The structure of Swiss alpine summer farms: an old tradition through a new lens

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***Abstract* - Understanding heterogeneity of agricultural production systems is important for the design of targeted and tailored policies that have multiple sustainability goals. In Switzerland, seasonal grazing of alpine summer pastures is important to many farms. Yet, these so-called *alpine summer farms* are under increasing pressure due to climate and farm structural change, resulting in loss of biodiversity and abandonment of farms. Swiss agricultural policies govern farms with uniform policy interventions through direct payments to address these challenges. However, these farms are highly heterogeneous in terms of socioeconomic and biophysical conditions and we lack an understanding of their structure. We therefore (1) investigate the structure of Swiss alpine summering farms using census data and unsupervised clustering techniques to generate a farm typology and (2) analyse associated dependence on public support and environmental performance. Our methodological approach enriches the existing socioeconomic farm level data with spatial data in order to depict the farms infrastructure and biophysical environment. Our results suggest (1) six types that differ in terms of organizational structure, herd composition, biophysical environment and accessibility and (2) varying dependence on public support and environmental performance. This work will help to develop targeted policies tailored to specific farm types by accounting for the heterogeneity of alpine farming systems that address both climate and farm structural change.**

Introduction

Grazing of mountain pastures is an integral part of global transhumance (Herzog and Seidl 2018, Jurt, et al. 2015). These pastures serve as an extension of the fodder base during the summer months for on average 100 days and enable production of winter fodder on the valley home farms (Bürgi, et al. 2013). The additional forage provided by summer pastures enable farms to increase their farm herds size, which is the main reason why Swiss farmers practise alpine transhumance (Herzog and Seidl 2018). In 2013, summer alpine farming generated about 11% of the income of Swiss agriculture. According to Herzog, et al. (2013), these alpine summer farms therefore constitute an important source of livelihoods for farmers.

Historical processes created a plethora of structural arrangements in Swiss alpine summer farms today. These farms represent a heterogeneous group in terms of location, farmed area, ownership, organizational forms, use regulations and non-agricultural businesses and therefore costs associated with production. To develop targeted agricultural policies tailored to specific farm types and their needs, a thorough understanding of the heterogeneity of farms across the alpine regions is needed, which has seen little attention so far, especially using quantitative methods. Farm typology studies relying on quantitative methods partition heterogeneous farms into groups of similar farms and have been conducted in many different contexts and geographical settings (Hardiman, et al. 1990, Pépin, et al. 2021, Usai, et al. 2006). Our research thus aims at building a typology of Swiss alpine summer farms. It will enable improved targeting of policy instruments and farm management recommendations through tailored policies to improve the environmental and economic performance of farms.

Materials and Methods

Our work relies on census data of 5900 alpine farms from the Farm Structure Survey of the Swiss Agricultural Policy Information System (FSS database), which encompasses 87% of the observations of the Swiss alpine farm population, plotted in Figure 1 below. Our analysis uses six variables, namely (1) *total livestock (*NSU, normal stock unit); (2) whether the farm has *milking cows* (yes/no) and therefore produces milk, which is one of the most important business activities in Swiss alpine farming; (3) if the farm has *sheep* (yes/no) and (4) *cattle* (yes/no); (5) *ownership* status (private or collective), which captures the institutional arrangement of the farm; (6) *elevation* above sea level (m), as an indicator of environmental conditions and harshness; and (7) the *accessibility* of the farm (1 if the farm has road connection by tarred or dirt road, 0 otherwise).

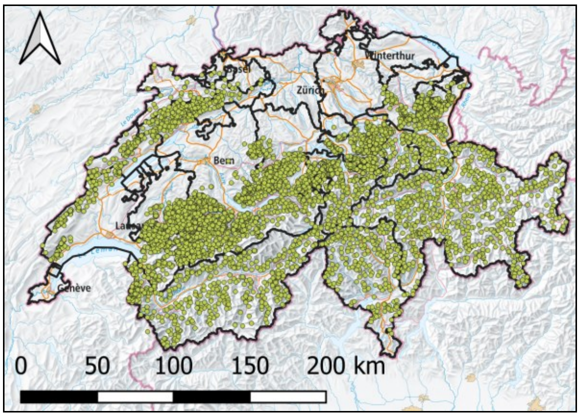

Figure 1: Distribution of summer alpine farms from database

For the latter two variables, we use the georeferenced farm location. We assess accessibility by using data on roads and tracks provided by OpenStreetMap (OSM). Both elevation and accessibility

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are derived using a 250m buffer at the farm location.

In a second step, we build the typology using cluster analysis. We use *partitioning around medoids* (Kaufman and Rousseeuw 1990), which is based on the k-means algorithm. As measure of dissimilarity, we use Gower's *General Similarity Coefficient* (Gower distance). We determine the number of types (clusters) by assessing (1) the maximized silhouette coefficient and (2) expert interpretation. As robustness checks, we additionally employ hierarchical clustering, which do not qualitatively change our results.

Results

The optimal number of clusters was found to be 6, which corresponds to a silhouette coefficient of 0,65, indicating a good within-cluster cohesion and between-cluster separation. The mean values for all clustering inputs by cluster are provided in Table 1:

Table 1. Typology results – Mean value of clustering inputs

Cluster	N	NST	Has milking cows [share]	Has sheep [share]	Has cattle [share]	Is private [share]	Elevation [m]	Has road access [share]
1	2180	37.01	1	0.04	0.97	1	1372.49	1
2	1350	73.82	1	0.06	0.97	0	1464.16	0.96
3	467	36.43	0	0.06	0.94	0	1355.45	0.8
4	523	46.08	0.87	0.13	0.98	0.72	1800.94	0
5	855	20.57	0	0.03	0.96	1	1275.48	0.91
6	517	33.08	0	0.91	0.06	0.72	1831.42	0.22

We interpret the clusters as follows: (1) *Private dairy farms*, (2) *Communal cattle and dairy farms*, (3) *Communal cattle farms*, (4) *Remote farms*, (5) *Small, private cattle farms*, (6) *Sheep farms*.

Additionally, we plot cluster-specific dependence on public support (blue) and environmental (red) performance indicators for the years 2014 to 2021 in figure 2.

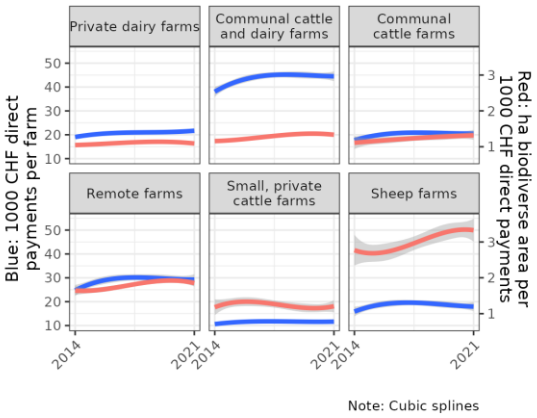

Figure 2: Dependence on public support and environmental performance by farm and farm type.

Communal cattle and dairy farms have the highest dependence on public support, proxied as direct payments per farm received. This indicator has an average of about 40k CHF and increased throughout the years. Sheep farms have the highest environmental performance of about 3 ha of biodiverse area per 1000 CHF direct payments received, which also increased since 2014.

Discussion and Conclusion

We are the first to systematically analyse structural characteristics of Swiss alpine farms using quantitative methods (Herzog et al. 2013). The six identified clusters capture the variety of alpine farms and are validated by expert knowledge.

Compared to similar farm typology studies (Hardiman, Lacey and Yang Mu 1990; Usai et al. 2006; Pépin, Pepin et al. 2021) our study differs in that it encompasses almost the entire farm population of interest. This makes the typology a robust tool of high relevance for policy-makers.

The farm types identified did not only differ in terms of the clustering inputs considered but also with respect to their dependence on public support and their environmental performance regarding biodiversity conservation. The fact that sheep and remote farms show the highest environmental performance suggests accessibility to be a decisive factor in this respect.

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