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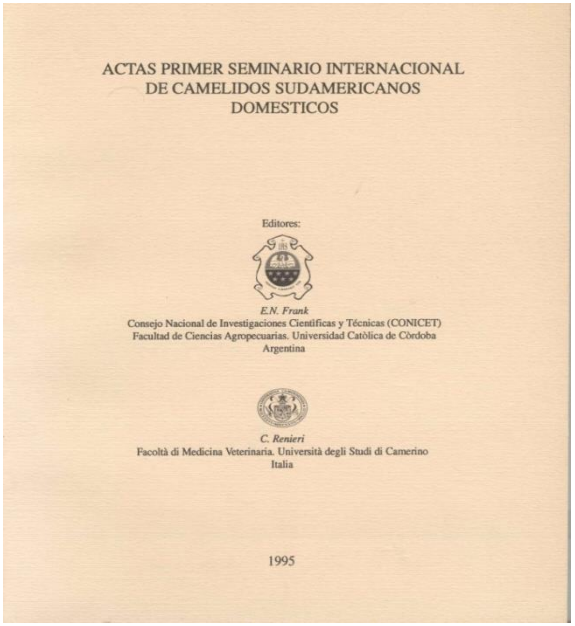
PRODUCTION POTENTIAL OF LLAMA AND ALPACA (Domestic South American Camelids) IN THE ANDEAN REGION

Ghent
29.08.2019

PROJECTS

Project		Partnership	Time
PELOS FINOS "Supported programme to improve Argentinean South American Camelids fine fibre production"	EU DG1	**Italy,** Spain, Argentina	1992-1995
SUPREME "Sustainable Production of Natural Resources and Management of Ecosystems : the potential of South American Camelid breeding in the Andean Region"	EU DGXII	**Italy,** Germany, France, U.K., Argentina, Bolivia, Chile, Ecuador, Peru	1996-2001
DECAMA "Sustainable Development of Camelid products and services marketed oriented in Andean Region"	EU INCO DEV	**Italy**, Germany, Argentina, Bolivia, Peru	2002-2006

- 1992 : informal South American Camelids Group
  - European Symposium of South American Camelids and Fibre animals
    - Bonn, 1993 ;
    - Camerino, 1995,
    - Gottingen, 1999,
    - Gottingen, 2004,
    - Sevilla, 2010,
    - Nantes 2013,
    - Assisi, 2017).
- 2009 : EAAP Animal Fibre Working Group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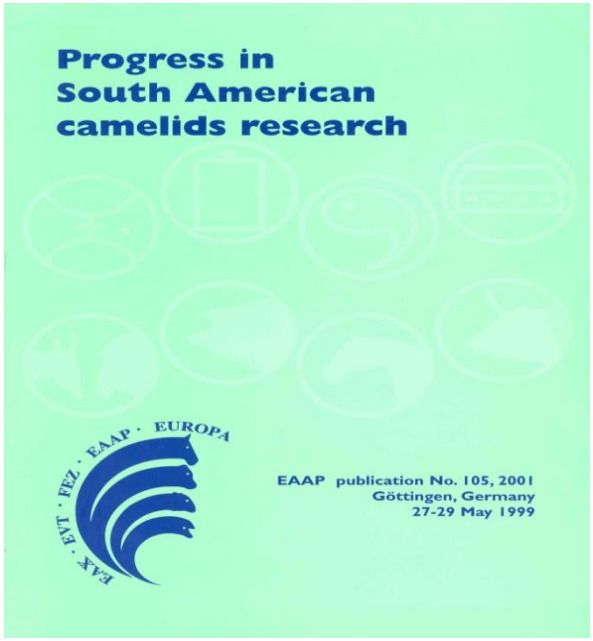
Facoltà di Medicina Veterinaria. Università degli Studi di Camerino
Italia
1995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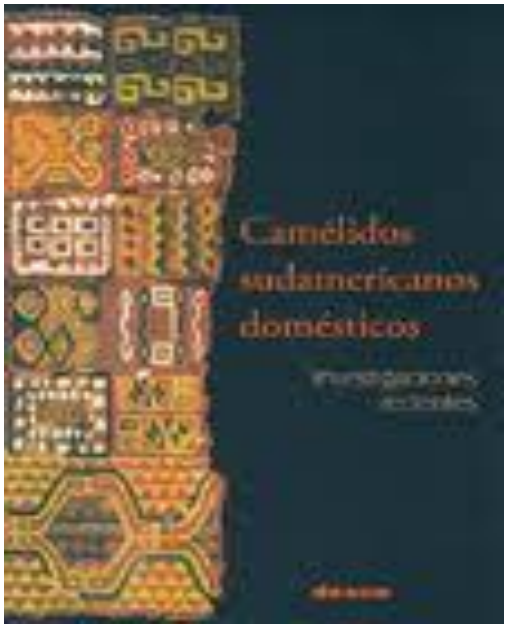
EAAP publication No. 105, 2001
Göttingen, Germany
27-29 May 1999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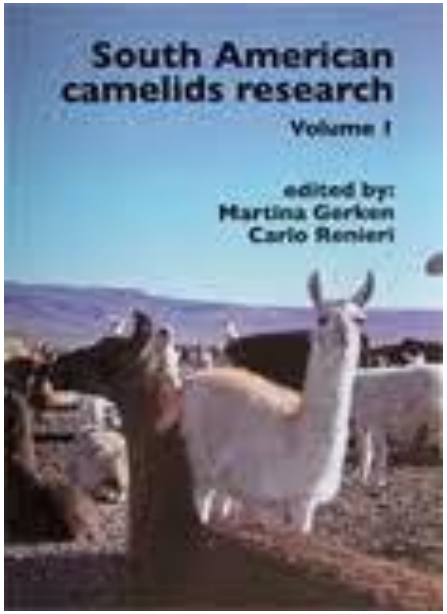
domésticos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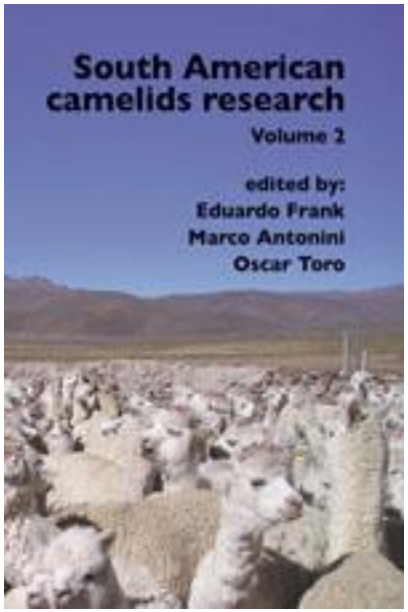
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Marco Antonini
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Fibre production
in South American camelids
and other fibre animals

Convenio UNICAM – INIA Quinsachata
2006-2010

ALPACA RESEARCH FOUNDATION (ARF) 2009-2011

Convenio UNICAM – MICHELL S.p.A.
Mallkini Project 2007-2012

Convenio UNICAM – UNAP Puno
2016-2020

PASTORES ANDINOS (EUROPAID)

TEJIENDO SOLIDARIDAD (EUROPAID)

ANDES

- Mountain range that forms a continuous chain of highland along the western coast of South America, from the Caribbean Sea to the island of Trinidad.
- It is composed of a series of chains parallel to the coast, some merely separated by longitudinal valleys, others by vast plateaus.
- The total length of the range averages c. 7500 km, with a maximum width of c. 800 km in correspondence with the Golf of Arica (Northern Chile).
- The range is divided into three sections: North, Centre and South.

PUNA

- The Central Andes in Ecuador comprise two chains linked so closely together that in certain places the total width reaches a mere 150 km
- In Peru the chains diverge, leaving space for a plateau (**Puna**), traversed by various tributaries of the Amazon River.
- In Bolivia the two *cordilleras* widen and close again in a vast plateau, also called Puna, which contains the closed basin of Lake Titicaca and Lake Poopò or Aullagas.

PUNA

- Puna is a type of montane and plateau grassland, which is found above the treeline between 3200-3500 m.a.s.l., and below the permanent snow line above 4500-5000 m.a.s.l.

- The World Wildlife Fund (WWF) defines three distinct puna ecoregions:
  - Central Andean wet puna (Bolivia, Peru),
  - Central Andean puna (Bolivia, Peru),
  - Central Andean dry puna (Argentina, Bolivia and Chile).

FLORA

- Alpine bunchgrasses interspersed with herbs, grasses, lichens, mosses, ferns, cushion plants, and occasional low shrubs, with sedges and rushes in poorly-drained areas.
- The puna is generally drier than the paramo montane grassland of the northern Andes.

PLANT COMMUNITIES BIO SYSTEMS

- **“Bofedales”**
  - HIGH DISPONIBILITY OF SURFICING WATER
  - HIGH VARIABILITY OF PLANTS
  - GREATER AVAILABILITY OF FOOD

- Other (Tolar, Pajonale and Yaretal) can support the camelids breeding in a very difficult time during the year

FAUNA

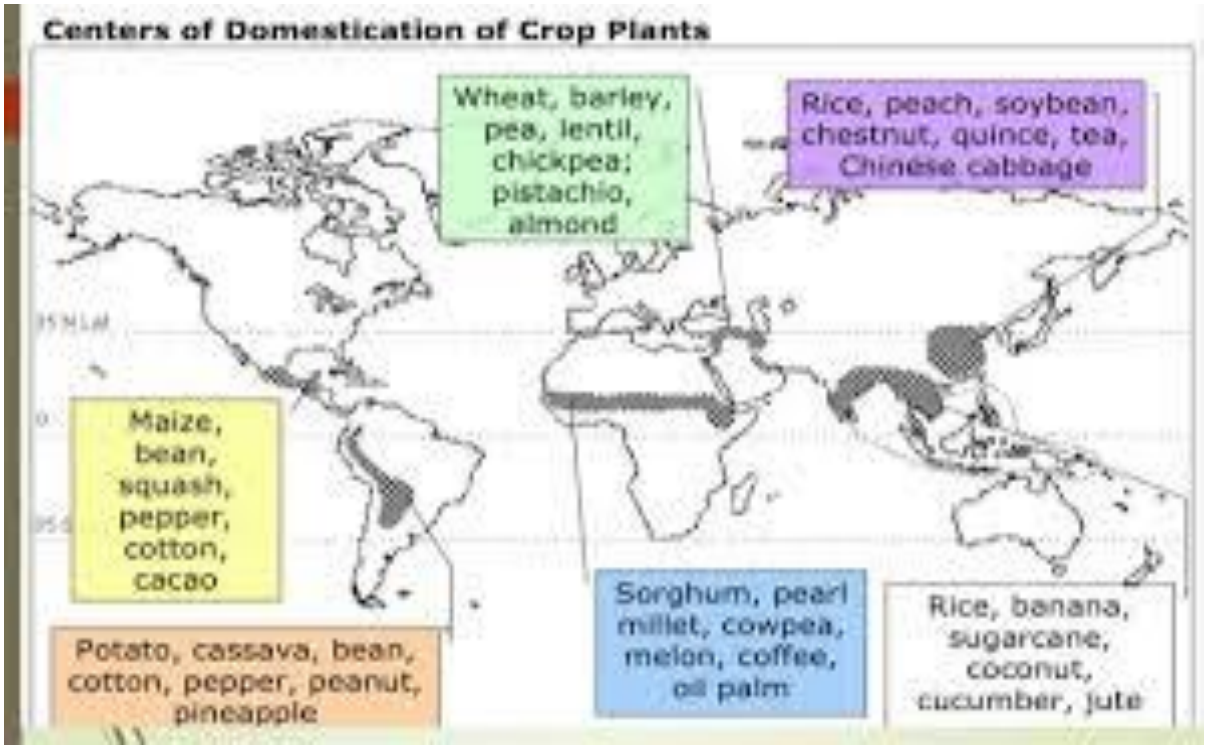
- Native mammals include llamas, alpacas, vicuñas, guanacos and wild and domestic guinea pigs.
- Native birds include the Andean Condor (Vultur gryphus), Andean Goose or huallata (Chloephaga melanoptera), Andean Flamingo or parihuana (Phoenicopterus andinus), Puna Teal (Anas puna), and other wading birds.

HUMAN DEMOGRAPHY PERU

LOCAL POPULATION

- Local people cultivate barley, potatoes and maca (*Lepidium meyenii*).
- Alpacas are raised only for wool whereas llamas for wool, transport and meat.
- Gender problem
  - Women under 41 years manage the 56% of the camelid flocks,
  - Women under 53 years the others.

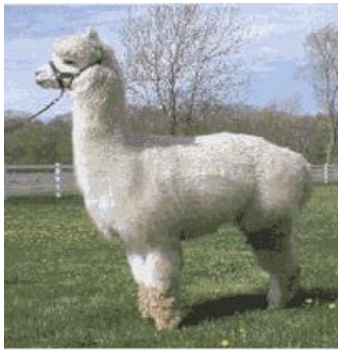
CENTER OF DOMESTICATION PLANT



ANIMALS

- llamas,
  (Lama glama Linnaeus 1758)

- alpacas,
  (Vicugna pacos Linnaeus 1758)



- domestic guinea pigs (cuy)
  (Cavia porcellus Linnaeus 1758)

ANCESTORS

- Vicuña vs alpaca
  - Vicugna vicugna Molina 1782

- Guanaco vs llama
  - Lama guanicoe Linnaeus 1758

- Unknown for guinea pig

DOMESTICATION

- The oldest archaeological traces leading to domestic llamas and alpacas can be found in the **Puna of the Peruvian Andes**, at some archaeological sites located between 4000 and 4900 m.a.s.l and associated to a culture of Andean hunter-gatherers

- The period of domestication can be traced back to the era between 4000 and 3000 B.C.

DIFFUSION

- Starting from the centre of domestication, the two domesticated animals diffused into an **area significantly larger than the area covered today**
- Most likely following populations of shepherds living on the Andean plateaus, llamas and alpacas spread to
  - the Interandean Valles of Peru, Bolivia , Argentina around 3800 A.C.,
  - the coastal plains of Peru c. 1600 years ago,
  - to Ecuador and Chile during the same period.
- However, it is likely that the animals spread to an even greater extent, including Chile, Colombia and perhaps the Amazonian region in Venezuela; traces of domesticated camelids also almost certainly exist in Central America.

PRE-CONQUEST

- Llamas and alpacas seem to be **well distinguished species** in terms of use within pre-Inca and Inca pastoral societies;
- **Alpacas seem to be associated only with fibre production**; the first findings of textiles linked to these animals date back to at least 2000 years B.C. As mentioned above, weaving was a well-known practice within pre-Incan societies;
- Llamas prove to be more diverse than alpacas, and this explains their **varied functions**: they were **draught animals**, both for civil and military purposes, they were sheared for their **wool** (in El Yaral, some llamas had very fine coats); finally, llamas are most likely also raised for their **meat**;
- both species were almost certainly used in **sacrificing rituals**

CONQUEST

- All historical reporters of the Conquest (Agustin de Zarate, Francisco de Xeres, Pedro Cieza de Leon) consistently describe a **great abundance of domesticated and wild camelids (**between 30 and 50 million)
- The arrival of the conquerors caused a **drastic decline in numbers**, estimated 90 % in total, as well as a decline by c. 80 % of the human population.
- There are numerous causes; however, the following can be considered amongst the most influential:
  - the **killing of animals for their meat**;
  - the arrival of **new diseases** brought by humans and domestic animals of European origin. Garcilaso de la Vega stated that the scabies was the most terrible disease ever encountered in Peru;
  - the **total disruption and abandonment of the well organised Incan breeding system**.

CONSEQUENCIES

Apart from the reduction in numbers, two further consequences are to be considered:

- The **geographic marginalisation** of the animals
  - Llamas and alpacas abandoned the coastal zones and Interandean Valles and took refuge, together with human populations on the Puna above 3800 m.a.s.l. The two domestic species therefore, returned to the habitat where they were domesticated and from which they had been forced away many millennia before.

- The **loss of reproductive barriers** between the two species.
  - The disarticulation of the breeding system leads to coincidental mixing between the two species and between the species and their wild ancestors, as a consequence of the 4 species co-existing within the same confined area.

GENETIC CONSEQUENCIES

- In genetic terms, the consequences of the Conquest are dramatic enough to permanently change the animals in comparison to the preceding situation.
-
- In particular, the following effects can be listed:
  - the **bottleneck effect** caused by the drastic decline in numbers. The effect of genetic drift was most certainly strong; nevertheless they are neither presently quantifiable, nor is it possible to reconstruct the quantity or the type of characters lost;
  - for the animals returning to the Puna, **natural selection** regains the upper hand in comparison to the human selection.
  - Consequently, **the specialisation is lost**, which appeared to already have been established during pre-Incan times;
  - the **efficiency of breeding collapses** completely;
  - the mixing of llamas and alpacas **reduces the genetic diversity** that was most likely greater during the Preconquest.

POST CONQUEST

- The phase succeeding the Conquest begins with a continuously slow increase in animal numbers
- At the end of Colonial power, the total number throughout the plateau was 440000 alpacas and c. one million llamas.
- The current number is far from the estimates for the Preconquist era, but it is undisputed that the domestic species are well established today

GLOBAL LLAMA AND ALPACA POPULATION

- global alpaca population = 3.128.849 million heads concentrated in Peruvian territory. The remaining individuals are distributed throughout Bolivia, Chile, Argentina and Ecuador.
- global llama population = 3.315.317 million heads primarily bred in Bolivia and Peru, followed by Argentina, Chile and Ecuador.

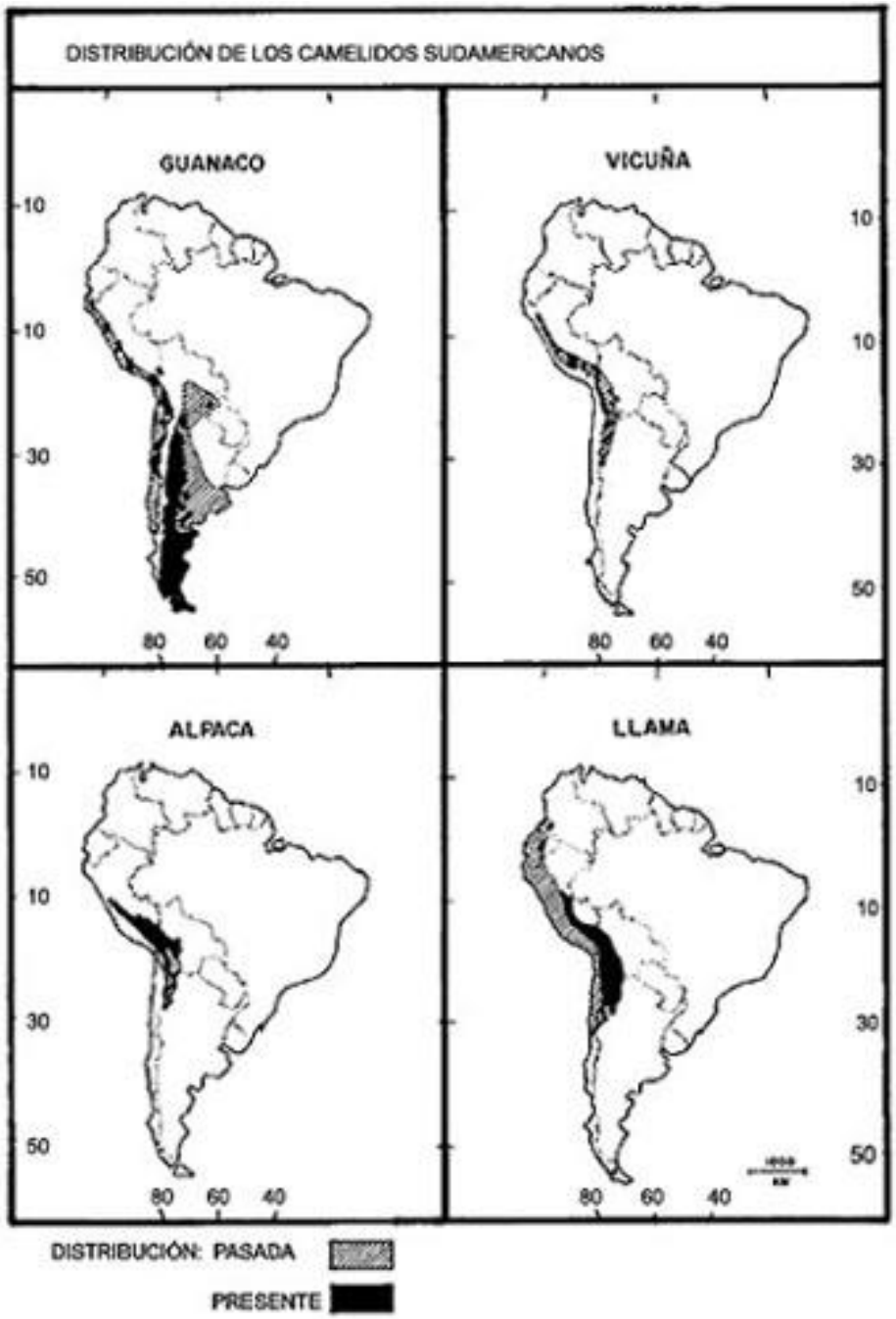
LLAMA

northernmost distribution reaches the Porto region, in Colombia (1° N) and Riobamba, in Ecuador (2° N). To the south, the llama distribution extends to c. 27° in the centre of Chile, with an area of maximum density between 11° and 21° S, at altitudes from 3800 – 5000 m.a.s.l.

ALPACA

Alpaca populations extend to Cajamarca, Peru and the department of Anca in the north, near Lake Poopa in Bolivia and finally to northern Chile and north-eastern Argentina.

They live at or above altitudes of 4000 m.a.s.l.



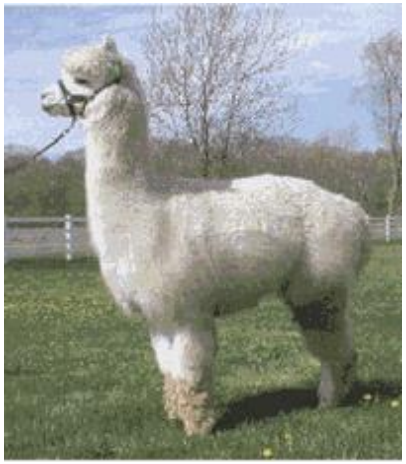
LLAMA TYPES

“Q’ara” or “sin lana”, characterised by a sparsely distributed coat of hair and coarse fibre quality

“Ch’aku” or “lanuda”, which displays an increased coat cover and a superior fibre quality

TYPE OF ALPACA

- **HUACAYA**
- FIBRE
  - compact,
  - soft
  - highly crimped
- LOCK
  - blunt-tipped
  - closely resemble those of Merinos sheep



- **SURI**
- FIBRE :
  - less-crimped,
  - lustrous,
  - silky,
  - very similar to mohair from Angora goat but not as bright.
- LOCK :
  - “cork-screw” shape and straight,

POPULATION STRUCTURE

- **Primary populations**, also called **primitive breeds**, have been identified in both llamas and alpacas
  - high variability of exterior characters,
- Secondary breeds do not exist at present
- Selection for white in alpaca

POTENTIAL PRODUCTION OF ALPACA

- **PRODUCTION OF HIGH QUALITY TEXTILE FIBRE**

- MEAT IS SECUNDARY PRODUCT:
  - OLD MALES AND FEMALES
  - MALES AND FEMALES DESCARTED IN BOTH PRE-SELECCION (DEFECTS) AND SELECTION PROGRAMMES

POTENTIAL PRODUCTION OF LLAMA

- **LLAMA Q'ARA**

  Typical single-coated animal, with dense guard hair (outer coat) and markedly less woolly fibres (undercoat) ranging from short to very short

- **LLAMA CH'AKU**

  Double-coated animal with soft, crimped secondary fibres but with a low quality fleece in comparison to alpacas, as there is mixing of primary and secondary fibres. A "Suri" type fleece segregates within the population.

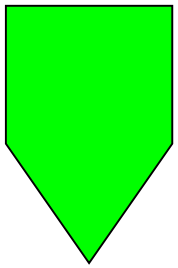
LLAMA

IMPROVEMENT

FLEECE TYPE

(single coat)

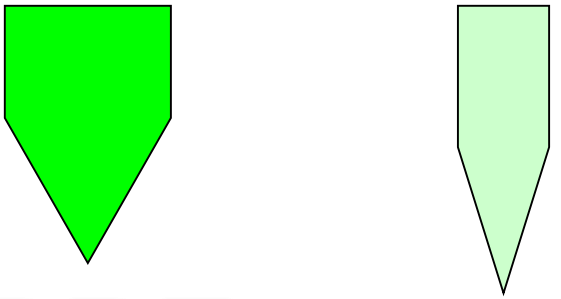
Q'ARA



MEAT

(double coat)

CH'AQU



FIBRE

Meat

MEAT PRODUCTION IN LLAMA

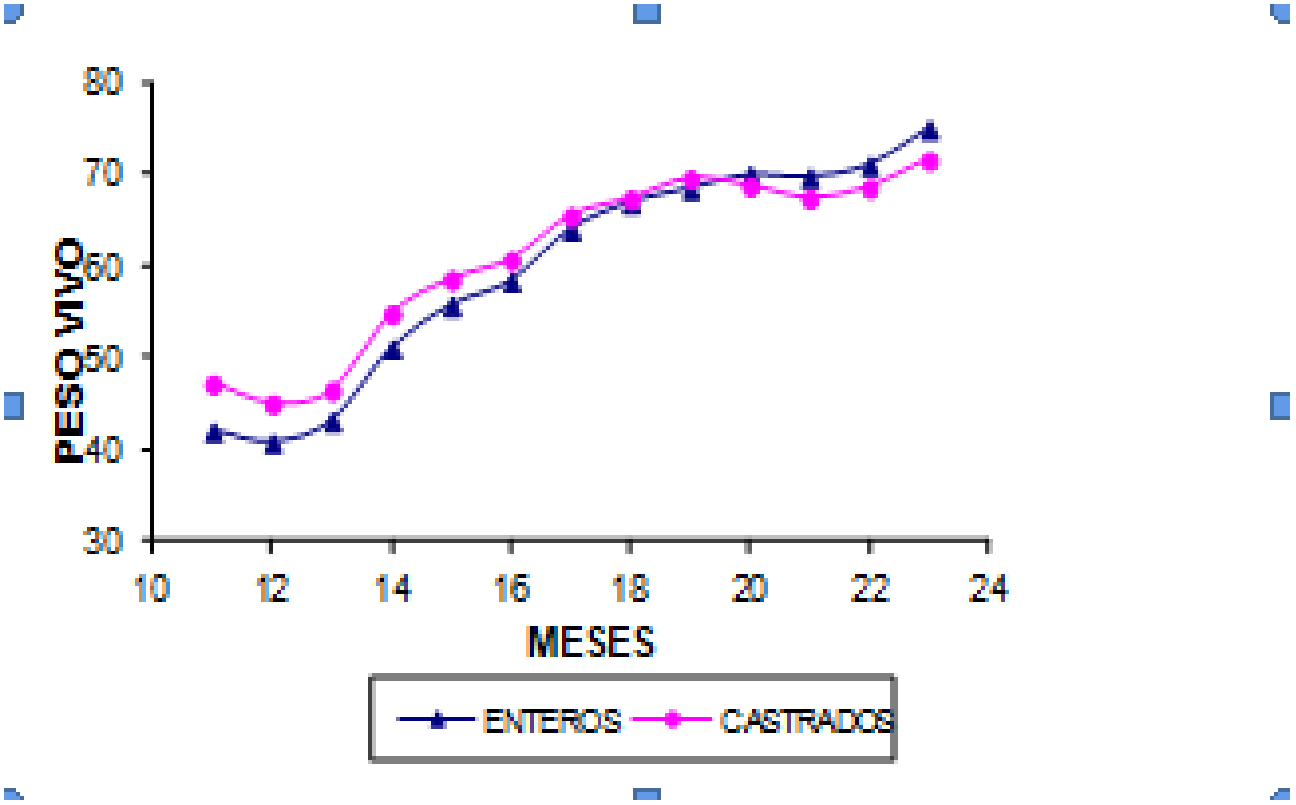
(Condori et al., 2001; Condori et al., 2003 a, b, c, d).

- 50 male llamas of the same age
- Choquenaria Experimental Station in Bolivia (Faculty of Agronomy, UMSA),
  - located at an altitude of 3750 m.a.s.l.
  - mean annual precipitation of 400-600 mm (confined to three months of the year)
  - mean annual temperature of 14 ºC

RESULTS:

- growth curve in llamas in exclusively Andean conditions
- definition of the ideal slaughter age;
- slaughter methods ;
- carcass classification method;
- Maturation of meat;
- correct method of dissection;
- qualitative characteristics of the meat;

GROWTH CURVE



pH AND WATER RETENTION OF MEAT

Fig. No 8 Variación del pH de la carne en 24 horas

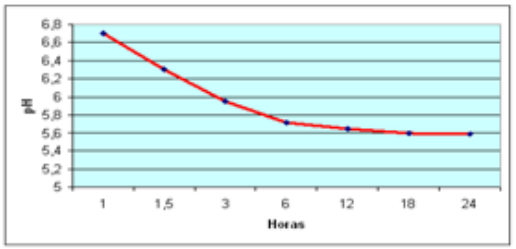
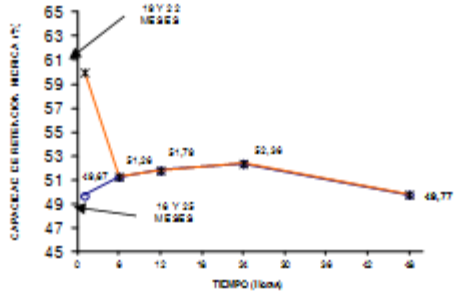


Fig. No.9. Capacidad de retención hídrica



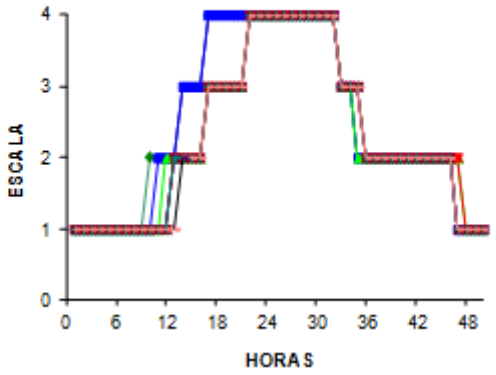
Cuadro No. 4. Capacidad de retención hidrica en la carne de llama

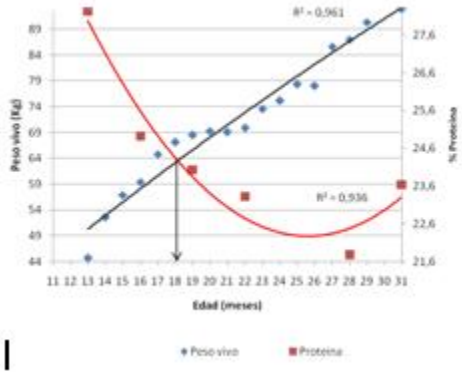
	Tiempo en horas				
Edad meses	1**	6**	12**	24**	48**
16	6.60	6.52	5.91	5.64	5.59 ΨABΨ
19	6.67	6.49	5.96	5.55	5.52 B
22	6.75	6.47	5.89	5.57	5.54 B
25	6.83	6.67	6.15	5.62	5.64 A
Media	6.71	6.53	5.97	5.59	A= 5.61 B=5.55

** Diferencias altamente significativas parta el factor edad (P< 0.01)
Ns Diferencias no significativas (P> 0.01)
Ψ Letras iguales no tienen diferencias significativas (P>0.01)

RIGOR MORTIS AND MATURING OF MEAT

Fig. No. 10. Proceso de rigidez cadavérica

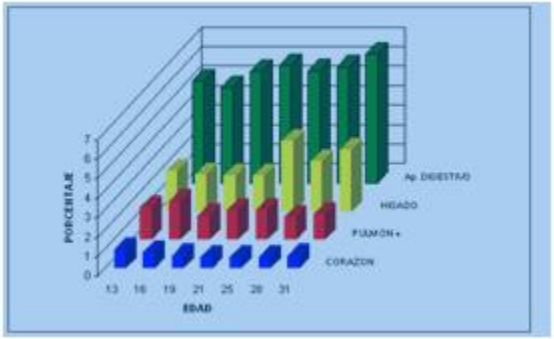




CARCASS YEALD + BOWELS

Cuadro No. 2 Rendimiento de la canal caliente y frio

Edad	Rendimiento	
	Caliente	Frio
13	57,68	54,33
16	60,03	54,76
19	55,29	51,63
22	59,21	54,21
25	55,59	52,38
PROMEDIO GENERAL	57,56	53,462



CARCASS CLASSIFICATION

Fig. No. 14 Clasificadas de la carcasa por conformación de músculos

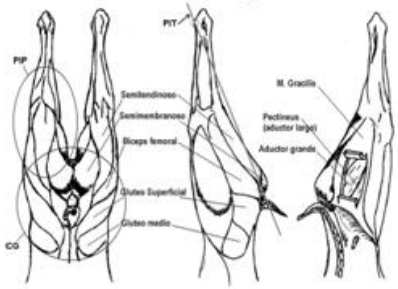
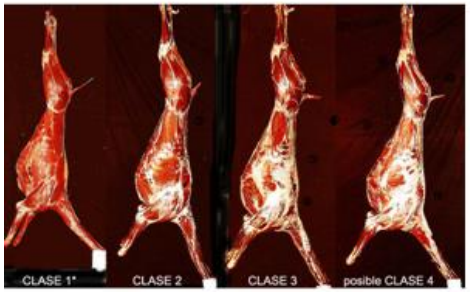
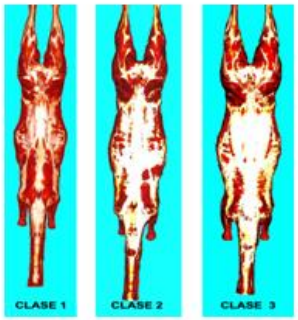


Fig. No. 13. Carcasas de llama clasificadas por cobertura de grasa



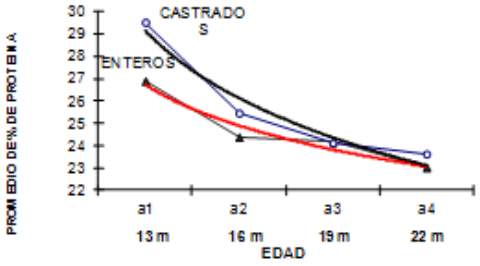


MEAT QUALITY

Cuadro No. 5 Componentes químicos de la carne de llamas

Edad (meses)	Humedad %	Ceniza %	Grasa %	Proteína %	Colesterol (mg/100g)
			Enteros		
13	74.77	1.97	3.25	26.93	54.75
16	69.19	1.20	5.56	24.39	57.50
19	71.44	1.12	3.03	24.19	43.00
22	71.98	1.25	3.19	23.04	68.78
			Castrados		
13	73.79	2.01	3.32	29.53	58.33
16	68.45	1.23	4.65	25.46	56.33
19	71.62	1.16	2.75	24.13	41.33
22	71.50	1.29	3.01	23.63	81.47

Fig. No. 12. Niveles de proteína según la edad de los animales



Cuadro No. 7. Niveles de acidos grasos en la carne de llama

Acido Graso	Mir C:14	Pand C:15	Pal C:16	Est C:18	Ara C:20
Entero	0.061	0.036	0.334	0.721	0.353
Castrado	0.062	0	0.309	0.663	0.358
Media	0.061	0,018	0.321	0.692	0.355

SUMMARIZING (1)

- The weight increases rapidly until the age of 19 months, with a live mean weight of 68.42 kg for entire males and 68.66 kg for castrated males.
- After this period, the growth rate is significantly lower.
- The highest mean daily growth rate can be observed during the 14^{th} month, with 215.8 g/d and 250 g/d for entire and castrated males respectively and corresponding weights of 50.54 kg and 53.52 kg respectively.

SUMMARIZING (2)

- The cold yield of carcass was c. 52%.
- The commercial leg meat cuts (brazuelo) show early development compared to other commercial cuts in animals between 19 and 25 months of age. Past this age, growth is almost absent.
- On the other hand, in the anterior part of the body the neck shows continuous growth during this period and beyond. For this reason, past the 25^{th} month the animal growth will offer less valuable meat cuts.

SUMMARIZING (3)

- The meat from an animal slaughtered appropriately reaches pH 5.5 within 24 hours.
- 9 hours post mortem, the rigor mortis starts to be visible, which is completely established between the 16th and 20th hour at a temperature of 15.2 ^{o}c and ceases completely between the 32nd and 42nd hour post mortem.
- Water retention reaches its maximum (54.88%) in the hours immediately following slaughter and diminishes to 49.77% during the 48th hour.

SUMMARIZING (4)

- Composition of the meat (19-month-old llama):
  - 71.51% water,
  - 24.19% protein,
  - 2.9% intramuscular fat
  - 1.13% ash.
- Fatty acid composition :
  - 50.34% saturated fatty acids,
  - 42.48% monounsaturated fatty acids
  - 7.18% polyunsaturated fatty acids.
- The cholesterol content is found to be 42.29 mg.

MEAT PRODACTION
Alpaca vs llama

- 40 male alpacas (12 castrated) and 20 llamas at same age
- Alpaquero Centre of Development in Toccra (CEDAT-DESCO)
  - Callyoma province, Arequipa region, Peru
  - average altitude of 4650 m.a.s.l.
  - mean annual precipitation of 150 - 400 mm
  - mean annual temperature is 9 °C with a maximum of 18 °C and a minimum of -15 °C.
- The animals were slaughtered at 25 months of age.

LLAMA vs ALPACA
BODY WEIGTH

a e b P≤0.0001

Età (mesi).	Alpaca x ± e.s.	Lama x ± e.s.
nascita	$5.99^{a} \pm 0.94$	$7.15^{a} \pm 1.37$
6	$20.19^{a} \pm 0.94$	$28.13^{b} \pm 1.37$
10	$27.99^{a} \pm 0.94$	$36.78^{b} \pm 1.37$
13	$37.19^{a} \pm 1.02$	$46.93^{b} \pm 1.47$
16	$41.35^{a} \pm 1.12$	$55.77^{b} \pm 1.67$
19	$40.05^{a} \pm 1.29$	$54.29^{b} \pm 1.80$
22	$42.87^{a} \pm 1.58$	$55.43^{b} \pm 2.09$
25	$46.07^{a} \pm 2.23$	$63.18^{b} \pm 2.92$

LLAMA vs ALPACA
WEIGHT OF CARCASS

a e b P≤0,0001

Periodo (mesi)	Alpaca x ± e.s.	Lama x ± e.s.
10	$15.32^{a}\pm1.29$	$19.7^{a}\pm2.20$
13	$19.62^{a}\pm1.67$	$24.70^{a}\pm2.20$
16	$20.84^{a}\pm1.49$	$28.70^{b}\pm2.20$
19	$21.67^{a}\pm1.40$	$33.03^{b}\pm2.20$
22	$23.51^{a}\pm1.40$	$27.41^{b}\pm1.93$
25	$24.42^{a}\pm1.53$	$31.16^{b}\pm1.93$

LLAMA vs ALPACA
CARCASS YIELD

a e b P≤0,05

ETA' (mesi)	Alpaca x ± e.s.	Lama x ± e.s.
10	54.23^{a}±0.71	52.31^{a}±1.21
13	54.86^{a}±0.92	52.69^{a}±1.21
16	54.96^{a}±0.82	52.57^{a}±1.21
19	53.34^{a}±0.77	52.79^{a}±1.21
22	54.96^{a}±0.77	51.40^{b}±1.06
25	55.69^{a}±0.84	52.37^{b}±1.06

LLAMA vs ALPACA
PROTEIN %

a e b P≤0,05

Periodo (mesi)	Alpaca x ± e.s.	Lama x ± e.s.
10	23.33^{a}±0.58	23.33^{a}±1.00
13	23.69^{a}±0.75	20.75^{b}±1.00
16	21.49^{a}±0.68	19.77^{a}±1.00
19	22.94^{a}±0.63	21.47^{a}±1.00
22	24.14^{a}±0.63	25.04^{a}±0.88±
25	23.33^{a}±0.69	23.12^{a}±0.88

LLAMA vs ALPACA
INTRAMUSCULAR FAT %

a e b P≤0.0001

Periodi (mesi)	Alpaca x ± e.s.	Lama x ± e.s.
10	$0.44^{a}\pm0.01$	$0.41^{a}\pm0.02$
13	$0.45^{a}\pm0.02$	$0.62^{b}\pm0.02$
16	$0.53^{a}\pm0.01$	$0.68^{b}\pm0.02$
19	$0.41^{a}\pm0.01$	$0.50^{b}\pm0.02$
22	$0.44^{a}\pm0.01$	$0.59^{b}\pm0.02$
25	$0.49^{a}\pm0.01$	$0.51^{a}\pm0.02$

LLAMA vs ALPACA
ASH

a e b P≤0.0001

Periodi (mesi)	Alpaca x ± e.s.	Lama x ± e.s.
10	1.39^{a}±0.16	0.80^{a}±0.28
13	1.27^{a}±0.21	1.33^{a}±0.28
16	2.55^{a}±0.19	1.67^{b}±0.28
19	2.04^{a}±0.18	1.38^{a}±0.28
22	2.11^{a}±0.18	2.08^{a}±0.25
25	2.54^{a}±0.20	2.43^{b}±0.25

Lettere esponenziali sulla fila indicano differenze significative: a e b P≤0.05

SUMMARIZING (1)

- Live llama bodies, as well as cold and warm llama carcasses, were significantly heavier compared with alpacas.
- Dressing percentage was higher in alpacas.
- Chemical composition of the muscle showed a significant difference in ash content between the two species.
- Cholesterol content was significantly higher in llama meat compared with alpaca meat (56.29mg/100g).

SUMMARIZING (2)

- Potassium is the mineral of highest concentration, showing a significant difference between the two species and followed by phosphorus, sodium, magnesium and calcium, as well as a smaller percentage of zinc and iron.
- Castration in both species did not show any significant effects.

Charqui

- Charqui is a meat that is dried or dehydrated through salt-curing processes and the climate, in particular cold nights.
- It is the system through which the Andean “campesinos” preserve meat.
- This know-how is ancient because it was already present in the Inca culture.

CHARQUI

Charqui preparation

Charqui can be prepared as follows:

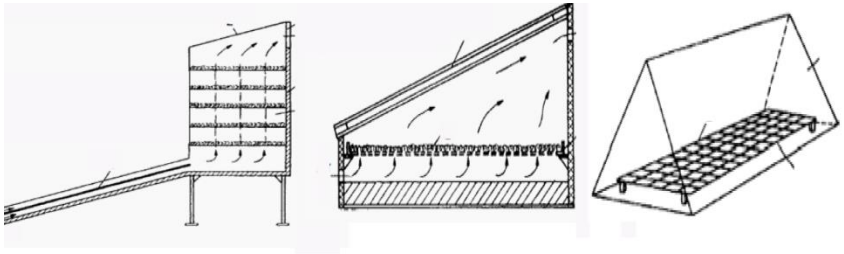
- carcasses are deboned and fat eliminated without damaging the muscles;
- the muscular masses are separated, tendons eliminated together with cartilage and ligaments;
- each cut is individually cured and cut into slices 0.5 – 1 cm thick, without mixing the different cuts;
- the slices need to be immersed in a 25% saline solution for a period of 3-4 days in cubicle cement containers at low temperatures in the shade;
- at the end of this treatment, the slices are washed under running water, in the shade, to eliminate excess salt;
- the slices are then pressed to reduce the water content;
- they are then left to dry in a cold environment for one week;
- finally they are insaccate

Charqui production

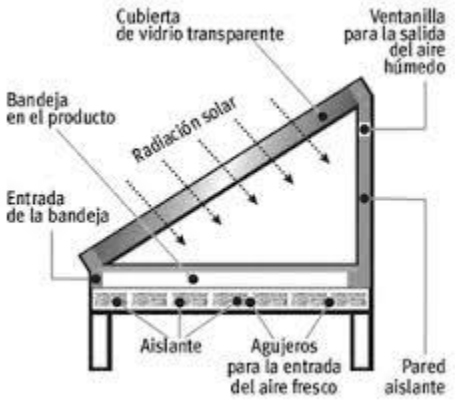
- *Charqui* production is carried out in both rural communities as well as in transformation enterprises.
- In Bolivia and Peru, a large part of the commercialised produce in urban centres originates from single farms or from specialised *charqueros*.
- In general, the sale price of charqui is extremely variable.
- The preparation of charqui seems to have followed similar procedures throughout Andean communities and despite regional variations a basic recipe is established.

- A new technology for charqui processing was developed within the DECAMA project :
  - **solar dryer with forced ventilation**
  - **temperature a salt concentrations were determined by elaboration of drying curves**.

SOLAR DRYER



a. b. c.



RESULTS

- **The use of a solar dryer reduces the drying time**
- No differences were found in microbiological composition for different salt concentrations.
- The chemical and microbiological contents do not seem to be influenced by the type of muscle used in the elaboration of charqui.
- There is a negative correlation between the NaCl concentration and the protein content.
- Charqui elaborated with a 10% concentration of NaCl received a greater sensorial acceptance in comparison with the other concentrations.
- Microbiological and chemical compositions of charqui were not influenced by the type of drying (solar or shade).
- **Optimal charqui production is obtained by drying the salted meat for 16 days with 10% salt concentration at an average temperature of 25°C (traditional method) or for 12 days in a solar dryer with an air-speed of 1m/s.**
- The type of muscle used in charqui production influences only the drying time.
- The organoleptic tests showed a high acceptance of the product.

CHARQUI
LLAMA vs ALPACA

- The protein content in charqui from llamas is greater than that from alpacas
- Charqui from alpaca meat has a greater sensorial acceptance than that of llamas.
- In both species the loin shows the greatest sensorial acceptance.

NEW PROCESSED PRODUCTS

- Three types :
  - (1) sausages with anatomical integrity
    - Ham (jamon),
    - bresoala,
    - meat enveloped with *femori cuadriceps* ms., “arrollado” in Spanish);
  - (2) sausages without anatomica integrity
    - “chorizo”,
    - salami with and without bacon content,
    - Frankfurter sausages
    - Spanish sausages
  - (3) pâté.
- .

RESULTS

- The new products proposed :
  - were subjected to chemical, physical and microbiological analyses
  - the organoleptic properties were examined in panel tests
  - the guidelines for organic products have been set up by checking the transfer of the respective European regulations to DSAC meat processing.
  - flowcharts for the new products were created, showing very good results obtained for all the products elaborated.

HAM
(Jamon – Violino)

- **RAW MATERIAL**
- **TRIMMING**
- **SALT BATH**:

  2-4°C for 10 days
- **COOL WINE WASH**
- **RUBBING WITH PEPPER AND JUNIPER BERRIES**
- **DRYING**
- **CURING**:

  15-16°C 80-82% R.H. for 5-6 months
- **STORAGE at 4°C**
- **SHELF-LIFE**

Bresaola

- **RAW MATERIAL**
- **TRIMMING**
- **SALT BATH**:

  4°C for 7-9 days
- **COOL WATER WASH**
- **DRYING**
- **CELLULOSE CASING**
- **STEWING**

  20°C 55-60 R.H. for 2-3 days
- **CURING**:

  15-16°C 80-82% R.H. for 10 days

  14-15°C 85% R.H. for 20-90 days
- **STORAGE at 4°C**
- **SHELF-LIFE**

  6 months vacuum packaged

Sfilacci

- **RAW MATERIAL**
  - refrigerated or deep freeze
  - defrosting
- **PIECE CUTTING**
- **SALT BATH** 4°c for 48-72 hours
- **COLD CELL DRYING** 4°C
- **DRY STEWING** 95-100°C for 12-18 hours
- **MECHANICAL FRAYING**
- **SMOKING**
  - hot 60-65°C for 20-30 minutes
  - cold 20°C for 60-90 minutes
- **SALTING**
- **PACKAGING**
  - vacuum packed or protected atmosphere packing
- **STORING** at 4°C
- **SHELF-LIFE** 2 to 5 months

Coppa

- **RAW MATERIAL**
- **TRIMMING**
- **SALT** :

  4% - 0 -1°C for 7 days (loss weight 1%)

  Rubbing every 3 days;

  Staying in refirigerated room (3 – 5)° for 7-10 days (loss weight 3,5%)
- **NATURAL CASING (CAECUM)**
- **STEWING**

  25°C 55-60 R.H. for 5-6 hours
- **CURING**:

  First Drying 3 days from 22° to 18° (third day) R.H. from 55% - to 75 (third day) (loss weight 12-13%)

  Second Drying 14-15°C 75% R.H. for 15 days(loss weight 5%)

  Ripening 90 days (loss weight 10%)

Salami (Dry sausage)

- **RAW MATERIAL**
- **TRIMMING AND MINCING**
- **MIXTURE:**

  Meat , pork fat, Salt (2,4 – 3,5%), Sugar (0,4 – 1%), Mixed Spices, Sodium Nitrate (250 ppm) or sodium nitrite (150 ppm), Ascorbic acid (50 ppm)
- **ANIMAL OR VEGETAL CASING**
- **STEWING**

  18-20°C 90% R.H. for 12 hours
- **CURING**:

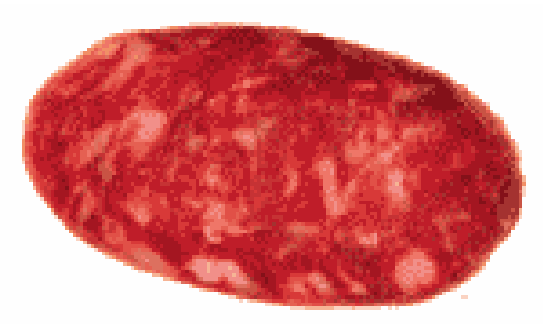
  First Drying 3 days from 20° to 16° (third day) R.H. from 75 - to 85% (third day) (loss weight 11%)

  Second Drying from 16 to 11° - 75-85% R.H. for 5 days(loss weight 5%)

  Ripening 60 days (loss weight 15%)

Salame “Milano”

Salame “Felino”



Soppressata

Salsiccia

- **RAW MATERIAL**
- **TRIMMING AND MINCING**
- **MIXTURE:**

  Meat , pork fat (30%), Salt (2,5%), Mixed Spices, Ice 1%, Ascorbic acid (50 ppm).
- **ANIMAL OR VEGETAL CASING**
- **COOLING**

  12-24 hours a 2°C.
- **VACUUM PACKAGING**
- **SHELF LIFE**:

  8 days a 4°C.

Coocked Sausages (Würstel)

- **RAW MATERIAL**
- **TRIMMING**
- **MIXTURE:**

  Meat (60%) , Animal or vegetable fat (20%), Water/Ice 20%, Salt (2,5%), Sugar (0,5%), polyphosphates (0,3%), Mixed spices, Ascorbic acid (50 ppm), nitrite (150 ppm)

- **MINCING AND BLENDING**

  Meat minced in coarse pieces, water, salt, nitrite 12-24 h 0-2°C

- **MINCING IN CUTTER**

  Cooked pork skin emulsion, cool water, fat and spices to 12°C (15° C with phosphates)

- **CASING**
- **COOKING**
- **VACUUM PACKAGING**
- **PASTEURIZATION OR STERILIZATION**

SOME VERY GENERAL COMMENTS

- PUNA ECONOMY :
  - **–TURISM**
  - **–MINES**
  - – CAMELIDS BREEDING
    - Completely marginalised

POINTS OF WEAKNESS

- Pure pastoralism
  - Water management
  - Pasture management
  - Forest management - Reforestation
  - No sustainable use of ecosystem (pasture and forest)
- No innovation (or very poor)
  - Only 50% of breeders develop complementary activities; For the other 50% the only income are camelids.
- Wild animals
  - Competition for pasture,
  - Predation (23 % of flocks)
- Low reproduction efficiency (11 months of pregnancy and 60-70% of fertility);
- High market competition with other valuable meat products (lamb, beef, etc.);
- Lack of an organized market for traditional Andean products;

MANAGEMENT OF ANIMAL RESSOURSES

- Llama and Alpaca populations should be managed according to different strategies
  - Alpacas as single purpose animals (fibre production). Meat should be not considered in the selection plan but utilised as secondary product obtained in the animals discarded from selection plan.
  - Llamas should be managed as dual-purpose animals (primarily for meat and secondarily for fibre).

BREEDING IMPROVEMENT

INCREASE PASTURE AVAILABILITY.

The availability of water correlates positively with the size of the farm.

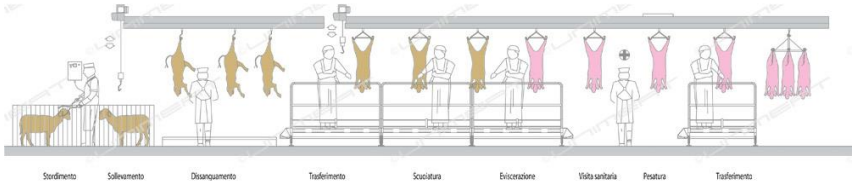
However, with respect to the harsh environmental conditions, this would only be possible within traditional Andean breeding areas.

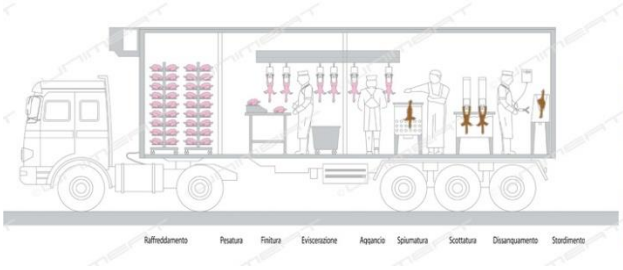
– INCREASE IN THE NUMBER OF ANIMALS BY FARM

– GENETIC IMPROVEMENT FOR MEAT PRODUCTION IN LLAMA
  - PERFORMANCE TEST
  - OPEN BREEDING NUCLEOUS SCHEME

BREEDING IMPROVEMENT

- **INTEGRATION BETWEEN PUNA AND INTERANDINAL VALLEYS**
  - REPRODUCTION = PUNA
  - GROWTH AFTER WEANING = INTERANDINAL VALLEY
    - More feed
    - Closer to slaughtering house
- **TAKE ADVANTAGE OF MOBILE AND MODULAR TECHNOLOGIES**
  - MOBILE AND MODULAR SLAUGHTERIN HOUSE


Stordimento
Sollevamento
Dissanguamento
Trasferimento
Scuoiatura
Eviscerazione
Visita sanitaria
Pesatura
Trasferimento


Raffreddamento
Pesatura
Finitura
Eviscerazione
Aggancio
Spiumatura
Scottatura
Dissanguamento
Stordimento

MEAT MARKET

- improved through:
  - evaluation of traditional products,
  - exploitation of new products,
  - increase of valuable by-products.
- Due to limited availability of meat products and vulnerability of the environment, it is advisable to put more emphasis on niche meat production, characteristic of the Andean region (e.g. Charqui, Organic certification system).

NEW TECHNOLOGIES FOR CHARQUI

SOLAR DRYER with forced ventilation

reduces the drying time

not influence the microbiological composition of the finished product.

DRYING CURVES for temperature and salt concentrations

MOBILE AND MODULAR INSTALLATION FOR CHARQUI PREPARATION

MARKET
AUTO CONSUMPION vs MARKETING

VERY STRONG INTEGRATION BETWEEN BOTH SYSTEM

- **AUTOCONSUMPTION** (3-20%).
  - Fresh meat
  - Charqui
  - by-products.
- **NICHE MARKETING**:
    - TRADITIONAL PRODUCTS (traditional charqui),
    - NEW PRODUCTS
      - Charqui with new technology,
      - New products,

RECOMMENDACIONES

- Sectoral policies designed both by governmental bodies or by non-governmental organizations should have the primary aims of improving the efficiency and encouraging the productive activities presently carried out in the *Altiplano*, of which Camelid breeding is one of the most important.
- While it is important to improve the basic services provided to the farmers, the presence of self sustained economic activities and of income opportunities is the main condition to maintain a human population in the *Altiplano*. In turn, a condition for increased profitability of farming and stockbreeding activities is the improvement of the products quality.
- These criteria should inspire any strategy to support Camelid production activities (for meat and fibre).

- Such a strategy should include at least some of the following elements:
  - Establish and enforce technical and hygienic standards and best practice regulations for animal slaughtering and meat processing.
  - Promote genetic improvement plans, on a sufficiently large scale, to improve the animal stocks, according to the criteria provided in the specific section below.
  - Foster scientific and technologic research for the genetic improvement of the Camelid population.

ROLE OF INSTITUTIONS

- UNIVERSITIES AND RESEARCH AGENCY
  - EXPERIMENTAL STATIONS

- LOCAL AND INTERNATIONAL NGO

COORDINATION

OTHER MEAT

- CUY
- GUANACO AS “NATIONAL MEAT” IN CHILE

MILK OF ALPACA Y LLAMA ?

- Very small daily amount
- Very important for the cria
- Very difficult milking
- Other species


GRACIAS
CAMERINO