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Genomic technologies to create new opportunities for wool growers

Introductory remarks

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The New Zealand wool grower has faced major challenges since the middle of the 20th century, driven largely through competition from synthetic fibres. For some farmers, the long-term downward trend in wool values has resulted in a wool cheque that now barely covers costs of production. Nevertheless, the many positive attributes of wool compared to synthetic alternatives have sustained an industry with a turnover still in excess of \$1 billion per annum.

The challenge to science is to assist in the re-vitalisation of the industry into a long term future. One avenue for industry transformation is through the application of genomics - our understanding of the DNA sequences that specify living organisms. Functional genomics is the study of genes and expressed proteins focused on the identification of specific biochemical roles in tissue and organ function. Over the last decade there has been an explosion in knowledge of mammalian genetic sequences, their inheritance, regulation and function that direct the growth, development and behaviour of all mammalian organs including hair follicles. Hence the leveraging of progress in human and agricultural genomics for applications that benefit the wool industry represents a major opportunity.

For example, the wool industry would be boosted by the development of new sheep

genotypes with increased wool growth productivity while also producing wool types with increased value suited to new markets. Production costs, especially wool harvesting, need to be significantly reduced. Animal health and welfare issues relevant to the New Zealand sheep farmer must also be addressed. The application of genomic technologies could contribute to achieving industry goals in all these areas. Examples of such technologies are described in the following contract session, including opportunities arising from the development of novel biomaterials derived from wool.

While innovations arising from research and development are essential to improving the fortunes of the wool industry, research uptake can be limited by existing processing and marketing channels. In several papers, current value chains in the wool industry are described and the requirement for new mechanisms that better link niche wool markets with producers are identified.

An important objective of the papers in this session is to encourage dialogue between scientists, farmers, processors and marketers on the key issues facing the sector. From these discussions, priority targets and the technical means to achieve them will drive the deployment of the limited R&D resources of industry and government. But, undoubtedly, opportunities are there to be seized.

Options for change within the wool supply chain

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ABSTRACT

Supply chains are the channels along which products flow from producer to processors and manufacturers, distributors and retailers until final consumers purchase them. The businesses along the chain are linked through the transactions between them and the information that they share. Wool is an inherently variable product that cannot be adapted quickly to changes in processor's requirements. As such it is a weak competitor in a section of the global textile marketplace dominated by synthetic textiles derived from petrochemicals. Nevertheless, wool has unique functional advantages over most synthetic fibres. Efficient supply chains are dependent on effective relationships between stakeholders. Reduction of costs incurred along the supply chain requires investment in horizontal and/or vertical relationships to improve information

transfer between stakeholders, or to benefit from economies of scale and/or scope. Improved information transfer strengthens stakeholder confidence enabling the development of innovative business initiatives.

Keywords: wool; supply chain; investments; relationships.

INTRODUCTION

Supply chains are the channels along which products flow from producer to processors and manufacturers, distributors and retailers until final consumers purchase them. The businesses along the chain are linked through the transactions between them and the information that they share. The focus of each business is on fulfilling the needs of their customer and their own operation.

Wool competes in a highly competitive section of the global textile marketplace dominated by synthetic textiles derived from petrochemicals. In general, wool is competing poorly in this difficult marketplace. Wool has unique attributes not matched by other fibre types. Unfortunately, wool is an inherently variable product that is more expensive to process into final products than highly specified synthetic fibres. It is harvested only once or twice a year on a seasonal basis. There is no measure of how climate and management has affected the fibre (Kendall *et al.*, 2006) until after it has been sampled and measured close to harvesting or at harvesting. Further, breeding decisions, which largely determine fibre characteristics, continue their influence within the flock for at least five years while selected female sheep remain in use for breeding. Nevertheless, wool has unique functional advantages over synthetic textiles. It has a low flammability; does not dissolve; is comfortable to wear in that it does not build up an electric charge; and is a good insulator even when wet. This review will consider the structure of the wool supply chain and opportunities for change within the chain.

STRUCTURE OF WOOL SUPPLY CHAIN

In 2000 wool represented 2.5% of global textile use, down from almost 10% in 1960 (AWI, 2006). Demand for wool is declining with on-farm costs increasing (Meat & Wool New Zealand Economic Service, 2003). Costs being incurred by firms along the supply chain are also increasing, squeezing their profit margins. However, the wool industry is still a significant contributor to New Zealand's export earnings, and as lamb prices decline from the recent highs of the early 2000s (Sumner & Davison, 2006), sheep farmers may again focus on the potential of wool (see Table 1).

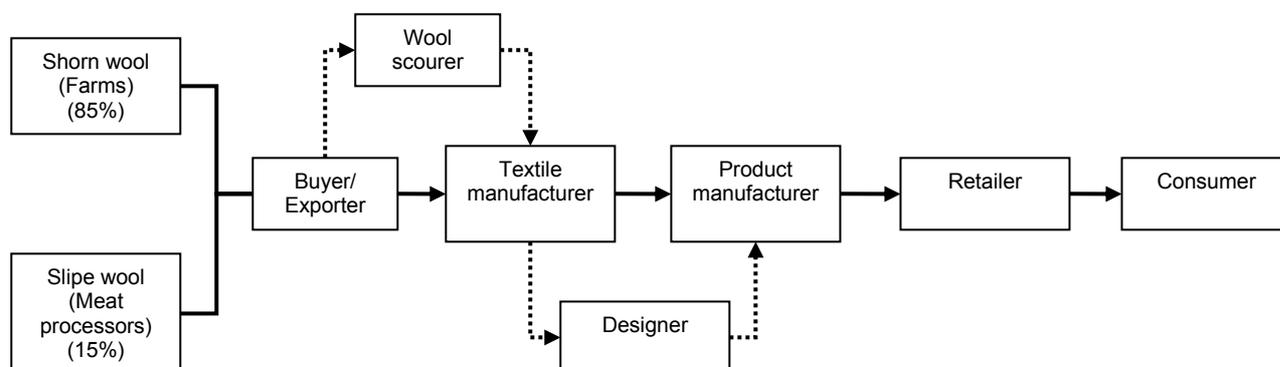
TABLE 1: Weighted average across all classes of farm in the Meat and Wool New Zealand Sheep and Beef Farm Survey for the returns per effective hectare derived from the sale of wool and its proportion of total farm income, and New Zealand's export earnings from wool and its proportion of New Zealand's total export earnings. Source: Meat and Wool New Zealand.

| Year (July 1 to June 30) | Average gross wool income/ha (% of gross income/ha) | NZ "free on board" export earnings from wool (% total NZ export earnings) |
|--------------------------------|---|--|
| 1974/75 | \$20 (35%) | \$262m (17%) |
| 1979/80 | \$64 (42%) | \$942m (19%) |
| 1984/85 | \$96 (35%) | \$1,475m (13%) |
| 1989/90 | \$105 (36%) | \$1,316m (9%) |
| 1994/95 | \$85 (29%) | \$1,253m (6%) |
| 1999/00 | \$68 (17%) | \$801m (3%) |
| 2004/05 | \$77 (15%) | \$972m (3%) |

The principal end-uses of wool have traditionally been apparels and interior furnishings where attributes of the raw wool affect the quality of the final product. To produce these products, wool flows along a long and sometimes torturous supply chain. Figure 1 shows this supply chain in a simplified form. The actual price paid for a parcel of wool as it moves through this chain is dependent on a number of factors, with the premiums for variations in fibre attributes often hidden by market forces such as exchange rates and the cost of competing fibres. Transactions are the main link between the businesses along the wool supply chain with information and market signals only shared amongst those firms close to each other and no understanding of issues pertaining to other firms further along the chain. For example, designers and owners of fashion labels care little for production and breeding constraints back on farms.

Most of the processes used in the wool industry have remained unchanged over a long period of time. With no major breakthroughs in processing technology in recent years the industry tends to be one where participants react to cost drivers rather than market-based value drivers. A consequence of this declining demand for wool has been overcapacity in the high-cost labour markets in Western countries where wool processing facilities have been traditionally located. In an attempt to stimulate demand through lowering prices, processing firms have relocated to the low-cost labour markets in Asia.

FIGURE 1: Current wool supply chain. Note: Solid arrows illustrate wool ownership; dashed arrows illustrate product flow without ownership. Several firms may be involved at each stage, and firms may be involved at more than one stage.



To be competitive, processors in the middle of the chain endeavour to control the behaviour of their suppliers and buyers by owning a large share of the inventory in the wool supply chain. This position has evolved from their perceived need to operate their plants at maximum economies of scale for 24 hours per day, seven days a week with adequate supplies of raw material available at the least possible cost.

This behaviour destroys many diverse and different characteristics of wool produced by individual wool growers as clips are blended to achieve processing specifications at lowest cost. Processing and end-use requirements determine the relative importance of blending parameters. For example, low crimp fibres are desirable for traditional handcrafted carpet yarns, while high crimp is important for tufted carpets. The long time required to achieve change in raw wool characteristics means that blending, within and between seasons and years, remains the most efficient method of providing continuity of wool “types”. Thus wool types that can fit many processing routes and end-uses provide increased flexibility to the processor. In contrast to this, the upstream customers seek to create diverse and differentiated products for the consumer!

Due to price competition, the processors in the middle of the chain trade away the incremental benefits from improvements in grower productivity, technology and promotion or innovation aimed at enhancing the consumer proposition. Similarly, whilst it is tempting to

assume that successful entry into higher value markets translate into improved grower returns, such price premiums are normally relatively short-lived because of the commoditisation of the subsequent products. As the products become successful, the focus of the processors and manufacturers quickly becomes cost reduction.

For example, high-end tramping socks involve much innovation through the processing stages and require relatively tightly specified wool. At a retail price of \$35/pair, woolgrowers receive less than 1.5% of the final product price (see Figure 2). Compare that to a relatively “unsophisticated” square metre of carpet selling for about \$95. The woolgrower receives about 4% of the final product price (see Figure 3). A further comparison can be made to Loro Piana suits that retail for \$1,200, of which the woolgrower receives about 0.8% (Figure 4). It is difficult to say which of these products is more reliant on specific fibre attributes delivered by growers. These examples demonstrate that high-end products do not always translate into growers receiving a higher proportion of the final return. Indeed, there is no reason why it should, when technical innovation beyond the farm gate provides the ability to produce these new products. The exception is where grower levies have funded the development. Even though the share of profit retained by wool growers from high value products is smaller, they receive a higher absolute return such as with protein extraction technologies (Sumner & Davison, 2006).

FIGURE 2: Prices received per pair of technical socks (120 g of wool fibre). Top of bar represents price received and bottom of bar represents price paid. Adapted from Insights Consulting (2005).

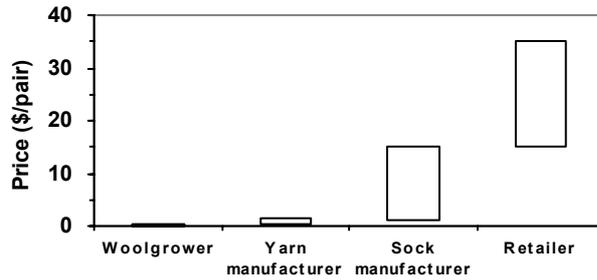


FIGURE 3: Prices received per square metre of carpet. Top of bar represents price received and bottom of bar represents price paid. Adapted from Insights Consulting (2005).

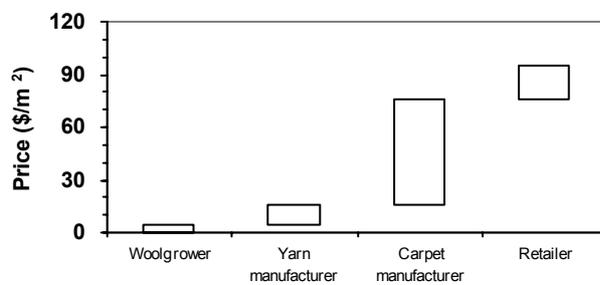
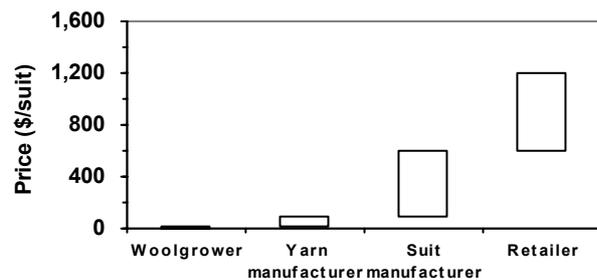


FIGURE 4: Prices received per suit (200 g of wool fibre). Top of bar represents price received and bottom of bar represents price paid.



Although drawn from different sectors, namely hosiery, interior textiles and apparel, another interesting feature of these three examples is the relative share of retail price received by the manufacturers and retailers. For socks, the retailer typically receives 57% of the final price while the manufacturer receives 40%. For carpet, the retailer receives 20% of the final price to cover their costs and earn a profit while the manufacturer receives 63%. For Loro Piana suits, the retailer and suit manufacturer typically receive 91% between them. These differences provide insights into the locus of

power within the chain, where the most valuable assets lie and the level of competition within the sector. The low margin earned by the retailer on carpets suggests the market is highly competitive with consumers spoilt for choice, fashion plays a role, and the most costly stages along the supply chain are in manufacturing. Other challenges facing the carpet market are that buying decisions are made once every 15-20 years and the total price tends to be thousands rather than tens of dollars, so price becomes a very real issue. In contrast, the high margin earned by the sock retailer suggests the market is not highly competitive and is servicing a consumer base with large disposable incomes. Branding, lifestyle and fashion play a key role in the behaviour of the suit and sock consumers.

SUPPLY CHAIN INVESTMENT OPTIONS

For wool to remain relevant to the consumer and for the textile industry to consider it a commercially viable fibre, woolgrowers must:

- understand that their business is fiercely competitive;
- accept that they contribute to a complex global processing, marketing and distribution network;
- adopt innovations that are the focus of the subsequent papers in this contract; and
- be prepared to change their supply chain arrangements.

Woolgrowers are not the only businesses in the wool industry that must change their expectations to create a high-value future for wool. Fortunately, there is a range of options for achieving change within the various sectors of the wool industry. Some of these would suit small-scale supply chains while others might suit much larger sectors of the industry. Further, these different options would have quite different levels of impact on national wool receipts and the average price received by growers. A few small chains may achieve high prices for their stakeholders, but have very little overall impact on the national situation while small price changes across the commodity sectors would have a significant national affect.

Change in behaviour by the various businesses along the chain is central to all of these options. First, we must consider the key supply chain strategy and investment decisions stakeholders make. Assuming the overall goal of most businesses is to grow equity by maximising net return within an acceptable level of risk, there are two critical investment decisions.

The first decision is deciding what product the customer wants. Is it a differentiated/niche product or is it a commodity product? This decision is based on the demand perceived for the product; whether the demand can be grown, or created if it does not yet exist; how much customers will be prepared to pay for the product and will its production be profitable?

The second decision is which route to market to use. Is complete ownership and investment in physical resources along the supply chain appropriate; or is investment in relationships with other stakeholders to take the product to market better; or is selling it to another stakeholder for them to take it to market to enable further investment in existing activities, more suitable? These choices are expanded below.

The investment choice depends on expectations of return and risk associated with each option. Provided the other stakeholders in a supply chain are willing, four investment choices exist:

- physical resources within the supply chain to expand the scale of the current activities;
- physical resources within the supply chain to expand the scope of activities through vertical integration;
- horizontal relationships by co-operating with stakeholders undertaking the same activities in the supply chain to increase scale; and
- vertical relationships by co-operating with stakeholders undertaking other activities in the supply chain.

These choices are not mutually exclusive as numerous supply chain structures are possible. Similar choices exist for each stakeholder at any stage along the supply chain.

The key differences between various supply chain structures are the nature of the risks involved, the communication that is required, and the type of product they are suited to deliver. The impact of the risks and communication relies entirely on the relationships between stakeholders. If the appropriate communication does not occur, the supply chain will also fail.

INVESTING IN PHYSICAL RESOURCES TO EXPAND SCALE

Growers could expand the supply base of specific wool types by breeding appropriate wool fibre characteristics into commercial flocks to support the intended consumer value proposition or end-use. These end-uses could be completely different to the traditional uses. This option

provides growers an opportunity to stake a claim for a higher price because they will have provided the very characteristics required to produce exactly what the consumer wants. The most significant improvements that could be made to wool to fit the apparel market would be improved softness. The carpet market requires colour stability and durability.

On the grounds of animal welfare and production costs, woolgrowers need to farm genotypes suited to the environments in which they farm. This creates a trade-off between wool and lamb production with the associated risks. Changing genotypes also has costs related to the speed of the change. Fashion, which operates on a seasonal time scale, will change. A related risk is that too many growers may change and create an oversupply of a particular type as recently happened with superfine wool, or conversely, too few growers may change as has happened with the development of high wool bulk sheep where a viable supply chain could not be established.

INVESTING IN PHYSICAL RESOURCES TO EXPAND SCOPE

Much is often said about the length of the supply chain and the need for producers to own and or control more of the supply chain to capture a greater share of the final price. Wool processing assets are large, lumpy investments with high operating expenses and low rates of return. It is therefore virtually impossible, and probably not feasible, for woolgrowers to integrate forward into wool processing, even in a collective manner. However, it may be possible for some niche growers to retain control of their product by contracting processing and then co-ordinating manufacturing, distribution and retailing stages, such as Stansborough Fibres. It is unlikely that processors or manufacturers would want to integrate backwards into wool production because of the large capital costs involved, their lack of knowledge of farming systems, and the natural variation in wool would not guarantee that they could produce wool with the desired characteristics. The performance of New Zealand's wool industry is thus unlikely to benefit from vertical integration through ownership.

INVESTING IN HORIZONTAL RELATIONSHIPS

Woolgrowers could obtain critical mass at the production stage by co-ordinating to supply wool of certain specifications at times and in volumes that processors require, thus, making it

easier for exporters or processors to manage batches of product. Such producer co-operatives like The Drysdale Carpet Wool Co-operative are not without their difficulties. Is the entire clip supplied or only specific types, and if so, how are off-types sold? What happens when the auction market pays more than the contractual agreement or when climatic conditions cause changes in specification of the wool produced? As with any co-operative, governance, the contribution of capital and the share of profits are key concerns for members. Woolgrowers typically also want to retain flexibility to choose the best price at the point of sale of their wool. Investing in a horizontal relationship has only limited scope to improve the performance of the wool industry in New Zealand.

INVESTING IN VERTICAL RELATIONSHIPS

Reducing raw material costs will always be a focus within the textile industry. Therefore, the most satisfactory and persistent way for woolgrowers to earn higher prices will be through relationships with the customer and businesses along the supply chain, including exporters, manufacturers, designers and retailers such as Merino New Zealand, The Escorial Company and Saxmere Limited. These vertical relationships are an investment, but unlike a change in genotype, are intangible. The earning potential of intangible assets is frequently much higher than that of tangible assets because they provide market feedback and insights, thereby helping to reduce volatility and uncertainty. These relationships may also require some form of capital contribution to capture improved returns in a way that is not necessarily reliant on raw material price premiums, but on the pursuit of niche business opportunities.

Product attributes such as differentiation, traceability, and having visual quality, influence the uncertainty of transactions between stakeholders and therefore the “ideal” supply chain structure. Williamson (1979) suggests this can be due to changes in:

- transaction frequency,
- need to invest in specific resources such as processing plants or market relationships, and
- inability to relate activities to final outcomes such as sorting wool on-farm after shearing.

For a commodity such as carpet tiles, spot market relationships or vertical integration would

be appropriate structures because of low uncertainty, high turnover, low margin potential, with a focus on efficiency and cost of production. For a novel or differentiated product, such as one closely aligned to ever-changing fashion like suits, furniture throws or floor rugs, uncertainty may be high, turnover may be low and even discontinuous, and margin potential is high. Therefore, the focus is on rapid delivery of product to satisfy or exceed consumer expectations and to respond to changing consumer requirements. Co-operative relationships may provide the most appropriate means of delivering differentiated products (Fisher, 1997; Miller & Palmer, 2001). Forming closer and open relationships along the supply chain seems crucial to improving the performance of New Zealand’s wool industry.

INVESTING IN OTHER INTANGIBLE ASSETS

On-farm quality assurance programmes such as Fernmark, have been and could be, developed to ensure that the differentiated lines of wool have the correct specifications for efficient processing. Significant measurement problems persist in combining small lots of wool into large processing batches. Differentiating fibre types at shearing is expensive because it requires labour. Current measurement technologies, while faster than yesteryear, cannot match the speed at which sheep are shorn, hence sorting of wool at shearing continues to be based on subjective assessments.

Identifying unique attributes of the product or the source of the raw material such as traceability, sustainability, being environmentally friendly or derived from a unique genotype, can be used to create brands. One problem for New Zealand woolgrowers is that the global rationalisation of the wool industry has resulted in the loss of the important infrastructure in New Zealand’s own industry. Wool is increasingly processed offshore with a loss of ownership and control. Continued loss of processing capability may ultimately result in the loss of propositions based on “New Zealand” brand values.

Branding that links the raw material and product interfaces may delay the inevitable decay in raw material prices. The drive to achieve manufacturing efficiencies is tremendously powerful. No commercial organisation will remain comfortable, let alone thrive, in an environment where they are at a production cost disadvantage to their peers with respect to their raw material supply.

SUMMARY

The wool textile market is supplied by a traditional industry which processes a variable raw product into increasingly highly specified end-products. A declining demand for wool products has resulted in global rationalisation by processors and product substitution by processors and consumers.

Wool processing plants are expensive to purchase and operate, and only generate low margins. Processing costs may be reduced through use of a less variable raw stock more suited to a specific purpose. Hence, reliance on existing relationships through the middle of the chain will continue to constrain attempts to link differentiated

raw materials to specific consumer propositions. New business models and tightly aligned supply chain relationships are required to support innovative initiatives.

Branding can play a role for part of the clip. Growers can match sheep genotypes to the environment and specific requirements through genetic technologies and breeding strategies. New uses could be found for wool. Regardless of the technological advances, close and open relationships along the supply chain, in which information on specifications, quality and trends is readily communicated, will be crucial for wool to continue to be a viable raw material in the textile industry

SheepGenomics – a trans-Tasman collaboration

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ABSTRACT

SheepGenomics is a major A\$30 million initiative of Meat and Livestock Australia and Australian Wool Innovation Limited supported by 10 leading research organisations in Australia and New Zealand. It aims to discover genes that influence economically important traits in sheep. By using discoveries made within SheepGenomics' research program, sheep producers will be able to start breeding for a wide range of economically important traits with greater confidence than is currently possible. One of the themes in the programme is to improve key aspects of wool quality and focus on genes that regulate follicle formation in the skin of foetal lambs. This paper describes key aspects of the management structure of SheepGenomics, an overview of three of the Subprograms (Muscle, Parasites and Coretech) and a more detailed description of the Wool Subprogram.

Keywords: sheep; genomics; wool; fleece; follicle.

INTRODUCTION

SheepGenomics ("the Program") was initiated in 2003 with the signing of a joint investment agreement committing Australian Wool Innovation Limited (AWI) and Meat and Livestock Australia (MLA) to invest a total of A\$30 million over a 5 year period to June 2008.

Since that time, 10 leading research organisations from Australia and New Zealand have become active participants in the Program bringing a wide range of infrastructure, skills and knowledge to complement the Australian sheep industry's cash investment in the Program.

This paper describes the integrated structure and activities of SheepGenomics with

particular reference to the wool follicle regulation research in the Wool Subprogram.

SHEEPGENOMICS AND AUSTRALASIAN SHEEP INDUSTRY RESEARCH

SheepGenomics' role in the Australian sheep industry is to conduct leading edge gene discovery and function work and commercialise the results of that research for the benefit of the industry. In order to do this, the Program is aligned and interacting with two other key organisations in the Australian sheep research infrastructure, namely Sheep Genetics Australia (SGA) and the Sheep Industry Co-operative Research Centre (CRC).

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