Testing socioeconomic development scenarios: an approach for assessing agricultural sustainability at territorial scale. Case study: the Abondance Valley (Haute-Savoie, France)

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Abstract: *The aim of our research is to assess patterns of change in agricultural sustainability at territorial scale without losing links with the farm and food supply chain levels. The study focused on the Abondance Valley in the French Northern Alps, through a three-strand approach: (i) surveys on farming systems and recent projects, (ii) extrapolation to all the farms recorded in the valley and building farm typology, (iii) prospective scenarios. Models and indicators were designed and used for the extrapolation phase. Three scenarios were developed ('as usual', and two 'what If' scenarios with more or less favourable local and international socioeconomic contexts), defining and mapping out patterns of change in key structural variables. Rules simulating adaptive changes were defined according to farm type and scenario. Agricultural sustainability was assessed according to these three scenarios and was characterized through indicators to grasp different factors: farming jobs, farm workload and economic viability of the farm fabric in the valley, environmental and landscape issues tied to the agro-pastoral land uses, and the dairy processing sector issues (forage autonomy and milk volume collected). The scenario simulations highlighted the issues for label of origin sector and land use (landscape closure, manure management). In particular, the workload of the livestock farmers makes it difficult to improve grassland upkeep and preservation, whereas collective organizations would appear better placed as a solution for ensuring that all manure produced gets spread. Local stakeholders qualified the importance of the various environmental issues, and are in the process of envisaging collective actions.*

Keywords: *sustainability, farm, territory, prospective scenarios, local stakeholder, land use*

Introduction

In mountain regions, local councillors are acutely aware of the land upkeep and landscape closure issues, especially in tourism-driven contexts (MacDonald et al., 2000). Research on agricultural sustainability in mountainous areas tackles the broader issue of interactions between livestock systems, food supply chain and territory (Dedieu et al., 2008). Working under the framework of the French TRANS research project (*Changes in livestock farming systems and land use dynamics*), our research question is to assess how local agricultural sustainability changes under the socioeconomic context influence. Our scale is the territorial level without losing links with the organizational farm level and food supply chain levels. We aim at helping local stakeholders to make shared diagnosis possible.

This research focused on the Abondance Valley (Haute-Savoie department, France), an administrative division governing 6 districts over a 18000 ha area that is highly dependent on tourism, and where agriculture — predominantly dairy cattle farming and production of the label of origin (AOC) certified Abondance cheese — remains a vital activity (the 2000 census counted 150 farms, 68 of which are dairy farms supplying the Abondance cheese supply chain). According to Corine Land Cover data, the territory's landscape is equally split between grasslands and woody species areas (forests and the currently-expanding shrubs).

There are regional tie-ins with tourism, which translate into opportunities to sell cheese direct from the farm, creating jobs, but which also generate issues related to urban development (urban land use +32% from 1991 to 2001 and +9% from 2001 to 2007 to total 337 ha, most of which was fit for mechanization land), landscape closure and manure management.

The sustainability indicators are assessed at different organizational levels: on-farm, at supply chain level, farm fabric and valley territory level (the territory is considered as a geographically delimited space appropriated by stakeholders). Work load and economic viability are tackled at on-farm level. Supply chain sustainability is assessed by summing changes effects in the valley's dairy farms (volumes of milk deliveries, on-farm cheese processing, direct on-farm sales; hay autonomy targeted under AOC-label production specifications). To assess environmental and land use issues, the farm-territory link is based on the field use, and field use is governed by its location, its agronomic profile, and the role assigned by the farmer. At valley scale land use maps can be produced by aggregating the field use patterns. We use spatially-explicit models which account farm functioning logics, spatial organization and management projects in a changing context capable of modifying the field use.

We start by outlining the set of models used to characterize the farms and, based on decision-rules built according to expert opinion, to predict farm field-use patterns, before going on to detail the content and development of the prospective scenarios. We then keynote the main results of the simulation outputs for the scenarios and highlight the lessons learned on agricultural sustainability, focusing in on patterns of land use according to the foreseeable evolutions.

Material and Methods

Monitoring farms

Around thirty-odd farms were surveyed in 2000/01, 2006 and 2008 (Camacho et al., 2008; Polge de Combret et al., 2009). We characterized their spatial organization and land use practices (Girard et al., 2001) and identified the processes of change over a 5-year time horizon in order to pinpoint recent mechanisms of change and exploit them to define approaches for coping with each scenario. We established a typology of farm functioning guided by production system, farm size and activity-based criteria (on-farm processing, on-farm holiday activities, off-farm activities, retirement) enhanced through further criteria related to field system configuration, livestock buildings modernisation, and available workforce.

Valley community breakdown into district-groups and sector-groups

The valley community can be broken down into three district groups based on how they connect to urban and tourism-related employment: the lowest district (three communes), where the population is swelling due to the influence of the Thonon—Evian employment area; the Abondance commune itself, where the population has begun to rise, and the highest district composed of two tourism-based communes, where net migration remains negative with a significant increase in second homes.

Building on Camacho (2004), we used criteria liable to have an impact on forage production and hay making (slope, altitudes) to divide the valley into iso-potential use areas. The zoning system used here essentially highlights three core sector feature-sets: bottom of the valley and terraces, mountain sides, and alpine pastures (Figure 1). The bottom of the valley is defined as land situated at less than 1,150 m altitude and terraces represent the relatively flat areas with southern exposure. Alpine pastures have been defined by their use (summer pastures, generally over than 1,400 m altitude). Mountain sides pools the remaining agro-pastoral land.

Extrapolation: spatial land use in the valley

Starting out with fragmented data on the whole of farms in the valley (chamber of agriculture registry data) and a key for identifying farm types based on simple criteria (Capillon, 1993), we

undertook an extrapolation step and classified all the farms into the pre-defined types, adding new *ad hoc* farm types to account for spatial patterns and specific configurations in the lowest district (e.g. sedentary systems with herds summering in the mountain sides, not in alpine pastures).

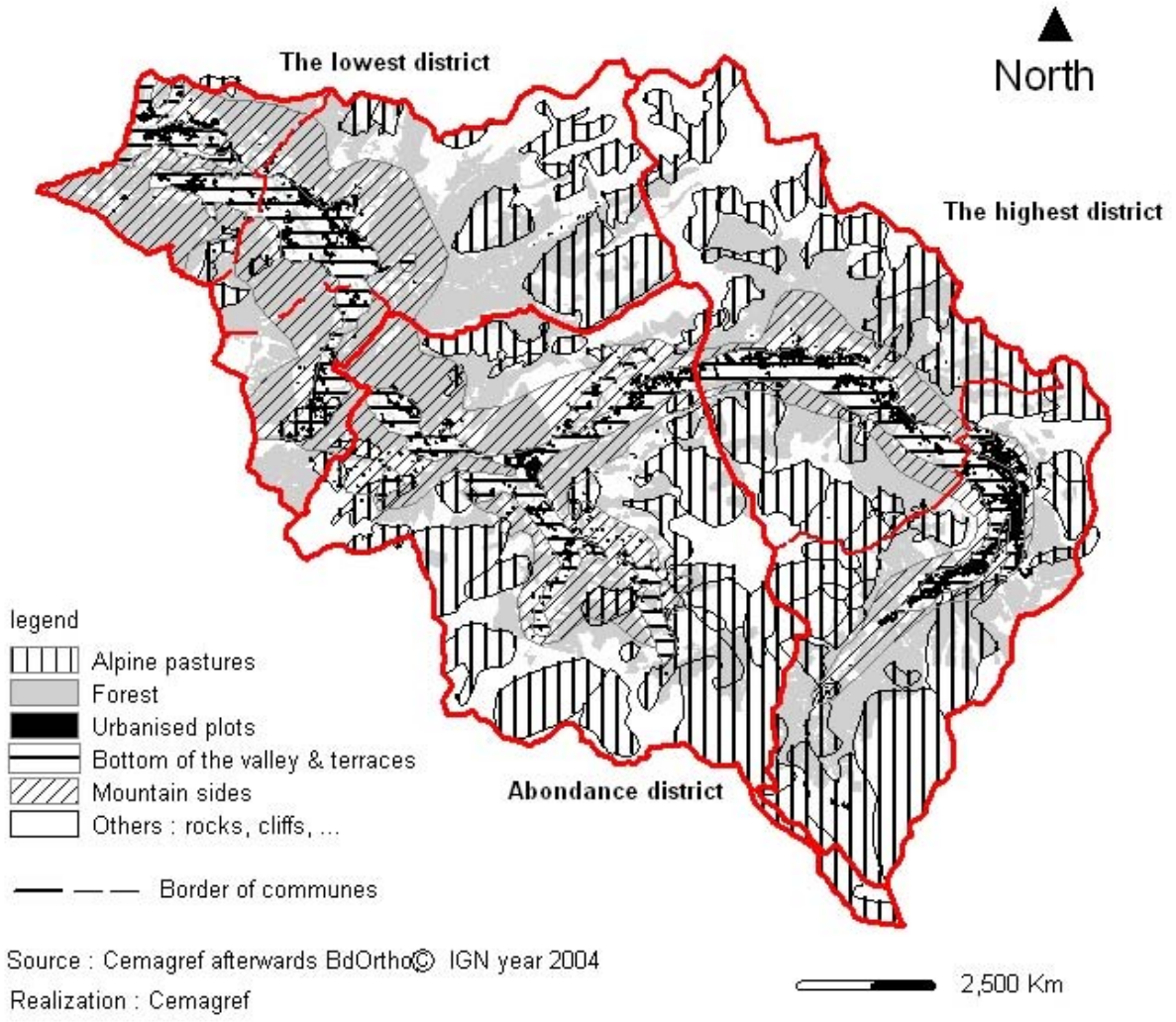

Figure 1. Breakdown of agro-pastoral land area in the valley.

Integrating other data input (administrative declarations completed with a handful of surveys) made it possible to pinpoint the exact border perimeter of every farm field, although without being able to identify field use for each individual field. To resolve this problem, we developed a spatially explicit model of agro-pastoral land use, borrowing from research by Camacho (2004) who highlighted how the local land was stringently planned out and unchanged from year to year (land use allocation highly compartmentalized between cut and grazed fields and between animal batches and grazing circuits).

A predictive land-use model

The model entails implementing decision rules formalized from monitoring data on 27 surveyed farms. The model describes a standard behaviour-set and then outputs adjustment measures adapted to the specific features of each farm. This model output makes it possible to extrapolate to valley-wide scale and to infer use allocations for each field. The analysis reported here illustrates a dairy cattle herd, but the same approach is employed for other types of livestock farming in the valley, excluding the close vicinity condition for milking.

Standard behaviour defines time-periods: from 1st November to 10 May, animals are in the cowshed and are fed with a hay basic forage ration (bale-wrapping and silage are barred under the AOC specifications); from 11 May to 4 June, the herd is put out to pasture the valley and hillsides, then climbs to the Alpine pastures until 30 September; in October, the herd grazes spring pasture and hayfield regrowth in the valley. For each period, a net forage requirement (expressed in tonnes of dry matter) is established based on reference data on animal requirements and grassland and Alpine pasture productivity rates (Camacho, 2004; Camacho et al., 2008). The rationale modelled for the livestock farmer is that he prioritizes farmland use allocation in order to achieve positive net forage for each period. Hence, in spring, the farmer's priority will be given to grazing the dairy cattle on close-by farmland, i.e. within 500 m of the milking place, and on the slopes, whereas his heifers batch will be grazed on sloped and distant pastures. The 'flat' grasslands are set aside for hay-making to build up the stocks need for wintering the animals, with any shortfalls completed by cutting on his slopes (those available after meeting the springtime pasture-grazing needs) in order to get as close as possible to winter forage autonomy (buying in the hay needed to meet net winter needs). *Adjustment measures* are tied to farm field pattern and to concerns connected with work organisation schedule. The aim is to reduce the needs of certain batches of animals and/or increase resource availability for the periods where net requirements are negative when the standard behaviour is applied. For example, if the net requirements for the dairy cows batch are negative in spring due to insufficient available sloped close-by grassland, rules are triggered to pasture the first vegetative cycle on 'flat' close-by fields (which means only the second vegetative cycle will be cut for hay). If this strategy still leaves net requirements in the negative, the farmer will delay turnout to grass or bring forward the date for climbing to Alpine pasture according to hay autonomy.

Pasture upkeep and fertilization

Land use is one of the key factors driving scrub encroachment into pastures (under-grazed, uncut pasture is liable to close in if the same pattern repeats over subsequent years), but there are compensatory practices (such as mechanical upkeep) that farmers can employ to minimize woody plant encroachment. Since it is impossible to predict these farmland upkeep practices based on farm type, we identified the determining factors using decision trees (Rakotomalala, 2005) on the variables that the monitoring surveys had identified as important: slope, field status and distance from farmstead, age of the farmer, workload, and type of animals grazing. Grassland left exclusively for grazing (no cutting and no mechanical upkeep) is considered at risk of shrub encroachment-driven close-out if grazing pressure is weak in relation to the resource available.

For the options for manure management, we adapted locally-produced maps (including from the chamber of agriculture) according to field slope, accessibility, size, distance to streams and distance from housing units.

Farm workload and incomes

We assessed the workload in each farm using a simplified schedule. Available workforce is expressed in annual work units (AWU) according to the work activities of the basic group (Dedieu et al., 2006), farmer age, and presence of salaried farm workers. Workload was given a general score based on daily work duties according to period of the year (herd size by AWU, winter constraints due to state of the farm building, milking, any on-farm processing and direct sale, summer work duties according to state of the chalet) and seasonal work (hay making modalities, on-farm holidays activities). The economic dimensions were integrated using reference data provided by the Savoie and Haute-Savoie rural economics centres together with the survey data collected in order to assess available farm income for different livestock farming systems.

Prospective scenarios

After consulting with experts and reviewing the literature on prospective studies (at local and international levels), we established the change scenarios in order to provide insight into the

dynamics involved and to promote thought and reflective analysis. Our research led us to focus on two scenario formats: an 'as usual' scenario S0 (*what changes will occur if the current trend is allowed to continue?*) and two 'what if' scenarios S1 and S2 (*what will happen if certain specific events take place?*). Baseline benchmark year is 2005. The model works to the 2015 time-horizon, which corresponds to the stated final date for milk quotas and the running deadline for council tenure, and which enables the current stakeholders to gain a grasp of the events and effects simulated.

Applying French-school methodology for prospective studies (Jouvenel, 1999), we went on to translate the impacts of these scenarios on the 'key structural variables' shaping the system under study. The final shortlist counts 21 variables: food supply chain, consumption, price (products and inputs), tourism, public policies (subsidies, quotas and animal welfare standards), farm households (activities and incomes, quality-of-life as a farmer), technical progress (animal-centred and grassland-centred), farmers attitudes to local issues, community awareness of the shrub encroachment issue, manure management, urbanization, sale of buildable land and preservation of farm areas, climate change (effects on tourism and farming).

We then ran scenarios S1 and S2 on each farm type according to trends of change in the key structural variables. Conditionals rules (e.g. 'if… then…') were defined that integrated recent changes, projects reported by the farmers surveyed, and expert opinion. This system can be illustrated using the tourism variable as an example: if the situation looks favourable to employment in the tourism sector, farm households running an off-farm activity continue to do so, as long as the on-farm workloads recorded for 2005 are not too high — otherwise they pull the plug (if it is a secondary activity) so to increase the on-farm workforce. The animal welfare standards variable offers a second illustration: if compliance on the animal welfare standard makes it compulsory to refurbish a cowshed that was substandard in 2005, then the additional annuity payment must not eat away too much of the farm's income, otherwise the herd size is cut by 10%. A further example is the quality-of-life as a farmer variable, with the concomitant consequences on land maintenance burden: if the farmers aim to lower their workload, they will opt to simplify the way they use the toughest land areas: stopping cutting on the heaviest-gradient mountain side slopes and stopping mechanical upkeep on pastures.

Scenario S0 updates the 2005 data with the 2008 economic context extended up to 2015, integrating any known succession events and applying a land use allocation rule that reassigns newly-available land to farms still in business (according to forage requirements).

Sustainability indicators used

We selected indicators translating valley-scale effects: landscape sustainability such as farm land lost to farming, land at high risk of scrub encroachment, manure management, urbanisation, but also farming jobs, work load and economic viability of the farm fabric and dairy industry sector challenges (hay autonomy and milk volume collected). Specifically, we elected to present changes in farm land use patterns according to valley breakdown in district-groups and sector-groups (§ 1.2.).

Demonstration to local stakeholders

The scenarios and a series of the simulations generated were set out at a meeting held with valley-community farmers, local councillors, agricultural advisors, and members of an environmental protection group. Discussions were centred on the trends predicted in the scenarios, even though given the short time-slot preceding the exchanges, it was unreasonable to expect the attendees to have fully integrated the procedures implemented by the research team and the hypotheses that we took time to outline.

Results

S1 and S2 scenarios

Tourism continued to develop in both these scenarios, as was the case with scenario S0.
Scenario S1 could be summarized as: *In a pro-tourism context, agriculture attempts to defend its hold in the valley*. Styled journalistically, scenario S1 could be described in the following terms (where each of the accepted meanings is a literary translation of the cost-assessed trends selected for each of the 21 structural variables): *Tourism is flourishing in Abondance Valley. Working to a 2015 time-horizon, winter snow cover has largely resisted global climate change. Despite the drop in purchasing power, people come flooding in from the cities in both the summer and winter seasons. Farming remains a major part of community life, offering visitors a vibrant landscape and top-quality local farm foods. The lowest district of the valley is seeing an increasing influx of workers from the Thonon—Evian employment area. In short, the valley's local economy is holding up well, propped up by income from tourism, whereas agriculture has been squeezed out from the chief concerns of local councillors and residents alike. Prices for raw-material inputs are rising, whereas milk prices have stagnated. The profession has elected to stick to the same quota-indexed management of milk production, despite the official phase-out of milk quotas. Farms with the resources to do so are doubling-up their activities in order to maintain incomes: as tourism continues to develop, on-farm production and sale of cheese or on-farm holiday activities become increasingly viable, and farmers or their spouses have no trouble finding off-farm work. In a measure to reduce work load and free up some time, livestock farmers no longer cut grassland on heavy-gradient slopes, which are consequently colonized by scrub. Fields with good workability (e.g. flat areas) thus become prized. However, they also became rarer: urbanization spreads fast throughout the valley, and there is no real effort to preserve threatened farmable land. This puts further pressure on the land application of manure, which is already banned in periods of peak tourist activity.*

Scenario S2 could be summarized as: *a tight-knit farming community with local population backing facing up to a tough international context*. *The phasing-out of the quota system has meant that milk prices have plummeted nationwide, with a knock-on effect undermining the Abondance cheese sector — despite the AOC quality label. The applicable animal welfare standards have to be scrupulously complied with. It is now compulsory to open-stable calves and turn cows out at regular intervals throughout the winter season: that contrasts with S1, which continued to tolerate current practices. In the wake of negotiations with the WTO, subsidies for CAP pillar-I were scrapped. This means cattle farmers can only count on pillar-II subsidies. Fuel prices, feeds prices and mineral fertilizer prices remain very expensive. Despite these constraints, Abondance Valley community farmers can still draw on other assets, as the valley continues to pull in tourists and workers from the Thonon employment area. Tourism provides income-generating opportunities for farm products, and valley-community farmers and their families can still find employment. The tourism-based communes in the highest district offer to farmers financial compensation to maintain the landscape, as both local and transient populations are sensitive to the issue of keeping the landscape open. Households needing to maintain or even increase their income can expect to double-up different activities. In a context making it tough to maintain a competitive edge, the specifications governing the AOC Abondance label have been relaxed. Cattle farmers now have the option of purchasing hay as much as they need from outside the AOC perimeter. With urbanization pressure driving down the land area available for forage-cutting, dairy farmers welcome this measure. Local councillors, who are aware of the importance of maintaining mountain agriculture as it produces top-quality cheese and preserves the landscape, make efforts to protect threatened farmable land from urbanization and increase urban density in the built-up zones — as stipulated in local urbanization regulations. Finally, the farming community has pooled its resources in order to develop new projects. Some farmers have formed employers' groups to recruit shared employees. The outstanding move, though, remains the construction of a collectively-run composting platform in the highest district — a project made possible by the commitment of the farmers and by local funding. This project is expected to facilitate the management of excess manure.*

Evolution of the sustainability

Table 1 presents the results for the sustainability indicators assessed at valley-wide scale, for each scenario. The results highlight core trends, whatever the scenario: (i) farmers numbers show the same across-scenario drop: farming declines sharply as a source of direct employment; (ii) keeping the landscape open develops into a very real issue, since around 800 ha of land is at risk of abandonment and encroachment before 2015, i.e. 17 to 18% of the agricultural area in use (excluding Alpine pastures); (iii) urbanization remains similar overall (approaching 90 ha), with little scenario-related variation between district-groups and sector-groups. It should nevertheless be underlined that low differences in urbanized land can mask stronger differences in the area available for land application of manure: better clustering of housing fields (scenario S2) increases the land application options by eliminating the creation of manure-banned splinter zones.

Table 1. Valley-scale agricultural sustainability according to scenarios modelled.

Sustainability indicators	2005 baseline	Scenario S0	Scenario S1	Scenario S2
number of farms / number of jobs, in agricultural work units (AWU)	89 / 125	67 / 107	66 / 111	67 / 113
farm income[1] < 1 *SMIC* (index-linked guaranteed minimum wage) without off-farm activity or pension (in % of farms)	25	9	8	9
high work overload[2] (in % of farms)	33	16	12	9
farm land and Alpine pastures potentially lost to farming (ha)	-	920	900	900
proportion of urbanized/closed-out land or land at high risk of scrub encroachment (as a % of agricultural area in use, excluding Alpine pastures)	- / -	6 / 18	6 / 17	6 / 17
excess manure not applied on valley land (tons / % of manure produced)	7,000 / 42	6,200 / 43	6,800 / 44	3,800 / 31
volume of milk sold (in thousand litres)	5,800	5,400	6,500	6,200
volume of milk delivered to dairies / processed on-farm (as a % of milk sold)	56 / 44	54 / 46	46 / 54	43 / 57
milk produced on farms that are not self-subsistent in hay[3] (as a % of milk sold)	37	35	54	38

[1] disposable income (=Gross Operating Surplus – annual loan instalments) per AWU of the basic group.
[2] based on a ratio comparing workloads (rating scale) against labour force available on-farm.
[3] farms that buy in over 30% of their hay.

Concerning keeping the landscape open (Table 2), surface area exposed to scrub encroachment is lower in scenarios S1 and S2 than scenario S0: performing an off-farm activity — made possible by the development of tourism — enables a handful of farms to stay in business (a development ignored in S0), and although to a lesser extent, the motivation to prevent the best farmland from being swallowed up by urbanization (S2) does has a positive impact. Nevertheless, the mountain sides close up more than in S0, due to a decrease in pasture upkeep practices in S1 (tangible change in the Abondance district) and to less exploitation of mountain in S2 (improved productivity in flat areas through composting combined with greater forage autonomy flexibility on AOC specifications).

Manure management control is a highlight issue that is particularly sharp in the communes situated in the highest district (Table 3). The results show a variation in tonnage produced that was tied to herd size, which dropped significantly in S2 as a result of compliance on animal welfare standards. The net result, depending on the scenario, is between 3,800 and 6,800 tons of manure not applied on valley area; however, the Pays de Gavot zone, which took on a major share of the excess manure, can no longer be used due to traceability requirements governing manure land-applied on the Evian impluvium, making it increasingly urgent to find alternative solutions. The quantity of excess manure thus drops sharply under scenario 2 as a reflection of the major impact of the collectively-run composting platform.

Table 2. Scrub encroachment into fields according to scenario (in hectares).

Sector-group	District group	S0	S1	S2
Bottom of the valley and terraces	Low	56.2	53.2	50.1
	Abondance	53.4	26.8	23.5
	High	35.6	33.0	31.4
	Total	145.2	112.9	105.1
Mountain sides	Low	41.2	40.9	46.1
	Abondance	44.8	57.6	49.2
	High	23.5	23.1	33.1
	Total	109.5	121.6	128.4
both sectors		254.8	234.5	233.4

Table 3. Manure management according to scenario (in tons)**.**

Type of manure	District group	S0	S1	S2
produced	Total	14,700	15,800	12,700
land-applied	Low	2,700	2,800	2,700
	Abondance	3,500	3,900	3,800
	High	2,300	2,300	2,500
	Total	8,500	9,000	8,900
excess	Low	0	0	0
	Abondance	1,000	1,000	800
	High	5,200	5,800	3,000
	Total	6,200	6,800	3,800
surplus manageable through land application[1]	Low	800	1,000	500
	Abondance	300	300	400
	High	200	200	600
	Total	1,300	1,500	1,600

[1] in farms producing less manure than they could theoretically apply on their land (standard adopted: ceiling of 25 tons/ha eligible for land application).

To recap, as shown in table 1, while scenario S1 betters S0 in terms of social viability of the farm fabric and equivalent rates of loss of farm area it appears a little less sustainable on the manure management front. Furthermore, even though the dairy sector collects more milk, most of the milk produced comes from producers who are no self-subsistent in forage, which could serve to undermine the brand-image of the AOC-certified cheese. Scenario S2 appears to offer greater sustainability, first and foremost on the spatial land-use issues, due to the lower quantities of excess manure, and also through an improved quality of farm life through the system of recruiting-in shared employees between farms. The results also highlighted that forage-subsistent farms also posted higher milk production volumes (with fewer cows to feed due to the animal welfare standards and the greater productivity of machine-workable grassland due to the composting possibilities). However, the drop in volumes collected by dairy farms (since the smaller-scale milk suppliers were hit greater by the animal welfare standards that the on-farm producers) remains a concern.

Reactions from the local stakeholders

The results of this research were presented to various different valley-community actors, prompting discussion on a number of points. Urbanization proved a divisive issue due to between-communes disparity in farmland protection policies, but the local councillors see urban land use zoning plans as offering an arena for thought and discussion, and as a potential solution for preventing the excesses that rob farmers of convenient access to their fields. The downward trend in milk prices together with the scheduled phase-out of milk quotas raises questions over the future viability of milk production and over the shift between the cooperative sector that processes the milk delivered-in by producers and individual on-farm producers. There are calls from some actors for a more collectively-organized on-farm dairy processing sector as a means of securing a guaranteed level of cheese quality, which is currently highly variable due to the increasing number of uncoordinated individual initiatives.

Landscape closure proves a more complex issue, as local councillors are overwhelmed by the extent of the land area at stake, yet fully aware of the workloads that farmers have to contend with. The question now is how to build up a support programme for communities that integrate this work time availability constraint? In contrast, the local councillors were unanimous on the manure management problem and the need to devise community-led action to deal with the issue. The composting platform sparked debate over the definition of compost and ways to create value from it (there appears to be demand for this type of fertilizer around the Lake Geneva perimeter).

Discussion

This research carries methodological limitations. The inflexibility of year-to-year practices in land use was one of the conditions governing implementation of the land use allotment model, which means its generic significance remains limited to similar settings, although they do remain frequent in mountainous regions (J.P. Theau, pers. comm.). Scenarios S1 and S2 appear to share a fairly optimistic outlook on global socio-economic trends, and may share too much overlap (a scenario S3 staging a context that ran counter to the expansion of tourism has been sketched out but has not yet been implemented). Furthermore, there was little room for innovative new ideas in projects for change, except possibly in S2 (collectively-run composting platform, employers' groups): since we are currently verifying that the approach can be suitable for local stakeholders, they have not been co-opted into the project-building process and we thought that a relay must be taken locally after this experimental stage.

In combining different component factors of sustainability at different organizational levels, this study highlighted potential sticking points. Projects that hinge on on-farm processing (which have broken through over the last ten years) are by no means easy, whether at farmer level (workloads, available financial backing) or at cheese supply chain (drop in milk deliveries). The increase in herd size, which was a significant factor in scenario S1, raises issues in terms of forage autonomy and keeping animal waste management under control.

Agri-environmental issues and work constraints are often interlinked (Bernard et al., 2006). This explains why tourism-based communes offering financial incentives to keep fields maintained (scenario S2) has only a limited impact in terms of keeping pasture grassland open, due mainly to farmer workloads but also in part to the improved productivity of hayfields that are better fertilized with compost. Indeed, local councillors are acutely aware of this issue, as they find themselves relatively powerless in seeking ways to help farmers with their field upkeep burden. Using shared employees may appear a promising solution for breaking the workload constraints deadlock, but as a policy it raises further questions over the limited time window in which mechanical upkeep is possible and the difficulties involved with machine work in sectors presenting the highest-gradient slopes.

Conclusions

This study illustrates the interactions between farming systems, territorial and food supply chain issues. We did not use the outcomes of the research ourselves to design new ways of realizing sustainable landscapes, but only provide input for a process that might lead to such designs. In order to take the process further and develop a tool for harnessing reflective thinking on sustainable agriculture, local stakeholders need to be placed at the centre of the debate. The chamber of agriculture team did so, when it built a local-level territorial development project : after our presentation, it started from a shared diagnosis showing stakes (some of them were included in our work) and defined an action programme where we could find lessons learned from the research presented here (the collectively-run manure storage platform) or other initiatives (support for projects to set up farms outside the dairy cattle-milk systems) that we did not integrate here (B. Jordan, pers. comm.).

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