Case study of the market situation of calves from Alpine dairy farms and the effect of dams' grazing during the last three months of gestation on auction parameters

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Case study of the market situation of calves from Alpine dairy farms and the effect of dams' grazing during the last three months of gestation on auction parameters

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ABSTRACT

The main aim of the study was to assess the recent evolution of cattle breeding in Alpine areas based on the number, quality and price of calves sold at local auctions in the South Tyrol region over the last decade, as case study. In addition, the effect of grazing during dam's late gestation on calves' auction quality was investigated to assess whether the inclusion of pasture in Alpine production system has an impact on auction parameters of calves beside its well-known positive effects on cattle welfare and the environment. Similarly, to other geographical areas, the study revealed that the numbers of crossbred calves (especially from specialised dairy breeds) has increased over the last years also in the Alpine area, because of more targeted breeding plans with an intensive use of beef bulls' semen. Further, purebred calves from dual-purpose breeds (Simmental, Alpine Grey, Pinzgauer) received a higher remuneration in terms of price and market value at auction than purebred calves from specialised Holstein Friesian and Brown Swiss cows. A part of these animals could be available to support an innovative alpine meat supply chain which, if grass-fed, could further strengthen the current landscape maintenance service provided by the mountain livestock husbandry. Dams grazing during the last 90 days of gestation had a limited negative effect on calves' liveweight and quality traits at auctions. All these results provide useful technical insights to support the switch from dairy to suckler herd system as future productive alternative for some small-scale mountain cattle farms whose viability is essential for the provision of several ecosystem services in the fragile Alpine environment.

IMPLICATION

The present study offers an overview about the evolution of cattle farming in the Alps over the last decade. Overall, the small-scale holdings operating in the case study area of South Tyrol maintain their dairy orientation, but there is a growing trend to implement crossbreeding schemes to increase the economic value of the offspring not kept for replacement. The local fattening of a part of these calves could support an innovative Alpine beef supply chain. As no relevant effect of the use of pasture by the pregnant dams on calves auction price and market value was observed, such chain, especially if grass-fed based, could further strengthen the landscape maintenance service provided by the mountain livestock husbandry.

HIGHLIGHTS

- An increase of crossbred calves over the years is recognisable in Alpine area
- Dual-purpose and crossbred calves are heavier than dairy ones and leading to higher selling prices at auctions
- Calves market value at auctions remained stable over the last decade
- The percentage of grazing dams was higher in dual-purpose breeds
- Dams grazing over the last part of the gestation had a limited effect on auction parameters of calves

Introduction

Cattle farms in the Alps are mainly characterised by small-scale dairy holdings with indoor housing systems and the use of highland pasture in the summer (Battaglini et al. 2014; Zendri et al. 2016; Zuliani et al. 2018). Environmental constraints such as elevation, climate, ground slope and lack of organic soil etc., often do not allow agronomic solutions alternative to forage production and pasture (Cozzi and Bizzotto, 2004; Zanon et al. 2022a). In this scenario, low-input farming practices, such as hay making and pasture grazing contribute to maintain diversity of species, habitats, and landscapes (O'Rourke et al. 2016), providing ecosystem services that are crucial for further sectors of Alpine economy, such as tourism (Battaglini et al. 2014).

The COVID 19 pandemic highlighted the importance of having a certain degree of food sovereignty and regional production cycles. Consequently, a location-adapted and location-dependent agriculture can and must be recognised and used as an opportunity for small scale farms in mountain areas. In this context, the supposed weakness, namely the small size of the Alpine farms, may turn into a strength, as it is close to the ideal concept of many consumers (family farm with close contact to the animal, pasture use) (Busch et al. 2018; Kühl et al. 2021). Based on these consumer inputs, the creation of a high-quality beef supply chain has been proposed in some Alpine areas. However, in order to implement economic sustainable farming solutions, there is a need to gather detailed information either on the current quality of the local calves or on their husbandry systems.

Cattle farms of South Tyrol can be considered a reliable sample of the livestock farms population across the Alps and their analysis can provide a useful insight about the current breeding and management decision. In the perspective of creating a local meat production chain, the main aim of the present study was to assess the recent evolution of cattle breeding in Alpine areas through the analysis of the quality and price of calves sold at local auctions. Furthermore, as consumers are increasingly asking for a more natural production systems with cattle having access to pasture in mountain areas (Busch et al. 2018), a second aim of the study was to investigate the effect of dams' grazing during the last three months of gestation on weight, and quality of male and female calves sold to the meat industry at auctions.

Material and methods

Market situation of calves

In 2021 a total of 63,574 calves (31,969 female and 31,605 male) were born in the region of South Tyrol (South Tyrolean Breeders Association, 2021). The South Tyrolean Consortium for Livestock Trading (KOVIEH) traded 35,6% of those calves. The remaining 64,4% were either used for restocking purpose in the region or were sold directly by the farmers as breeding or fattening animals. The data for the present study were retrieved from the databank of a local wholesale cattle organisation named Kovieh, the South Tyrolean Consortium for Livestock Trading (Bolzano, Italy). Most traded calves were males of dairy and dual-purpose breeds or crossbreds with specialised beef breeds (mainly Belgian Blue and Limousin). The female calves were crossbreds or pure-bred animals that exceed the farm's requirement for replacement. Kovieh is in charge of the transport of the animals from the farms of origin to the auction site in Bolzano. Most of the calves commercialised *via* Kovieh are sold and sent to fattening units located mainly in the Po Valley of Italy (SM 1). Only a small share (13%) remained in the province of Bolzano to be reared and then slaughtered locally to supply the local quality meat chain (SM 1).

Data and editing

The initial dataset considered 525,518 individual calf records recorded at the actions from the year 2011 to the year 2021. Each record had information on calf's ear tag, breed, gender and date of birth; ear tag and breed of the dam; price (AC), live weight and market value (€/kg) of the calf at respective auction (CW) and information on pasture access during the last 90 days of gestation of the dam.

Editing concerned the sale live weight of the calf, which had to be between 25 and 100 kg, the price per kilo which had to be between 0.40 and 7.00 €/kg as the market price of the calf which had to be between 40 and 530 €. Further, only calves sold between 10 and 60 days of age whose mothers were at least 22 months old at the time of first calving were considered. Moreover, solely calves from breeders who had sold at least 5 animals during the study period (2011–2021) were retained in the final data set. Last, crossbreed calves were not considered, as there was no reliable information about their parents. After editing, 256,280 records were available for statistical analysis referring exclusively to pure-bred calves of Brown Swiss (BS), Holstein Friesian (HF), Alpine Grey (AG), Simmental (SI) and Pinzgauer (PZ). A further editing step was performed to assess the effect of the use of pasture by the mother during the last 90 days of gestation on calf quality at the auction. As this information was available

only from the years 2018 on, the corresponding dataset considered only the auctions in which calves born from dames that grazed during the last three months of gestation were present (106 levels). The dataset used for assessing the effect of grazing during the last three months of gestation on auction parameters comprised 50,962 records from 2018–2021.

Statistical analysis

The PROC GLM of SAS software v.9.4 (SAS Institute Inc., Cary, NC) was used to perform the analysis of variance. Post-hoc Bonferroni test was used to test the significance of the differences between the levels of certain factors included in the models. The statistical models used for the analysis of both datasets were consistent with those used by Dal Zotto et al. (2009) and Penasa et al. (2012) in previous similar studies. The model used for the processing of the complete archive (256,280 records) was the following:

$$Y_{ijklmn} = \mu + Auction_i + Seller_j + Breed_k$$
$$+ Gender_l + Breed * Gender_{kl} + Age\ dam_m$$
$$+ Age\ calf_n + e_{ijklmn}$$

where Y_{ijklmn} is the observation value of the dependent variable (calf weight at the sale (kg); calf price (€/kg); market price (€/calf) including VAT), μ is the overall intercept of the model, $Auction_i$ is the fixed effect of the respective auction (498 levels), $Seller_j$ is the fixed effect of the breeder, $Breed_k$ is the fixed effect of cattle breed (BS, HF, AG, SI, PZ), Sex_l is the fixed effect of calves' sex, $Breed*Sex_{kl}$ is the interaction between the fixed effects of breed and sex, $Age\ dam_m$ is the fixed effect of dam's age at calving (16 levels: age$< =26$ months; 26.1–29; 29.1–32; 32.1–35; 35.1–38; 38.1–42; 42.1–45; 45.1–48; 48.1–51; 51.1–54; 54.1–57; 57.1–60; 60.1–66; 66.1–72; 72.1–78; >78), $Age\ calf_n$ is the fixed effect of age at calf sale (linear covariate), and e_{ijklmn} is the random residual.

The model used for the analysis of the reduced dataset (85,480 records) to test the effect of the use of pasture by pregnant cows, including the following factors:

$$Y_{ijklmno} = \mu + Auction_i + Seller_j + Breed_k$$
$$+ Gender_l + Breed * Gender_{kl}$$
$$+ Age\ dam_m + Age\ calf_n + Grazing_o$$
$$+ Breed * Grazing_{ko} + e_{ijklmno}$$

where $Y_{ijklmno}$ is the observation value of the dependent variable (calf weight at sale (kg); calf price (€/kg); market

price (€/calf) including VAT), μ is the overall intercept of the model, $Auction_i$ is the fixed effect of respective auction (106 levels), $Seller_j$ is the fixed effect of breeder, $Breed_k$ is the fixed effect of cattle breed (BS, HF, AG, SI, PZ), $Gender_l$ is the fixed effect of calves' gender, $Breed*Gender_{kl}$ is the interaction between the fixed effects of breed and gender, $Age\ dam_m$ is the fixed effect of dam's age at calving (16 levels: age$< =26$ months; 26.1–29; 29.1–32; 32.1–35; 35.1–38; 38.1–42; 42.1–45; 45.1–48; 48.1–51; 51.1–54; 54.1–57; 57.1–60; 60.1–66; 66.1–72; 72.1–78; >78), $Age\ calf_n$ is the fixed effect of age at calf sale (linear covariate), $Grazing_o$ is the fixed effect of grazing during the last 90 days of gestation ((2 levels: yes/no), $Breed*Grazing_{ko}$ is the interaction between the fixed effects of breed and grazing during the last 90 days of gestation, and $e_{ijklmno}$ is the random residual.

Results

Calves' quality at auctions

Figure 1 depicts the number of calves sold at the auctions by year and its percentage partition among breeds within a year. Over time, a strong upward trend (+22%) was observed in the number of cross-bred calves sold at auctions, which increased from 19,808 calves sold in the year 2011 to 23,992 calves sold in the year 2021. Similarly, dual-purpose SI calves showed an increase (+18%) while a negative trend was observed for specialised purebred dairy calves, especially for BS (-49%) as well as for HF calves (–31%). The selling numbers for purebred PZ calves (+13%) increased while for AG calves decreased (–23%) throughout the study period (Figure 1).

The results of the ANOVA for the different traits considered in the analysis of the calves' quality at auctions are reported in Table 1. Despite being statistically significant, the age of the calves at the auctions was very similar across breeds, resulting 28.8 ± 8.9 d for AG (mean $\pm$ SD), 27.4 ± 9.7 d for BS, 25.1 ± 9.6 d for HF, 25.5. $\pm$ 10.0 d for PZ and 28.6 ± 9.4 d for SI. Dual-purpose breeds calves SI (68.1 kg), AG (63.7 kg) and PZ (65.9 kg) were heavier ($p < 0.001$) than calves of specialised dairy breeds HF (61.0 kg) and BS (62.2 kg) (Table 2). As expected, there was a significant gender effect on the liveweight at auction with male calves being heavier than female ones. However, the magnitude of the weight difference due to the gender effect differed across breeds leading to a significant gender x breed interaction (Tables 1 and 3). The market value of all dual-purpose breeds was significantly higher ($p < 0.001$) than that of two specialised dairy breeds (Table 2).
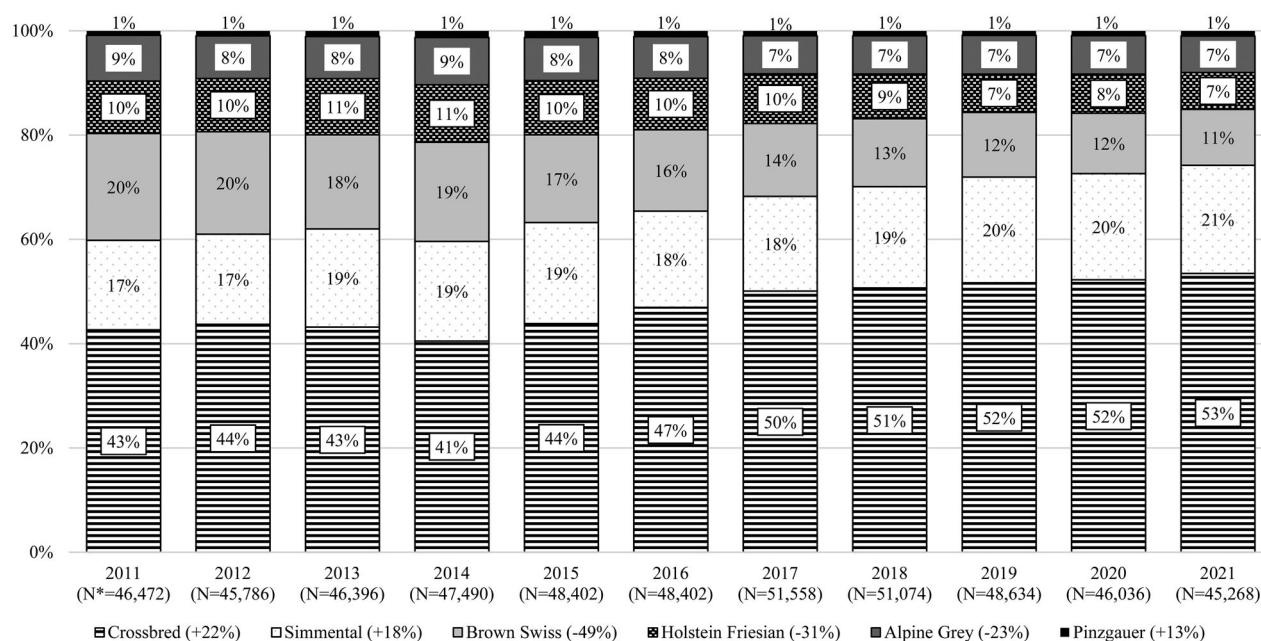
Figure 1. Number of calves sold by year and its percentage partition among breeds within year. *N: Total number of sold calves for respective year; values in brackets highlight the respective trend within each cattle breed

Table 1. Results of the ANOVA for the different traits considered in the analysis of the dataset on calves' quality at auctions.

Traits	DF	Live weight (kg)		Price per kg liveweight (€/kg)		Market value (€/calf)	
		F	Significance (P)	F	Significance (P)	F	Significance (P)
Auction	497	11.7	<0.0001	203.1	<0.0001	122.9	<0.0001
Seller	5250	23.7	<0.0001	12.1	<0.0001	19.5	<0.0001
Breed	4	1104.8	<0.0001	29,784.9	<0.0001	19,848.9	<0.0001
Gender	1	4910.3	<0.0001	5662.5	<0.0001	6853.6	<0.0001
Age of calf	1	24,681.1	<0.0001	4157.6	<0.0001	228.6	<0.0001
Dam's age at calving	15	665.2	<0.0001	59.3	<0.0001	280.8	<0.0001
Breed*gender	4	87.1	<0.0001	199.5	<0.0001	287.8	<0.0001

Table 2. Least-square means of the selling parameters the auctions for purebred calves of different breeds.

Breed	Liveweight (kg)	Price per kg liveweight (€/kg)	Market value (€/calf)
Brown Swiss	62.2[d]	1.77[e]	127.6[e]
Holstein Friesian	61.0[d]	2.19[d]	153.5[d]
Alpine Grey	63.7[c]	3.27[b]	233.5[b]
Simmental	68.1[a]	4.64[a]	350.6[a]
Pinzgauer	65.9[b]	2.82[c]	210.8[c]

Different superscripted letters within column indicate a significant breed difference ($p < 0.05$).

Table 3. Gender difference in liveweight and auction price for calves of different breeds.

Breed	Live weight at auction (kg)			Auction price (€/kg live weight)		
	Male	Female	Difference	Male	Female	Difference
Brown Swiss	67.1	57.3	17%	2.01	1.52	32%
Holstein Friesian	64.3	57.8	10%	2.44	1.94	26%
Alpine Grey	67.1	60.1	12%	3.68	2.85	29%
Simmental	71.4	64.8	15%	5.04	4.24	19%
Pinzgauer	70.6	61.2	11%	3.17	2.47	28%

Similarly, the auction price (€/kg live weight) was significantly higher ($p < 0.001$) for dual-purpose calves (SI, AG, PZ) than for HF and BS calves (Table 2). In particular, the auction price of SI calves was the highest followed by AG and PZ (Table 2) and this trend was observed throughout the study period (Figure 2). For BS and HF calves auction prices were the lowest with a slight negative trend throughout the study period (Table 2 and Figure 2). As for the live weight, the auction price per kg live weight was significantly higher
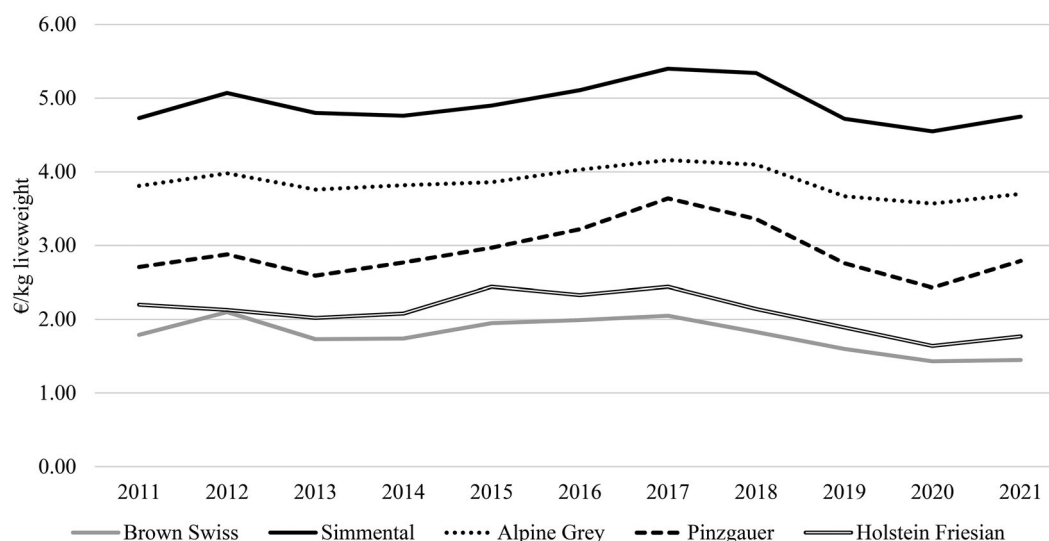
Figure 2. Mean auction price (€/kg liveweight) of calves by breed and year.

Table 4. Number of calves within breed according to use of pasture by their dams during the last 90 days of gestation.

Breed	No grazing	Grazing	Total	Percentage of calves from grazing mothers
Brown Swiss	11,626	1292	12,918	10.0%
Holstein Friesian	7422	502	7924	6.3%
Alpine Grey	6846	1534	8380	18.3%
Simmental	18,783	1900	20,684	9.2%
Pinzgauer	920	136	1056	12.9%
Total	45,598	5364	50,962	10.5%

($p < 0.001$) for male than for female calves (Table 3). According to a significant gender × breed interaction ($p < 0.0001$), the auction price difference was highest for AG calves (0.83 €/kg) and lowest for BS calves (0.49 €/kg) (Table 3).

Effect of the dam's grazing during the last three months of gestation on calves' quality at auctions

Data in Table 4 highlight the number of sold calves by breed that were born from dams that had or did not have access to pasture during the last 90 days of gestation. Overall, 10.5% of the late pregnant cows had access to pasture before calving and the percentage of calves born from grazing dams was higher for the local dual-purpose breeds AG (18.3%) and PZ (12.9%), while it was lower for SI, BS, and HF (Table 4). The results of the ANOVA for the different traits considered in the analysis of the calves' quality at auctions are reported in Table 5. The age of the calves at the auctions did not differ according to the use of pasture by the dams. Grazing during the last 90 days of gestation had very limited effects on the mean values recorded for all the auction parameters and the difference due to the grazing effect differed across breeds leading to

a significant gender × breed interaction (Tables 5 and 6).

Discussion

Evolution of cattle breeding in Alpine area

During the last decades, dairy farming systems located in mountain areas such as the Alps have experienced an intensification trend aiming at increasing milk yield (Berton et al. 2020). Driven by this productive target, the traditional small-scale farms showed a trend towards the substitution of the local dual-purpose breeds with specialised dairy breeds and the use of high energy rations richer in purchased concentrates (Cozzi and Bizzotto, 2004). High specialised dairy cattle promoted a significant increase in the milk yield per cow, and fewer cows were needed to produce the same the product than decades ago (Brito et al. 2021). The latter could help to reduce the environmental impact of dairy production in terms of greenhouse gas emissions per unit of livestock product as Hörtenhuber et al. (2022) highlighted in their case study for Austrian livestock farms. However, the specialisation towards milk production was accompanied by unfavourable genetic responses on cattle fertility and other functional traits like longevity and health

Table 5. Results of the ANOVA for the different traits considered in the analysis of the dataset used to assess the effect of dam's grazing during the last three months of gestation on calves' quality at auctions.

Traits:	DF	Live weight (kg)		Price per kg liveweight (€/kg)		Market value (€/calf)	
		F	Significance (P)	F	Significance (P)	F	Significance (P)
Auction	105	14.7	<0.0001	103.7	<0.0001	66.7	<0.0001
Seller	3398	16.9	<0.0001	6.4	<0.0001	9.4	<0.0001
Breed	4	385.9	<0.0001	5575.9	<0.0001	3469.1	<0.0001
Gender	1	1894.9	<0.0001	615.9	<0.0001	885.1	<0.0001
Age of calf	1	4291.9	<0.0001	750.2	<0.0001	43.9	<0.0001
Dam's age at calving	15	144.2	<0.0001	11.2	<0.0001	53.0	<0.0001
Grazing	1	12.7	0.0004	0.3	0.5974	0.1	0.9799
Breed*gender	4	17.6	<0.0001	43.0	<0.0001	50.4	<0.0001
Breed*grazing	4	8.1	<0.0001	8.1	<0.0001	7.3	<0.0001

Table 6. Least square means of the interaction between breed and grazing during the last 90 days of gestation for of calves selling parameters at auctions.

Breed*	Live weight at auction [kg]		Auction price [€/kg]		Market value [€/calf]	
	No grazing	Grazing	No grazing	Grazing	No grazing	Grazing
Brown Swiss	62.2	61.0	1.39	1.37	101.0	99.2
Holstein Friesian	60.8	61.2	1.82	1.81	128.0	132.3
Alpine grey	63.4	62.4	3.11	3.06	221.9	213.7
Simmental	67.9	68.1	4.44	4.50	336.2	338.4
Pinzgauer	63.1	62.4	2.64	2.72	189.8	193.2

*The interaction of breed and grazing during the last 90 days of gestation significant ($p < 0.05$) for all dependent variables.

(Miglior et al. 2017; Brito et al. 2021). Male calves of specialised high-yielding dairy cattle breeds have become a redundant economic factor with sometimes no alternative options than their on-farm euthanasia (Bolton and von Keyserlingk et al. 2021). Consistent with the dairy areas of the lowland (Balzani et al. 2020; Seidel Jr. and De Jarnette, 2022), the present study recorded an increasing trend of the crossbreeding between specialised dairy breeds and beef bulls also in Alpine farms (Figure 1). This type of breeding scheme improves the future carcase quality of the offspring in specialised dairy herds using beef bulls' semen to mate cows and heifers not used for the replacement production (Berry, 2021). In our study, as already stated, cross bred calves were excluded as there was not reliable information about the sires. Therefore, no direct comparison between crossbred animals and purebred animals in terms of selling parameters at auctions was possible.

So far, approximately 90% of the calves sold at the auctions by cattle farms in South Tyrol are transferred to the fattening units of the lowland (SM 1). Consequently, as for the dairy industry worldwide (Wilson et al. 2020; Reed et al. 2022), concerns about calves' health and welfare due to their long-distance transport have been rising for the mountain farms and appropriate solutions in terms of final purpose should be found (Creutzinger et al. 2021). The creation of an innovative Alpine meat supply chain with calves' fattening in mountain areas could avoid health and welfare problems related to their transport. Beef cattle

breeding appears to be more in line with the current priorities of many mountain farmers, who seek more flexibility in terms of working hours and workload (Zanon et al. 2023).

From a meat production perspective, the outcomes of the study also highlighted that dual-purpose breeds still play a relevant role in Alpine areas (Figure 1) which is in line with findings reported by Zanon et al. (2020b), as they are a source of valuable calves for veal and beef production. Simmental calves received the highest remuneration on the market, confirming the previous findings reported by Dal Zotto et al. (2009) and Zanon et al. (2020b). Generally, calves from dual-purpose breeds received higher remuneration on the market than calves from specialised dairy breeds which is confirmed by Zanon et al. (2020b). Switching from dairy to suckler to beef system and/or calf to beef system in the form of heifer/steer fattening could therefore be an interesting future productive alternative for some dual-purpose cattle farms (Zanon et al. 2023). The meat productive perspective could particularly be attractive, especially for smaller farms, which are currently run as a side-line activity (Zanon et al. 2023). Fattening of calves, heifers or young bulls is less demanding and the working hours required are more flexible than the rigid daily schedules imposed by milk production. However, the prerequisite for the creation of a local meat supply chain is the high-priced marketing of its products, which makes small-scale fattening economically viable in the mountain (Zanon et al. 2023). In this regard, the grass-fed option

of the young stocks could further strengthen the maintenance of the landscape along with other related ecosystem services (Hoffmann et al. 2011).

Pasture grazing and possible related effects on auction parameters

Dairy farming in the mountains is generally associated with the use of pasture, but in reality, grazing is a practice that concerns only a part of the dairy cows in the Alpine region (Lora et al. 2020). Confirming that seasonal calving is no longer a common practice for most Alpine farms, data from this study showed that only a small share of cows grazed during the last 90 days of gestation and the higher percentage of grazing dams belonged to local dual-purpose breeds. This result might be explained by the robustness and better adaptability of the local dual-purpose breeds to the harsh mountain environment and thus the possibility of using them for pasture grazing in difficult Alpine terrain (Zanon et al. 2020a). In this study, the use of pasture during the last 90 days of gestation had very limited effects on the quality of calves at auctions (live weight, price, market value), with inconsistent trends among cattle breeds. Therefore, based on these results, the summer grazing of cows during late gestation could become an attractive management option for several farms. Cattle grazing is a key factor for the Alpine livestock systems as it provides several ecosystem services like landscape maintenance, management and quality of water availability, conservation of animal and plant biodiversity as well as support to the economic development of the local communities (Battaglini et al. 2014, Marsoner et al. 2018). Moreover, as consumers are asking for more natural production systems in mountain areas (Kühl et al. 2021), the development of a local beef chain based on pasture grazing could increase its attractiveness and the market values of its end-products. From a welfare point of view, grazing has positive effects on cow calving ease (Mee et al. 2011) and udder health (Arnott et al. 2017; Zanon et al. 2021). Katzenberger et al. (2020) observed a lower prevalence of lameness in cows that had access to pasture compared to animals that were permanently indoors housed. Last but not least, grazing enables cows to display natural behaviour patterns and social interactions with conspecifics which altogether have a positive impact on animal welfare (Arnott et al. 2017; Zanon et al. 2022b). Promoting the use of pasture in mountain livestock farming could reduce feeding costs and fuel consumption for forage harvesting and therefore improve the economic resilience of small-scale mountain farms. (Gazzarin et al. 2011; Gloy et al. 2002). The authors are aware, however, that the implementation of seasonal pasture-based production systems naturally requires several preconditions in terms of structure and management, as well as market demand for seasonal products.

Conclusion

Using data from the calves' auctions in South Tyrol as a case study, this study offers interesting insights about the evolution of cattle farming in the Alps over the last decade. Overall, the small-scale holdings operating in the Alpine area maintain their dairy orientation, but there is a growing trend to implement crossbreeding schemes with the use of beef bulls' semen to increase the economic value of their calves, especially by farms rearing specialised dairy breeds. The study has also highlighted that the use of pasture by late pregnant cows had no negative effects on the quality of their offspring at sale. These results provide useful technical insights for the local development of an Alpine beef chain as an alternative productive system for some small-scale mountain cattle farms. This innovative beef chain could be supplied by a part of the calves that are now sold at auctions and it might further strengthen the current landscape maintenance service provided by the traditional small-scale cattle farms whose viability is essential for the provision of several ecosystem services in the fragile Alpine environment.

Author contributions

Thomas Zanon: Conceptualisation, Investigation, Writing-Reviewing and Editing; Giulio Cozzi: Conceptualisation, Investigation, Writing-Reviewing and Editing, Supervision; Lorenzo Degano: Data curation, Investigation, Visualisation, Software; Pietro Sartor: Investigation, Writing; Gauly: Conceptualisation, Supervision, Reviewing

Acknowledgments

Ethics approval

This study was exclusively based on economic and productive figures which did not require the approval of the Ethical Committee for the Care and Use of Experimental Animals of the Free University of Bolzano.

Disclosure statement

The authors state that they have no conflict of interest.

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author, Dr Thomas Zanon. The data are not publicly available due to privacy/ethical restrictions.

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