Species, breeds and potential for improvement in animal fibre production in Europe


EAAP Animal Fibre Working Group (AFWG)

* Presenting author

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Animal fibre is Keratin-based “Wool”, produced by hair follicles in skin.

Evolutionary development benefiting thermoregulation in animals: seasonal/natural shedding; more continual - need shearing (welfare!)

Different follicles types (eg 1° and 2°) produce fibres with varying properties.

End uses of wool are determined by the main fibre properties, eg:

- Diameter, length, strength, colour, crimp, medullation, lustre, insulation, AND

- Presence of “faults” eg. contaminating fibres, vegetable matter and felting

Note; processing of raw fibre; cleaning; designer properties...
Animal fibre is Keratin-based “Wool”, produced by hair follicles in skin

“End uses of wool are determined by the main fibre properties”:

“Fineness” (diameter) is particularly important for end use

Fibre diameter...

http://www.fao.org/docrep/v9384e/v9384e04.htm
Focus On Europe:
What are the species and breeds of importance?
Producing fibres varying in yield and fineness

1. Goats: “Cashmere”, Angora (mohair)

2. South American camelids:
- (alpaca (mainly), llama, guanaco, vicuña, varying genotypes..)

3. Rabbits: (Angora wool)

4. Sheep (wide range of breeds) (Wool.... _)

Note: Camel: Musk ox...also; No data for Europe)
Scientific Background in Europe? eg.
Context: husbandry to genomic sciences

7th European Symposium on South American Camelids (SAC) and 3rd European Meeting on Fibre Animals
June 12 - 14, 2017
Assisi, Italy

BMBS COST Action TD1101 A Collaborative European Network on Rabbit Genome Biology (RGB-Net)

*Note: collaboration with major producing countries for SAC (eg Peru and Bolivia) and Cashmere (China including Inner Mongolia)
Species 1; a. Goats... Cashmere

(Contrasts with utilisation of imported cashmere)

“Double-coated” animal (1°: 2° follicles): Seasonal growth; (2°) cashmere; fineness (diameter), 12-18 \( \mu \)m: Yield, 0.06-1.0kg

Cashmere: major interest in Europe in 1980’s and 90’s

From (Russel, 1998) “The establishment of cashmere production in the European Union”

.. “cashmere production ..a viable alternative to traditional ..livestock farming throughout the EU, and also ... benefits to the European textile Industry”.

2016 perspective:

• Development unsuccessful; inadequate numbers
• producing the required yield and quality.
• Limited small-scale production and “craft” manufacture
Species 1; b. Goats... Angora (mohair)
Greater production, although decreasing

Single coated animal (2° follicle product); permanent fibre growth
(22-35 μm: yield, 2-5 kg): World ~ 5000 t/year

Turkey:
2009- 147,000 head (from 1,185,000 in 1991)
• Mohair yield: 174 tonnes (from 1,379 in 1991) from;

UK:
• 2015 : 2.8t auctioned in South Africa via British Mohair Marketing Ltd
• Adult fleece value/kg - 8-9£. (10-11 €) From;
  http://www.angoragoats-mohair.org.uk/2016/05/2015-mohair-fibre-collection-sale-results/

France:
• *5000 head; 5.00kg/animal; 25t
• http://w.w.w.capgenes.com/pdf_angora.anglais.pdf

Utilisation:
Used alone or mixed with other fibres to make luxury garments, a variety of wools, cloth, velvet...

*D Allain, 2016)
Species 2. South American Camelids
(2⁰ follicle products - typical diameter and yield)

Alpaca: “single” coated: 18-30 μm; 1.5-5.5kg
*Breed types: Huacaya; Suri

Llama: 20-30 μm; 1.5-2.0kg:
*Breed types: predominantly “single” (T’amphullis) and “double coated” (Q`aras)

Guanaco: “double coated”: 15-18μm; 0.5-1.5kg
Vicuña: “double coated”: 8-15 μm; 0.5-1.5kg)

(EU populations: Comparison with 3.7m Alpaca, Peru)

*M Antonini
Species 2. South American Camelids, continued

Estimates from Bonavia D; 2009. http://escholarship.org/uc/item/7xs9j2zs

**Europe**: “7000 llama; 2000 alpaca (!!!) ; 1000 vicuña”

**England**: ca. 2750 llama; 2750 alpaca
(25,000 in UK..(2008) http://www.purealpacas.co.uk/AlpacaHistory/tabid/125/Default.aspx)

**France**: 2000-3000 (llama and alpaca)
*2000 Alpaca- 2.0kg/head; 4t/year

**Germany**: 1700 llamas; 800 alpaca; 200 guanaco...

**Italy** - 60 alpaca, 6 llama, (Umbria) Roma area - 60 llama+30 on Sardinia.

Utilisation: small scale; local craft; sell direct to public... ( £12/kg: (Euro 14)...: UK Alpaca Ltd

*D Allain, 2016
Species 3. Angora (Rabbit) wool
Very fine medullated fibre; 14 -15µ; yield 1.5kg/year

World 10,000 tonnes (98% China - 50m rabbits)
EU: about 10t;
*France 3.5t (*2,500 rabbits) in 2015 (200t in 1990): REDUCTION....
Also Hungary, Germany, Czech Republic, Finland....

*Breed types (Both double-coated)
**French** type: Annual yield 1,5 kg: Harvested by defleecing (depilatory forage - mimosine);
Produces yarn with « fluffing» effect

**German** (Chinese) type: Annual yield 1,5 - 2.0 kg: Harvested by shearing
Produces normal fine yarn
- Warm and/or thermal clothes

Notes: cages; welfare issues...

*D Allain, 2016*
Species 3. Angora (Rabbit) wool continued

*Angora wool price
- World market: 30 € /kg (China import)
- France: 60 €/kg (>120 € before 1990)

*French and EU Angora industry
- a niche market vertically controlled by farmer/breeder organisation
- direct marketing of final products by farmers

- Uses: luxurious products
- Knitted clothes, such as pullovers, scarves, socks and gloves, producing a moderate "fluffing" effect.
- Angora fabric ideal for thermal clothing and for people suffering from arthritis and wool allergies.

*D Allain, 2016
Species 4. Sheep. Populations
Well adapted in Europe


[CIS Europe, 21.9m; South Eastern Europe, 5.96m;
EU Central and Eastern, 12.9m; EU other and EFTA, 90.1m]

Total for European Regions: 130.9m

UK, 34m

World: Total
~1,148m
Species 4. Sheep. Wool Production

European production (2010; tonnes (t)) (From: www.fao.org/dorep/017/i3138e09.pdf)

CIS Europe, 60,000t;
South Eastern Europe, 9,000t;
EU Central and Eastern, 31,000t;
EU other and EFTA, 160,000t

(FAO stats, greasy raw wool)

Total for European Regions: 260,000t

World total: 1,168,196 tonnes

UK, 21.6k t

Species 4. Sheep. In EU. Wool a secondary product to meat and milk....

Breeds and wool properties in different countries: Trends in Europe against time?
Examples: (Case studies) Breeds and production; Statistics for France.

<table>
<thead>
<tr>
<th>Breed Type</th>
<th>Population (no animals)</th>
<th>Annual wool production (1000kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Dairy breeds</td>
<td>1,470,000 (33%)</td>
<td>1,537,000 (16%)</td>
</tr>
<tr>
<td>**Meat breeds</td>
<td>1,253,200 (25%)</td>
<td>3,901,600 (42%)</td>
</tr>
<tr>
<td>**Hardy breeds</td>
<td>2,150,520 (43%)</td>
<td>3,642,720 (39%)</td>
</tr>
<tr>
<td>Conservation breeds</td>
<td>89,200</td>
<td>248,720 (3%)</td>
</tr>
<tr>
<td>Total</td>
<td>4,962,920</td>
<td>9,330,040</td>
</tr>
</tbody>
</table>

* Dairy production: **meat production

<table>
<thead>
<tr>
<th>Wool quality type</th>
<th>Mean fineness (µ)</th>
<th>wool production (kg) / quality type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine merinos</td>
<td>21.0</td>
<td>780,000</td>
</tr>
<tr>
<td>medium merinos</td>
<td>25.0</td>
<td>351,360</td>
</tr>
<tr>
<td>Fine medium</td>
<td>28.6</td>
<td>4,117,500</td>
</tr>
<tr>
<td>Medium crossed</td>
<td>32.1</td>
<td>1,571,340</td>
</tr>
<tr>
<td>coarse</td>
<td>37.0</td>
<td>28,450</td>
</tr>
<tr>
<td>kempy</td>
<td>35.6</td>
<td>2,307,810</td>
</tr>
<tr>
<td>Pigmented</td>
<td>29.2</td>
<td>173,580</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>9,330,040</td>
</tr>
</tbody>
</table>

Data compiled from « French Dispositif INOSYS Réseaux d’élevage – Institut de l’Elevage / Chambres d’Agriculture »
Economics (eg. France, UK). Example for France. Variation of wool gross product /ewe
(in constant € without subsidies)
from 1988 to 2014 for sheep plain (or meat) breeds and hardy breeds.

Cost of shearing:
1.5 – 2 € /ewe
Plain (8.0- 1.5 €)
Hardy (2.5 - 0.1 €) *

*Hardy breeds: Better to move to breeds shedding fleece without shearing...??

Source: Marc Benoit and Gabriel Laignel (INRA, UMRH, Theix), 2015
Personnal communication to D Allain.
For UK: BWMB: Latest Sale Results; 16 August 2016
(average clip value guide)
After all costs (excluding VAT)
For breeds:
Fine - £0.93: Medium -£1.00: Cross - £0.92
Lustre - £4.13 (Blue Faced Leicester !)
Hill - £0.78-1.18: Mountain - £0.4-0.6

<table>
<thead>
<tr>
<th>Average Price (greasy)</th>
<th>Indicator (clean)</th>
<th>Offered</th>
<th>Sold</th>
<th>Clearance</th>
<th>+Cumulative Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>126 p/kg</td>
<td>131 p/kg</td>
<td>192 p/kg</td>
<td>1.97 million kgs</td>
<td>1.66 million kgs</td>
<td>85 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Countries:</th>
<th>Year:</th>
<th>1990</th>
<th>Greasy Wool, t</th>
<th>Year:</th>
<th>Greasy Wool, t</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1990</td>
<td>2010</td>
<td>1990</td>
<td>2010</td>
</tr>
<tr>
<td>Albania</td>
<td>1 646 300</td>
<td>2 900</td>
<td>1 806 000</td>
<td>3 300</td>
<td></td>
</tr>
<tr>
<td>Bosnia and Herzegovina</td>
<td>-</td>
<td>-</td>
<td>1 046 040</td>
<td>1 382</td>
<td></td>
</tr>
<tr>
<td>Bulgaria</td>
<td>8 130 310</td>
<td>27 811</td>
<td>1 400 250</td>
<td>7 000</td>
<td></td>
</tr>
<tr>
<td>Croatia</td>
<td>-</td>
<td>-</td>
<td>630 000</td>
<td>660</td>
<td></td>
</tr>
<tr>
<td>Czech Republic</td>
<td>-</td>
<td>-</td>
<td>205 923</td>
<td>310</td>
<td></td>
</tr>
<tr>
<td>Czechoslovakia</td>
<td>1 051 320</td>
<td>6 555</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Estonia</td>
<td>-</td>
<td>-</td>
<td>76 500</td>
<td>154</td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>2 069 200</td>
<td>7 337</td>
<td>1 223 000</td>
<td>4 300</td>
<td></td>
</tr>
<tr>
<td>Latvia</td>
<td>-</td>
<td>-</td>
<td>70 700</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Lithuania</td>
<td>-</td>
<td>-</td>
<td>52 500</td>
<td>109</td>
<td></td>
</tr>
<tr>
<td>Macedonia</td>
<td>-</td>
<td>-</td>
<td>778 404</td>
<td>1 025</td>
<td></td>
</tr>
<tr>
<td>Montenegro</td>
<td>-</td>
<td>-</td>
<td>220 653</td>
<td>327</td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>4 158 470</td>
<td>14 783</td>
<td>258 262</td>
<td>950</td>
<td></td>
</tr>
<tr>
<td>Romania</td>
<td>15 434 800</td>
<td>38 167</td>
<td>9 141 500</td>
<td>17 600</td>
<td></td>
</tr>
<tr>
<td>Serbia</td>
<td>-</td>
<td>-</td>
<td>1 475 400</td>
<td>2 445</td>
<td></td>
</tr>
<tr>
<td>Serbia and Montenegro</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Slovakia</td>
<td>-</td>
<td>-</td>
<td>376 978</td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>Slovenia</td>
<td>-</td>
<td>-</td>
<td>138 108</td>
<td>188</td>
<td></td>
</tr>
</tbody>
</table>
Examples: Germany: Estimates of sheep population (1.6m: Statistisches Bundesamt. 2014)
Wool produced (no official statistics)

*Estimated Production: (Mainly meat with some milk).
  - 3,000 t greasy/ raw wool. (0.5 to 1 Euro/ kg) (50% yield)
  - 1,500 t of pure wool
  - 51 registered breeds (Schafzuchtverbände Niedersachsen (2016)).
  - Pre 1991 DDR Merino no longer economic

90% exported to Asian countries, particularly China.
End use including carpets

10% of greasy wool processed in Germany (about 300- 400 t/ year).
This wool (in excess of 28µ) is mainly used for:
  - Carpets
  - Socks,
  - “Regia wool” (Trade mark) for hand knitting.
  - Insulation material (due to low flammability): e.g. for roofs and walls of houses
  - Filling/ padding material: eg. in automobiles and airplanes
  - Geotextiles: pads made from wool fitted with plant seeds for greening of land endangered by soil erosion

Addition to synthetic fibres in textile industry

*M Gerken, 2016
**BREEDS**
14 sheep breeds with Stud Book: 3 are wool breeds:
- GENTILE DI PUGLIA (6,800:394 rams and 6406 ewes)
- SOPRAVISSANA (10,001: 592 rams and 9409 ewes)

**WOOL**
- 90% of total exported in the international market.
- 10% only processed in Italy.
Note: first Official wool collection Centre (Biella) by the Biella Wool Company Consortium,
- Also Abruzzo Region by the Gran Sasso and Monti della Laga National Park.
- New Wool collection Centres are in process of formalization in Puglia Region (Alta Murgia National Park), Sicily Region and Umbria Region.

8 million sheep, mainly milk breeds
9000 tonnes wool of which
250 tonnes Merino breed type

(*C Renieri)
Examples. Wool production Spain.

<table>
<thead>
<tr>
<th>Year</th>
<th>Fine (toneladas)</th>
<th>Extra-fine (toneladas)</th>
<th>Coarse (toneladas)</th>
<th>Lana negra (toneladas)</th>
<th>Total (toneladas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td><strong>17.745m</strong></td>
<td><strong>5.807</strong></td>
<td><strong>17.115</strong></td>
<td><strong>7.176</strong></td>
<td><strong>30.341</strong></td>
</tr>
<tr>
<td>2014</td>
<td><strong>12.369m</strong></td>
<td><strong>4.179</strong></td>
<td><strong>12.784</strong></td>
<td><strong>4.792</strong></td>
<td><strong>21.930</strong></td>
</tr>
</tbody>
</table>

**Number of animals sheared: *JP Gutiérrez, 2016**
Examples. *Animals and Wool production in Austria

<table>
<thead>
<tr>
<th></th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of sheep</td>
<td><strong>349 087</strong></td>
</tr>
<tr>
<td>Number of sheep farmers</td>
<td>13 801</td>
</tr>
<tr>
<td>Number of goats</td>
<td>70 705</td>
</tr>
<tr>
<td>Number of goat farmers</td>
<td>9 029</td>
</tr>
</tbody>
</table>

Table 1. Sheep and goat population and number of farms in 2012-2014
Source: BMLFUW, 2015; BMLFUW, 2014; BMLFUW, 2013

Marketing by selling to trading companies or directly to end-consumers


Alpacas and llamas
6000 animals estimated in Austria.
Animals are shorn for processing fibre at home or giving to small companies for processing

*M Wurzinger 2016
Examples: Wool (clean raw) production in UK
Sheep population 33m: 21,600t tonnes:

**British Wool Marketing Board: Since 1950....**
“Collecting, grading, promoting and selling
great British Wool ....”

http://www.britishwool.org.uk/

Priority in UK - meat, with wool sometimes a nuisance “by-product”

Many breeds recognised for wool production eg. “groups”- fine; medium; cross; lustre; hill; mountain; naturally coloured...

Historically: wool very important economically (....William Shakespeare`s family)

Why fall in economic value?
- Impact of competition with synthetically (laboratory)-produced fibres

But...
- Cellulose-based; nylon; acrylic, polyester... microfibres...
- Limited (BIO)degradability
- Problem... microplastics (microfibres) shed from clothes (eg fleeces) may be major pollutant in oceans).


Also competition from plant-based fibres (eg. Cotton...)
Examples. UK Breeds eg. Extensive Scottish “Black face” vs “Improved” Intensive cross breeds

Hardy, low quality and yield. Contributes to economy on “the edge”

Yield 1-2kg likely unprofitable

In contrast: Breeds eg. Multi-purpose (New Zealand breedline approach - Cross breed sheep (Leyn, Texel/Finn Dorset/ Shetland/Border Leicester....)

Yield 2-4 kg: Potentially profitable (Low maintenance; +“Easycare”)

Also. Produce Heterogeneous fleeces
C-crimp
L- lustre
N- no (relatively absent)
Examples. UK Breeds eg. Traditional Scottish “Black face…” *Modern shearing system

New Zealand contract shearers

Also heterogeneous fleeces

Crimp

No Crimp

Note: Value of wool marginal over cost of shearing

*Better to have ++“Easycare” breeds.. Shed fleece without shearing…??
Examples. UK Breeds
Variation in mean diameters of finest fibres across breeds
( Wool samples from BMWB: Moreno et al, 2010)

<table>
<thead>
<tr>
<th>Breed/Colour Code</th>
<th>Mean Diameter (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross NL NC</td>
<td>44.05</td>
</tr>
<tr>
<td>Jacob (white)</td>
<td>43.52</td>
</tr>
<tr>
<td>Jacob (black)</td>
<td>42.54</td>
</tr>
<tr>
<td>Cheviot</td>
<td>41.62</td>
</tr>
<tr>
<td>Greyface</td>
<td>37.80</td>
</tr>
<tr>
<td>Cross NL C</td>
<td>37.79</td>
</tr>
<tr>
<td>Blackface short fine</td>
<td>35.78</td>
</tr>
<tr>
<td>Charollais</td>
<td>34.19</td>
</tr>
<tr>
<td>Suffolk</td>
<td>34.00</td>
</tr>
<tr>
<td>Cross L NC</td>
<td>33.49</td>
</tr>
<tr>
<td>Zwartble (white)</td>
<td>33.19</td>
</tr>
<tr>
<td>Blackface Mattress</td>
<td>32.07</td>
</tr>
<tr>
<td>Bluefaced Leicester</td>
<td>31.94</td>
</tr>
<tr>
<td>Zwartble (black)</td>
<td>30.33</td>
</tr>
<tr>
<td>Hebridean</td>
<td>26.69</td>
</tr>
<tr>
<td>North Ronaldsay</td>
<td>21.96</td>
</tr>
</tbody>
</table>

Finest: North Ronaldsay
Coarsest: Cross; No lustre; no crimp.

https://northernlace.wordpress.com/2013/03/
Conclusions on wool as raw material

NOTE: additional value of meat, milk, hides (leather) and lanolin (for cosmetics...)

- Natural “wool” production is a valuable, renewing, natural resource
- Four major species and numerous breeds producing “wool” of variable properties
- Scale industrial and international: or small and locally-based

- Production, marketing and record-keeping, varies among countries

- Sheep wool, large scale with prices low and frequently loss-making
- Production of higher value goat, SAC and rabbit fibres, small by comparison
- Clear, (particularly for sheep wool: 150,000t + post slaughter wool), that there is under-utilisation in Europe

What are current approaches to improving utilisation?
Potential opportunities from biology and husbandry
(Taking into account environmental sustainability)

- Context; Socially responsible in recognising replacement of non-renewable oil-based hydrocarbons (noting also the suggested environmental pollution)
- More effective production and husbandry
- Exploiting new meat/milk breeds maintaining fleece quality and quantity
- Applying increased knowledge of hair follicle biology along with Application of new genetic tools for selection and breeding
- Better use of current and, development of novel, end-products (e.g., textiles and biomedical applications)
UK sheep wool utilisation
Quality, design and marketing...

Scottish Italian tartan...

Famous tennis player

Designer footwear

Knitwear

Wool coat

http://www.amazing-shoes.co.uk/wp-content/uploads/2014/07/Beige.......

https://www.ewm.co.uk/aran-cable-knit-jumper-2078698.html?___store=default
“The Campaign for Wool is a multi-national, cross-industry coalition working together to raise the profile of wool as the natural sustainable fibre for fashion and interiors”

“Launched in January 2010, the Campaign for Wool embraces leading figures from the fashion industry, interior design, wool carpet manufacturers as well as the world of insulation and building”
The Campaign for Wool (UK)

http://www.britishwool.org.uk/page/wool-promotions/campaign-for-wool.php

http://www.swaledalewoollens.co.uk/

http://www.campaignforwool.org/2015/12/21/campaign-for-wool-announces-wool-floor-show-london-is-a-sell-out/

Carpets...

Wool insulation
The Campaign for Wool... Netherlands

Knitting, garments...

The Making Of Wool Week Netherlands
The Campaign for Wool is coming to Italy 8 - 13 September!

Italy...

Clothes fashion!

Milano; Quadrilatero della Moda
Wool Week Berlin bringt Kunst und Wolle zusammen

The Campaign for Wool... Germany...

Campaign for Wool Paris 2015

Wool Week Paris kicks off at the Palais de Tokyo

Thank you for your attention, from AFWG