Act in favor of agricultural biodiversity: novel strategies for sustainable conservation and development of endangered livestock breeds

Marescotti Maria Elena[1[0000-0002-3186-7358]], Corradini Annafrancesca[1[0000-0003-0936-3580]], Demartini Eugenio[1[0000-0002-6733-9098]], Lodde Valentina[1[0000-0002-9768-2292]], Franciosi Federica[1[0000-0001-8742-0291]], Luciano Alberto Maria[1[0000-0002-0381-2114]], and Gaviglio Anna[1[0000-0002-0842-0988]]

[1] Department of Veterinary Medicine and Animal Sciences, University of Milan, Via dell'Università 6, 26900 Lodi, Italy

Abstract. The use of Assisted Reproductive Technologies (ART) is specifically recommended by FAO for livestock breeds classified as "endangered" or "vulnerable" concerning extinction risk. However, the success of conservation strategies implying ART depends on their acceptance among breeders. The present research explores farmers' acceptability of ART for conserving the Varzese-Ottonese-Tortonese (VOT) cattle. Data have been collected through in-depth interviews with the cattle breeders members of the VOT Association. Results from this study are especially important considering the limited adoption and diffusion of ART among endangered livestock farmers and give a hint to support breeders in developing more economically sustainable conservation strategies.

Keywords: Varzese-Ottonese-Tortonese cattle, Assisted Reproductive Technologies, Farmers attitudes.

Introduction

Since 90s, the Common Agricultural Policy (CAP) of the European Union has acknowledged the importance of agricultural biodiversity with the adoption of payments aimed at improving the conservation status of agricultural breeds, habitats, and landscapes. Specifically, conserving traditional endangered livestock breeds contributes to the resiliency of agricultural activities [1]. However, traditional livestock breeds give farmers with a lower income regarding milk and meat products. This is particularly the case of the Varzese-Ottonese-Tortonese (VOT) cattle, which is a multipurpose breed (milk, meat, and labor) of the Lombardy region [2]. The agricultural industrialization of the last century led to a progressive replacement of this traditional breed, mainly with the Holstein cattle [3, 4]; consequently, VOT reared animals drastically decreased from 40,000 in 1960 to 39 in 2001, risking extinction. In recent decades, great efforts have been made to preserve this breed. Nevertheless, VOT's actual population, accounting for 800 officially registered cows, is still far from the 4,800 heads identified by FAO [5] as the minimum threshold necessary to avoid the risk of extinction. Surely, the low productivity and the payments provided by the CAP that do not compensate for the lower income make VOT unattractive for farmers [6].

However, VOT's capability to adapt to difficult environmental conditions and low food availability could be useful in rural marginal areas, where intensive farming is not sustainable, leading to farmland abandonment. VOT is also characterized by a high fertility rate and longevity; these traits have been included only recently in the selection indexes of mainstream cattle breeds. In addition, considering climate change and the reduction of water resources foreseen for the next decades, the conservation of this traditional breed is fundamental [7]. Scholars can contribute to the conservation of this endangered livestock breed by promoting conservation plans *ex-situ*. This type of conservation approach implies Assisted Reproductive Technologies (ART) that are recommended by FAO for breeds classified as "endangered" or "vulnerable" [5]. However, the success of conservation strategies implying ART is strongly dependent on their acceptance among breeders [8].

Although ART can provide many advantages in livestock management, their diffusion in traditional breeding is still limited. In the frame of the INNOVA Project (*Innovative program for safeguarding biodiversity and maternal heritage of the indigenous bovine breed Varzese*) related to the preservation of the VOT cattle, the present research aims to explore farmers' acceptability of ART for the conservation of an endangered native cattle breed. The results from this study are especially important considering the limited adoption and diffusion of ART among endangered livestock farmers [9, 10]. Understanding drivers and constraints that affect the adoption of these technologies is fundamental for developing effective policies and interventions aimed at increasing the use of ART and identifying strategies to raise awareness of their potential in biodiversity conservation.

Material and methods

Data about farmers' attitudes towards ART have been collected through in-depth interviews with the cattle breeders members of the VOT Association (n= 10). Farmers were interviewed before the beginning of the INNOVA project activities related to ART application and after the implementation of ART interventions in their farms. The first questionnaire consisted of questions on (i) farmers and (ii) farms', (iii) VOT production, (iv) reproduction management, (v) perceptions towards initiatives developed for VOT conservation, and (vi) ART knowledge. The second questionnaire was focused on ART use and consisted of two sections related to (i) ART knowledge, and (ii) drivers and constraints to ART use in VOT breeding.

Results

Most of the farms are small in size (Mean UAA= 34 Ha; Mean n. of full-time workers= 2), adopt organic certification and maintain multifunctional activities (agritourism, direct selling, educational farm). The herd consistency is reported in Table 1.

Table 1. VOT heard consistency.

Breeder	Calves	Heifers	Cows	Bulls	Castrated	Total
1	3	1	3	0	0	7
2	3	5	11	4	0	23
3	5	7	10	0	1	23
4	5	4	10	7	0	26
5	25	18	27	3	8	81
6	10	20	30	0	15	75
7	1	1	3	0	0	5
8	20	30	45	10	0	105
9	6	0	8	2	4	20
10			22			22
Total	*78*	*86*	*147*	*26*	*28*	*387*

The total number of VOT cattle in our sample is 387. Despite the dual attitude of the breed, 90% of the breeders raise VOT with the final goal of producing meat. According to breeders, meat yields are 20% lower than conventional breeds, while they have discordant opinions about VOT meat products' values: 50% of the respondents were unable to answer, and the other 50% declared that VOT meats have a value from 10 to 50% higher than conventional meats. The main reasons why farmers breed VOT are: (i) to safeguard biodiversity, (ii) for its high cultural value, (iii) because it is a rustic breed, (iv) to differentiate their products, and (v) for the CAP direct payments. The institutional activities for preserving the VOT cattle adopted so far are considered inadequate to guarantee the breed's preservation, while the activities and techniques adopted to ensure the recovery and improvement of the genetic heritage are judged positively. The interviews highlighted the weaknesses and strengths of VOT cattle breeding. The main weaknesses are the low productivity of the breed, the high inbreeding, and the lack of a structured supply chain for VOT products. Concerning reproduction management, most of the farmers adopt natural mating (n= 7); only three farms use exclusively artificial insemination. The main drivers related to ART use reported by interviewees are related to improving the issues connected to cattle inbreeding, genetic improvement of specific traits, enhancement of reproductive efficiency, and the possibility of a faster herd expansion.

On the other hand, some constraints connected to the VOT cattle breeding intrinsic characteristics have been reported by farmers. The cattle grazing management and the use of organic breeding methods might represent a major obstacle to ART use. Among all the ART methods, the Ovum Pick Up (OPU) and the genetic salvage are considered the most effective and suitable in VOT cattle breeding, since they are less invasive than methods requiring hormonal treatments (such as Multiple Ovulation and Embryo Transfer - MOET). They, thus, are more compatible with organic farming practices.

Conclusions

The use of ART in endangered livestock breeding could contribute to biodiversity conservation by solving problems related to inbreeding, leading to a faster genetic improvement and expansion of the herd. Despite some constraints connected to VOT cattle breeding, the activities implemented during the INNOVA Project increased the knowledge and acceptance of ART among farmers.
Results from this study hint to support breeders in developing more economically sustainable conservation strategies for endangered livestock breeds. Nonetheless, besides the intervention on the producers' side, it is fundamental to increase consumers' awareness of the importance of biodiversity in animal husbandry and develop specific marketing strategies aimed at enhancing the value of the products of endangered livestock breeds. In fact, through the enhancement of the final products, farmers can increase profits, thus becoming less dependent on CAP subsidies. In conclusion, our findings highlight the possible role of agricultural economics in developing successful forthcoming biodiversity interventions.

References

1. Nunes, P. A., van den Bergh, J. C.: Economic valuation of biodiversity: sense or nonsense?. Ecological economics 39(2), 203-222 (2001).
2. Pirani, A., Gaviglio, A., Demartini, E.: Management tools for agricultural biodiversity: a model for the classification of autochthonous livestock breeds. Rivista di Economia Agraria 65(4), 569-593 (2010).
3. Cicia, G., D'Ercole, E., Marino, D.: Costs and benefits of preserving farm animal genetic resources from extinction: CVM and bio-economic model for valuing a conservation program for the Italian Pentro horse. Ecological Economics 45(3), 445-459 (2003).
4. Tisdell, C.: Socioeconomic causes of loss of animal genetic diversity: analysis and assessment. Ecological Economics 45, 365-376 (2003).
5. FAO: The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture, edited by Scherf B.D. & Pilling D. FAO Commission on Genetic Resources for Food and Agriculture Assessments, Rome (2015).
6. Signorello, G., Cucuzza, G., Pappalardo, G.: La tutela della biodiversità zootecnica italiana nei piani regionali di sviluppo rurale. Rivista di Economia Agraria LIX(1) (2004).
7. Hoffmann, I.: Climate change and the characterization, breeding, and conservation of animal genetic resources. Anim Genet 41(1), 32-46 (2010).
8. Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M., De Haan, C.: Livestock Long Shadow. FAO, Rome (2006).
9. Blondin, P.: Logistics of large scale commercial IVF embryo production. Reprod Fertil Dev 29, 32-36 (2016).
10. Moore, S.G., Hasler, J.F.: A 100-Year Review: Reproductive technologies in dairy science. J Dairy Sci 100, 10314-10331 (2017).