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PAPER

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Economic evaluation of genetic improvement in local breeds: the case of the Verzaschese goat

Gustavo Gandini[a], Federica Turri[a], Rita Rizzi[a], Matteo Crotta[b], Giulietta Minozzi[a] and Flavia Pizzi[c]

[a]Department of Veterinary Medicine, University of Milan, Milano, Italy; [b]Veterinary Epidemiology, Economics and Public Health Group, The Royal Veterinary College, Hatfield, UK; [c]Institute of Agricultural Biology and Biotechnology. CNR, Lodi, Italy

ABSTRACT
The paper analyses expected costs and benefits of closed nucleus selection in 1100 females of local goat breed Verzaschese. Returns are based on income from the sale of milk per unit of genetic gain. Costs include milk and pedigree recording, housing and maintenance of males and their transport from nucleus to commercial herds, semen production and artificial insemination in the nucleus. Discounted profits, under eight economic scenarios, over investment periods of 10, 15 and 20 years are analysed. Discounted profit for the 14 breeding schemes under the 'best conditions' economic scenario, taking into account returns from increased milk production in both nucleus and commercial population, ranges from 2517–226,434 Euros (10 years period), from 46,387–564,753 Euros (15 years period), and from 106,73–986,676 Euros (20 years period). When we consider genetic gain returns only from the nucleus, over a period of 10 years no breeding schemes show positive discounted profit. In the 15 years period, three schemes show positive discounted profit and two negative discounted profits but above 10,000 Euros; five schemes have positive discounted profit and two schemes above 10,000 in the 20 years horizon. Sensitivity analysis on profit per year shows the variable cost for recording ranking first, followed by return from milk, and by percentage of pregnancy failure.

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Introduction

A major challenge in genetic improvement of local breeds is to adapt the classical selection schemes developed for commercial breeds to small population sizes, and to production systems often characterised by organisational shortcomings (Biscarini et al. 2015). In small ruminant local breeds of the Mediterranean area selection often faces inadequate performance and pedigree recording and absence of artificial insemination (Serradilla & Ugarte 2006). Under these conditions, genetic improvement can be generated in a small fraction of the population, the nucleus and then disseminated to the commercial population through genetically superior breeding animals (e.g. Roden 1995). The open nucleus breeding system has been shown to result in higher rates of genetic gain than the closed nucleus system, and to require lower control on inbreeding (Roden 1995; Kosgey et al. 2006). However, the open nucleus involves pedigree and performance recording also in the lower tiers, with increased costs and management complexity, which is not the case with the closed nucleus. Then, the closed nucleus with only migration of males provides the simplest system for field implementation.

Inbreeding can increase rapidly in closed nuclei. However, methods to control inbreeding in selected populations are available today, reviewed by Fernandez et al. (2011). Selection with inbreeding control has been investigated in simulated small local breeds, including pig (Gourdine et al. 2012), cattle (Gandini et al. 2014b) and small ruminant species (Gandini et al. 2014a).

Population dimension can influence feasibility and efficiency of selection programmes also in economic terms. Costs can be a major constraint for selection in small breeds. Performance and pedigree recording, also if restricted to the nucleus, might be economically not sustainable. The production of small numbers of semen doses per donor, expected in small populations, might substantially increase semen costs with respect to large populations. Beside the above-mentioned difficulties, selecting for enhanced production in local breeds remains an attractive option to provide adequate economic returns to farmers and to increase breed self-sustainability (FAO 2013).

CONTACT Dr. Gustavo Gandini gustavo.gandini@unimi.it DiMeVet, University of Milan, Via Celoria 10, 20133 Milan, Italy

Index selection was experimentally introduced, between 2000 and 2003, in a small fraction of the Italian population of the Verzaschese local goat breed, in the framework of the EU programme INTERREG (Comunità montana Valli del Verbano 2013). At the end of the experimental period, farmers have shown interest to continue the breeding programme, aimed to increase milk yields for cheese production. In this context, the Breeder Association envisages, as a feasible solution, the creation of a nucleus and the use of superior bucks from the nucleus in the commercial population.

This paper analyses the expected costs and benefits of closed nucleus selection in the Italian Verzaschese population, under different scenarios that are reasonably common to other dairy goat breeds farmed in the Mediterranean area.

Materials and methods

The breed

The Verzaschese goat was imported in Northern Italy in the early seventies, from the Ticino Canton, Southern Switzerland. Today the breed is farmed in the provinces of Como and Varese with 1100 goats, and an average herd size of 40 females. Migration between the Swiss and the Italian populations is absent since many years. Pedigree recording is poor, often limited to the maternal side, and no artificial insemination is used.

Selection schemes and genetic progress

Selection of a dairy trait is simulated with a semistocahstic model, with closed nucleus and inbreeding control. The essential features of the model are described below: additional information can be found in Gandini et al. (2014a). The simulated population is divided in two tiers: a closed nucleus where selection is carried out, and the unselected commercial population that uses only sires coming from the nucleus. The simulation interval is one year. Selection is simulated for a single dairy trait, kg of milk per lactation, with genetic parameters estimated in the breed: heritability 0.3, repeatability 0.5, and additive genetic standard deviation 54 kg, (Rizzi, unpublished). A single trait repeatability model is used for estimating animal model BLUP EBVs. In the nucleus, one-year-old young sires (YS), the unselected male offspring of sires of sires (SS) and dams of sires (DS), are used for a one-year mating season on dams of dams (DD). SS are selected among YS and used on DS in the same one-year mating season. DS are selected among all females in age of reproduction. The female offspring of SS $\times$ DS mating are kept for replacement. Should these not be sufficient, females born from YS and DD are randomly selected as replacements. Progeny testing is not considered because the small breed size. In the selection of SS and DS, genetic gain is maximised subject to a fixed annual inbreeding rate of 0.3%, corresponding to approximately 1% per generation, as suggested by FAO (2013). The problem of maximising genetic gain at a fixed inbreeding rate is solved with the optimal contributions methodology (Meuwissen 1997), performed by using an annealing algorithm as illustrated by Berg et al. (2007).

SS and YS, after being used in the nucleus for one year, are moved to the commercial population and mated to females either for one year (Schemes B1)or for two consecutive years (Schemes B2). Figure 1 summarises the simulated breeding scheme. Milk and pedigree recording, and artificial insemination are carried out exclusively in the nucleus. The homogeneous use of males is the only management constrain in the commercial population. Nuclei of 100, 200 and 400 goats, supporting commercial populations of 175, 350 and 650 goats are simulated, for a total population affected by selection ranging from 275 to 1050 goats, corresponding from 25% to 100% of the breed. Table 1 reports the 14 breeding schemes analysed, and the corresponding number of YS produced in the nucleus driven by the reproductive requirements of the commercial population. Assuming a female to male ratio of 25:1, as observed in the Verzaschese and in other Mediterranean local goats, commercial populations of 175, 350 and 650 females require each year 7, 14 and 26 sires, respectively (Schemes B1). When sires are used for 2 years (Schemes B2), the number of sires is halved and rounded to 7 and 13, respectively, for commercial populations of 350 and 650 females. Scheme B2 is not simulated for the population of 175 females, because numbers of males lower than seven do not allow keeping annual inbreeding rate at 0.3% or below. The 14 breeding schemes, deriving from the combinations of nucleus size, commercial population size, and scheme of use of males in the commercial population, are reported in section 'Results' as 'nucleus-size/commercial-size/buck-scheme'.

Costs and return

Breeding costs and returns are computed per breeding scheme, per year and over longer intervals.

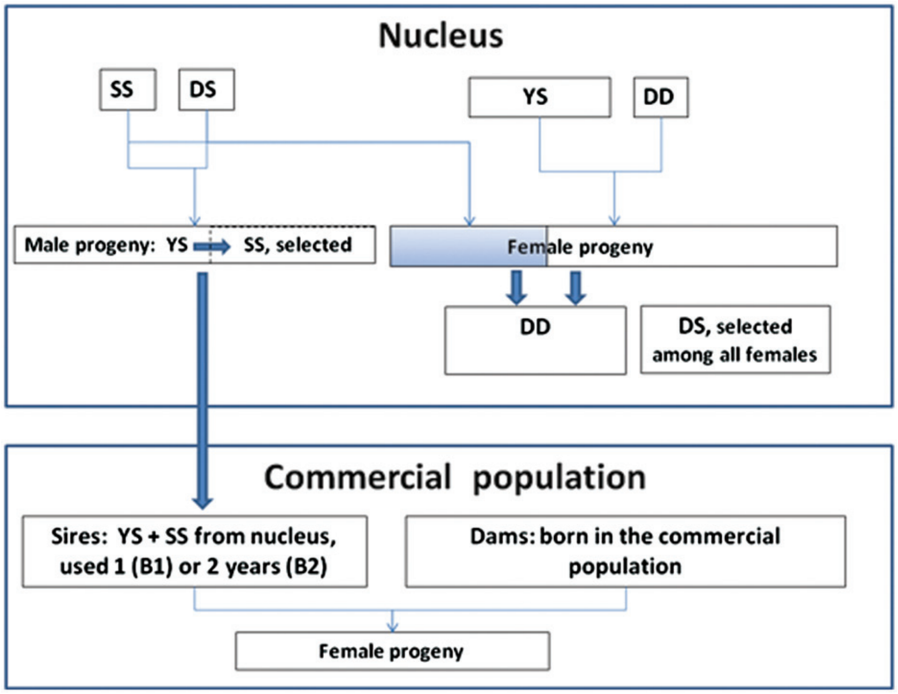

Figure 1. The simulated breeding scheme: nucleus and commercial population. SS: sires of sires; YS: young sires; DS: dams of sires; DD: dams of dams. B1 and B2 refer to different uses of sires from the nucleus in the commercial population, one and two years, respectively (modified from Gandini et al. 2014a).

Table 1. Total population size affected by selection, as the sum of nucleus and commercial population females, of the simulated breeding schemes.

	Commercial population, no. females				
	175	350		650	
Nucleus, no. females	B1	B1	B2	B1	B2
100	275 (7)	450 (14)	450 (7)	750 (26)	750 (13)
200	375 (7)	550 (14)	550 (7)	850 (26)	850 (13)
400		750 (14)	750 (7)	1050 (26)	1050 (13)

Number of young sires in brackets (YS). Use of sires in the commercial population for one (B1) or two years (B2).

Returns from the breeding programme are based on income from the sale of milk per unit of genetic gain, considering alternatively the nucleus or the whole population affected by genetic improvement (i.e. nucleus and commercial population). Calculation of returns considers a net monetary value of one milk kg of genetic gain of alternatively 0.96 and 1.56 Euro, which are the minimum and maximum monetary values observed in a recent economic investigation among Verzaschese farms by G. Zanatta (ARAL, Milan, Italy, personal communication). For sensitivity analysis, intermediate return hypothesis are considered.

Calculation of breeding costs includes milk and pedigree recording, housing and maintenance of males and their transport from nucleus to commercial herds, semen production, and artificial insemination. Costs and return parameters, estimated in the Verzaschese goat context, are summarised in Table 2:

- *Milk and pedigree recording (CR)* – Two situations are evaluated, the current one with eight lactations recorded and with public subsidies covering 88% of costs, resulting in 6 Euro per goat, and the situation expected in a few years of 30 Euro per goat with no subsidies and milk recording limited to three lactations. The reduction of recording from eight to three lactations does not affect rate of genetic gain (Rizzi, unpublished). For sensitivity analysis, intermediate public subsidies hypothesis are considered.
- *Housing, maintenance and transport of males (CM)* – Considering seasonality of reproduction and the use of males for one year in the nucleus, males are kept in the nucleus for 21 months before being

Table 2. Unitary costs and returns.

Parameter	Euro
Milk and pedigree recording, per goat year	6 (with subsidies, 8 controls); 30 (no subsidies, 3 controls); (10,15,20 for sensitivity analysis)
Housing and maintenance, per buck	472.5
Transportation, per buck	100
Semen collection and evaluations (manpower), per collection	49
Freezing set of 1–30 semen doses (manpower, material)	37.25
Freezing one semen dose (additional material)	0.5
Insemination (hormone treatment, insemination), per goat	35
Net return, per kg of milk of genetic gain	0.96; 1.56 (1.06, 1.16, 1.26, 1.36, 1.46 for sensitivity analysis)

moved to the commercial population. The average distance between nucleus and commercial herd is assumed of 50 km. Cost for keeping males is CM = (ca + ct) * nys, where ca and ct are unitary costs for keeping and transport, and nys is the number of YS of the breeding scheme analysed.

- *Semen production (CS)* – A production of 30 semen doses per collection is assumed on average, considering suboptimal production conditions of bucks. Cost for semen production is CS = (cc * ns * nys) + (ct * nl) + (cd * nd), where cc is the unitary cost of collection that includes semen quality analysis before freezing and after thawing, ns is the number of collections per buck, ct is the cost of freezing one 'set of doses' (1–30 doses), nl is the number of sets of doses of the breeding scheme, cd is the additional freezing cost per semen dose and nd is the number of semen doses produced for the breeding scheme. The number of sets of doses varies if we consider processing one buck per day, assuming field conditions, or processing up to seven bucks per day, assuming working at station. In the latter case, one set of doses can be constituted by semen from different bucks, and the number of sets can be lower with respect to processing one buck per day. Travel costs to collection sites are not considered.
- *Artificial insemination(CI)* – It Includes hormonal treatment and insemination costs. An additional cost derives from the fact that 30% of goats, under current conditions, do not become pregnant when artificially inseminated, corresponding to one month of lactation loss (60 kg of milk), as estimated by G. Zanatta (ARAL, Milan, Italy, personal communication). Insemination cost is (CI) = (cf * nf) + (rl * 60 * nf * 0.3), where cf is the unitary insemination cost including hormonal treatment, nf is the number of female in the nucleus, and rl is the net return from one kg of milk. For sensitivity analysis, lower percentages of pregnancy failure, expected by improving insemination techniques, are considered.

Costs for estimating breeding values and for the overall management of the breeding scheme are not taken into account. Then, costs per year are (Cyear) = CR + CM + CS + CI. The combinations of the two principal options for milk return, for milk recording cost and for semen processing (on field or at station), reported in section Results as 'milk-return/recording-costs/bucks day', correspond to eight economic scenarios analysed per breeding scheme.

Discounted profit (DP) is computed per breeding scenario as DP = DR − DG, where DR is the discounted return and DG the discounted costs (Weller 1994). Discounted returns are computed as the monetary value of the annual genetic gain over the time of investment of 10, 15 and 20 years. A discount rate, for both costs and return, of 3.5%, suggested for most EU countries by the European Investment Bank (2013), is used. The eight economic scenarios evaluated across the 14 breeding schemes, over the three periods of investment, correspond to 336 cases analysed.

In order to identify the variables with greater influence on profit per year, a sensitivity analysis (Vose 2008) is carried out. For the purpose of the analysis, the following independent variables were replaced by discrete uniform distributions: milk return (from 0.95 to 1.56 Euro/kg, with increments of 0.1), milk and pedigree recording cost (6, 10, 15, 20, 30 Euros/goat/year), and percentage of goats not pregnant following artificial insemination (from 0 to 30%, with increments of 10%). Independency among distributions is assumed. Results of the sensitivity analysis are given as tornado chart with independent variables ranked by effect on a baseline computed as outputs mean.

Results

Expected genetic gain per year in the 14 breeding schemes is given in Figure 2. Genetic gain in the commercial population is the same as in the nucleus, but with a genetic lag of 7.7 and 8.2 years, respectively in Schemes B1 and B2. Through the paternal line the

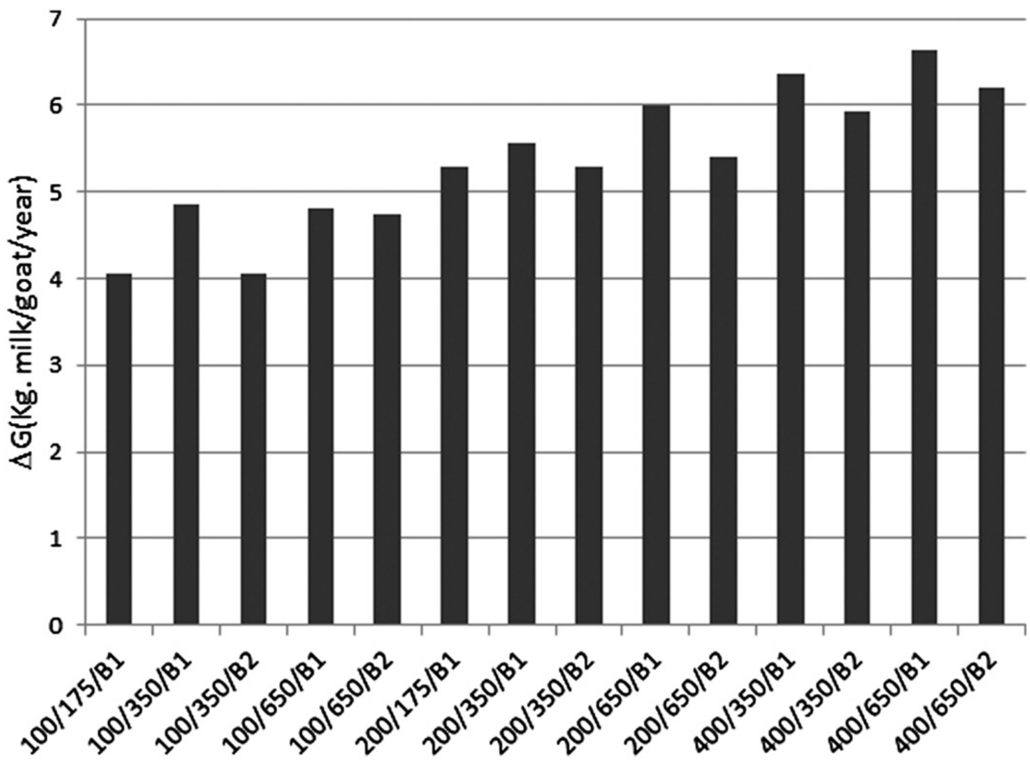

Figure 2. Genetic gain (ΔG) (kg of milk) per goat per year, as a function of the fourteen breeding schemes analysed (nucleus-size/commercial-size/buck-scheme).

Table 3. Annual costs per breeding scheme (Euro).

	Costs						
	Milk – pedigree recording				Semen production		
Scheme	Subsidies	No subsidies	Buck housing, maintenance	Buck transport	1 buck/d	2–7 bucks/d	Artificial insemination
100/175/B1	600	3000	3307.5	700	653.8	653.8	3500
100/350/B1	600	3000	6615	1400	1257.5	1257.5	3500
100/350/B2	600	3000	3307.5	700	653.8	653.8	3500
100/650/B1	600	3000	12285	2600	2292.5	2143.5	3500
100/650/B2	600	3000	6142.5	1300	1171.3	1022.3	3500
200/175/B1	1200	6000	3307.5	700	703.8	703.8	7000
200/350/B1	1200	6000	6615	1400	1307.5	1307.5	7000
200/350/B2	1200	6000	3307.5	700	703.8	703.8	7000
200/650/B1	1200	6000	12285	2600	2342.5	2230.8	7000
200/650/B1	1200	6000	6142.5	1300	1221.3	1146.8	7000
400/350/B1	2400	12,000	6615	1400	1407.5	1407.5	14,000
400/350/B2	2400	12,000	3307.5	700	1407.5	1146.8	14,000
400/650/B1	2400	12,000	12,285	2600	2442.5	2368.0	14,000
400/650/B2	2400	12,000	6142.5	1300	2442.5	1995.5	14,000

genetic lag is 3.0 (B1) or 3.5 (B2) years. Besides, the male direct flow, genes between the nucleus and the commercial population are shared also through females from age class two (born from sires moved at time t and then mated to new sires at time $t+2$) onwards, with a genetic lag from 5 years upwards, resulting in the observed genetic lags. Genetic gain increases by enlarging the dimension of the nucleus, from 4.1 to 4.9 kg, from 5.3 to 6.0 kg, and from 5.9 to 6.6 kg, respectively, in nuclei of 100, 200 and 400 goats. Within a given nucleus dimension, by increasing the number of YS genetic gain increases. With OCS methodology animals are selected accounting for both breeding values and genetic relationships, therefore, it is difficult to understand how number of YS affects genetic gain in the selection pathways of DS and SS.

Table 3 reports annual costs for milk and pedigree recording, housing-maintenance and transport of males, semen production and insemination of goats in the nucleus across the 14 breeding schemes, based on the principal unitary costs of Table 2. Milk and pedigree recording, with the two options considered, and insemination costs are direct function of the size of the nucleus. Costs of semen production, with the two options, are function of both nucleus size and number of bucks. In the economic scenario with no subsidies for recording and the possibility of collection of one buck per day, as average across the breeding schemes, milk recording covers 27% (SD .07) of total costs (not reported in Table 2), housing-maintenance of males covers 29% (SD 0.12), and insemination 32% (SD 0.08). Buck transport and semen production cover a smaller proportion of total costs, in both cases 6% (SD 0.02). In the economic scenario with recording cost of 6 Euros and the possibility of collection of up to seven buck per day, as average across the breeding schemes, recording covers only 7% (SD .02) of total costs, housing-maintenance of males 36% (SD 0.12), and insemination 42% (SD 0.14). Buck transport and semen production cover, as in the previous scenario, a small proportion of total costs, 8% (SD 0.03) and 7% (SD 0.02) respectively.

Figure 3 illustrates discounted profit for the 14 breeding schemes under the 'best conditions' economic scenario, taking into account returns from increased milk production in both nucleus and commercial population, over 10, 15 and 20 years periods. The 'best conditions' economic scenario corresponds to milk recording cost of 6 Euros, up to seven buck collected per day, 30% pregnancy failure, and return of 1.56 Euro per kg of milk. Discounted profit, positive in all schemes, increases by prolonging the time horizon, ranging from 2517 to 226,434 Euros (10 years period), from 46,387 to 564,753 Euros (15 years period), and from 106,737 to 986,676 Euros (20 years period).

Figure 4 illustrates, for the 14 breeding scenarios, discounted profit over 10, 15 and 20 year periods under the 'worst conditions' economic scenario, considering genetic gain returns from both the nucleus and the commercial population. The 'worst conditions' economic scenario corresponds to milk recording cost of 30 Euros, one buck collected per day, 30% pregnancy failure, and milk return of 0.96 Euro per kg of milk. Discount profits are positive in 2, 9 and 13 scenarios, considering periods of respectively 10, 15 and 20 years. Also in this case, discounted profit increases by prolonging time horizon, ranging from −95,549 to 22,746 Euros (10 years period), from −42,479 to 124,047 Euros (15 years period), and from −16,317 to 323,155 Euros (20 years period). On average, differences between the best and the worst conditions economic scenarios are of 142,863, 253,574 and 377,200 Euros, respectively in the 10, 15 and 20 years periods.

Discounted profit decreases substantially when we consider genetic gain returns only from the nucleus, as shown in Figure 5 for the 'best conditions' economic scenario. Over a period of 10 years, no breeding schemes show positive discounted profit. In the 15 years period, three schemes show positive discounted profit and two negative discounted profit but above 10,000 Euros. In the 20 years horizon, five schemes have positive discounted profit, and two schemes show profits above 10,000. The 'worst conditions' economic scenario corresponds to negative discounted

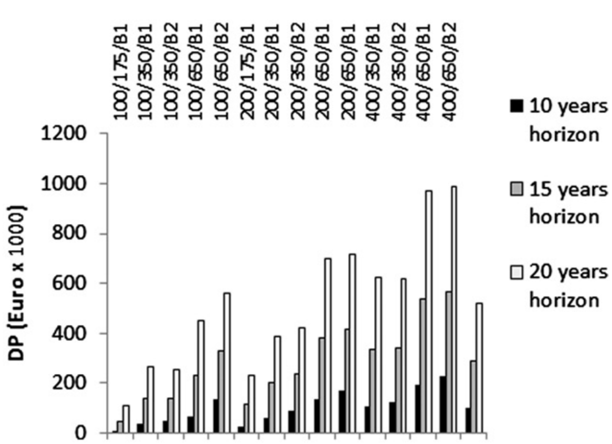

Figure 3. Discounted profit (DP) in Euro ×1000, considering returns from both nucleus and commercial population, under the best economic scenario (milk recording cost 6 Euros, up to seven buck collected per day, 30% pregnancy failure, and return of 1.56 Euro per kg milk)over time of investments of 10, 15 and 20 years, as a function of the 14 breeding schemes analysed (nucleus-size/commercial-size/buck-scheme).

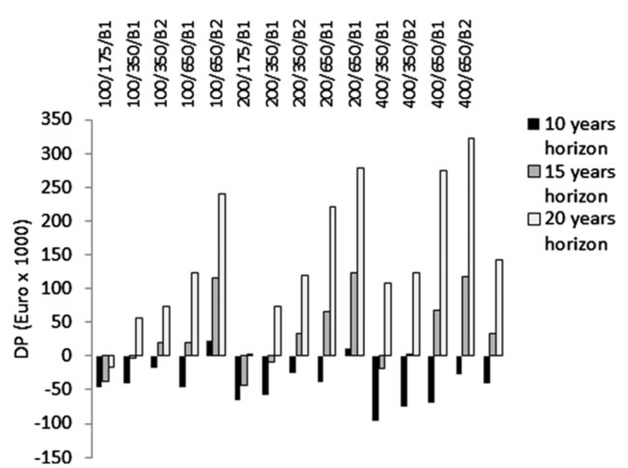

Figure 4. Discounted profit (DP) in Euro ×1000, considering returns from both nucleus and commercial population, under the worst economic scenario (milk recording cost 30 Euros, one buck collected per day, 30% pregnancy failure, and milk return of 0.96 Euro per kg milk), over time of investments of 10, 15 and 20 years, as a function of the fourteen breeding schemes analysed (nucleus-size/commercial-size/buck-scheme).

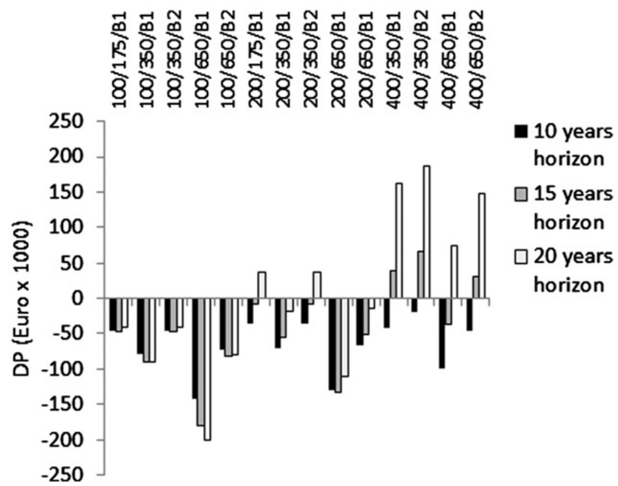

Figure 5. Discounted profit (DP) in Euro ×1000, considering returns only from nucleus, under the best economic scenario (milk recording cost 6 Euros, up to 7 buck collected per day, 30% pregnancy failure, and return of 1.56 Euro per kg milk), over time of investments of 10, 15 and 20 years, as a function of the fourteen breeding schemes analysed (nucleus-size/commercial-size/buck-scheme).

profit for all scenarios: 10 years (from −75,315 to −247,303), 15 years (from −94,701 to −279,503), and 20 year period (from −105,784 to −272,362).

Table 4 analyses, across the eight economic scenarios (milk-return/recording-costs/bucks day), five breeding schemes shown in Figure 5. These are the breeding schemes that, over the period of 15 years, show discounted profit higher than 10,000 Euros when considering returns from the nucleus only and the 'best conditions' economic scenario. Schemes are not all directly comparable as they differ in size of the commercial population, 175 and 650 females (one scheme each) or 350 females (three schemes). Scenarios differ also for the genetic gain they produce, however, Table 4 also reports discounted profit per kg of milk of genetic gain. Discounted profit ranges from −211,142 (breeding scheme 400/650/B2, economic scenario .96/30/1) to 65,978 (breeding scheme 400/350/B2, economic scenario 1.56/6/7). By comparing the three schemes with a commercial population of 350

Table 4. Discounted profit (Euro), over a period of 15 years, across the eighth economic scenarios (columns: milk-return/recording-costs/bucks day[a]), considering returns only from nucleus, for five breeding schemes (rows)); in italics discounted profit per kg milk/year of genetic gain.

	ΔG[b]	.96/30/1	.96/30/7	.96/6/1	.96/6/7	1.56/30/1	1.56/30/7	1.56/6/1	1.56/6/7
200/175/B1;200/350/B2	5.3	−117,850	−117,850	−62,566	−62,566	−64,014	−64,014	−8730	−8730
		−22,236	*−22,236*	*−11,805*	*−11,805*	*−12,078*	*−12,078*	*−1647*	*−1647*
400/350/B1	6.4	−200,541	−200,541	−89,974	−89,974	−70,895	−70,895	39,672	39,672
		−31,335	*−31,335*	*−14,059*	*−14,059*	*−11,077*	*−11,077*	*6199*	*6199*
400/350/B2	6.0	−168,449	−165,446	−57,882	−54,878	−47,592	−44,589	62,975	65,978
		−28,075	*−27,574*	*−9647*	*−9146*	*−7932*	*−7432*	*10,496*	*10,996*
400/650/B2	6.2	−211,142	−205,994	−100,575	−95,427	−84,792	−79,644	25,775	30,924
		−34,055	*−32,225*	*−16,222*	*−15,391*	*−13,676*	*−12,846*	*4157*	*4988*

[a]See text.
[b]ΔG: genetic gain per year.

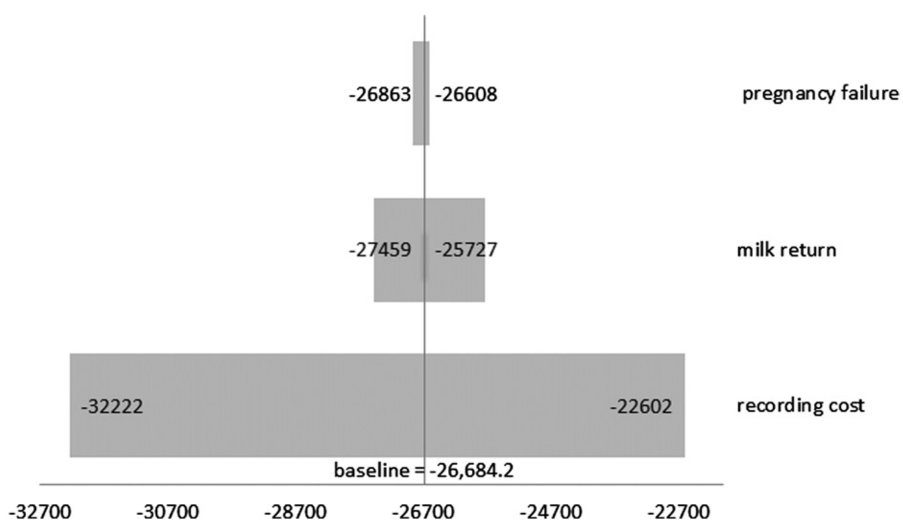

Figure 6. Tornado diagram showing the relative importance on profit per year (Euro) of three independent variables: recording cost, milk return and pregnancy failure. Breeding scheme (nucleus-size/commercial-size/buck-scheme) 400/350/B1.

females in terms of discounted profit per kg of milk genetic gain, we observe that the most profitable scenario is function of the economic scenario considered. The use of a nucleus of 200 goats (scheme 200/350/B2) provides the highest profit when milk return is low and recording cost is high (economic scenarios .96/30/1 and .96/30/7). Under the remaining six economic scenarios, the use of a nucleus of 400 goats and the use of bucks for two years (scheme 400/350/B2) provides the highest discounted profit.

Figure 6 shows the results of the sensitivity analysis on profit per year, for the scheme 400/350/B1. The effects of each independent variable are shown as deviations from the baseline of −26,684.2 Euro, computed as average of all combinations of values of the three independent variables. The variable recording cost ranks highest with a range from −32,222 to −22,602 Euro. Return from milk ranks second, with and effect of 18% with respect to recording costs. Percentage of pregnancy failure affects profit per year only by 3% with respect to recording costs. Sensitivity analysis on other schemes shows (not reported here) identical ranking of the three variables and similar effects.

Discussion

In designing selection schemes for small local breeds, an objective and realistic economic evaluation of alternative breeding schemes is mandatory. The variation of genetic gain observed across the 14 breeding schemes analysed (range 4.1/6.6 kg of milk), and the variation of discounted profit examined across the different economic scenarios (range −211,142/65,978 Euro), underline the importance of investigating different options before implementing breeding programmes in small local breeds. When we include in the economic analysis the returns from the commercial population, profits are positive in most of the scenarios analysed. However, in this paper we designed introduction of selection mainly as a conservation action, to support the local goat breed that is at some risk of extinction because of its small population size (Gandini et al. 2005). Within this framework, returns from genetic gain in the commercial population are not used to compensate selection costs. For the same reason, commercial herds do not participate to costs for the production of bucks and for their transportation to commercial herds, although bucks are kept for one year in the nucleus and then are used in the commercial population for one or two years.

The approach of excluding commercial farms from profit analysis was adopted here also considering the high genetic lag expected between nucleus and commercial population. The genetic lags in both Schemes B1 and B2 could be reduced by decreasing the generation interval of females in the commercial population or, more effectively, by transferring not only males but also females from the nucleus to the commercial population, as analysed by Bichard (1971).

We first compared three times of investments of 10, 15 and 20 years, and we analysed further the period of 15 years, a time of investment in animal breeding already proposed in König et al. (2009). By increasing the time of investment over 20 years, progressively all scenarios are expected to show positive discounted profits.

Discounted profit is mainly affected by returns from milk and by costs for recording, marginally by costs of semen collection. Return from one milk kg of genetic gain is analysed in the range of 0.96 and 1.56 Euro, the minimum and maximum values observed in an economic investigation recently carried out among Verzaschese farms. In this survey, the higher values were associated to farms transforming milk into a branded cheese (named '*formaggella del luinese*') either at the farm or in cooperatives of cheese production. It is reasonable to expect the majority of Verzaschese goat farms moving rapidly to milk transformation into the branded cheese, as observed in Italy, among others, in the Reggiana cattle (Gandini et al. 2007), and in different areas of the world (FAO 2010). We considered two scenarios for cost of recording with rather different values: the highest value is expected to occur soon in the current context of progressive removal of economic incentives. The two options of in field and at station semen processing affect discounted profit only in the scenarios 400/350/B2 and 400/650/B2, where number of doses per buck is above 30 and the possibility of processing more than one buck per day allows optimisation of semen processing costs. Sensitivity analysis indicates that with a return from milk of 1.26 Euro/kg, corresponding to the average of the simulated values, recording costs affects remarkably profit per year, while percentage of pregnancy failure is of minor importance. Costs could be reduced by introducing artificial insemination in the commercial population, thus reducing the number of YS produced in the nucleus to meet the reproductive requirements of the commercial population. The use of artificial insemination in the commercial population could also facilitate insemination management and health control, on the other hand it will increase complexity in the breeding scheme. More generally, the costs used in this study refer to the specific breed-context analysed. These costs can be considered reasonable common to other dairy goat breeds farmed in the Mediterranean area, however, in implementing the methodology in other breeds, the context specific costs and the population distinct reproduction parameters should always be analysed and used.

Conclusions

In conclusion, in this investigation we simulated a single milk trait, according to the current selection aim of the Verzaschese Breeder Association. However, in selecting local breeds, attention must be given to not alter breed's adaptation to local conditions and more generally the traits of conservation interest (FAO 2013). Moreover, the economic balance of a breeding programme for a local breed should also consider, among returns, the contribution that the breeding programme will give in the medium and long-term to the conservation of the local breed, by increasing the profitability for farmers and, more generally, the interest around the breed.

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Disclosure statement

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ORCID

Federica Turri http://orcid.org/0000-0003-2876-999X
Giulietta Minozzi http://orcid.org/0000-0002-0020-8798
Flavia Pizzi http://orcid.org/0000-0002-5076-0265

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