Fibre production

in South American camelids and other fibre animals

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Producing alpaca fibre for the textile industry

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Abstract

The textile industry has changed its way of buying fibre, looking for more fine fibre and paying better prices for the finer categories. A change is needed in the type of animal that is bred, e.g. an alpaca that produces more and finer fibre. Traditional methods of genetic improvement have been applied in Peru with no tangible results so it is necessary to use modern methods such as quantitative genetics. The objectives of selection should be focused on the current market, selecting the best animals and reproducing them with advanced techniques achieving its rapid distribution within the alpaca herds of Peru. Pacomarca is an experimental ranch founded by the INCA group with the aim of acting as a selection nucleus from which genetic improvement for alpaca fibre can spread throughout the rural communities in the Peruvian Altiplano. State-of-the-art techniques in animal science, such as performance recording or assisted reproduction including embryo transfer, are applied to demonstrate their usefulness in the Altiplano conditions. Pacomarca has developed useful software (Paco Pro) to carry out the integral processing of production and reproduction data. Mating is carried out individually, gestation is diagnosed via ultrasound, breeding values estimated from a modern genetic evaluation are used for selection and embryo transfer is applied to increase the selection intensity.

Keywords: Alpaca, genetic improvement

Introduction

Raising alpacas in the highlands of Peru is the only source of income for thousands of families. These families make up the lowest social, economic and educational sector. The income for the alpaca breeders is very low and is determined by two key issues that affect the quality and quantity of the product offered to the market: the poor genetics of their animals and the lack of knowledge (education) about modern farming techniques.

The alpaca fibre market has changed substantially over the past ten years. Finer fibre fetches the best market prices to the detriment of courser fibre. There is therefore a great interest among producers to improve the fibre quality produced by their animals. However, most breeders do not know how to produce this kind of fibre, or do not have access to superior genetics that will improve the quality of future offspring.

Due to various social, political and economic factors that have affected Peru in the last 40 years, the size of alpaca herds has fallen (90% are held by small farmers), private investment in breeding has been almost non-existent and the genetics of animals have deteriorated greatly. This genetic problem is the cause of the thickening of the fibre and the very low production rates. However, raising a course fibre alpaca costs the same as raising an improved finer fibre alpaca, while the genetically improved animal can fetch up to 10 times more income. Therefore, the genetic rescue of fine fibre alpacas and greater production efficiency is essential to address this type of breeding in the 21st century, leaving aside the empirical production patterns based on ancient traditions.

The Pacomarca project

In the absence of serious ventures and long-term (state or private) breeding centres for Alpacas in Peru, it was decided to create Pacomarca in the year 2001.

The primary goal of the project was to install a model farm, modern and efficient, which carried out a programme of raising and breeding alpacas using the best technology for producing fine animals and guaranteed the provision of the basics for improving the quality of the national alpaca herd in the hands of small producers. The Pacomarca project objectives can be summarised as follows:

- Genetic improvement focused on the alpaca fibre required by the textile industry.
- Improving animal husbandry techniques allowing better production indices.
- Transmitting the knowledge gained to Andean producers so they can improve alpaca breeding techniques.
- Becoming a genetic core that provides high-quality animal genetics to Andean farmers.
- Research genetics, reproduction, nutrition and other sciences related to the Alpaca.

Genetic improvement programme

The breeding programme of the Pacomarca farm aims to find the quality and quantity of textile fibre needed today, so the selection objectives have been focused on the intended end market where the alpaca fibre goes. To achieve this objective, quantitative genetics techniques were used that have been successful in other species. The stages of the Pacomarca breeding programme are discussed below.

Definition of selection goals

We must select only those traits that are economically relevant for alpacas. In the beginning 26 possible selection objectives grouped were analysed into Fibre Production goals, Biometric goals, Phenotype goals and Yield goals. Taking into consideration the genetic correlations and the importance of each objective, 9 objectives are currently used and divided into two groups (Figure 1): Fibre (objective) and Phenotype (subjective)

The information for objective analysis of fibre is obtained through analysis of fibre sample. Pacomarca animals are analysed once a year by OFDA 100. Until now, 11,553 analyses have been carried out. For the phenotypic information a physical assessment is used at weaning, which

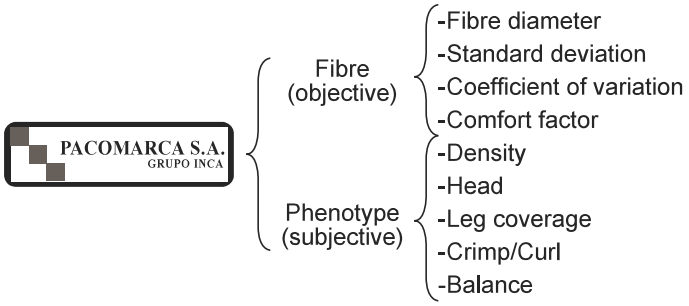

Figure 1. Selection objectives of Pacomarca.

has been standardised for all team members. 3,950 phenotypic assessments have been performed. In Pacomarca 100% of the population for phenotypic analysis and fibre is included.

Performance recording

It is not possible to make genetic improvement if there is no available herd to improve; herds must be systematised and accessible for the project at all times. Pacomarca has developed the PACO PRO software as a main support for the breeding programme (Figure 2). PACO PRO management software can store and organise all data relevant to raising alpacas, saving time and allowing the decision-making process to move on.

The information stored in PACO PRO covers:

- identification and pedigree identification of individual, parents, date of birth, sex;
- reproductive information: breeding, diagnostics, births;
- information on fibre: diameter, standard deviation, comfort factor, coefficient of variation;
- production information: type of fleece, weight, staple length;
- phenotypic information on density, crimp/curl, head, leg coverage, balance;
- medical information: treatments, diseases, defects.

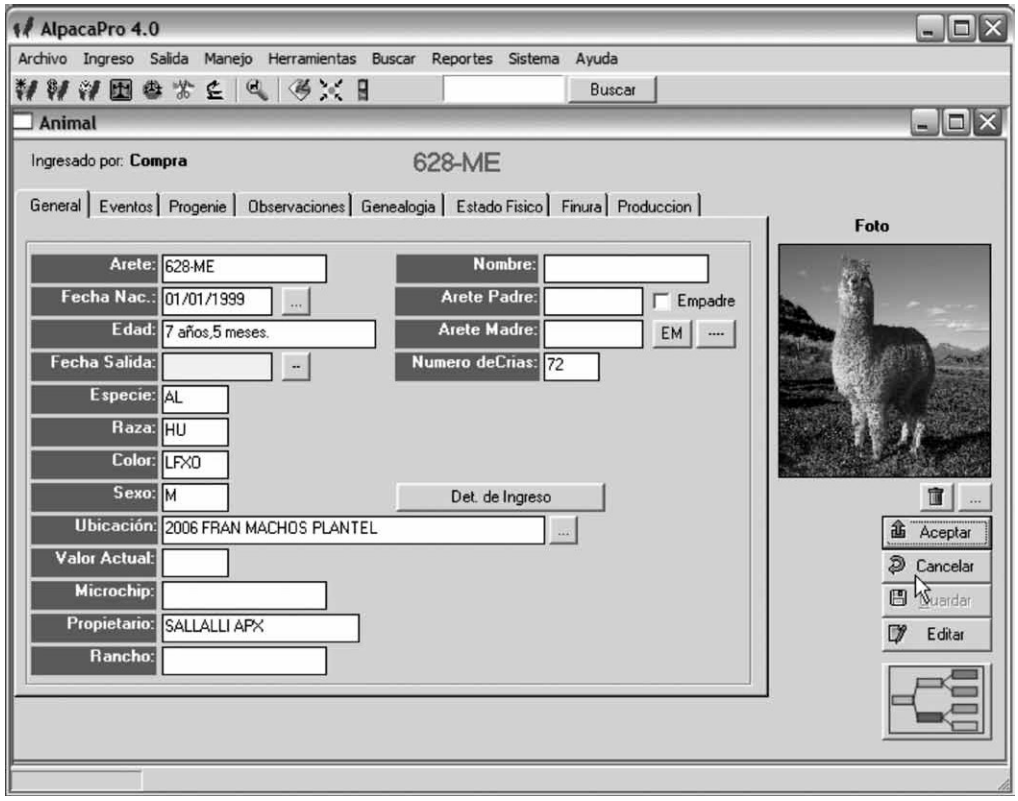

Figure 2. PACO PRO software: individual identification of each animal in the Pacomarca breeding programme.

Estimation of genetic parameters

You can only improve those parameters that have a high heritability. Pacomarca has been able to determine the heritability for the main performance parameters of alpacas (Table 1 and Table 2). Pacomarca has a cooperation agreement with the Univesidad Complutense de Madrid for genetic evaluations of animals based on information from the software Pacopro using restricted maximum likelihood, VCE.

Genetic evaluation

The genetic evaluation (Table 3) is the most reliable statistical estimation of genetic value of a particular individual for a particular trait. Pacomarca uses BLUP (Best Linear Unbiased Predictor) to determine the genetic evaluation of all alpacas in the programme. A genetic evaluation for a

Table 1. Estimated heritabilities (diagonal) and genetic correlations (over the diagonal) for the fibre and phenotype in Huacaya.

	MIC	SD	CONF	CV	DEN	RIZ	CAB	CAL	BAL
MIC	0.3694	0.7194	-0.968	0.0944	-0.079	-0.3	-0.279	0.0279	-0.134
SD		0.417	-0.79	0.7511	-0.257	-0.52	-0.123	0.1105	-0.063
CONF			0.2546	-0.219	0.1076	0.3318	0.2359	-0.077	0.1019
CV				0.3797	-0.296	-0.477	0.1055	0.148	0.059
DEN					0.2364	0.7251	0.2086	-0.145	0.2139
RIZ						0.4198	0.3303	0.0856	0.3672
CAB							0.4254	0.7646	0.9209
CAL								0.4746	0.826
BAL									0.1484

Grey cells: the best alpaca for the trait.
White cells: the worst alpaca for the trait.

Table 2. Estimated heritabilities (diagonal) and genetic correlations (over the diagonal) for the fibre and phenotype in Suri.

	MIC	SD	CONF	CV	DEN	RIZ	CAB	CAL	BAL
MIC	0.6988845	0.74988	-0.97548	0.08664	0.283993	-0.19308	-0.0349	0.1665	0.0341
SD		0.68429	-0.75836	0.7188	0.141035	-0.15329	-0.01	0.1305	-0.02
CONF			0.56518	-0.1376	-0.33301	0.22377	0.01625	-0.1865	-0.049
CV				0.60515	-0.05584	-0.01802	0.03869	0.0397	-0.052
DEN					0.269231	0.43229	0.71481	0.7919	0.5728
RIZ						0.2854	0.63228	0.4139	0.6877
CAB							0.17598	0.7897	0.9356
CAL								0.3722	0.7287
BAL									0.2585

Grey cells: the best alpaca for the trait.
White cells: the worst alpaca for the trait.

Table 3. Example of a genetic evaluation chart drawn up for Huacaya males from Pacomarca. Green shows best animal for the trait and red the worst. Male 178-05M is son of male 17M showing the genetic gain.

ARETE	DOB	MIC VG	SD VG	FCO VG	CV VG	DEN VG	RIZ VG	CAB VG	CAL VG	BAL VG
505-07M	07-03-07	**-2.39572**	-0.13734	4.55725	-0.10795	0.27155	0.49527	0.29288	0.28385	0.33169
549-06M	10-05-06	-2.22733	-0.25671	3.52586	0.69244	0.26001	0.26227	0.50187	0.29505	0.26631
373-05M	01-03-05	-2.12048	-0.16223	4.24445	0.56557	0.24192	0.30132	0.22031	0.16533	0.18304
557-06M	14-05-06	-2.02425	-0.30582	1.57401	0.10927	0.01458	0.63657	0.10591	0.20374	0.02644
35M	07-03-00	-1.83636	-0.54211	4.64751	-1.30565	0.21939	0.53465	0.24074	0.24715	0.22842
44M	19-01-04	-1.73619	-0.52152	1.87182	-1.21075	0.02911	0.18504	-0.26624	**-0.24144**	-0.08362
436-07M	17-02-07	-1.53701	-0.55877	1.77469	-1.24383	0.16331	0.30021	*0.85083*	0.38175	0.28574
309-07M	23-01-07	-1.49774	-0.23280	1.43647	-0.29754	0.12211	0.15933	0.39515	0.51422	0.22272
374-05M	01-03-05	-1.47652	-0.57071	0.74719	-0.70127	*0.69799*	*1.31615*	0.39915	0.47308	0.39930
122-07M	15-12-06	-1.47576	**-0.64508**	2.51595	-1.01303	0.16213	0.20088	0.12658	-0.19402	0.15112
079-06M	29-12-05	-1.42677	0.15371	*4.75618*	0.62861	0.05061	0.41967	0.13262	0.25080	0.23967
34M	07-01-00	-1.27016	-0.37026	1.54858	-0.52700	0.17085	0.20216	0.19840	-0.05787	0.12095
374-06M	16-02-06	-1.25376	-0.18887	-1.17160	-0.30822	0.44500	0.39631	0.69042	0.35212	0.33450
124-06M	07-01-06	-1.19700	-0.34699	1.78120	-0.81013	-0.05477	0.37608	-0.13841	0.18406	-0.05188
619-07M	23-04-07	-1.17759	-0.18832	-0.11902	0.46401	0.05593	0.26341	0.18207	0.32550	0.13857
043-02M	16-01-02	-1.06246	0.13772	-0.79671	0.66705	0.39888	0.31654	0.54022	0.06511	0.35420
178-05M	14-01-05	-1.03305	0.21704	0.77700	1.11221	-0.14584	-0.03153	0.15731	0.59750	0.15044
303-06M	06-02-06	-0.98028	-0.41995	0.87505	-0.38156	0.40957	0.42464	-0.06384	-0.21983	-0.08168
293-06M	04-02-06	-0.85667	-0.40015	1.65770	-0.27741	0.48571	0.56126	0.34411	0.04476	0.11338
6M	15-02-95	-0.83755	-0.48089	4.02589	**-2.20956**	0.13748	0.25957	0.12792	-0.05056	-0.03551
213-05M	21-01-05	-0.68192	-0.15531	0.75239	0.24303	0.43266	0.64204	0.11209	0.48520	0.21231
553-06MR	11-05-06	-0.59486	0.00145	-0.10427	1.06636	0.02501	**-0.19898**	**-0.45627**	0.03498	**-0.16376**
12M	01-01-00	-0.44560	-0.44342	0.63863	-0.17334	0.08328	0.21790	-0.22352	-0.10493	0.01301
004-01M	27-12-00	-0.44067	-0.25648	-1.34579	0.16313	0.61239	1.08804	-0.17538	-0.00931	0.13106
363-06M	14-02-06	-0.43264	-0.48333	1.68519	-0.55005	0.19950	0.16608	-0.41273	-0.04051	-0.05885
053-02M	24-01-02	-0.35441	0.07461	**-1.89626**	0.77514	-0.10833	-0.14478	0.74816	0.98439	*0.50068*
17M	23-01-00	-0.32551	0.61089	-1.51371	3.09721	-0.46094	-0.05667	0.37561	0.84230	0.30379
207-06M	20-01-06	-0.26960	0.06364	-0.41885	0.07811	0.53355	0.81455	0.33184	-0.05798	0.03971
059-04M	25-12-03	-0.21110	-0.32211	-0.34557	0.06727	0.64676	0.58272	-0.06305	-0.04006	0.12865
454-06M	15-03-06	-0.20673	-0.21479	-0.72318	-0.38947	0.16373	0.28865	0.49716	0.49083	0.28946
026-05M	16-12-04	*-0.02907*	-0.58663	0.90629	-1.41583	0.11496	-0.15623	0.64662	*1.00021*	0.40586

Bold: the best alpaca for the trait.

Italic: the worst alpaca for the trait.

Grey cells: male 178-05M is son of male 17M showing the genetic gain.

given trait is the expected difference between the average value of the offspring of an individual and the average value of the trait in the rest of the population. The value lets you determine how much better or worse an animal is with respect to the mean for each trait, allowing the selected alpacas the transmission of the best production traits to their offspring.

Genetic testing is carried out every year for all animals, based on these results; breeding decisions are made, where the male complement the lack of females. Likewise with the results of genetic evaluation animals can be selected for entering the embryo transfer programme.

Selection criteria

The two main tools of genetic improvement are the selection (to determine which individuals are going to leave offspring) and mating systems (to determine how the individuals selected will be paired). Breeding involves the processes of genetic evaluation and dissemination of selected genetic material in which you can use artificial reproductive technologies such as embryo transfer (ET).

Pacomarca uses the following breeding techniques:

- Individual breeding: for which replicated facilities designed to facilitate this work achieved 92% fertility.
- Embryo transfer: after the experience of genetic evaluations, Pacomarca has acquired the ability to identify their best animals. However, a rapid genetic response is limited by the number of offspring produced naturally, only one offspring born to each female per year. To address this limitation, Pacomarca has initiated a programme of assisted reproduction through embryo transfer. Males and females with the best breeding values were selected. Up to six embryos, with an average of four, were obtained from each female and transferred to females with high maternal capabilities. Thus, each female can provide four offspring per year on average. Table 4 shows the summary of the data for embryo transfer in the 2009-2010 season, showing 68% of successful pregnancies and 60% of offspring born.

Table 4. Summary of embryo transfers production in 2009-2010.

	n	%
Donor females	25	-
Recipient females	145	-
Flushings	131	-
Collected embryos	101	77.10
Transferred embryos	101	77.10
Successful pregnancy	69	68.32
Offspring born	61	60.40