Mitchell Associates

2005

CONTENTS

1. BACKGROUND

1.1 The All-Sheep project, initiated by Welsh wool knitwear producers Joyce Pitt and Heather Mitchell and funded by Glasu, explored the operation and needs of producers, processors and users of non-edible sheep by-products.

1.2 The findings suggested that

i) producers wanted to have access to processing services
ii) processors were under pressure to turn round their current workload
iii) there were large and small scouring plants but nothing in between.

1.3 As a result of the study, and with further WEFO funding for further stages of the Sheep project in Powys, this feasibility study was commissioned. Its aim is to assess the viability of a small to medium size scouring plant in Powys and, if feasible, to explore how that might be funded and operate.

2. WHAT IS SCOURING?

2.1 Scouring is the early stage processing of wool which involves sorting, blending and washing.

2.2 The object of scouring is to extract grease, dirt and other foreign matter. Wool can lose up to 30% of its original weight during this process. A by-product of scoured wool is lanolin, the "wool grease" which is used in the manufacture of soaps and cosmetics.

2.3 If required, treatment of wool fibres for machine washable wool, anti-microbial and anti-fungal application, and moth-proofing can be carried out after scouring.

2.4 Once the wool is clean, tangled wool is then carded to tease out the fibres and spun into woollen yarn. Wool for worsted yarn is also combed before opening, drawing out the larger fibres to lie parallel.

3. UK SCOURING PLANTS

3.1 There are two large-scale commercial scouring plants in the UK – Chadwicks and Howarths in Yorkshire - which deal with millions of tonnes of wool each year. Howarths process around 1million kilos a week and Chadwicks 600 kilos. This compaires with large scale processing plants such as Gilbourn in Australia which processes 20,000 tonnes of greasy wool annually.

3.2 Both UK plants are scouring to produce clean and carded fleece suitable for producing carpets. The scouring carried out at these mills is not necessarily consistent with producing yarn for knitwear and the processing vastly reduces the handle of the fleece.

3.3 In addition, because of their size, they do not deal with small quantities of wool.

There are a number of smaller scale units in Wales – namely the mini-mill operation at Merlins Mill in Builth Wells and the slightly larger scale Natural Fibre Company in Lampeter (which is currently relocating to Cornwall and expected to be operational from April 2006).

There is also an alpaca processing mini mill in North Wales.

3.4 In the UK, the 59,000 producers produce a clip of 37 million kgs. Almost all of this is collected by the British Wool Marketing Board. Dispensation from the BWMB would need to be sought if breeders organised their own collection service and placed their wool outside the system, unless a separate arrangement was developed with the BWMB.

4. SCOURING HISTORY AND APPLICATION

4.1 Wool scouring can be traced back to earlier centuries when sheep were driven into streams. The wool would be washed by hand. This practice was ineffective as grease inherent in wool would retain dirt particles and cold water would not remove the grease.

4.2 In Australia, historians of the time described this practice as "marginally more intelligent than milking a cow by one person holding the teats, while four more lift the cow up and down."

4.3 Then a significant move forward came when warm water was used in baths or tanks and later when short wool, instead of full wool sheep, were used. The process was eventually mechanised and detergents and other technologies introduced.

4.4 Wool scouring is now the first step in the wool processing industry and the basic function of scouring is to remove dirt, wool grease (lanolin), suint (sheep sweat) and some organic matter from the wool.

4.5 Wool scouring plants were one of the earliest polluting industries in traditional sheep-rearing countries like Australia. Untreated waste from scouring can impact on the environment through detergent, loading, high nutrient content and very high Biological Oxygen Demand (BOD). Initially scouring plants main objective was to scour wool. Wastewater was not viewed as an issue.

4.6 These views are being replaced by the notion that all by-products from the scouring industry are a valuable reserve with economic and environmental gains to be made from intelligent use of the by-products.

4.7 In many plants wool is blended. This is to:

- Homogenise different wool types to achieve a single consistent blend.
- If necessary to remove dirt and vegetable matter from the wool before scouring to make the actual scouring process less different and more efficient on resources.

4.8 However, wool blending does not allow true traceability and many smaller breeders prefer to pay a premium to keep their own fleeces separate from others.

5. SCOURING BY-PRODUCTS

5.1 A number of bi-products come out of the wool scouring process. Wool grease is an important one; mud and dirt are removed from the waste water in some plants ad used in renovating irrigation areas.

5.2. Wool grease is a natural product that has numerous applications. Refined wool grease (lanolin) is used in cosmetics and in pharmaceuticals. The wool grease can also be used as a natural, light industrial grease.

5.3 The Environment Agency does not accept wool grease to be discharged into the sewers and therefore any new plant would need to look at separating the grease out, probably using centrifuges.

5.4 Mud and dirt from the scouring process can be used to enhance impoverished soils, as it promotes the development of soil structure and increases the availability of nutrients in soil. Research is continuing into using these products (essentially dirt off a sheep's back) as soil fertiliser as they are rich in micronutrients particularly potassium as well as nitrogen.

6. FINE WOOL PRODUCTION

6.1 The UK is the largest sheep and wool producer in Europe and is regarded throughout the world as a major manufacturer of high quality knitwear and cloth. However the majority of the high quality products are produced from fine wool imported from the southern hemisphere at an annual cost in excess of £100 million. 25% of the cost of the imported fine wool is said to be attributable to freight.

6.2 The majority of wool produced in the UK is coarse and therefore of low quality and value, used mainly in the manufacture of carpets, soft furnishings and less quality knitwear.

6.3 The UK and the EC have long regarded wool as a by-product of the sheep industry with the absence of any mention of the product in the Common Agricultural Policy (CAP). Wool currently represents as little as 5% of the output of an average UK sheep flock, production of finished lamb and breeding stock being the primary products.

6.4 Fine wool can be produced by only one type of sheep – the Merino, which is rarely found in the UK in any large numbers. In the past decade, a number of Merino derived breeds have been introduced into the UK from Europe and Australasia and have been promoted as dual-purpose sheep, producing high value fine wool while losing none of the lamb producing qualities associated with native British breeds. To date this increased interest in wool production has failed to convince the majority of the UK sheep producers that fine wool production is a viable proposition.

6.5 Australia is the world's largest producer of wool with 607,000 tonnes being clipped from 132 million sheep (BWMB). Three quarters of these are pure bred Merinos with fine, high yielding wool of under 24 microns fibre diameter (60's Bradford quality).

6.6 China has the largest number of sheep in the world with 133 million and is the second largest wool producing country with 295,000 tonnes of raw wool clipped per year (BWMB 2001). Most of the sheep are farmed in remote barren areas of the country, producing low quality wool due mainly to the poor quality of the pastures.

6.7 New Zealand is the third largest wool producer with 246,000 tonnes of wool being produced from 45 million sheep (BWMB, 2001/2002). The breeds of sheep are mainly Merino crosses such as Polwarth, Corriedale, Coopworth, Perendale, Drysdale as well as the British Lincoln Longwool and Romney Marsh. New Zealand produces 45% of the world's coarse wool. As in Australia, sheep are farmed on an intensive basis both for their meat and wool.

6.8 The UK is the largest producer of wool in Europe producing about 50% of Europe's wool output. The UK currently has around 70,000 producers, 24 million sheep producing 51,000 tonnes (BWMB) about 3% of the current world output of 2.9million tonnes.

6.9 In the UK, as in the rest of Europe, sheep are farmed more intensively than in other major sheep farming countries, with meat being the major product. The UK currently exports two thirds of its total clip with 47% of UK's exported wool going to the rest of Europe.

6.10 Consequently wool is now regarded as a by-product of the UK sheep industry, the annual clip representing only 5-6% of the value of the output of the industry. The wool produced being mainly coarse ranging from 20-34 microns and being used chiefly for carpet production.

6.11 As quoted in the All-Sheep research report, in his dissertation, "An Analysis of the Viability of Fine Wool Production in the UK" R.J.A Birt concludes that analysis of the gross margins indicates that fine wool production is viable and that the UK is ideally suited to this type of agricultural enterprise. The different breeds that have been introduced and developed in the UK cater for varying types of fine wool production and the different agricultural environments.

6.12 Mr Birt comments: "The current scale of fine wool imports indicate that there is an opportunity for UK farmers to produce higher quality wool of 19 to 24 microns at a lower cost i.e approximately 50% of the cost of imported wool."

6.13 Relatively few sheep farmers have been tempted to diversify into fine wool production due to the high cost of the setting up of an enterprise and the limited increase in profitability gained as a result. This explains the fact that most fine wool producers also rely on other sources of income or occupations for their living. The limited numbers of fine wool breeding stock and their small genetic base are additional factors which restrict the growth of the UK fine wool industry.

6.14 There is a Catch 22 situation in that the BWMB prices for fine wool relative to private sales suggest that prices will need to be increased significantly to attract sheep producers towards fine wool production. Slight improvements in the quality of the wool of traditional British breeds is unlikely to increase returns significantly. This has been shown in research by the Centre for Agricultural Study.

6.15 It is worthwhile noting that the British Wool Marketing Board structure in the UK is envied by many other countries who do not operate a similar sort of co-operative and whose farmers have to market their wool independently.

6.16 The difficulties with fine wool production can be overcome as has been illustrated by the now defunct Scottish Fine Wool Project (although severely affected by Foot and Mouth). Producer co-operatives seem to be essential if fine wool production is to become more widespread in the UK. Co-operation with the British Wool Marketing Board is also of great importance so that the wool can be sold through the Board or alternatively sold to the Board and bought back to be marketed privately.

6.17 A.J.F Russel in his publication "Quality Animal Fibre – Research and

Application" suggests that the production of high quality, high value animal fibre has the potential to make substantial contributions to the economy of hill and upland farms, not only in the UK but also in those countries in Europe and beyond which have a history of ruminant livestock enterprises.

6.18 At one time the annual income from wool was sufficient to pay the rent of the average UK sheep farm. Now the income from wool does little more than pay the cost of shearing, and in some cases does not even do that.

6.19 The main reason underlying the change in profitability of wool production is the poor quality of the product in relation to present day demands As with other commodities, the expectations of the consumers as regards quality have risen with improvements in living standards; the quality of wool produced in the UK, and indeed in most European countries, has changed little if at all. Research at the Macauley Land Use Research Institute, through development of its Bowmont flock, a cross between merino and Shetland, has shown that the production of high quality, high value wool is eminently feasible.

6.20 A flock of thirty-two ewes and two rams are now being developed in Mid Wales at the ADAS Pwllpeiran research centre near Aberystwyth in conjunction with Glasu. The breeding project was suggested in the AllSheep research project.

6.21 The flock have had their first lambs and have been shorn with the wool, after being processed, will be used to create a range of exclusive garments. The rational behind the project is that wool currently represents as little as 5% of an average UK sheep flock. Financial returns from wool could be increased by producing finer wool. In Scotland, a new breed, the Bowmont, has been developed to produce fine wool in the UK by crossing the Shetland with the Australian Saxon Merino.

6. 22 The Bowmont is a small hardy breed which produces 2.5-3.5 kg of fine wool.

Fig 1

	SM	B	S	C	WM
Live weight (kg)	42	38	33	57	35
Fleece weight (kg)	3.5	3.0	1.0	2.0	1.5
Fibre diameter (microns)	19	20	25	30	31

Key: SM Saxon Merino, B Bowmont, S Shetland, C Cheviot, WM Welsh Mountain

6.23 The Fine Wool project will evaluate the Bowmont breed under Welsh conditions over a 4-year period. 35 ewes and 2 rams form the basis of the flock. The flock will be bred pure. Assessments will be made on:

- Wool quality – fibre diameter, staple length
- Hardiness
- Carcass quality

The flock will be scrapie genotyped.

6.24 The economics of the flock will be evaluated including

- Wool price
- Carcass price
- Replacement rates
- Values of wethers

In addition, markets for the wool and skins will be investigated.

6.25 The CAP reforms will place less emphasis on quantity of flocks for farmers and encourage them to think more of quality.

6.26 The reforms involve entitlements to claim and be paid the new Single Farm Payment (SFP) each year from 2005.

The entitlement is made up of a flat rate area payment and a secondary payment based on an individual historic claims history in the based period 2000-2002. The resultant SFP will be allocated against land claimed in 2005. The history payment will reduce from 2005-2011 and the area payment will increase from 2005-2011.

6.27 Some producers such as Leslie Wickham of Cwmchefrau Farm near Llandrindod Wells are already producing good quality, soft wool by concentrating less on individual breeds but crossing from a range of animals with the focus on achieving better fleeces.

7. DEMAND FOR WOOL PROCESSING

7.1 Two surveys show that there is demand for wool processing. The most recent was carried out through the database of the Natural Fibre Company in Lampeter by prospective purchasers of the business.

7.2 The NFC survey generated a high response rate of 15% (2-3% standard survey rate). 11% were from Wales and 18% from the South West. 59% were in sheeps wool, 8% organic, 4% alpaca and 5% mohair.

7.3 The total volume of wool from the responses was 25 tonnes of which 10% was from Wales (affected by the larger organic producers in the South West).

7.4 There was a wide range of services required in terms of types of spun fibre and presentation of returned fibre, with no single type predominating and considerable interest in share schemes for weaving.

7.5 The survey carried out for the All-sheep project produced the following results**:**

FARMERS QUESTIONNAIRE

RESULTS

Number of returned forms: **45**

Breeds of sheep **(respondees classifications)**	**Quantity**
Welsh Mules	5,920
Texel	1,730
Texel X	350
Welsh Mule X Texel	
Welsh Mountain	2,050
Welsh X Cheviot	2,100
Cheviot Cross	900
SMF BFL Mules	900
X Breed	3,000
Suffolk	100
Suffolk Cross	30
Improved Welsh Mountain	30
Speckled Face	1,520
Lleyn/Texel	1,800
Mule/Speckle Face/Kerry Hill	550
Lambs (Editor - ?)	750
Texel X/Suffolk X	300
Beulah	500

Beulah/Speckle	3,460
Beulah/Welsh Mules	2,650
Welsh Mule Beulah	2,200
Welsh &Texel Half Breeds	997
Speckled Welsh Mule	1,100
Welsh	1270
Hardy Speckle	1,800
Mule Ewes	1,900
LLeyn	1,500
Speckled Face	1,250
Texel X/Suffolk X/Charalois X. (Beltex Pedigree Flock)	420
Mule X	1,200
Welsh Speckled Face	1,000
Mule	800
Clun & Texel	400
Welsh Hill Speckle Face	1,500
Various Rare Breed Crosses	100
Speckle	120
Welsh Mule/Welsh Beulah Speckle	800
Welsh Hill	300
Total	47,327

How many sell wool to the Wool Board: **43**

How many buy wool back: **0**

How many are interested in selling wool elsewhere: **36**

How many have wool spun: **2**

Where are the Markets: **LOCAL 20** **WALES 12**

U.K. 4 **OVERSEAS 3**

How many willing to go on database: **38**

8. EQUIPMENT

8.1 There are a number of large scouring plants around the world (two in the UK) and a large number of small-scale scourers. The middle road is not well-trodden.

8.2 The size of plant envisaged – say processing around 40 kilos per day (30 fleeces) – might well have to provide more than just scouring. A one-stop shop, with carding and spinning – might provide to be a more viable option because of the negative eco impact of transporting the clean wool to other spinning facilities.

8.3 Mini-mills - A number of small producers have invested in mini-mills. Mini-mills Ltd in association with International Spinners Ltd designs and manufacturers fibre processing machines. The company is located in Prince Edward Island, Canada.

A full range of scouring, carding and spinning machinery costs around £80,000.

8.4 The manufacturers claim that electronics have eliminated almost all set up time and the addition of computerised displays gives the operator continuous awareness and control of the yarn being produced.

8.5 Almost any yard can be produced and the mini mills regularly spin at 10,000 yds per lb in very fine fibre. The manufacturers say that operating a mini mill is a fairly simple business and one person can usually operate several machines at one time. Productivity depends on the configuration of machines and on the end product. It takes longer to produce fine spun yarn than any other product and the operator needs to build good skills to produce the medium to fine range likely to be processed at any new facility.

8.6 Mini-mills offer 20 different machines to be configured to suit particular requirements. They suggest, for effective evaluation before purchase, a visit to their demonstration facility where the particular fibres to be processed can be matched with appropriate machinery.

8.7 After installation, continuing support is available to provide advice and handle any problems that arise due to fibre variation or in the use of the machines. The company offers individual machines, complete mills, information and training.

8.8 Mill machines include:

Picker – opens and blends fibre

Carders – carding separates and aligns the fibres individually

Sliver maker (part of carder) - turns carder output into rovings (sliver)

Fibre separator – removes trash, vegetable matter and coarse hair

Draw frame – the essential interface between carding and spinning

8 & 4 spindle spinners – for spinning and plying

Skeinwinder – removes the yarn from bobbins into measured skeins.

Feltmaker – converts batts of fibre to sheets of felt.

8.9 Educating the fleece producers is essential so that they are free of discoloration or fungal or bacterial damage, not soiled by excreta, have no vegetative contamination and be correctly sheared (the British Wool Marketing Board publicise this requirements widely with producers).

8.10 Mini-mill scouring - mini-mills suggests a four-bath system of scouring with the first and second baths containing soap solutions and the third and fourth a rinsing operation. Weight loss of 20-50% occurs in washing.

Typically the first bath, one gallon of water at 130 deg-f with 0.5% soap addition will adequately scour one lb of wool.

The second bath, slightly lower in temperature (around 120 deg-f) with 0.25% soap solution, and again one gallon per lb of wool.

The third and fourth or rinsing bath should contain no soap, temperature around 110 deg-f one gallon per lb of wool.

At each bath, gentle agitation with the fingers is necessary. Heavily contaminated wool, such as Merino, will benefit from longer soaking. If continuous agitation is not possible, then a minimum of 30 minutes soak at each stage is essential. It is preferable that the maximum amount of spent liquor is removed from the wool on removal from each bath. Some form of mechanical device, such as a wringer or mangle can be used. Agitation must be slow and gentle as vigorous movement of fibres under scouring conditions will result in felting or heavy entanglement of fibres. This in turn will lead to excessive fibre breakage in opening and carding.

On exit from the rinse bath, the wool should smell clean. A residual grease content of below 0.5% is ideal.

8.11 Drying - if it is not possible to use a wringer on exit from the rinse bath, the wool must be “spun” in a commercial machine using fine mesh synthetic fibre bag which will substantially reduce the drying time.

Cost effective drying is most easily achieved using large open mesh racks. The wool, first opened by hand, then spread in a thin layer over the mesh. If natural drying with preferably both sun and wind cannot be achieved within 24-48 hours, then assisted drying using hot air blowers or fans should be used.

It is important that the wool is dried evenly and not over-dried. Residual moisture content of over 25% will result in fungal growth. Residual moisture content below 7.5% will result in processing difficulties and fibre breakage. As before, “handle” indicates correctness. The wool should not feel damp and this can be sensed by

pressing a handful against the nose and face. Harshness and rigidity of the fibres indicated over drying.

The dried wool should be stored in closed polythene bags and closed to prevent the wool from further drying. If any doubt exists as to the wool being too damp, then Mini-mills suggest opening the bag daily to check for the aroma of fungal growth. Preferably, store below 60 deg-f.

8.12 Technical Support - during the pre-sale period, Mini-mills encourages thorough research and provides a demonstration site to help prospective customers fully appreciate the requirements of setting up and operating a mill.

At time of delivery they offer on-site assistance to correctly set up the machinery, instruction in fibre processing and machine operations is usually available on-site or at their demonstration mill.

Post-sale, mini-mills are available for consultation and they stock and supply any consumable products needed for continuous operation.

8.13 Environmental - there is no mention on the mini-mills website, as far as the author could ascertain, of environmental issues relating to dealing with the discharge/by-products of scouring.

8.14 CANESIS MEDIUM-SCOURING PLANT - Canesis, the successor to the New Zealand WRONZ research group, is developing a medium scouring plant. The system recycles water to reduce costs and comes as a labour-intensive or mechanised unit. This is reflected in the costing of up to around £180K. Full details cannot be included in this report due to commercial confidentiality and patent pending.

Environmental
The Canesis system incorporates a liquor management system which optimises water usage and limits wastewater depending on the quality of the input raw fibre.

Canesis suggests that full wastewater treatment facilities would not be economically viable and recommends “low tech” approach to the treatment/disposal of the dilute wastewater. The suggested options including disposing of the dilute wastewater onto farmland (although other sources say this is unlikely to be an option for long in the UK), providing irrigation and nutrients back to the soil, or tankering the wastewater for disposal to a municipal wastewater treatment facility.

9. KEY ISSUES

The key issues to be addressed when further considering the feasibility of a wool scouring plant in Wales are:

9.1. LOCATION

9.1.1.Where in Wales could a static scouring plant be established? Various factors need to be considered including:

9.1.2.Running costs – the plant will need considerable amounts of water. Currently Severn Trent business water costs are lower than Welsh Water. The plant will also need access to electric and possibly gas, depending on the type of heaters used. Any location which has access to free water would be preferable in order to reduce processing costs.

9.1.3 Environmental – any discharge of waste to mains need to be done through a licence arrangement. Currently the Environment Agency (according to Severn Trent) is not granting any new licences for this type of waste. Severn Trent advises that its most up to date sewage treatment plant in Powys is at Newtown and that, coincidentally, Newtown has a licence in existence which related to the former tannery in the town (the site of the current Wool Producers of Wales site).

9.1.4 A Newtown location would be a central point in Wales in terms of access from the North and the South.

9.1.5 If a mobile system were eventually established (perhaps operating in addition to the fixed location) this could visit farms and waste could be returned to the farmer's land.
The farmers own water and electric could be used in processing which would reduce fixed costs.

9.2 Size – mini-mill v medium scale

9.2.1 A mini-mill offers a proven system for processing wool but the scouring tubs used are small and if an economic quantity were to be scoured would mean the purchase of several units. Also the units require hand processing or long soaks which can be time consuming and limit the cost effectiveness of the process. There is also the environmental issue relating to the disposal of waste.

9.2.2 The mini-mill manufacturers suggest an output of 10kg per day but one mill contacted said that, even after a year with currently 4 staff, only about 5kg per day was being achieved.

9.2.3 A medium sized scouring unit would provide economies of scale and, if the mechanised version installed, rather than the low-tech manual handling, provide scope for the operator to work other machinery eg spinning.

9.3 Equipment and scope

9.3.1 Currently in the UK, coarser wool rather than fine is the norm. Micron rates of 30 plus are more common than the Bowment and Merinos 20. However, as farmers look at maximising quality and scope of their flocks this may change. It seems sensible to develop a scouring plant capable of coping with the full range of fibres. This would also create the option of dealing with fibres other than wool such as alpaca or angora.

9.3.2 In terms of equipment, a one-stop shop would provide the option to have wool scoured and processed into wool on one site. Various types of wool need to be offered including hand knitting wool, machine knitting wool and weaving wool. A felting machine would also be of interest to a number of customers.

9.3.3 Reliability and support. The mini-mill option is well proven and already there are producers using this system in the UK (Merlin's Mill and North Wales alpacas). The quality of wool produced can vary according to the skill and experience of the workforce. The Canesis medium scour system has been piloted in New Zealand but not installed elsewhere. The company is well used to commissioning larger systems and has a skilled team of designers and engineers. Both manufacturers offer training and support.

9.3.4 Andar has the biggest range of scouring equipment but tends to provide at much larger scale. A new 6-howl Andar wool scouring range introduced at Buckfast spinning in Devon in 2000 cost more than £1million. The plant deals with 50-60 tonnes per week and total equipment costs are around £3.4m.

9.4 Environmental

9.4.1 Wool scouring with water leads to the discharge of an effluent with a high organic content (2 to 15 l/kg of greasy wool at about 150-500g COD/kg of wool) and variable amounts of micro polutants resulting from the pesticides applied to the sheep. The most common pesticides are organophosphorous (OP), synethetic pyrethroids (SP) and insect growth regulators (IGR). Organochlorine (OC) pesticides are still found on wool from certain grower countries outside the UK.

9.4.2 The implementation of dirt removal-grease recovery loops (as in the Canesis option) allows water and energy savings. Net specific water consumption figures of 2-4 l/kg greasy wool have proven to be achievable for course and fine wool (EC IPPC).

Additionally a valuable by-product is obtained (25-30% of the grease estimated to be present in the wool scoured), along with a significant reduction of the organic load sent to the effluent treatment plant.

9.4.3 If the dirt removal/grease recovery loop is combined with evaporation of the effluent and incineration of the sludge, with full recycling of water and energy, additional environmental benefits are achieved in terms of water savings and amount of solid waste disposed of. Nevertheless, the technology is complex and involved very high capital costs and high running costs.

9.4.4 - Organic solvents. Wool scouring with organic solvents avoids the use of water in the actual cleaning process. The only source of water emission is moisture introduced with the wool, steam used in the vacuum ejectors and moisture recovered from air drawn into the equipment. This water is contaminated with perchloroethylene (PER).

9.4.5 To avoid any risk of diffuse emissions, the water stream is treated in two steps, comprising a solvent air stripping unit and a residual solvent destruction unit. Since pesticides partition strongly to the solvent and are removed with the grease, the clean wool is reported to be pesticide free. This has the benefit implications for the downstream processes where the wool is finished. Another positive effect of this technique is the reduced energy consumption, due to the latent heat of an organic solvent compared to water.

9.4.6 Waste water - for wool scouring waste water, the environmental performance of an evaporation plant is far superior (EC, IPPC) to that of a flocculation plant. However the initial cost of the evaporation plant seems to be much higher and payback (versus discharge to sewer) takes 4-5 years for small mills (3,500 t/yr of wool). For medium sized mills (15000 t/yr of wool), evaporation is slightly cheaper than flocculation over 10 years.

9.4.7 The use of a dirt removal/grease recovery loop with evaporation of the effluent and incineration of the sludge with full recycling of water and energy is the best option from an environmental point of view. However, the complexity of the technique and the initial capital cost make it more suitable for 1) new installations 2) existing installations with no on-site effluent treatment and 3) installations seeking to replace life-expired effluent treatment plant.

9.5.7 In the case of effluent treatment by biological processes, it is known there are scourers in Europe (particularly in Italy) using biological processes as their main methods of effluent treatment. However no precise information was submitted by these plants to the EC's IPPC reference document authors.

9.5.8 It is clear from this that the installation of any scouring facility needs further thought and research in order to develop an Environmental Management System (EMS) which would satisfy effluent treatment works operators and the Environment Agency.

9.5.9 Location – as discussed above, a static plant would need a licence and this therefore reduces siting options.

9.5.10 Both the mini-mill and the Canesis systems try to minimise environmental impact through for example rinse water being recycled to carry out the initial dirty washing stage.

9.5.11 However, neither have yet seem to have addressed Environment Agency requirements ever-decreasing limits in terms of COD rates and suspended solids. Canesis have accepted the need for more trials and assessment.

9.5.12 It would be helpful if the system were designed to use the waste produced as resources so that for example lanolin/light grease can be refined and sold. The mini-mill system appears to be less versatile in this respect. The system needs to include centrifugal systems to extract the grease and also methods of ensuring that any discharge to sewers complies with current regulations and anticipates future ones where these are known. Other solid waste can, as with larger sites, currently be spread on fields as fertiliser although the author is advised that the Environment Agency may soon have another view on this.

9.5.13 The use of chemicals to control sheep tics and flies is a problem. The amount of organophosphate (OP) used is decreasing but use of synthetic pyrethroid (SP) chemicals is increasing. OPS are considered more harmful to man but SPs are now thought to be more than 100-fold more toxic then OPs for stream and river life.

9.5.14 The chemicals can be difficult to remove for the wool scourers and they can be detected in minute amounts by the Environment Agency which has to enforce environmental quality standards (EQS) on rivers. Sheep are likely to have about 6000 parts per million of OP insecticide in their wool for several weeks after treatment (Source: Coopers Animal Health, sheep dip producer).

9.5.15 Effluent from scourers is treated to extract pollutants before it is discharged to sewage works for more treatment. When there is a lot of sheep dip in the effluent, the technology for removing chemical residues is efficient: when there isn't much dip there – but still enough to damage river ecology – the technology is less efficient (source: Pesticide News, 1997).

9.5.16 When the Environment Agency gives wool scouring companies and water companies discharge consents, these technical shortcomings are picked up. Scourers like W and J Whitehead (Laisterdyke) Ltd on the River Aire in West Yorkshire put in a £400,000 effluent plant to reduce the chemical content by another 10% and Buckfast Spinning Company on the River Dart in Devon spent £1m on new wool scouring equipment to concentrate the chemical part of the effluent into the components of landfill. Buckfast is now sending its waste to be recycled with the local council's garden waste collections.

9.5.17 The existing tests for sheep dip chemical residue costs around £120 and taken 10 days.

9.5.18 The BAT (best available techniques) proposed by the EC is that in wool scouring, emphasis is given to using available information and to encouraging collaboration initiatives between competent bodies in order to avoid processing wool

contaminated with OC pesticides and minimise at source any legally used sheep ectoparasiticides. The selection of wool yarn spun with biodegradable spinning agents instead of formulations based on mineral oils and/or containing APEO is also part of BAT.

9.5.19 The BAT also proposes

- chemicals used are constantly reviewed
- measures sought to minimise water usage and energy usage

9.5.20 In February 1999, the European Union (EU) included textile products as part its ecolabel requirements. The European Ecolabel for Textiles enables consumers to recognise garments that are made from clean, low-residue wools and have been processed using clean production methods (Evans/Karlsson).

9.5.21 Ecolabel does not mean nil residue wool and the limits for pesticide levels are:

Figure 2

Total synthetic pyrethroids	Less than 0.5 mg/kg
Total organophosphates	Less than 2 mg/kg
Total insect growth regulators*	Less than 2 mg/kg
*diflubenzuron and triflumuran	

9.5.22 To meet these expectations, woolgrowers will need to manage lice and fly problems with less reliance on chemicals. Suitable ectoparasite control can be achived through in integrated pest management (IPM) approach.

9.5.23 In 1996 in Wagga, NSW, Austrlia a team of shearers successfully sued a woolgrower for allegedly endangers their health by improperly using chemicals. Shearers and other wool handlers are becoming more aware of the potential risks associated with exposure to chemicals, particularly the OP group which can cause serious nerve disorders.

9.5.24 Proper protective clothing, withholding periods and effective breeding and selection can reduce the risks and usage of pesticides.

9.5.25 Wool scouring company Thomas Chadwick & Sons in Yorkshire were granted £788,620 over two years through a Bio-Wise demonstrator project grant. The project aims to replace sulphuric acid and other chemicals in treating wool waste effluent by use of an anaerobic digestion system which recovers a biogas (methane) to produce energy for the site. Stage one, testing of two systems went well, and one was chosen but the full scale plant design stage is on hold “due to unforeseen circumstances” (Biowise web site).

9.2.26 The Natural Fibre Company in Cornwall has a compliance statement that all non-organic customers have to sign confirming total non-usage of OP/SP/allopathic products on animals or fibre or withdrawal in the three months before shearing (giving all details of the previous 12 months usage).

9.2.27 The NFC also requires all organic customers to provide accreditation and certificates.

9.5 FUNDING

9.5.1 One of the problems in establishing scouring/spinning facilities is that the start-up cost is large. If funding is available to meet this initial cost, then revenue costs are likely to be recovered more easily and the plant will be more able to be self-funding.

9.5.2 Partnerships in terms of provision of space for the operation would further reduce capital costs.

9.5.3 Funding could be available from the Welsh Assembly Government. For instance, it 30% funded the mini-mill purchase (£90,000 total) for the Alpaca farmers in North Wales.

9.5.4 Funding might be available from Glasu, although the latest phase of their Objective 2 funding has been fully allocated.

9.5.5 Objective 1 funding might be available if the project were either based in Objective 1 area or could show proven benefits to users in those Objective 1 areas.

10. CASE STUDIES - USERS

Denmark

A group of producers in Denmark have joined together to send their wool for processing to Portugal for scouring (2 Euros per kilo) and then to Bradford for spinning and dyeing.

UK

Lesley Wickham is sheep breeder, spinner, knitter, weaver and potter.
She has a flock of 300 sheep which are bred purely to provide the best possible fleeces and sheepskins. She has used Natural Fibre Company, Lampeter services up to this point. She pays around £15-20 per kilo for processing.

India

In India, a number of regional scouring plants are being established in Jammu and Kashmir, Gujaret, Himachal Pradesh, Maharashtra and Karnataka. This is a Government drive to encourage better use of sheep's wool. Expertise in environmental issues is also being provided by Australian wool processors.

CASE STUDY – PROCESSOR

Buckfast Spinning Company

Buckfast Spinning is the third largest scouring plant in the UK, after Chadwicks and Howarths in Yorkshire. It scours wool, spins into yarn and dyes it for carpet production. It has a consent to withdraw water from the River Dart and uses about 18 litres per kilo (including dyeing). The water is filtrated as it enters the plant. Wool purchased from the British Wool Marketing Board and from Ireland. The sludge from scouring is sent 20 miles to EcoSci in Plymouth for composting with local authority collection waste. The water waste is sent to the local sewage plant to be treated which costs the business around several hundred thousand pounds per year.

Their technical manager suggests that even if farmers waited 12 months between treating sheep with SPs and sending the wool for scouring, a large amount of SPs would still remain in the wool. The plant sends waste for testing at the National Laboratory Service (Environment Agency) and a suite of tests costs about £180. The Environment Agency takes an overall view of the situation as tests results, in line with changing conditions at the plant, can vary. Buckfast is looking at a joint venture with an effluent treatment plant manufacturer to update its waste treatment at great expense.

11. FEASIBILITY - CONCLUSIONS

11.1 The cost of setting up a commercial operation without grant funding is not feasible because of the start-up capital required to fund the building and equipment. For example Sue Blacker who has bought the NFC processing equipment to be re-established in Cornwall has gained Objective 1 funding.

11.2 Cheapest option

11.2.1 The cheapest option for producers in Wales would be to join together as a co-operative and send wool (although you would not get your own wool back) to Portugal, the Czech Republic or Italy to be scoured then to one of the finishing plants in the UK. This option has significant problems in terms of environmental impact eg wool miles.

11.3 New scouring plant

11.3.1 It would be economic for a new scouring plant to be established in Powys (perhaps Newtown where there is a licence agreement and a suitably advanced sewage treatment works) as long as the start-up and capital costs could be funded by grants.

11.3.2 Also, in order to develop markets, it would be worth offering a one-stop shop to do the entire processing, spinning and finishing of the products. There is a dearth of finishers in the UK, particularly to a decent blanket width, so any new facility might want to consider offering this service.

11.3.3 The Canesis equipment option could be considered because of the medium sized scale of the plant. The mini-mills do not offer the capacity to generate enough income unless two units were installed alongside each other which could be operated together by one team of staff. Trials would be needed to resolve the waste aspect for both options.

11. 6 Environmental impact

11.6.1 The Soil Association is considering a recommendation that no fleeces be sent for wool processing unless there is a gap of 12 months since SP treatment. This would be part of their standards for organic wool. This type of arrangement would be helpful to any new plant in order to reduce the amount of SPs in the cleaning water. Also there are currently ideas about the use of biochemistry to solve the SP problem.

11.6.11 Any new processing facility would need to produce a set of agreements to be signed by users which would guarantee withdrawal periods for SP/OPs. In addition, an educational pack would need to be developed in order to encourage producers to provide wool that is as clean and suitable for processing as possible.

11.7 Energy/production costs

11.7.1 With gas and electricity prices anticipated to rise at a rate greater than the level of inflation, any operator would need to carefully assess any plant and equipment in order to install equipment which minimises/reduces that cost.

11.7.2 Commercial water costs are now around £1 per cu litre and with scouring taking at least 5 cu litres per kilo any site which has consent to pump water from a river/water course/private borehole is going to be preferable.

11.8 Cost-effectiveness and added value

11.8.1 Cost-effectiveness can be best met by:

- Reducing the cost of processing by ensuring suitable, clean, chemical-free fleece is provided by producers
- Start-up capital grant funding can be secured to purchase plant and equipment
- The operator works in partnership with others in recycling waste products and to meet legal, environmental standards.
- Suitable staff who have mechanical and wool handling experience are recruited.
- Ensuring as large a run as possible to prevent lost time between batches and ensuring a pricing structure to reflect this ie higher cost per small units.
- Machinery can be run to capacity for as long as possible (ie sweating assets).
- It may be cost effective to provide a processing plant in Wales without scouring (as scouring has a negative environmental impact) if a suitable – and reasonably priced - scouring facility in the UK or abroad were to be identified.

11.8.2 Added value can be best met by providing

- Services to those users who are have markets that command higher prices (eg finer wools and other fibres such as alpaca). Mass-produced products such as insulation, where there is likely to be great pressure to keep down costs to ensure a competitively priced end-product, are unlikely to provide enough profit unless there is sufficient, regular, volume to in-fill between better value throughput.

- A range of finishing services which can help add value to the processed wool.

- A system providing full traceability and identifiable/recorded processing stages for the fibre will be beneficial for those higher value products which require transparency and integrity of production by manufacturers and purchasers.

NB This scouring study is the intellectual property right of Mitchell Associates Ltd. The study was commissioned by Glasu. It should not be quoted or used without Glasu and the author's written consent.

The author can take no responsibility or liability for advice or information provided by third parties or any omissions or inaccuracies in this document. Anyone using this document for commercial purposes (with the permission of those mentioned above) should carry out their own research as information, legislation and best practices are constantly changing.

12. ACKOWLEDGEMENTS

Michael and Celia Berry, Norweft, Denbigh

Sue Blacker, Natural Fibre Company, Cornwall

Andrew Duffield, Buckfast Spinning Company, Devon

Chris King, Garthenor Organic Wools

Wool Producers of Wales

Ian Hartley, British Wool Marketing Board

Neil Howard, WEFO

Environment Agency

Myra Mortlock

Dr Barbara McLean, ADAS, Pwllpeirian, Aberystwyth

Joyce Pitts

Richard Poole, British Wool Marketing Board

Dr Robert Finch and John Fox, Canesis

Lee Price, Glasu

Lesley Wickham

Natural Fibre Company

Severn Trent Water

Welsh Water

13. REFERENCES

All-Sheep Directory, Glasu, 2004-2005.

ADAS, The Fine Wool Project Fact Sheet, July 2005

Centre for Organic Waste Management, Perth Australia (2005) Biological Treatment Processes.

Dale Dr NL (2004), Plastic Media for Water Filtration Units
Department of Agriculture, Government of Western Australia, 2002 "Wool residues – market, environmental and occupational health issues" (Evans)

Department of Primary Industries and Fisheries, Queensland Government, "Quick guide to commonly used treatments for blowflies and lice", August 2005

Department of Primary Industries, Water and Environment, Tasmania "Reducing Pesticide Residues in Wool" (2005).

Department of Trade and Industry, UK "Biowise Demonstrator Projects" 2005

Environment Agency for England and Wales, Scottish Environment Protection Agency (SEPA) and the Northern Ireland Environment and Heritage Service (NIEHS), 2005, PPC: UK Technical Guidance: S6.05: Guidance for the Textile Sector (guidance for delivering the PPC (IPPC) Regulations in the Textile sector based on the BAT reference document BREF produced by the EC Commission).

Government of Western Australia, Dept of Agriculture. Farmnote (No 30/2002) Wool residues – market, environmental and occupational helath issues. Evans and Karlsson.

European Commission (2003), Integrated Pollution Prevention and Control (IPPC), Reference Document on Best Available Techniques for the Textiles Industry

Glasu, The Powys All Sheep Project, Mitchell H, Pitts J 2003

Natural Fibre Company/Sue Blacker, Market Research Wool Processing Wales/S. West Spring 2005

Pesticide News New Restrictions on Wool Production, 1997.

Poole, AJ (2004), Treatment of biorefractory organic compounds in wool scour effluent by hydroxyl radical oxidation, *Water Research* 38, 3458-3464

Wool Manufacturers Journal, June 1996 Effects of organophosphate pesticide residues on wool textile manufacturers

www.andar.co.nz (Environmental loop for waste water treatment and composting system).

www.gwsr.com (Gilbourn Wool Scour)

www.tumpline.com (British Sheep Breeders Societies and Association)

www.nationalsheep.org.uk

www.rare-breeds.com (Rare Breeds Survival Trust)

www.sheepdairying.com

www.bcsb.com (British Coloured Sheep Breeders Association)

www.blueleicester.co.uk

www.spinnersweaversanddyers.com

www.cil-groupcom

www.britishwool.org.uk

http://agsprv38.agric.wa.gov.au

http://www.autexrj.org/no3-2004

www.biowise.org.uk (anaerobic digester trial)

http//cowm.murdoch.ed.au/expertise/biologicalhtm

www.ccsa.asb.au/esa/wool.htm

www.gwsr.com.au (Gilbourn Wool Scour)

scouringreportv3.doc