agriculture.

Furthermore, some of the windfall gains from agricultural policy support end up in up- and downstream companies with a vested interest in maintaining protection. Thus, better policy coherence should not only focus on aligning policy instruments but also include the actors along the value chain. In this context, the link between public incentives and private sustainability initiatives (e.g. trough labelling) is key (Poppe & Koutstaal, 2020). For example, the development of a new, pesticide-free standard for wheat production in Switzerland has allowed the creation of synergies between public and private (market) goals, where farmers receive compensation for not using pesticides from governmental direct payments and private price mark-ups (N. Möhring & Finger, 2022).

The political system in Switzerland enables partial policy success for different interest groups when negotiating policy reforms (Metz et al., 2020). Together with public plebiscites on agricultural policy questions (Huber & Finger, 2019), this can have the effect that the resulting policy has to tolerate certain conflicts in the overall policy. Here, the alignment of agricultural policies with more coherent strategies, such as a common food policy that includes a wider range of stakeholders (De Schutter, Jacobs, & Clément, 2020) within specific areas such as pesticides (N. Möhring et al., 2020) and nitrogen use (Kanter et al., 2020) is important . Beyond the integration of stakeholders along value chains, a food system policy could also include demand-side policy instruments for sustainable food consumption (Ammann, Arbenz, Mack, Nemecek, & El Benni, 2023), consider sustainability standards in global agri-food supply chains (e.g., Meemken et al., 2021) or support sustainable public food procurement (e.g., Schleiffer, Landert, & Moschitz, 2022). This could provide the basis to initiate the necessary transformation of the agricultural and food system. In Switzerland, the policy goals formulated in Article 104a provide a constitutional basis for the future development of such a food policy approach that could also be exemplary for other countries.

5.3. Strengthening cross-compliance

Strict cross-compliance measures provide an effective tool to achieve environmental outcomes. While this had also been discussed in the context of the CAP (e.g., Pe'er et al., 2019), the Swiss example clearly shows that the conditionality of payments is effective in reducing negative environmental externalities and increases the provision of positive externalities in agricultural production. The introduction of the proof of ecological performance as cross compliance measure in Switzerland has had a leveraging effect on the environmental performance of Swiss agriculture (Herzog et al., 2008). Stricter conditions for the proof of environmental performance

could, under certain market and production scenarios, actually contribute to the better achievement of environmental targets with little reduction in farm incomes (Schmidt et al., 2019).

However, there are also critical aspects that need to be discussed in this context. Increasing production standards via cross-compliance measures might create leakage effects i.e. some stricter regulations would increase the number of non-complying farms—that is, farms that do not receive direct payments but also do not comply with cross-compliance regulations; (Schmidt et al., 2019). While the overall strong support of agriculture in Switzerland attenuates this risk to a certain extent, since farms would lose a considerable amount of their income share, this would be more pressing in countries with lower overall support. This implies that command and control instruments could replace cross-compliance measures, but their implementation would certainly create more opposition in the agricultural sector (Erjavec & Erjavec, 2021). In addition, it could also create leakage of negative environmental effects to other countries if imports were to increase due to the stricter regulation (Bystricky, Nemecek, Krause, & Gaillard, 2020). Finally, our review does not provide a direct comparison of cross-compliance measures between Switzerland and other countries. While some studies have looked at certain commonalities and differences (BAFU, 2023; Baur & Nitsch, 2013; Nitsch & Osterburg, 2005), the extent to which Switzerland, through its experiences with cross-compliance, could serve as a role model for other countries would certainly need additional research.

5.4. Supporting differentiation

The targeting and tailoring of policy incentives in space, time and across farm types allows for the transparent and efficient support of public goods provided by the farming sector. The Swiss case shows the advantages of such policy designs that try to implement the idea of "public funding for public goods". This allows us to differentiate between regions with different production conditions, which is a prerequisite for the successful support of local public goods provided by agriculture, such as landscape maintenance and biodiversity conservation (Gawith & Hodge, 2019; Navarro & López-Bao, 2018). In addition, the high degree of targeting and tailoring (in combination with the cross-compliance measures) in the Swiss direct payment system enables attenuation of the tendency of adverse selection into voluntary agri-environmental programmes, which is key for economic incentives for public good provision (e.g., Sven Wunder, Börner, Ezzine-de-Blas, Feder, & Pagiola, 2020).

A step forward in payment differentiation would be to extend the use of results-based incentives (i.e. paying farmers for achieving targets and not for certain aspects of management). Recent studies have shown a promising effect on the effectiveness and efficiency of a more widespread use of such results-based agri-environmental schemes in Switzerland (e.g., Huber, Späti, & Finger, 2023; Huber et al., 2021; Kreft, Finger, & Huber, 2023; Mack et al., 2020; Wuepper & Huber, 2022). These schemes would also enable farmers to use their own discretion over how to achieve outcome goals (e.g., Ehlers, Huber, & Finger, 2021).

The flipside of increasing targeting and tailoring to achieve efficiency gains is more complex systems with potentially high administrative burdens (e.g., El Benni et al., 2022). Here, the use of digital technologies and the digitalisation of entire agricultural policies plays a key role (Ehlers et al., 2022; Ehlers et al., 2021). This could not only reduce the administrative burden but also create new opportunities to measure the outcomes of instruments and thus establish results-based or collective policy schemes that do not have to rely on controls on individual farms.

6. CONCLUSION

There are four implications from these Swiss experiences for policymakers and researchers alike. First, efficiency must be increased to re-allocate funds towards programmes that effectively support the provision of public goods or reduce negative externalities. Second, the coherence of different policy programmes is key. Increasing funds for public goods might be a necessary condition for a more sustainable agricultural sector, albeit one that is not sufficient. The Swiss case shows that the coordination of policies along value chains and across sectoral policies and stakeholders (i.e. in the sense of a "food system policy") is indispensable for making agriculture and food production more sustainable. Third, cross-compliance measures (i.e. minimal economic, environmental, and social standards) for receiving governmental support have an important leverage effect. Even though we observed that setting these standards can lead to political conflicts, they have made a decisive contribution to improving the environmental performance of Swiss agriculture. Fourth, the examination of Swiss agricultural policy suggest that some environmental targets can be achieved while allowing for windfall gains from farmers' provision of environmental public goods. Our conclusion is not that other countries should also apply programmes with low additionality, espe-

cially given the fact that they might face much stricter budget constraints, but a carefully differentiated agri-environmental policy programme that focuses on landscape, biodiversity, animal welfare and ecosystem services should also allow for maintaining economic viability and rural incomes.

Our review and the derivation of the lessons learned imply two important research gaps. First, more studies that effectively provide scientific evidence for policymakers are needed (El Benni, Grovermann, & Finger, 2023). Special emphasis shall be on scientifically sound approaches for policy evaluation, including increased attempts to estimate the causal effect of policies. This is often hampered, however, by the complex regulatory environment and the many interactions between programmes and instruments that are often introduced at the same moment in time. Second, future research could focus on the transferability of these lessons, especially with respect to the specific effect of policy mixes and how an integrated policy framework could alleviate trade-offs in the joint provision of food and ecosystem services. Our review is context-specific, and we cannot draw direct implications for other countries (e.g. for countries with lower financial resources to support agriculture). However, the implications from the lessons learned in Swiss agricultural policy have been mirrored in many ongoing proposals on how to improve the CAP (e.g., Guyomard et al., 2023; Kelemen et al., 2023; Pe'er et al., 2020). Thus, providing further evidence will also be of value beyond Switzerland.

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