Animal fibers in Argentina: production and research

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Abstract
Argentina is amongst world's largest producers of fine wool and mohair, in addition to llama and small amounts of cashmere, silk, vicuna and guanaco fiber. Most wool and all mohair are produced in Patagonia. More than 50% of the wool is Merino which averages 20.0 mic, is of good color and has low vegetable content. Argentinean mohair is white, fine but often medullated. Most llamas are single coated and about 40% are white. Adult llama fiber diameter averages 22-23 mic. Guanaco fleeces weigh 0.4 kg, 80% is down fiber which averages 15 mic and has a fiber length of 35-40 mm. Vicuña fleeces weigh 0.3 kg and more than 90% is down fiber which averages 13 mic and has a fiber length similar to guanacos. Three laboratories analyze wool bale core test samples and individual animal samples aiding marketing, selection programs and research. Research has been on management issues like optimum shearing date. Research showed that it is possible to produce 18 mic Merino wool in Patagonia, as long as shearing is pre-lambing. Extensive R&D went into the development of the national sheep and goat genetic evaluation scheme.

Resumen
Argentina está entre los mayores productores de lana fina y mohair del mundo, además de producir fibra de llama y pequeñas cantidades de cashmere, seda, vicuña y guanaco. La mayoría de la lana y todo el mohair se producen en la Patagonia. Más del 50% de la lana es Merino que promedia 20.0 mic, tiene buen color y bajo contenido de vegetales. El mohair argentino es blanco, fino y a menudo medulado. Gran parte de las llamas son de capa simple y un 40% son blancas. Fibra de llama adulta promedia 22-23 mic. El vellón de guanaco pesa 0,4 kg, 80% es down cuya finura media es de15 mic y tiene un largo de 35-40 mm. Vellones de vicuña pesan 0,3 kg y tiene 90% de down con promedio de 13 mic y largo de fibra similar al de guancos. Tres laboratorios analizan muestras de calado de fardos y muestras individuales contribuyendo a la comercialización, programas de selección e investigación. La investigación ha sido en temas de manejo como fecha óptima de esquila. La investigación mostró que es posible producir lana Merino de 18 mic en Patagonia mientras la esquila sea pre-parto. Considerable I&D se dedicó al desarrollo del plan nacional de evaluación genética de ovinos y caprinos.

Keywords: wool, mohair, cashmere, llama, guanaco

Introduction

Argentina is among the top producers of fine wool and mohair in the world. In addition, Argentina produces llama fiber and small amounts of cashmere, vicuña, guanaco and silk. Fiber production statistics for South American countries were reported by Cardellino and Mueller (2009) and updated figures for Argentina are in Table 1. Wool production figures are about 30% lower than previous ten year average because of the negative consequences of the eruption of the Puyehue Volcano in June 2011 and prolonged drought in some areas of the country. Table 1 also shows a big difference between the number of cashmere goats or llamas and the number of these animals actually shorn. The populations of wild vicunas (*Vicugna vicugna*) and guanacos (*Lama glama*) are also very large but the collection of its fiber is difficult and strongly regulated by wildlife management authorities. Meat from domestic small ruminants is for home consumption and for the domestic market, whereas wool and mohair is almost entirely exported. Main wool export destinations are EU countries and China, 75% are in form of tops. Mohair is exported to EU countries. Angora fiber from rabbits and silk production were popular en the past. Angora rabbits have been replaced with meat breed rabbits and silk production has been reduced to about 500 kg in backyard systems. The relative economic importance of small ruminants in Argentina´s agricultural sector is low and fiber production is less important than meat production. However fiber production has regional economic importance and is particularly relevant in the most marginal areas where little alternative livelihoods are available. Published and unpublished information on Argentina´s animal fiber production systems, fiber characteristics and fiber improvement efforts are reviewed in what follows.

Table 1: *Fiber production statistics in Argentina.*

Fiber	Farmers	Animals	Animals shorn/year	Production (kg/year)	Year
Wool	71,517	14,696,903	12,242,412	44,000,000	2011/2012
Mohair	3,210	809,566	600,000	900,000	2012
Llama	3,303	195,882	58,765	105,776	2011
Cashmere	1000	350,000	20,000	7,500	2009
Guanaco	34	491,923	4,000	1,200	2011
Vicuña	39	131,220	2,104	776	2011

Note: The number of guanaco and vicuña farmers refers to management units.
Source: Adapted from FLA (2012), SENASA (2013) and unpublished surveys.

Fiber production systems

Patagonia desert system

Two-thirds of Argentina's sheep population, all Angora goats and almost all cashmere producing goats are bred in Patagonia. This region covers the southern third of the country and can be described as a cold desert. Annual precipitation is 100-300 mm and daily temperatures average 0-15° C, with minima of -15° C and snow covers that can remain several weeks. The region periodically suffers the effects of prolonged droughts and volcanic eruptions. Sheep in Patagonia are managed on natural grasslands throughout the year with stocking rates from 1 to 10 ha/sheep. Approximately two thirds of farms have less than 1000 heads of sheep. But several farms run more than 50,000 sheep. In the drier areas of Patagonia Australian Merino sheep are preferred and in more humid areas the double purpose Corriedale breed is more common. It has been shown that wool provides a more stable income to farmers than sheep meat in extensively managed and variable environments such as Patagonia (Easdale & Rosso, 2010).The general trend in Patagonian sheep production systems is towards more meat and finer wool. Towards the North of Patagonia the climate becomes warmer and farms and flocks are smaller. Here, in smallholder systems Merino sheep are run together with Angora goats. Angora flocks are of about 300 goats. Northwest in Patagonia, sheep disappear altogether and Angora goats are replaced by local meat type goats. A large proportion of these goats are double coated and recently some cashmere is being harvested from them (Lanari *et al*., 2009). Patagonia is also home to guanacos, a wild South American camelid species from which a valuable fine undercoat fiber can be collected and marketed for export or transformed regionally into expensive garments. Guanacos can be caught in the wild for shearing following strict wildlife management rules (Montes *et al*., 2006). In a few cases guanacos are also held for shearing in semi-captive systems using appropriate facilities (Cancino, 2008).

Other production systems
Central Argentina is a large flat region, called "Pampa", with rich soils and consistent rainfall of about 1200 mm. The region is intensively cropped for cereals and legumes in high input commercial farms. Beef cattle and some sheep are run on some of these farms as part of the crop-livestock rotation or using crop stubbles. Typical flocks are of 50-150 heads. Sheep breeds are double purpose Corriedale, Romney Marsh and Lincoln, sometimes crossed with Hampshire Down, Suffolk or Texel rams for prime lamb production. Sheep production in this area is a secondary activity where wool is not important and little attention is paid for its improvement. Towards the Northeast of the country weather becomes hotter and more humid, in particular between the two large rivers Parana and Uruguay, an area called "Mesopotamia". Here, Corriedale, Romney and Polwarth breed sheep are run for meat and wool. Often sheep are managed together with beef cattle in mixed livestock systems. Sheep play an important role in weed control. In the high plateau (4000 masl) and valleys of the extreme Northwest of the country, the "Puna", smallholders run sheep, goats and llamas in mixed livestock systems. Flocks are small and graze largely on communal land. Sheep are of local or "criollo" type with different degrees of upgrading to Corriedale. In this region the vicuña, another wild South American camelid, is common and as mentioned for guanacos in Patagonia, some vicuñas are captured for shearing from the wild using ancestral gathering systems, the "chakkus" (Rigalt *et al*., 2006), or are sheared in semi-captive systems. It should be noted that exploitation of fiber from wild camelids is subject of controversy because of alleged negative or positive effects on the conservation of these species. A summary of fiber production systems is in Table 2.

Table 2: *Summary of animal fiber production systems in Argentina.*

System	**Fiber**	**Climate**	**Farmer type**	**Flock size**
Patagonian desert	Wool, guanaco, mohair, cashmere	Dry and cold (snow)	Family and company, low input	70%>100 40%>500
Pampa mixed crop-livestock	Wool	Template	Family and company, high input	50-150
Mesopotamia mixed livestock	Wool	Hot and humid	Family and company	100-300
Puna high altitude	Wool, llama, vicuña	High amplitude	Smallholder	<50

Fiber quality

The Argentinean National Institute for Agricultural Technology (INTA) runs a fiber analyses support structure based on a net of three laboratories located strategically in Patagonia (Bariloche, Rawson and Río Gallegos). These labs service farmers, industry and marketing with fiber metrology using IWTO standard analyses methods and own validated methods (e.g. Sacchero and Mueller, 2005). Wool quality reports produced by these laboratories are used in 95% of wool sold by farmers and 40% of its further marketing, transformation and export transactions. In order to ensure quality of results the laboratories participate in inter-laboratory round trails. Two laboratories are ISO 17025 accredited and IWTO licensed. The fiber laboratory net is strategic for the development of the fiber industry of the country.

Wool quality

Exported wool fiber diameter profile clearly shows two frequency peaks at about 20 and 29 mic, related to the contributions of the two main sheep breeds: Merino and Corriedale (FLA 2012). Of the Merino wool 9% is superfine (less than 18.5 mic) and of all wool produced only 2% is coarser than 32.5 mic. Average core test results from two laboratories over 5 wool clips in the main Merino producing provinces are in Table 3.

Table 3: *Merino wool quality.*

Province	Shearing moment	Core tests	Combing yield[1] (%)	Fiber diameter[2] (mic)	Staple length[3] (mm)	Staple strength[3] (N/ktex)
Rio Negro	Pre-lambing	5489	57.1	20.0	85	28.6
	Post-lambing	2277	53.7	20.0	91	22.1
Chubut	Pre-lambing	961	62.6	19.9	85	33.8
	Post-lambing	2181	57.3	19.9	88	26.4

[1]IWTO Test Method 19, [2]IWTO Test Methods 12 and 28, [3]IWTO Test Method 30.
Source: Elvira *et al*. (2006).

Patagonian Merino wool is very white and soft. Elvira & Albertoli (2009) measured Merino wool whiteness and brightness by IWTO 56-03 D65/10° method in different regions of Chubut province obtaining 7.7 (Y-Z) tristimulus units for whiteness and 68.9 (Y) for brightness, where lower Y-Z units indicate whiter color and higher Y units indicate more brightness. For comparison, it has been estimated that only 1-3% of the Australian wool clip measures 7 (Y-Z) units or lower and that 70-80% measures greater than 8.5 and hogget wool averages 9.6 units (Hebart & Brien, 2009). Patagonian wool is also known for its low vegetable content: less than 1% in 95% of commercial lots. While Merino wool is produced exclusively in Patagonia, Corriedale wool is produced all over the country. Therefore its quality depends strongly on the particular production region. South Patagonian Corriedale is known for its whiteness and rather low fiber diameter (typically 24 and 27.5 mic for hogget and adult wool respectively. Combing yield in this region is 65-70%. In Mesopotamia, Corriedale wool is known for its high combing yield (70-75%) but somewhat yellowish color due to the high temperature and humidity. Average fiber diameter is 27.5 and 32 mic for hogget and adult wool, respectively. In the Pampa, Corriedale is of better color than in the Mesopotamia but also rather coarse (27-31 mic). In the humid and hot areas of Mesopotamia, Polwarth sheep have better wool color than Corriedales and 22 and 25 mic for hogget and adult wool, respectively. Romney and Lincoln wool is found in the Pampa region, these breeds produce coarse wool destined to the carpet and upholstery industry. In the Puna, wool comes from local “criollo” sheep and is rather coarse, contaminated with vegetables and often colored. This wool is marketed at low prices and often used in local handcrafts.

Goat and camelid fiber quality

Argentinean mohair is white, relatively fine and with a variable amount of medullated fibers, both med and kemp. Cashmere production is just starting and initial characterization indicates the presence of a variety of colors and high variability between animals and flocks. Fiber diameter resembles Iranian cashmere (Table 4). Cashmere fleeces shorn pre-lambing weigh 558 g, combed cashmere fleeces weigh 119 g (Maurino, 2013, unpublished). The quality of llama, guanaco and vicuña fiber in Argentina are summarized in Table 5, including some of the data reviewed by Mueller *et al.* (2010). More recently Hick *et al.* (2012) updated previous llama fiber characterization results surveying 173 flocks in the main llama production province of Jujuy. The observed color frequencies were 42.2% white, 31.1% terra, 16.2% camel, 8.1% gray and 2.3% graphite. According to fleece type, 36.1% were double coated, 39.9% were single coated and 24.0% were luster type of fleeces. The variability of llama fiber quality within and between populations is high but in any case the textile value is high. This is because fiber diameter and the proportion of double coated fleeces are rather low when compared for example with average Bolivian llama fiber (Quispe *et al*., 2009).

Table 4: *Goat fiber quality in representative samples.*

Fiber	n	Fleece weight (kg)	Down yield (%)	Fiber diameter (mic)	Medu-llation (%)	Reference and description of sample
Mohair	1983	1.34	-	24.8	4.0	Taddeo *et al*. (1998a) kid
Mohair	2806	2.29	-	31.9	5.1	Taddeo *et al*. (1998a) adult
Mohair	n.a.	n.a.	-	24.0	3.0	Sacchero (2013, unpub.) kid
Mohair	n.a.	n.a.	-	28.2	3.2	Sacchero (2013, unpub.) adult
Cashmere	727	n.a.	40.5	20.0	-	Maurino *et al*. (2008) sheared
Cashmere	98	n.a.	85.0	18.5	-	Maurino *et al*. (2008) combed

n.a.: not available

Vicuña and guanaco fiber quality is known for captive and for wild populations. Mueller *et al*. (2010) summarized several studies noting that vicuña fleece weight increases with increased age at first shearing (about 15.6 g/year). Adult vicuña fleece weights varied widely between populations and there is some evidence that fleece weights are higher at higher altitudes. Experimental evidence from repeated biannual shearing indicates that first fleece weight is somewhat higher and fibers are longer than in the following shearings. In any case repeated biannual shearing of vicuñas seems to be justified since fleece weights and fiber lengths remain constant at about 300 g and 35 mm, respectively. Fiber diameter increase slightly from 1 to 4 or 5 years of age and then remains constant. Guanaco fiber quality has also been studied in captive and wild populations.

Table 5: *South American camelid fiber qualities in representative samples.*

Species	n	Fleece weight (g)	Down yield (%)	Fiber diameter (mic)	Fiber length (mm)	Reference and description of sample
Llama	10989	n.a.	n.a.	22.2	n.a.	Hick *et al*. (2012) Puna
Llama	151	1270	90.4	21.3	117.5	Cancino et al. (2006) Puna males
Guanaco	182	n.a.	86.2	15.2	34.0	Elvira (2006, unpublished) captive
Guanaco	279	n.a.	84.4	15.1	n.a.	Sacchero *et al*. (2006) 7 sites
Guanaco	11	377	73.4	14.9	39.7	Cancino *et al*. (2008) captive
Guanaco	80	n.a.	n.a.	16.0	n.a.	Fernandez (2007, unpub.) captive
Guanaco	100	n.a.	n.a.	15.1	n.a.	Fernandez (2007, unpub.) wild
Vicuña	61	230	92.0	12.6	37.7	Rigalt *et al*. (2006, unpub.) wild
Vicuña	1263	427	n.a.	n.a.	n.a.	Rigalt (2013, unpublished) wild
Vicuña	232	312	92.0	13.4	49.7	Rebuffi (1999) captive

n.a.: not available.

Research to improve fiber production

Shearing, nutrition, health and husbandry

Research to improve sheep production in general went into general husbandry issues such optimum stocking rates, strategic feeding, reproduction technologies, health issues, etc. Perhaps the most influential research in sheep production has been on the effects of pre-lambing shearing instead of the conventional post-lambing shearing. It has been consistently shown that in seasonal lambing systems such as is the case in Patagonia, shearing pre-lambing, that is in early spring, increases survival of lambs (Mueller, 1980) and improves clean yield of wool (González *et al*., 1988 and Table 3). Specific studies were performed on variation of wool quality over the body (Rodríguez Iglesias *et al*., 2013) and fiber diameter profiles (Sacchero *et al*., 2011), including the methodology for its analyses (Sacchero *et al*., 2012). Much of the research leading to improved wool quality has been incorporated in Argentina's national wool quality program "Prolana" which is based on proper shearing, conditioning and marketing protocols (Prolana, 2013). Skin studies in Angora goats showed that follicle density reduces after 53 months of age, S/P is smallest at 41 months and secondary follicle number increase till 65 months of age while primary follicles do not change (Carro *et al*., 2010). Debenedetti *et al*. (2007, unpublished) also compared Angoras with cashmere producing Neuquen Criollo goats and found that skin follicle traits are related to fiber traits such as CV of fiber diameter. Cashmere harvesting methods and timing were studied by Lanari *et al*. (2011) who showed that shearing goats pre-lambing collected more cashmere but of less quality than combing. In more detail, cashmere growth pattern was studied by Lanari *et al*. (2008). Llama coat color distribution and inheritance were studied by Frank *et al*. (2006a) and others. Frank *et al*. (2006b) also studied the effect of fleece type, age and shearing intervals on llama fleece weight and fiber quality. Their results show that annual shearing reduces fleece weight and staple length significantly. Fleece weight and mean fiber diameter tends to increase with age and staple length tends to decrease with age.

Breeding and genetics

Research on GxE interaction showed that it is possible to breed superfine Merinos in Patagonia instead of regular Merinos in either high or low nutritional level without loss of wool quality, as long as shearing is pre-lambing (early spring). Thus with shearing in the most restrictive period, mid breaks of staples can be avoided (Mueller *et al*., 2005a, 2005b). Studies on fiber diameter profiles (Sacchero & Mueller, 2007; Sacchero *et al*., 2010) showed that fiber diameter changes in superfine Merinos are similar to regular Merinos. Mueller and Carlino (2010) proved that Merino sheep selected for high fleece weight and low fiber diameter are more efficient converters of feed into wool than unselected sheep. In sheep regular crossbreeding or change of breed are uncommon practices in Argentina. Sire breed evaluations in terminal crossbreeding confirmed expected results of higher crossbred lamb growth rates as long as enough feed is available for their dams. Genetic parameters for Argentinean Merino sheep were reported by Mueller *et al*. (2003). Vozzi *et al*. (2011) analyzed the pedigree finding a high influence of imported animals and little impact of locally produced rams. Central progeny testing of stud rams and imported Merino and Corriedale rams were performed during many years (Mueller *et al*., 2009; Mueller *et al*., 2007) but eventually replaced by population-wide BLUP evaluations. Progeny test results were helpful to convince breeders of the usefulness of objective measurements for management and breeding. Also useful for extension purposes was a selection experiment with a control flock. The genetic trend in fleece weight, body weight and fiber diameter showed that it is possible to improve simultaneously fiber diameter, fleece weight and body weight despite unfavorable genetic correlations with fiber diameter (Mueller 2012, unpublished). Sheep breeding research results were extensively used for the development of the national small ruminant genetic evaluation scheme “Provino” (Provino, 2013). The service is run by INTA and offers estimation of within contemporary group breeding values and population wide breeding values, based on BLUP Animal Model analyses. In 2012 Provino accumulated 170,533 sheep with wool records. The Argentinean Merino Breeders Society adopted formally Provino in its genetic improvement program. The program is particularly well accepted in non-pedigreed ram producing flocks such as nucleus and multiplier flocks. Fleece sampling site, environmental factors affecting mohair production and genetic parameters in Angora goats were studied by Taddeo *et al*. (2000, 1998ab). These and other studies contributed to the Angora improvement program which started with the establishment of a central open nucleus and multipliers in 1988 (Mueller, 1995), later aided with imported bucks in a circular mating scheme amongst nucleus and multipliers (Abad *et al*., 2002) and BLUP evaluation. Breeding objective was to increase fleece weight and reduce medullation. The breeding program is a key activity of the national Mohair Program (Sapag & Arrigo 2007, unpublished). A review of phenotypic and genetic description of fiber traits in South American domestic camelids was done by Frank *et al*. (2006a). Genetic parameters were calculated in llama populations outside their normal high altitude habitat (Frank *et al*., 2011). Heritabilities of fiber traits are in the order of 0.3-04, thus genetic progress can be expected from selection. Argentina is however short of organizing a comprehensive llama genetic improvement program.

Since a decade attempts to find markers associated to wool and mohair quantity and quality were made. In Merino sheep a QTL related to fiber diameter was found on OAR3 in a region linked to type II keratin genes. Also, a QTL related to fleece weight on OAR4, clean yield and CV of fiber diameter on OAR25, were found (Bidinost *et al*., 2008). Roldan *et al*. (2010) found a QTL affecting several wool traits on OAR1 (average curvature of fiber at first and second shearing, and clean wool yield measured at second shearing) and on OAR11 (weight and staple strength at first shearing, and coefficient of variation of fiber diameter at second shearing). In addition, the results of the single trait method and the two-QTL hypotheses showed an additional QTL segregating on OAR11 (for greasy fleece weight and clean wool yield). Pleiotropic QTLs were found on OAR1 (clean wool yield, average curvature of fiber, clean and greasy fleece weight and staple length, all measured at second shearing). Otherwise, in goat fibers, putative QTL that affect mohair were first identified by Cano *et al*. (2007) including CV of fiber diameter linked to CHI1 and CHI13; percentage of discontinuous medullated fibers and staple length associated with CHI2 and evidence of percentage of kemp contamination on CHI 13 in Angora goats. This resulted in further investigation into goat chromosome 19 (Cano *et al*., 2009) confirming a QTL affecting CV of fiber diameter on CHI19 (Cano *et al*., 2003) and two new putative QTL affecting staple length at first shearing and greasy fleece weight in second shearing on CHI19. The presence of QTLs for CV of fiber diameter, percentage of fiber with diameter over 30 mic, percentage of continuous medullated fibers and greasy fleece weight were detected on CHI1 (Cano *et al*., 2009b). Otherwise, putative QTL affecting fleece traits including average fiber diameter, proportion of fiber over 30 microns, greasy and clean fleece weight were identified by Debenedetti *et al*. (2010) on CHI5 in a backcross Angora × Creole population. Debenedetti *et al*. (2012) also found a possible QTL affecting secondary to primary hair follicle relation on CH1. Despite the accumulating information on QTLs and recent use of SNP50K beadchip there is no use made of DNA information in Argentina´s small ruminant breeding programs.

Value adding

Different ways of adding value to raw fibers have been considered and implemented. For example, on-farm classing of raw llama and mohair, improved overall fiber price (Lamas, 2006 unpublished; Sapag & Arrigo, 2007 unpublished). Other strategies to add value to raw wool include organic production and additional quality certification (La Torraca *et al*., 2004 unpublished). The textile quality of particular Patagonian wools when transformed into suits was tested by Elvira (2008, unpublished). Adding value to cashmere and camelid fleeces includes dehairing. For example Frank *et al*. (2012) showed that from the point of view of the textile behavior, there are substantial differences between llama fleece types. Lustre types have less capacity to form „bulk" than non-lustre types, and generally, respond less to dehairing, while in double coat fleeces the coarse fibre reduction is notably greater. As a result, double coat fleeces have a lower yield than other types of fleeces. Frank (2011) proposes special dehairing devices and breeding in order to reduce the coarse edge of fiber diameters in camelids and other species. Lanari *et al*. (2009) described efforts on cashmere and guanaco fiber transformation into handcrafts.

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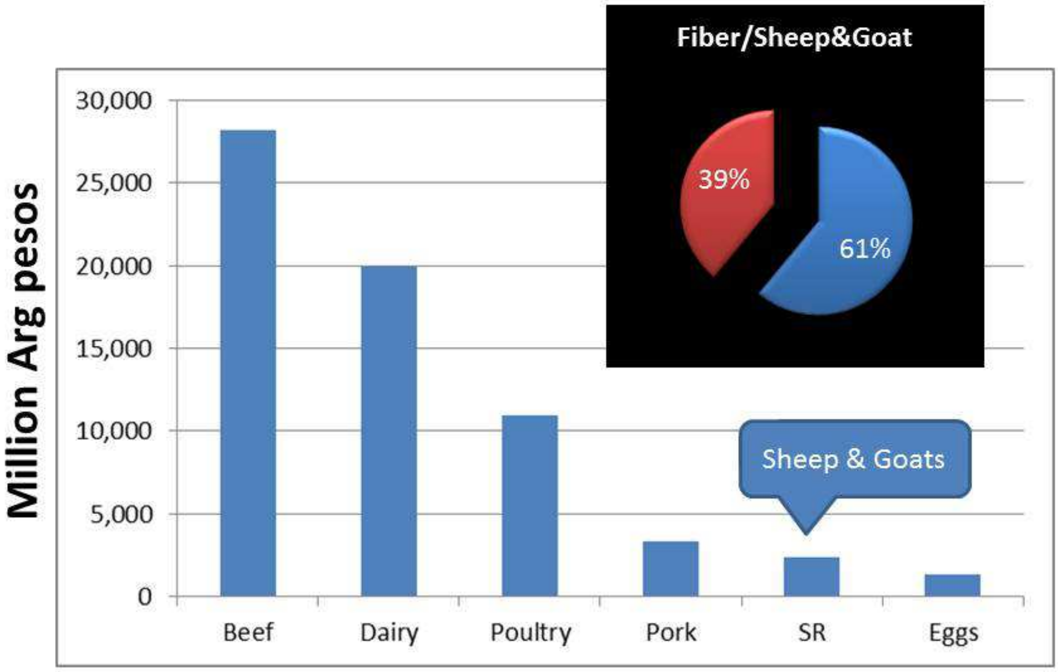
"Animal fibers in Argentina: production and research"

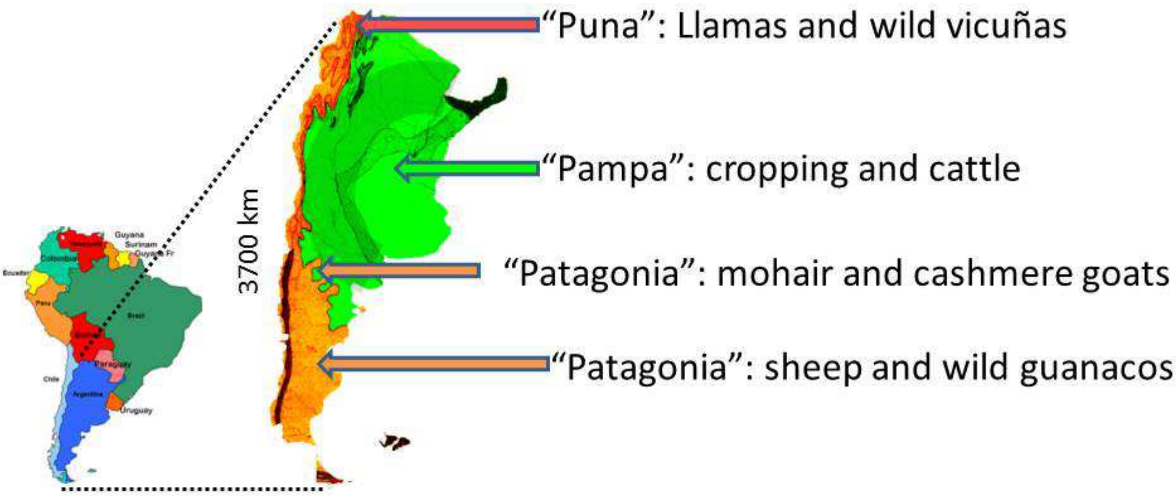
Mueller JP, Elvira ME & Sacchero DE
National Institute for Agricultural Technology, Argentina

6th European Symposium on South American Camelids and 2nd European Meeting on Fiber Animals at the 64th EAAP, 29 August, Nantes, France

Fiber production in Argentina is of low economic importance



Most SR occupy poor agro-ecological regions, most farmers are smallholders



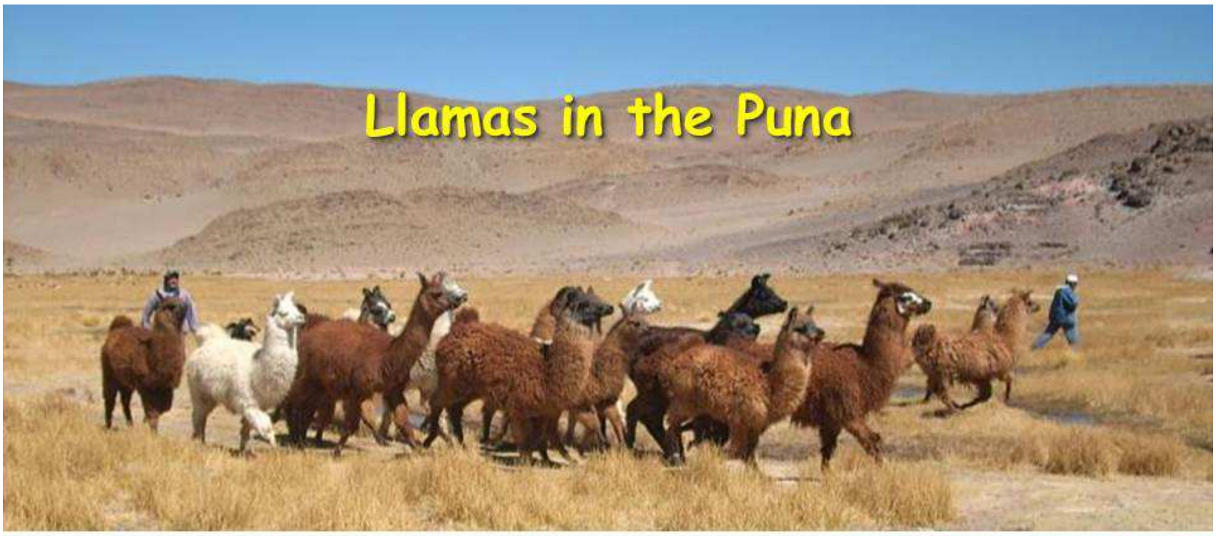
>> Importance of SR is in regional economy and food security

Wool is by far the most important animal fiber in Argentina

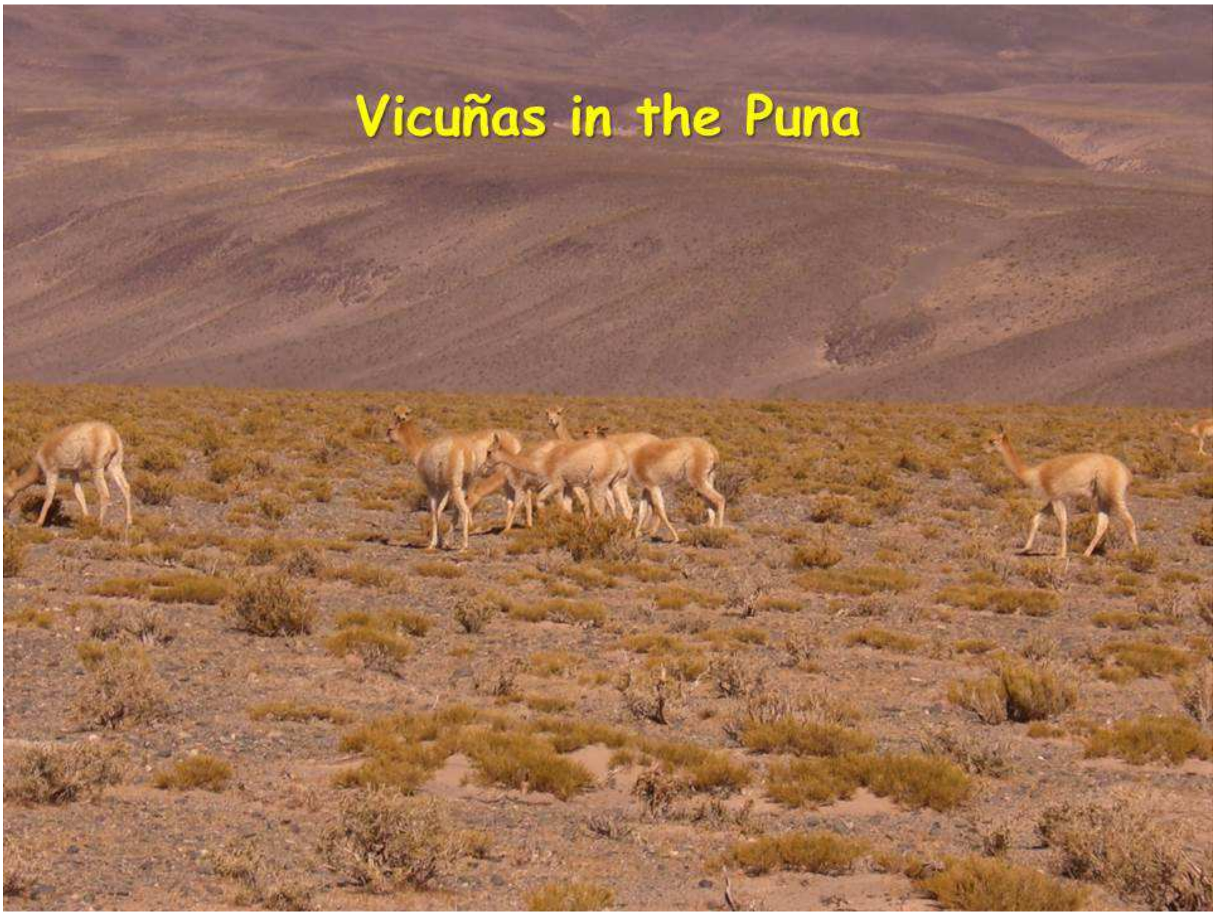
Fiber	Farmers	Animals	Animals shorn/year	Production (kg/year)	Survey year
Wool	71,517	14,696,903	12,242,412	44,000,000	2011/2012
Mohair	3,210	809,566	600,000	900,000	2012
Llama	3,303	195,882	58,765	105,776	2011
Cashmere	1,000	350,000	20,000	7,500	2012
Guanaco	34	491,923	4,000	1,200	2011
Vicuña	39	131,220	2,104	776	2011

Note: The number of guanaco and vicuña farmers refers to management units.
Source: Adapted from FLA (2012), SENASA (2013) and unpublished surveys.

Note: no alpacas in Argentina



- Smallholders at > 3500 masl
- 1-8 USD/kg
- Raw fiber sales contribute 10% of income
- 30% of fiber is home-used or sold with added value




Community "Chakku" of vicuñas
Vicuña shearing

Vicuña fiber: "Gold of the Andes"

- Protected: only controlled shearing and releasing
- 600-900 USD/kg raw
- Home made ponchos or sale for export

Patagonian guanaco fiber collection

Similar to vicuña:

- Using horses
- 60-120 USD/kg raw
- Exported / dehaired

South American camelid fiber quality in representative samples

Species	n	Fleece weight (g)	Down yield (%)	Fiber diameter (mic)	Fiber length (mm)	Reference and description of sample
Llama	10989	n.a.	n.a.	22.2	n.a.	Hick et al. (2012) Puna survey
Llama	151	1270	90.4	21.3	117.5	Cancino et al. (2006) Puna males
Vicuña	61	230	92.0	12.6	37.7	Rigalt et al. (2006b) wild
Vicuña	1263	427	n.a.	n.a.	n.a.	Rigalt (2013, unpublished) wild
Vicuña	232	312	92.0	13.4	49.7	Rebuffi (1999) captive
Guanaco	182	n.a.	86.2	15.2	34.0	Elvira (2006) captive
Guanaco	271	n.a.	84.4	15.1	n.a.	Sacchero et al. (2006) 7 sites
Guanaco	11	377	73.4	14.9	39.7	Cancino et al. (2008) captive
Guanaco	80	n.a.	n.a.	16.0	n.a.	Fernandez (2007) captive
Guanaco	100	n.a.	n.a.	15.1	n.a.	Fernandez (2007) wild

Patagonian cashmere production

- Dry mountain environment – transhumant system
- 100-400 goat - smallholders
- Local goat breeds for meat
- Some with cashmere, combed or shorn

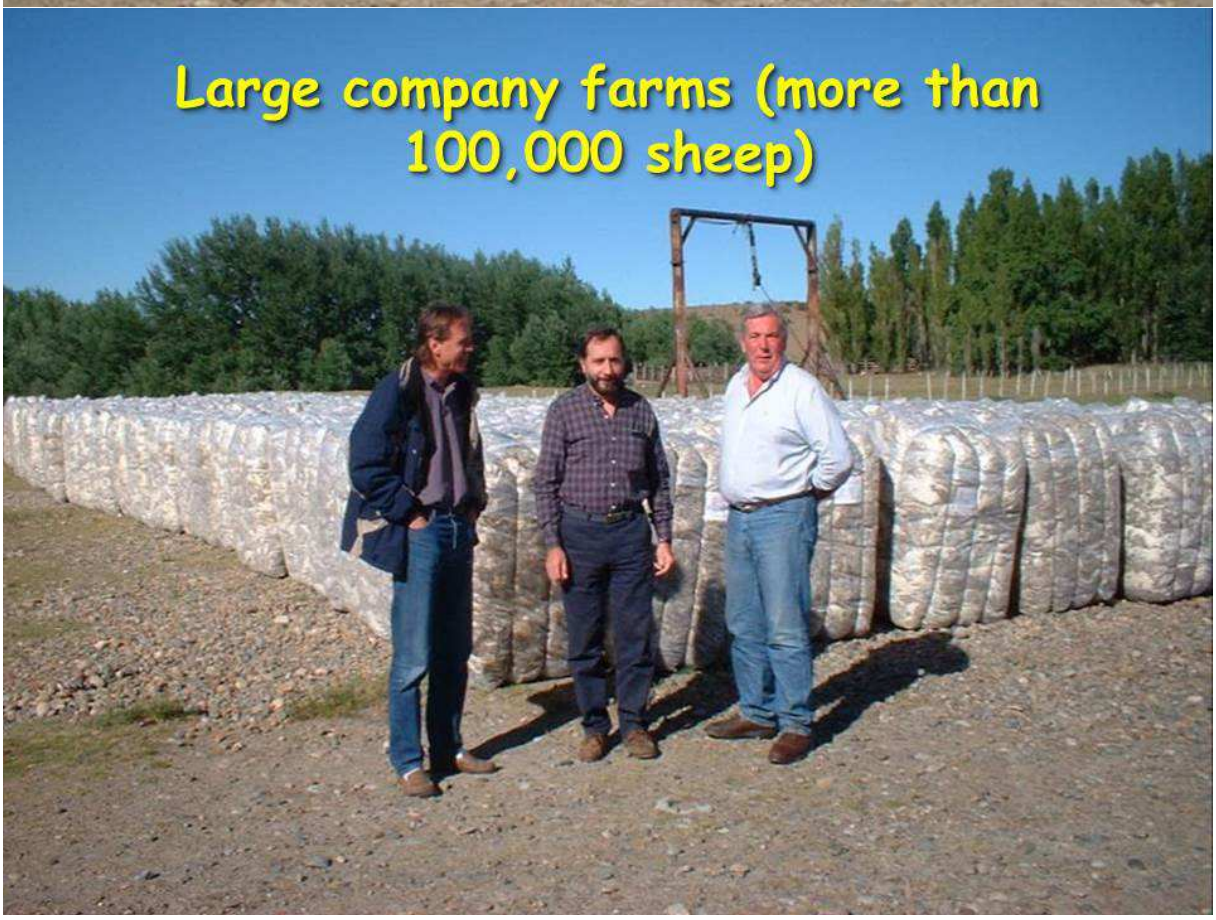
Patagonian mohair production

- 100-400 goat smallholder - family systems
- Low input – extensive - non-housed
- 5-15 USD/kg raw
- Export

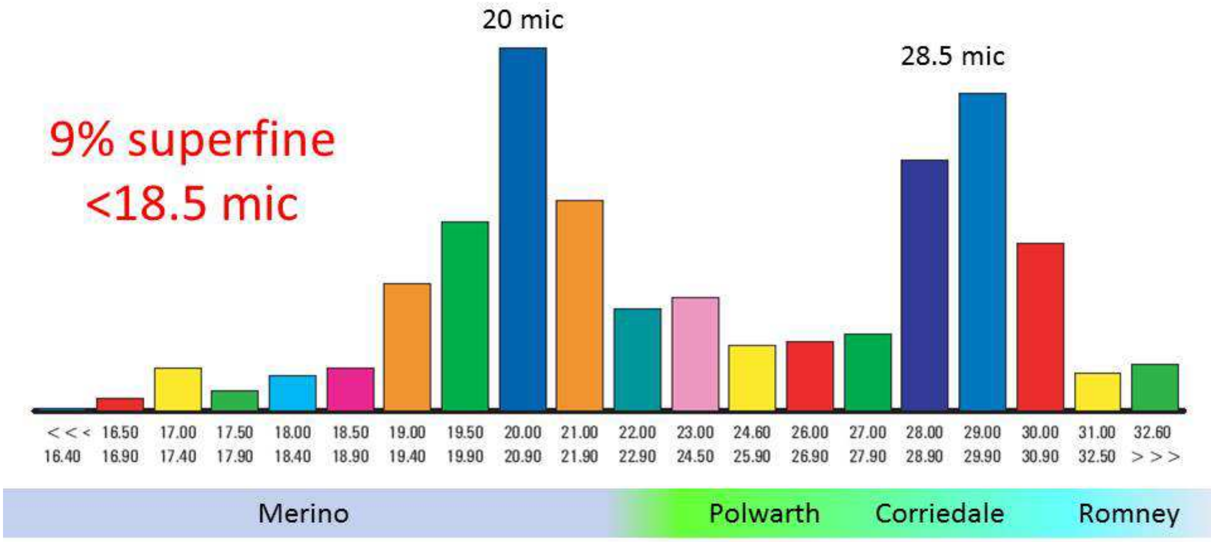
Goat fiber quality in representative samples

Fiber	n	Fleece weight (kg)	Down yield (%)	Fiber diameter (mic)	Medu-llation (%)	Reference and description of sample
Mohair	1983	1.34	-	24.8	4.0	Taddeo et al. (1998a) kid
Mohair	n.a.	n.a.	-	24.0	3.0	Sacchero (2013, unpub.) kid
Mohair	2806	2.29	-	31.9	5.1	Taddeo et al. (1998a) adult
Mohair	n.a.	n.a.	-	28.2	3.2	Sacchero (2013, unpub.) adult
Cashmere	727	0.558	40.5	20.0	-	Maurino et al. (2008) sheared
Cashmere	98	0.119	85.0	18.5	-	Maurino et al. (2008) combed


Small family farms (400-1000 sheep)


Large company farms (more than 100,000 sheep)

Micron profile of wool exports (95%)



Source: FLA (2013)

Overall wool quality (Patagonia)

Breed	Core tests	Combing yield[1] (%)	Fiber diameter[2] (mic)	Staple length[3] (mm)	Staple strength[3] (N/ktex)
Merino	961	62.6	19.9	85	33.8
Corriedale	349	63.6	26.6	99	34.4

- Very white: 7.7 tristimulus units (Y-Z) and bright: 68.9 units (Y)
- Low vegetable content: <1% in 95% of patagonian wool lots
- Farmers get intl price for wool quality

[1]IWTO Test Method 19, [2]IWTO Test Methods 12 and 28, [3]IWTO Test Method 30.
Source: Elvira *et al*. (2006).

Wool quality at first shearing in stud flocks

Breed	N	Greasy fleece weight (kg)	Clean yield (%)	Mean fiber diameter (mic)	CV Mean fiber diameter (%)	Staple length (mm)	Staple strength (N/ktex)
Merino	13856	4.14	68.6	17.3	21.5	87.8	31.0
Corriedale	2166	4.57	73.4	25.1	23.3	na	na

Source: Mueller, 2013 unpublished

- Trend towards larger sheep with finer wool
- Larger Merinos – Finer Corriedales

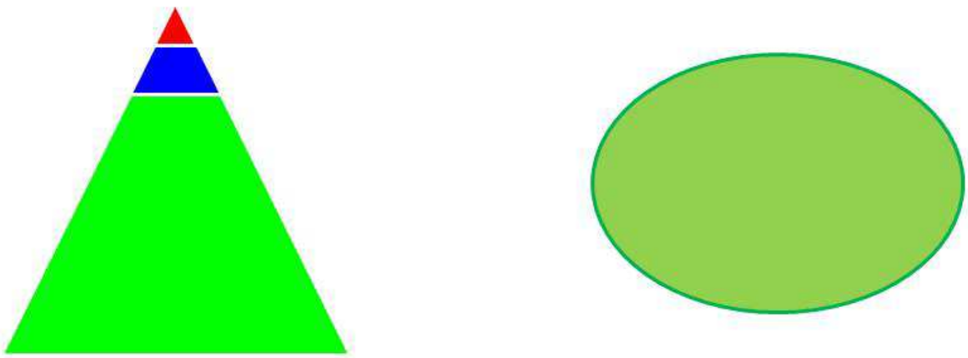
Research to improve fiber production

- General husbandry (health, reproduction, nutrition)
- Characterization and fiber quality
- Fiber harvesting
- Breeding and genetic improvement
- Value adding and processing

Ongoing research in breeding and genetic improvement

- Breeding objective functions
- Genetic parameters
- Data adjustment models
- Selection criteria - Index selection
- Design and implementation of breeding programs
- Breeding structures (open nucleus systems)
- Searching for QTL in wool and mohair
- Economic evaluation of breeding programs

Intervention strategy depends on population structure



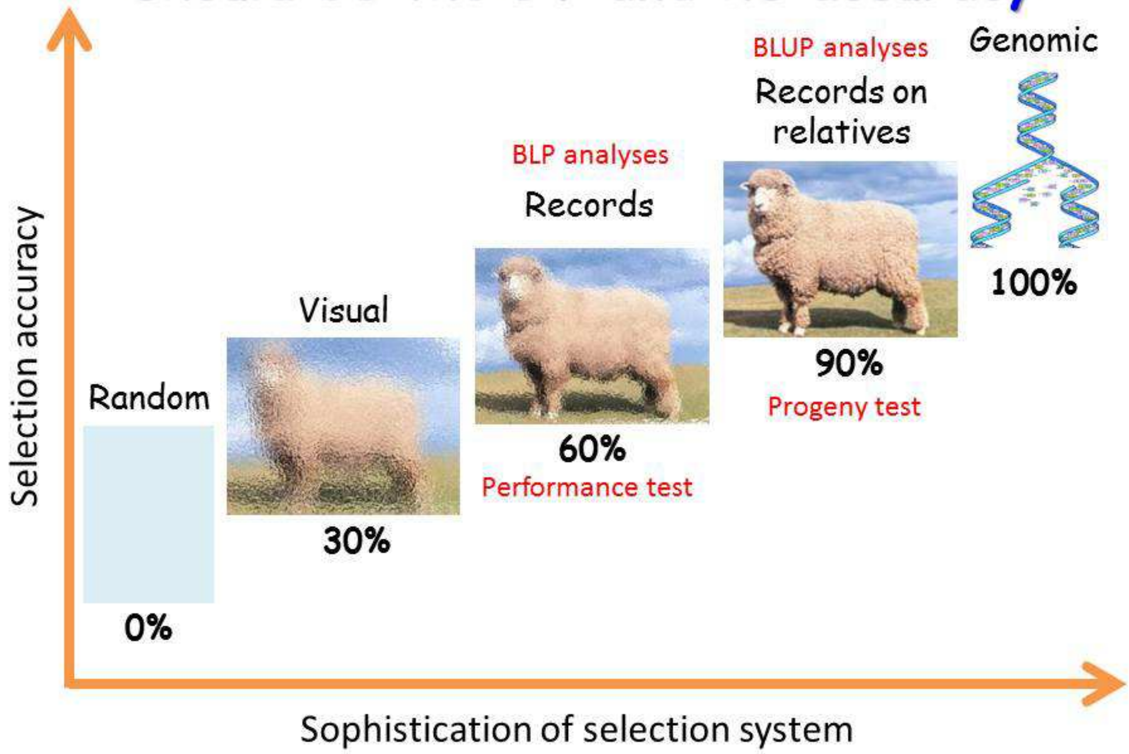
Formal genetic structure
Most sheep

No genetic structure
Most goats

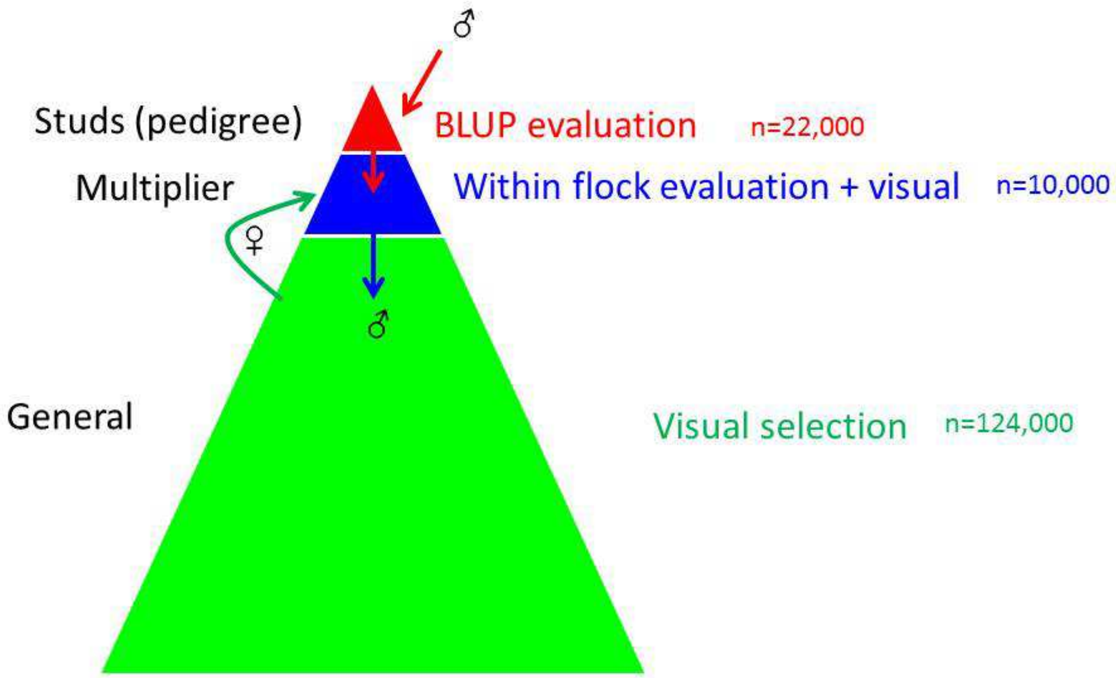
Make it functional

Generate a structure

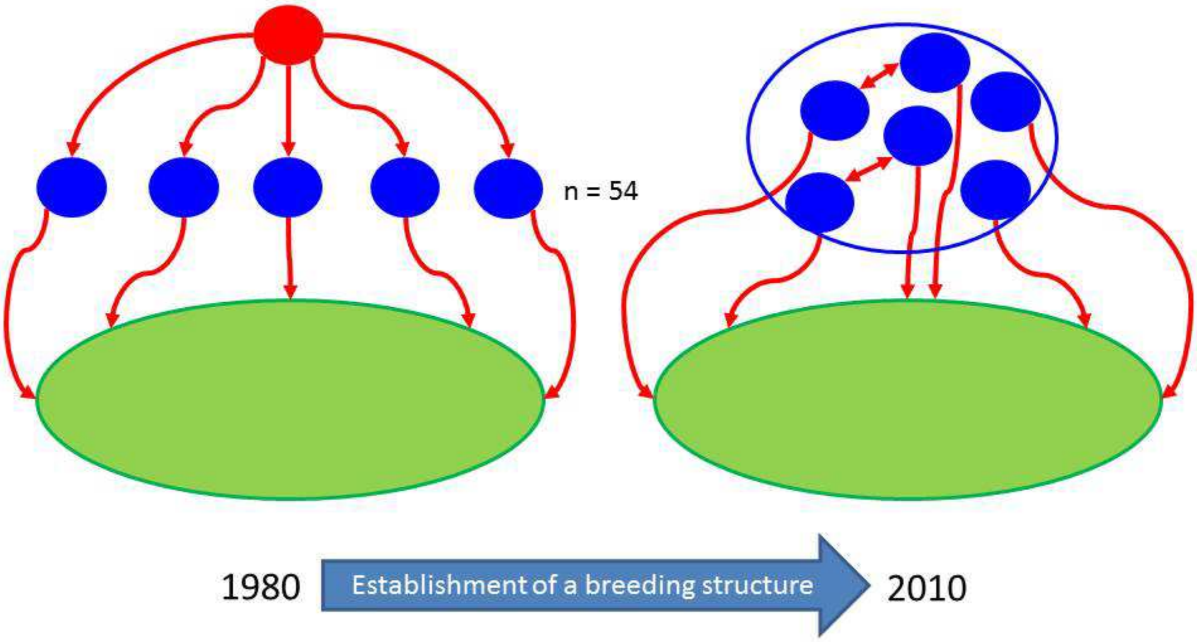
The higher the dissemination, the higher should be the BV and its accuracy



Example: Merino sheep project

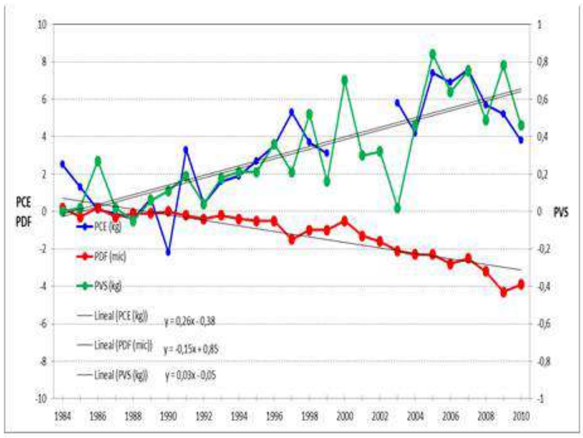


Example: Angora goat project



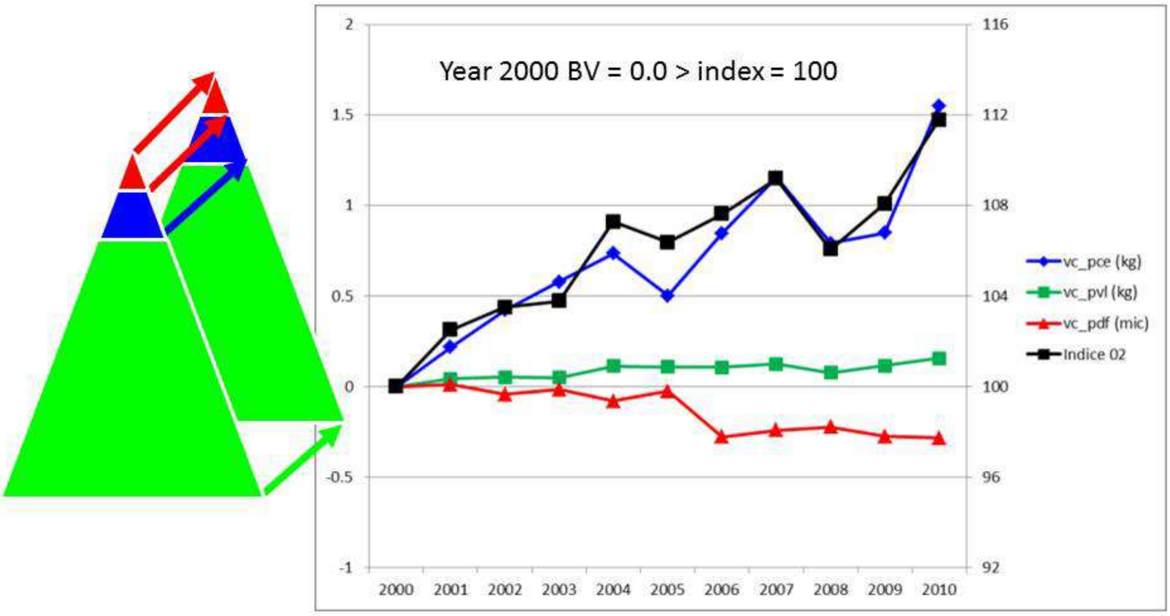
Implementation

- Note: no governmental subsidies for famers
- Key extension tool: Central progeny testing
- National recording & genetic evaluation service
- Demonstration flock



Source: Mueller 2013, unpublished

Genetic progress in Merino breed (average BV per year)



Source: Mueller et al., 2013, unpublished

Economic benefit of genetic improvement (Provino service) expanded to national level

Items	Service	Breeders	Producers	Processors	Total
Research	-100 000				-100 000
Genetic evaluation	80 000	-80 000			0
Rams		1 390 000	-1 390 000		0
Wool			4 800 000	-4 800 000	0
Tops				16 905 810	16 905 810
Benefit (income - costs)		1 310 000	3 410 000	12 105 810	16 825 810
Revenue (income / costs)		17.4	3.5	3.5	169.1
Participation in total benefit		8%	20%	72%	100%

Assumptions:

20,000 rams tested, 50% selected, only FD of wool processed to the level of tops

Source: Mueller 2009, unpublished. In USD.

General challenges for Argentinean fiber production

- Increase fiber quantity to increase production inputs, market share, local processing, etc.
- Increase fiber quality to maintain competitiveness.
- Smallholders should try to add value through transformation or differentiation.
- Research needed to reduce production variability, reduce fiber contamination, etc.
- A main challenge for animal breeders is to increase adoption of effective breeding programs in low input systems.

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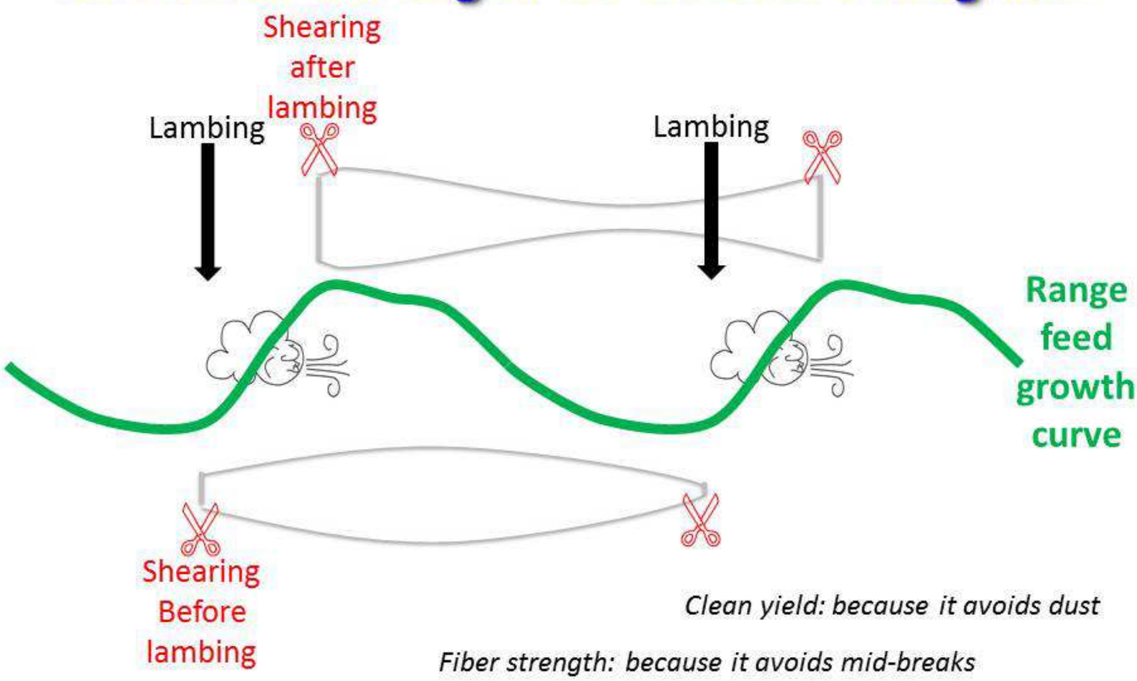
Search for genetic markers for wool

- QTL on Ch3 for MFD region of type II keratin genes.
- QTL on Ch4 for fleece weight,
- QTL on Ch25 for clean yield and CV of MFD (Bidinost et al., 2008).
- QTL on Ch25 for curvature at 1st and 2nd shearing, clean yield 2nd shearing (Roldan et al., 2010) .
- QTL on Ch11 for weight and staple strength at 1st shearing, CV of MFD at 2nd shearing.
- QTL on Ch11 for greasy fleece weight at 1st shearing and clean yield trait at 2nd shearing.
- Pleiotropic QTLs on Ch1 for clean yield, curvature, clean and greasy fleece weight and staple length, all at 2nd shearing.

Search for genetic markers for mohair

- QTL on Ch1 and Ch13 for CV of MFD; percentage of discontinuous medullated fibers and staple length associated with Ch2 and evidence of percentage of kemp contamination on Ch13 (Cano et al., 2007).
- QTL on Ch19 affecting CV of MFD (Cano et al., 2003) and two new putative QTL affecting staple length at 1st shearing and greasy fleece weight at 2nd shearing (Cano et al., 2009).
- QTLs on Ch1 for CV of fiber diameter, percentage of fiber with diameter over 30 mic, percentage of continuous medullated fibers and greasy fleece weight were detected (Cano et al., 2009b).
- QTL on Ch5 affecting MFD, proportion of fiber over 30 mic, greasy and clean fleece weight in a backcross Angora × Creole (Debenedetti et al., 2010) .
- QTL on Ch1 affecting S/P hair follicle relation using 9 microsatellites (Debenedetti et al., 2012).

Shearing pre-lambing improves clean yield and fiber strength of wool in Patagonia



More than 30% of the Argentinean wool clip is now shorn pre-lambing

Shearing date	Clean yield %)	Staple strength (N/ktex)
Pre-lambing	62.6	33.8
Post-lambing	57.3	26.4

Source: Elvira et al. (2006)

Additional crucial advantage

Shearing date	Lamb survival (%)
Pre-lambing	92.6
Post-lambing	82.7

Source: Mueller (1980)

Shearing pre-lambing requires organization: all in < 12 hours