# PART II

# ESTABLISHING A SCIENCE-BASED NATIONAL INNOVATION SYSTEM FOR THE WOOL INDUSTRY: 1930s-1950s

## INTRODUCTION TO PART II

*The call from the producer has never been so urgent nor has the confidence in scientific aid ever been so pronounced.* *Sir David Rivett 1933* [1]

Despite the technological achievements before the 1930s, the wool industry was still confronted with an increasing number of technical and biological problems to solve. As noted in Part I, industry support of scientific research to address these was neither automatic nor generous in the first three decades of this century. Though woolgrowers already had a history of being adaptive and innovative in the management of the woolgrowing enterprise, by 1930, this was counterbalanced by a large measure of conservatism and a form of individualism which shunned the involvement of both governments and scientists. Moreover, during the 1920s the industry was not in a position to commit itself financially nor inclined to philosophically because of its preference for marketing solutions. Building effective research establishments and successful promotional campaigns required a long-term commitment both in terms of continuity of funding, as well as being at a level sufficient to achieve worthwhile outcomes.

The unwillingness to have collective action imposed through a compulsory levy and the languishing of the voluntary research fund meant wool research was underfunded and a clear example of market failure was evident. Although many recognised the opportunities for research were significant, and the threat from synthetic competition real, it was regarded as long-term and unlikely to help their immediate needs. Of much greater appeal for woolgrowers was the prospect of organised marketing or promotion. This reluctance by the wool industry meant the early wool research effort was largely facilitated and financed by the Commonwealth, either through the CSIRO or by creating and supplying the bulk of the finances for the statutory research/promotion organisation. The intention on the part of the Commonwealth was to get the structures going and afterwards encourage woolgrowers to become more involved financially over time as the results flowed. In the case of the states, small landowner pressure and a sentiment that the future lay in intensive land-use, resulted in the state agricultural departments concentrating on assisting the development of horticulture, orchard, and dairying industries. The state departments were the first to be involved with research at a time when the universities were too few, too small and too under-funded to do much. Universities first priority was to concentrate on training people for the other arms of the research and extension infrastructure, although even here they struggled to provide sufficient graduates for many years. After establishment, the CSIRO quickly dominated the wool research area, although mainly at the fundamental and strategic end of the research spectrum.

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[1] Rivett, R., *David Rivett: Fighter for Australian Science*, Rivett, Melbourne, 1972, p.132.

For their part, bringing science into partnership with Australia's most successful rural industry was seen as strategic by the Commonwealth government in the 1920s because, not only did it help woolgrowers, but it had the added broader advantage of furthering Australian science and the scientific ethos for the benefit of the entire community. CSIR understood their future would be dependent upon how successfully they provided the technological underpinnings to improve the productivity of the wool industry. It was during this period that the establishments that were to comprise the wool research industry for the next four decades were first established. The research networks and geographically dispersed innovation system which developed, generated a significant portion of the innovation the industry adopted.

Assisted by international liaisons and grower funding, the minuscule wool research effort grew into a handy, if still somewhat disparate, organisational unit before the second world war intervened. After the second world war, the research institutions virtually started again, but this time they were assisted by much larger investments from woolgrowers and the Commonwealth. Expansion was rapid and in the two decades to 1965 an extensive infrastructure was established. The infrastructure to generate discoveries and disseminate innovations included research facilities replete with trained and experienced scientists many of which came from overseas. For their part, the Departments of Agriculture were beginning to employ extension officers and educational establishments were looking to provide trained scientists attuned to wool industry needs.

The innovations during this period were principally land based and in a couple of instances quite spectacular in their impact. Generally, the level of research carried out was affected by funding constraints and the interruption of war but what was achieved was a considerable start towards laying the foundations for the more detailed and better funded activity that took place after the war.

# Chapter 3

## ESTABLISHING A SCIENCE-BASED WOOL INNOVATION SYSTEM

Prior to the first world war, the wool industry had no dedicated research facilities; there were few scientists tackling wool specific research, and very little training capacity to carry forward or adapt new techniques to Australian conditions. Woolgrowers readily adopted shearing and wool transport innovations, but there was little appreciation of what science could contribute or commitment for funding research. The Commonwealth government wanted to initiate a research infrastructure and culture for the benefits that would be derived and as a way of contributing to the Empire research effort. The first hurdle was to correct the absence of facilities and trained scientists.

Before the Waite Institute and CSIR were formed in 1925 and 1926 respectively, the only ongoing wool production research was that undertaken within the NSW Department of Agriculture. Only with the passing of the wool research legislation in 1936, did wool research receive the sort of financial boost it required. In developing the research capacity, it was therefore fortunate that Australia had close these ties with Britain because that country provided the training ground and a steady supply of eminent research scientists who initiated research programmes and helped build the knowledge base for others to take further. Some ten years elapsed between the setting up of CSIR and the wool industry commitment to funding research through a levy payment. This indicated that in spite of the early and in a few cases significant successes from scientific research, influential woolgrowers had misgivings about funding scientific research on a regular basis The ability of science to assist was acknowledged, R&D was but one option for growers to protect future demand and wool usage. The industry debates centred around whether or not to concentrate on either marketing or promotional activities. Even here views on how best to meet the synthetic threat varied and there was considerable tension between the supporters of various options. The preoccupation was more with the more immediate returns that could be obtained from marketing and promotion. This partly explains the absence of grower-enthusiasm for funding longer-term research.

## 1. EVENTS LEADING TO INDUSTRY FUNDING OF RESEARCH.

*Australian Pastoral Research Trust.*

The support for wool production research reflected the foresight of a few influential growers, and those within the scientific community who were encouraging the industry to dedicate more funds. For example, in June, 1927, a meeting of Graziers Federal Council of Australia (GFC) in Adelaide was informed about Professor Brailsford-Robertson's animal nutrition investigations, and Professor Richardson's pasture mineral-deficiency work at the Waite Agricultural Research Institute, as well as Professor Woodruff's animal disease research. This meeting convinced those present of the economic potential, and they passed a number of resolutions to press for the creation of a voluntary fund to provide the means and facilities for more wool-related research.[2] However, it was over three years before an incorporated body was created. First known as the Australian Pastoral Research Trust Limited (APRT), and administered by a committee comprising WC and NCWSB representatives, it was a company limited by guarantee (a business structure the Australian Wool Testing Authority was to use some fifty years later). It was decided that a voluntary payment of 2/- per bale be used to establish a capital fund of £200,000 (only the income from the capital would be used for research). The research areas nominated for funding were those relating to animal diseases, animal pests and plant problems.

George Aitken, woolgrower, Manager of Dalgety in Melbourne and Chairman of the NCWSB, was the driving force behind establishing the trust. The APRT started collecting money in 1928, but one year later only £39,000 had been received. The then Prime Minister, S.M. Bruce, was disappointed with the grower-response, and suggested in a letter to George Aitken:

> *Would it not be possible for your Annual Conference to persuade the wool-growers of the Commonwealth to contribute at least £20,000 per annum towards organised research work for the benefit of the industry? My Government would be prepared to contribute an equal amount, and possibly a good deal more, through the Council for Scientific and Industrial Research over a period of years, and independently of any provision which the Empire Marketing Board might be induced to make. A united attack would then become possible. Whether your money was raised as interest on a large Trust Fund, or as a regular annual levy of a few pence per bale is a matter for your own consideration....*
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> *It seems to me that the time has come for the industry to define its attitude towards scientific research work. If it shows itself in earnest, it may rest assured that support from the Commonwealth Government will not be lacking or niggardly.*[3]

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[2] CSIR, First Annual Report, 1927, pp. 45-6. The focus was to be on diseases affecting stock; rabbits and other animal pests; edible plant life and harmful plant life. Dr. L. Gillbank, University of Melbourne, provided copies of the early CSIR Annual Reports in 1992.

[3] Letter from Bruce, S.M., to Aitken, G., Melbourne, 14th June, 1929, ANU Archives of Business and Labour, E256/1377.

After this experience with the APRT the Commonwealth was beginning to see that their financial support would be need to ensure the subsequent development of the research system. In the meantime the efforts to collect research monies continued to be disappointing so that by 1930, only around £45,000 had been gathered - well short of the hoped-for £200,000. Many growers were reluctant because those involved with the trust had been vague about how the money was to be spent and financially constrained by the drought that year. Nor had the cause been helped by the refusal of many woolbrokers to collect the levy from sales-accounts (despite George Aitken being the Chairman of the NCWSB). Although the original proposal was not to spend any money until the £200,000 had been collected, with donations coming slowly it was suggested that, despite the shortfall, interest received from capital should be spent on research because this might encourage more donations.

Around the same time as the voluntary trust was being created, the CSIR was experiencing financial difficulties because of the need for capital and recurrent funding in the early years. Fortunately, the Imperial Agricultural Research Conference (held in 1927) had recommended the exchange of research workers and financial support for the fledgling 'colonial' research. To this end, the Empire Marketing Board helped keep the Australian research effort afloat during the depression by offering to contribute to CSIR research up to £3,000 per annum for five years on a '£ for £' basis. The APRT accepted an amount equal to the current income from the capital amount of about £2,000 per annum.[4] In addition to funds for CSIR research, the Trust operated it own facilities, and seconded staff from the CSIR as required. The Waite Institute, between 1928 and 1934, also received annual grants from the Empire Marketing Board and the Carnegie Corporation of New York of £1,875 per year. These interim measures during the depression were welcome but they were not the basis for an ongoing viable research effort. The APRT did not get the support it wanted, especially with low prices during the depression. The timing to set up the Trust was unfortunate, and donations continued to be slow over the next few years.[5]

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[4]CSIR, Fourth Annual Report, 1930, pp. 23-4; Fifth Annual Report, 1931, p. 21; Anon, CSIR, 3 (1930), p. 233.

[5] One of the substantial and ongoing contributors was the Alexander Fraser Memorial Fund, established under the will of Mrs Mary Fraser, which contributed a sum of money each year. (Annual Report, George Aitken Pastoral Research Trust, 1960, ANU Archives of Business and Labour, E256/1413.) In 1935, when the Empire Marketing Board deal ran out, the Commonwealth entered the fray for the first time by undertaking to contribute £2,000 for three years to match the Trust's funding of CSIR. This funding was for work at McMaster Animal Health Laboratory, the Animal Nutrition Laboratory, Adelaide, and at the National Field Station "Gilruth Plains", Cunnamulla, Queensland. With the war, the trust was again unable to press for more contributions, and the funded work was severely disrupted. Nevertheless, some very large isolated donations were received from private estates, and by 1939 the Trust had over £66,000, a level at which it roughly remained for the next twenty-five or so years. By 1939, over £21,000 had been granted towards research out of the Trust. The Commonwealth funding on a dollar-for-dollar basis was extended to September 1941, and meanwhile the APRT was renamed the George Aitken Pastoral Research Trust (GAPRT), after its foundation chairman, in 1940. The Commonwealth continued to contribute towards these early projects, even after the statutory funding arrangements had been created. The Trust's greatest moment was to substantially assist the funding of work on myxomatosis at the suggestion of Sir Ian Clunies Ross. Money to conduct trials, and to purchase rabbit enclosures and field caravans was all provided by the Trust, as were

Effectively the Pastoral Trust experience had by 1935 demonstrated that something beyond voluntary approaches had to be established, but the political debate was becoming much even more supportive of promotion or marketing. Research was in danger of remaining marginalized and left to the struggling efforts of the GAPRT. Consideration of wool research was peripheral to the larger and stormy debates over wool marketing and promotion.

Since the First World War and to the year 1936, all plans for 'orderly marketing' had been frustrated by the large and influential woolgrowers. Until the issue was settled, promotion and R&D were embroiled in what was largely an unproductive debate. Continued disaffection by small growers and sheep/wheat farmers about the lack of industry action with respect to marketing led to further discussions between the GFC, the NCWSB, and the Australian Woolgrowers' Council (WC), the main upshot of which was to do the next best thing and establish a promotion organisation. The support for further R&D was lacking and many argued research was incidental to solving the industry's immediate problems. Divergent views on the issue lead to an ongoing debate during the first six months of 1936. The outcome ensured support for research but only because it was consolidated with other measures - support for research became part of the package the industry would be required to accept if it wanted the promotion levy instituted on a statutory basis.

*The threat from synthetics.*

What first began to bring about a significant change of attitude, and very much guided the nature as well as timing of the postwar research, was the expansion of the synthetic fibre industry and the threat it posed to wool markets. The imperative to meet the synthetic competition was considerable. The synthetic competition and the nature of its technical development became central to wool's fortunes both in the way it responded with promotion and the focus of wool textile research undertaken. Over the course of this century a number of

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follow-up research work and equipment needs during the 1950s. However, by 1960 it had been many years since further contributions had been made to the GAPRT, and in the Chairman's report of that year it was noted:

> *...the Trust, although it cannot now achieve the full objectives of its formation it can and does perform a useful service to our industry; its modest and unspectacular contributions in the research field have had quite important and far-reaching results in the past, and we hope to continue this good work in the future.* Annual Report, George Aitken Pastoral Research Trust, 1960, ANU Archives of Business and Labour, E256/1413.

The AWGC continued to have the responsibility of the Trust and of nominating board members until 1979, when it was handed on to the National Farmers Federation (NFF). At this stage, the number of board members was reduced in recognition of the relatively diminished scale of the funding. By this time, the objective of the Trust had been confined to granting scholarships. (National Farmers Federation Memo to Executive Director, Wool Council of Australia, 23rd Oct. 1979, ANU Archives of Business and Labour, Z266 Box 29 2C2.)

differing fibres and yarns have been created. Whereas natural fibres come from either protein (animal), cellulosic (vegetable) or mineral fibre, technically there are two sets of man-made fibres that are loosely bracketed together and labelled 'synthetic'.[6] The first group of man-made fibres were 'organically' regenerated from natural products such as wood or other protein materials.[7] Viscose rayon, developed by C.F.Cross and E.J. Bevan, was an early cellulosic fibre of this type. The British rights for rayon were bought by Courtaulds Ltd., who then became responsible for most of the ongoing R&D. In particular, it was the market power of the synthetic industry which obliged the industry to act collectively rather than risk fragmenting the limited funds that could be collected within a fund or invested by individuals.

The impact from the synthetic competition was not felt all at once, but rather, came in waves as new fibres or techniques for using synthetic fabrics or yarns were developed and commercialised. For example, a continuous production method was devised by S.W. Barker and J. Nelson in 1934 in Britain, and in 1938 by the Industrial Rayon Corporation in the USA.[8] This allowed large scale and much cheaper production, so that from the mid-1930s the prices of these fibres were becoming extremely competitive with natural fibres. The rapid utilisation of cellulosic worried the wool processing industries because they were witnessing the demise of the silk industry during the 1930s. At this stage of development, cellulosic fibres had properties and uses which were generally very different from those of wool, so the impact on the woollen trade was not as marked as for the cotton or silk industries. The concern was that a technical breakthough would allow synthetics to compete with wool directly. Ian Clunies Ross, (first Chairman of the International Wool Secretariat and research scientist with CSIR) reported the competitive threat as:

> *In the woollen trade the position is rather different. There the fibre (rayon) is still mainly used for blending, and the novelty effects obtainable by its use may broaden the field for fancy worsted costume materials, dress materials and suitings. The whole textile world, however, is watching the staple fibre position very closely and the day when synthetic fibres will tend to oust the natural fibres from any uses may be much nearer than is generally believed.*[9]

Wool markets were affected at this time, but it was difficult to know the extent of the impact from the competition because the severity of the 1930s depression had already limited

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[6] There is some overlap in these divisions, because the regeneration of organic material into a new cellulosic form is a synthetic process.

[7] Protein fibres such as Lanital (Italy), Ardil (U.K.) and Aralac (USA),were not successful and went out of production; others like them took many years to gain a share of the market. Lipson, M., in Barnard, A., *The Simple Fleece*, MUP, 1962, pp. 543-9.

[8] 'Polymers Based on Natural Materials', and 'Textile Manufacture' by Whewell, C.S., both in *A History of Technology*, Williams, T.I., (ed.), Vol.VI The Twentieth Century c.1900 to c.1950 - Part One, Clarendon Press, Oxford, 1978, pp. 649-50.

[9] First report from Ian Clunies Ross as Chairman of the International Wool Secretariat, 26th May ,1936, ANU Archives of Business and Labour, E256/394.

international wool trade and sales. The downturn in international trade in itself fostered the development and production of other textile substitutes. For example, Germany in the early 1930s reduced its consumption of wool from 227 to 127 million pounds, after increasing the production of substitutes from 16,000 tons in 1935 to 90,000 tons in 1937.[10]

The synthetic-fibre market was further expanded by the entry of non-cellulosic fibres which competed directly with wool, and especially cotton. These truly 'synthetic fibres' were 'inorganic', and produced from by-products of petroleum-refining (although they can also be made from coal and gas derivatives). Building on fundamental discoveries made in the 19th century, the chemical industry expanded rapidly during the 1930s and 1940s, making large advances through synthetic fibre research and the development of production techniques. An example of the rapid introduction of synthetic fibres was 'Nylon 66' first discovered in the USA in 1935 by Dr Carothers, working for the Du Pont chemical company, and also later in Germany. The speed of development and commercialisation of this new fibre was spectacular:

> *Production of the polyamide, Nylon 66, began on the 28th October 1938 after almost four years' development work, involving 230 chemists and engineers and costing Du Pont $27M. Nylon stockings appeared in 1939 and 64M pairs were sold in the first year.*[11]

The timing was impeccable because the competition from synthetics was about to expand enormously. The main technical deficiency of synthetic fabrics and yarns that were used in place of wool in the early years was the tendency to shrink irregularly and unpredictably when placed in hot or boiling water. This problem was solved and the consumer acceptance of synthetic fabric was assured around 1939 it was found that before dyeing, the material could be 'heat set' at 180-200 degrees centigrade whilst being held at the appropriate width. Though more expensive than wool in the early years, protection and other government incentives ensured that the production of such fibres soon attained economies of scale and a very significant proportion of the textile market. Events such as the Second World War disruption to the international wool trade, price increases in wool market after the war, and the military requirement for a greater surety of supply provided further incentives to expand synthetic fibre production. An example of this stemming from the inability of the United States to secure cheap wool purchases from Australia during the Korean War saw them introduce or increase wool taxes on imported wools to encourage the rapid expansion of the synthetic industry. Ironically, the US purchases of wool during the 1950 Korean Wool Boom in Australia not only to advantaged the synthetic industry worldwide, but also provided the wool industry with an

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[10] Second AWB Annual Report, 1937, p. 4.
[11] Williams (ed.), loc.cit.

enormous opportunity to invest in new technology and more adequately invest into establishing the wool research industry.

In these circumstances the incentives for the chemical companies encouraged a postwar avalanche of new fibres and fabrics. This was perhaps started by the discovery of polyester in Britain by J.R. Whinfield and J.T. Dickinson in 1941, and first manufactured in the USA by Du Pont in 1949. In 1952, the Chemstrand Corporation introduced polyester under the name 'Acrilan'. Polyester was introduced into the United Kingdom in 1950 by Imperial Chemical Industries (I.C.I.), which by 1955 was using the name 'Terylene'. Du Pont went on developing fibres, and in 1950 it commenced production of an acrylic fibre called 'Orlon' in the USA, and marketed polyester under the name of 'Dacron' in 1954. By 1960, the synthetic fibres comprised four groups: the polyamides ('Nylons'), vinyl and acrylic polymers ('Orlon', 'Dynel', 'Acrilan'), the polyurethanes ('Lycra', 'Vyrene'), and the polyesters ('Terylene', 'Dacron'). At this stage the synthetic share of the textile market was 4%, compared with 66% for cotton, 18% for rayon and 10% for wool. As will be outlined later, the timing of these discoveries and introduction to the marketplace has a significant impact on the wool industry and the timing for significant changes in its structures and modes of operation.

Clearly, the way wool research and promotion activities were established was influenced by the growing market-power the synthetic industry was building. From the outset, synthetic production was highly concentrated and based in Western Europe, the US and Japan, where the large chemical and petrochemical multinational companies were operating. In the US, three-quarters of all man-made fibre sales over the period have been made by four companies, and a similar situation existed in Europe. This aided the construction of large-scale production plants, and enabled very high cost-efficiencies. The sheer scale of the enterprise also created a barrier to entry for newcomers. Capital for plant construction, continued large-scale R&D, and the capacity to fund extensive promotional budgets for the introduction of a new fibre, created an enormous advantage over the comparatively small and generally disorganised natural fibre producers. No woolgrower or wool processor could match this level of market power. The synthetic giants were aggressive marketeers of their product, with large promotions (subsidies of up to 50%), quality assurance, extensive technical services (including loans for machinery and extended credit) and assistance with product presentation for garment makers.

Economies of scale enabled the synthetic fibre industry to provide price stability and continuity of supply, which were very important when competing against the fluctuating markets of natural fibres. They could also sustain periods of loss to gain market share. When combined with tariff barriers and other forms of protection, it was a formidable commercial environment for wool to compete in. There was also little direct price competition between the various

synthetics in the first couple of decades because the strategy was to capture what was possible from the natural fibre markets (mainly cotton), and then secure the large part of new markets as they were opened up.

Extensive research and development continued in the synthetic industry because, as patents expired, new generation fibres would provide another period of market position. Patents also prevented the entry into the textile market of small innovative firms which might have diluted the economic clout of the textile giants. Synthetic fibre promotion expenditures constituted around two per cent of total sales, and R&D was about a similar level. All these factors provided a clear rationale for supporting the introduction of industry-wide R&D and promotion levies. Collective funding meant the wool industry could begin to match the organisational and promotional weight of the man-made fibre industry, restore confidence to processors and buyers, and maintain an active presence in the marketplace. This needed to occur at the producer and processor ends of the wool pipeline although the textile research was initially left to the processing industry in England to organise.

The first reaction to synthetics was the desire to undertake promotion. Realising the competitive pressures were fast approaching and appreciating the need for scientific research, leading politicians of the time argued that more research should be undertaken. Advocating the need for an ongoing, well-funded research effort and knowing the likelihood that woolgrowers would be hard to organise caused Dr Earle Page to call upon the Commonwealth to take the lead and encourage that development. On his overseas travels, he had seen the enormous disparity between the massive investments in substitute fibre research and the low levels of wool research. Visits to Britain and the Torridon wool textile research facility, he had also become acquainted with the uncoordinated and financially difficult position of the international textile research effort. Dr Page was informed that the financial commitment from Australian woolgrowers was about a year behind. Torridon had financial troubles at this stage, and might have shut down, were it not for the cash injection from the IWS. This enabled the proper employment of more staff and the purchase of needed equipment. The IWS also supported work at Leeds University and created a research fellowship at Cambridge University. Later, there were difficulties because of the war, and the fellowship was moved to Torridon. The Commonwealth again asked the wool industry to voluntarily commit itself to funding research on a firm basis. Leading scientists were similarly forthright in their advice. In 1936 Hedley Marston, of the Animal Nutrition Division of the CSIR, argued strongly against the investment in promotion in a letter to a prominent grazier, Sir Frederick Tout:

> *The most secure insurance against such a possibility [being eclipsed by substitutes] is for the wool grower to increase the efficiency of his management and so reduce production costs to a level at which the product will be able to stand a considerable drop in price,*

*which may at some time become necessary to combat the use of substitutes, without disrupting the industry. Level-headed research in all departments of sheep husbandry has already done much towards this and will continue to do so. The graziers should more generally realise this, and support the type of scientific work which bears directly on their own problems before entering into extravagant advertising of doubtful value.*[12]

However, the industry preference for funding wool promotion made it difficult to focus growers on the need for a compulsory R&D levy. The earlier funding arrangements of the Australian Pastoral Research Trust, though a step in the right direction, had by 1936 proved to be an unsatisfactory long-term scheme. For its part, the government wanted to see a levy for both promotion and research and made this a precondition for passing any facilitating legislation for a promotion levy.

For woolgrowers, the downturn of the early thirties made it an inopportune time to suggest a tax be imposed to fund wool research, but by 1936 it had become more economically feasible, and the right moment politically. One justification for funding promotion and R&D was that both South Africa and New Zealand already imposed levies on their own wool exports, and were moving towards a joint effort on wool promotion. Another encouragement for promotion was the example of the advertising campaign launched by tea growers in India, Ceylon and the Netherlands East Indies. The slogan encouraged the public to "Drink More Tea", and was funded by export levies. There was also a campaign in 1936 by the Australian fresh fruit industry (who launched the similarly forthright slogan "EAT MORE FRUIT").[13]

At a joint conference of the Grazier's Federal Council and the Australian Woolgrowers' Council, resolutions were passed calling for the imposition of a compulsory levy under the Federal government's excise powers, and the creation of a statutory body to administer a joint research and promotion fund.[14] The proposal for the compulsory levy was seen as a way of sharing the burden of promotion and research costs equitably, rather than allowing them to fall on relatively few, but the invasion of the private rights of the woolgrower created by the imposition of a compulsory levy was likened by many to 'socialism'. The prospect of government involvement was rejected by many growers and the proposal generated much letter-writing to papers and debate between various farmer groups. Many, including those supporting George Aitken, thought that if it must happen, it would be better for the voluntary fund to receive the statutory research funds and administer them. This did not eventuate, largely because the Australian Pastoral Research Trust would not countenance any involvement

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[12] Letter from H.R. Marston to Sir F. Tout, 20th January, 1936, ANU Archives of Business and Labour, E256/394.

[13] The first slogan for the wool industry was "Wear more wool".

[14] At this stage the Australian Woolgrowers' Council was the only federal organisation of wool growers. In 1939, several of its affiliated associations withdrew and formed another federal body, the Australian Wool and Meat Producers' Federation. The council changed its name in 1960 to Australian Woolgrowers' and Graziers' Council.

with promotional activities. The research side of wool production, the success of the early scientific efforts, especially the prickly pear episode, and the growing recognition of the benefits of topdressing pastures with superphosphate, encouraged growers to accept the research and promotion levy. The determination of the wool leaders to have the promotion levy meant that the package deal had to be taken, which involved a combined promotion and R&D structure.

So in an atmosphere of panic over the spectre of synthetic competition, the industry swallowed its collective pride and accept what many regarded as state coercion.[15]

> *Over the past two or three years, the prospect of substitute materials becoming a danger to wool has become much more insistent and a source of anxiety to all those connected with the industry. I do not wish to assume any particular knowledge of the question or to make any authoritative statement regarding it, but one cannot help feeling that it does constitute a real problem and is worthy of the closest consideration and attention of any representative body of wool men, be they producers or manufacturers. Various methods of attack have, of course, been suggested, but they may probably be summarized under two headings: firstly, to use all the resources of science in perfecting woollen goods in their existing fields and in extending their use to further fields at as low a cost as possible, and, secondly, to use all the arts of propaganda in stimulating the demand for the product. J.A. Lyons PM 1937* [16]

Prime Minister Lyons' speech further highlights the factors which led the industry to accept the Commonwealth's suggestion to fund wool promotion and research via the imposition of an export tax on wool. The involvement of government money was seen as an investment on behalf of future generations of Australians. Australia would remain a supplier nation of agricultural products, so using funds from the current generation of taxpayers to support wool industry related research was seen as legitimate, even though the direct results would mostly be appropriated by privately owned rural enterprises. Expanding the productive capacity of the rural sector, improved the national account results and the spillovers improved the indirect economic development benefits. However, irrespective of the long-term national interest or the prospects for return, the government still had to be accountable for what was in effect a subsidy to an industry that was better placed to look after itself than most other industries. Over the ensuing years, the issues of industry subsidy and the efficiency of the expenditure, generated recurring debates as to what role government could play in facilitating industry structural change and innovative development. Questions of this nature became more persistent from around the mid-1970s. By the 1930s it was clear that if research were to happen at all, government would have to take the lead. Pooling the financial resources of many woolgrowers

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[15] 'Compulsory Wool Levy', *Argus*, Thursday, 30th January, 1936, ANU Archives of Business and Labour, E256/394.

[16] Prime Minister speech after the research and promotion acts had passed through parliament. First AWB Annual Report, 1937, p11.

reduced the market failure associated with long-term research being beyond the funding capacity (or inclination) of either individual growers or companies within Australia.

After the formal requests from grower organisations were received, the Commonwealth passed three related Acts in July of 1936. The *Wool Tax Act , 1936*, imposed a levy of 6d. per bale on all shorn wool produced in Australia; the *Wool Tax Assessment Act, 1936*, outlined arrangements for the collection of the levy and the *Wool Publicity and Research Act, 1936*, established the Australian Wool Board to administer promotion and research expenditures. It could:

> *Make with any authority, association or person any arrangement which, in the opinion of the Board, is likely to be conducive to-*
> *(a) The improvement of the production of wool in Australia; or*
> *(b) The increase and extension, by publicity and research, or any means, of the use of wool throughout the world.*[17]

The division of research responsibilities within Australia and overseas meant:

> *[t]hat in general, biological research be conducted in the dominions and that, in general, technical research be conducted overseas.*[18]

## 2. STATUTORY OVERSIGHT OF WOOL RESEARCH AND DEVELOPMENT.

Thus was established the Australia Wool Board and the first in a series of statutory organisations to look after wool promotion and R&D funds held in trust fund arrangement, as well as supervise the allocation of research monies and the managing of research projects. As with other statutory research organisations in Australia, the organisation was established by law directly under a Commonwealth Minister, rather than the permanent head of an administrative department. This structure conferred a greater degree of autonomy and a quasi-business approach to its operations which suited the wool industry in the 1930s.

Choosing between research proposals will always be difficult, not least because of differing research aspirations of the stakeholders. Society (government) supports research because it values the broader economic payoff; the woolgrower wants to have farm problems solved and to remain viable; and, the scientist who values research for its intrinsic scientific merit and the enhancement of his/her reputation. To help mediate these conflicting objectives and also inject industry perspectives was the function of the statutory funding body. The steady flow of funds into most aspects and levels of wool research since 1936 has meant the concerns and problems

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[17] ibid.
[18] ibid.

of the industry have had a guiding influence on the nature of projects funded and the research/extension facilities provided. It did this by research planning and priority setting, providing the financial allocations, developing human resources, and communicating results through the funding of conferences and journals. What it achieved in the first place was a rapid establishment of the research system and the setting up of structures in which scientists could undertake the tasks the wool industry wanted.

The wool research trust was the first research trust fund created by the Commonwealth government, and in the fifty-five years of its existence, the funding/administrative arrangements have been substantially altered seventeen times.[19] As the wool market fell into serious decline, the administrative structures or the levy amounts were reorganised according to the prevailing preference with respect to government intervention and economic management within government, as well as the capacity of the grower to pay a levy.

*Australian Wool Board 1936/37 to 1944/45*

In the first year of its operation, the Wool Board set about reviewing the current state of research activity and to better coordinate Australian pastoral research it held a conference in Melbourne on January 13th, 1937.[20] At this meeting, the problems of sheep diseases, inadequate nutrition, and the increase of yield and quality of wool were highlighted as the most urgent areas needing research. The AWB called for applications for research funding from researchers and their organisations and by the 2nd of April, 1937, these had been considered, and the first allocation, totalling £22,844, approved. An amount, of £10,000, was set aside to fund the establishment of a sheep research station for CSIR, with the remainder spread between a number of research projects in state departments of agriculture and at universities. The largest grants related to the blowfly pest, animal nutrition, toxaemic jaundice, and parasitology.

Until 1945, all funds in the trust were from growers, and R&D funding was provided in the form of annual grants upon application. Reflecting this use of grower funds only, the Wool Board was given complete discretionary powers, to undertake wool promotion in Australia and overseas, and to execute wool research. All monies collected were held in a combined Wool Publicity and Research Fund, and the balance increased for the first few years because the promotion side was not yet organised. During the wartime period the fund of the AWB went from £114,315 in 1938-39 to £314,719 in 1944-45. The allocation between research and

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[19] The Tobacco Research Trust Fund (1927) predates the wool trust fund, but it was non-statutory. Its research commenced after the offer from the British-Australian Tobacco Company of £50,000 to the Commonwealth. Industry funding continued until 1933; thereafter, the research was fully funded from the Commonwealth Treasury.

[20] First AWB Annual Report, 1937, p7. This was just before the Empire Wool Publicity Conference, 14th to 20th January, 1937.

promotion from consolidated funds was a yearly decision for the Wool Board, but as research was not using all the annual levy collected, no disbursements were made. Promotion expenditures were also curtailed because the establishment of the promotional machinery overseas took some time, and was delayed further by the second world war . The war years were also not conducive to large increases in research expenditure, especially given the fairly modest fixed incomes growers received, and the manpower shortages because scientists were engaged in war-related work. Between 1938-39 to 1944-45, funds required by CSIR for research ranged from £64,500 to £84,000; the contribution from the Wool Board increased from £8,400 to £12,300. It was the activity of the Wool Board and the threats from synthetic competition especially in the years prior to early 1950s that the wool research industry developed. In particular it was the expansion of the CSIR that took centre stage.

*Rural sector expansion and national reconstruction.*

In the postwar period, Commonwealth funding of wool research (and agricultural research generally) ensured that agricultural sector output expanded and contributed positively to national reconstruction. As Australia led the world in the production of apparel wool, with few imports of capital or technology, from a national accounts point of view, the net capital inflow was not far below the gross export income it generated. This was in contrast to manufacturing-based export industries, which needed much overseas capital and equipment to get them started before they could operate efficiently and match the net rural sector contribution. Supporting an industry capable of earning significant amounts of foreign exchange was more important to the long-term capital investment capacity of the nation than whether these might be a justified return on the research investment in the short term from the pastoral sector alone. Increasing the level of external earnings would help balance the national accounts, facilitate diversification, provide the capital for broadening economic development, and generate the growth needed to pay for the imported capital equipment flooding in after the second world war. These wider considerations need to be remembered when weighing up the social return from wool industry research.

With this economic strategy in mind, and the conclusion of the war in sight, in 1944 the Curtin Government reviewed the operation of the 1936 legislation as part of its general review for rebuilding post-war Australia. The competitive threat from synthetic fibres had developed enormously during the course of the war, and although by 1944, of the £71,150 collected through levies, only a small portion was going to the CSIR for research. It was further understood that the income flow for wool research and promotion under the existing arrangement would be grossly inadequate. To upgrade the level of research, a new fund called the Wool Research Trust Account (WRTA) was established, into which the government paid

the equivalent of 2/- for each bale of wool shorn in Australia.[21] The levy on wool exports was also increased to 2/-, but it was only to be used for promotion. This funding division required changes to the Wool Board to narrow its powers and functions to the field of wool promotion. With the passing of the Wool Use Promotion Act, 1945, the authority to sponsor research activities was removed from the Wool Board, and the government assumed full responsibility for the financing and administration of wool research.[22] This reverted to the position advocated by growers before the 1936 Acts. Provision was also made within the 1945 Act for extra research money to be transferred from the promotion fund by the Wool Board, if considered necessary. As it happened, monies collected via the Wool Tax Act were not transferred to the WRTA, either because research expenditures were adequately catered for or promotion funds were fully committed. In this way, the industry could maximise its own outlays as well as the government's.

Whereas the first phase of the statutory involvement was fully funded by the woolgrower and expenditure from the WRDF at the full discretion of a woolgrower controlled statutory organisation, this situation was completely reversed after 1945. Moreover a division of responsibilities and functions was created between the respective research organisations that was in many ways later to haunt the wool ITC structures and be the source of system inefficiency. As a result, the 1945 funding-changes were pivoted to the way institutions and their priorities would develop. The Board concentrated on liaising with the IWS and Australian promotional activities, although it did accept the Commonwealth invitation to be represented on a statutory committee established in 1945 to comment on the annual wool research programme.

The close relationship with government was clearly a bonus but it came at the cost of increased levels of bureaucratic control. The administration of wool R&D was placed in the hands of four ministers, who were in turn advised by an Interdepartmental Committee composed of Federal Department officials, and wool industry representatives presided over by a 'Commonwealth Wool Adviser', who acted as Chairman.[23] All scientific, biological and technical research under

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[21] An incidental levy, also imposed in 1945, was the Wool (Contributory Charge) Assessment Act. It was struck at the rate of 1/8%, to provide money towards administrative expenses in conducting the Wool Disposals Plan operated by the Joint Organisation vested with disposing of stockpiled wools after the World War II. With the successful trading of stockpiled wool, this charge proved unnecessary, and the fund was discontinued on the 1st July, 1952, with the total of £153,000 being transferred into the wool promotion fund.

[22] Why this was done is not clear. Perhaps the government preferred to circulate money through the WRTA as a way of securing the industry commitment to promotion as well as making visible the support it was providing for political reasons. Williams, R., and Evans, G., 'Commonwealth Policy for Rural Research Past and Present: A Review', in *Workshop on the Organisation and Funding of Research for the Rural Industries*, Canberra, 12-13 May 1988, Proceedings No. 4, Bureau of Rural Resources, 1988.

[23] These were the Minister for Commerce and Agriculture, the Treasurer, the Minister for Post-war Reconstruction, and the Minister administering the Science and Industry Research Act. The first Wool Advisor was Mr Frank Murphy who, just prior to his appointment, had retired as Secretary of the Department of Commerce and Agriculture. He held the advisory

the new act became the responsibility of the CSIR, which quickly became the principal research agency conducting wool production and processing matters. Other existing research facilities such as those within the state departments of agriculture and universities, were required to cooperate closely with CSIR but because the legislation did not spell out what this meant, it was clarified by an informal agreement between the various parties late in 1945. Economic research was spurned by CSIR, and left to either the Department of Commerce or the Departments of Agriculture to undertake.

The Federal government became the self-appointed driving force to ensure the research was firmly underway and the CSIR because of its independent charter developed into a key stakeholder within the wool innovation process. To get things moving the Cabinet in 1944 approved an initial amount of £20,000 into the WRTA to enable the preparation of detailed plans, visits of experts from England and key appointments to be made.[24] For its part, the CSIR mobilised itself and its senior staff effectively, and was soon ready to handle the increases in funding that were to follow. CSIR management decided that funding in the first five years would maintain existing programmes, allowing an emphasis on the development of infrastructure and capital equipment expenditures. The money was flowing, but it soon became apparent that even more would be needed. Providence was to play a part in this respect.

*The Wool Industry Fund Act, 1946.*

In 1946, it was decided that unremittable profits that had been generated from wartime wool marketing operations of the Central Wool Committee (via the Wool Realisation Commission) would be set aside in a special fund for industry distribution. This became known as the Wool Industry Fund (WIF) and was created by the Wool Industry Fund Act, 1946. After much discussion over whether the money should be dispersed amongst growers or used to fund a wool marketing plan, research became the beneficiary. The reason for the leftover money was that growers could not be traced, or else the cheques which were sent out were not cashed. There are cases of large cheques being found amongst papers after the death of a woolgrower. It therefore became a tax free donation to R&D. With no particular research project in mind when the money was transferred, expenditure from the Wool Industry Fund (growers' money) was made subject to the control of three federal ministers who acted as trustees. With the creation of this new fund, there were five repositories of wool money: the Wool Use Promotion Fund (WUPF), Wool Research Trust Account (WRTA), Wool (Reserve Prices) Fund (WF),

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position until his death in 1949, when J.G. Crawford (later Sir John Crawford) was appointed. Letter to Sir John Crawford from L.P. Duthie, DPI, Canberra, 6th October 1982. From the Sir John Crawford papers held by Pamela Chapman, Canberra, 1993.

[24] Document prepared for Cabinet meeting on 23 Sept, 1944. Provided by Dr.L. Gillbank, Melbourne University.

Wool (Contributory Charge) Trust Account (WTA) and the Wool Industry Fund (WIF). This made for cumbersome complexity as the relationships and objectives of each fund became confused.[25] For example, when funds became short, the WIF, intended for capital expenses, was used to assist the WRTA's maintenance and ongoing funding commitments. By June, 1951, there was £7,828,120 in the WIF, £153,000 in the WTA, and approximately £4 million in the WF. In the 1950s the Wool (Reserve Prices) Fund was disbursed by paying around £2 million for the wool stores purchased by the British government during the war for storing wool, and the remainder was forwarded to the promotion fund.

## 3. ESTABLISHING INSTITUTIONAL R&D FOR THE WOOL INDUSTRY.

*Growth and restructure of Commonwealth Science and Industrial Research (CSIR).*

With a much higher level of funding from the Commonwealth and the state agencies, the years immediately after the war marked an important growth phase for the wool R&D and extension infrastructure. Research of national importance was the focus for establishing CSIR and wool industry research was a large component of the early research programme. Given the structure of the economy of that stage the flow-ons to other industries were potentially enormous. However, the strategic and scientific focus of CSIR research work caused wool growers to doubt they should fund such research. The disappointing experience of the private funding of research via the APRT inclined them further to think the broader research work should strictly be a matter for national interest and hence government funding. As a consequence, the industry did not accept levy funding commitments (the only way to avoid the free-rider problems associated with the APRT) for nearly ten years after the establishment of CSIR.

It was mainly the economic expansion during the postwar years that permitted an expansion of the entire research, extension and education infrastructure. Not only were the funds coming from the wool research trust larger than before, but the grants to CSIR and the state governments were contributing more to their agricultural research and extension activities. The investment was made to assist Australia's comparative advantage in pastoral industries through local research and thereby increase foreign earnings, and also avoid any dependence that might develop on imported overseas technology. As a result, the character and size of the R&D and extension establishment changed markedly from the struggling and uncoordinated position that existed before the war. Production and biological research was continued and extended by the CSIR, in many cases in conjunction with the state departments of agriculture and the

[25] Letter to J.J. Dedman M.P., from the Chairman of the CSIRO, 6th Sept., 1949, CSIRO Archives, SB4/101/1. The WRTA was principally for non-recurring equipment purchases and ongoing project funding, while the WIF was designated for the purchases of non-recurring fixed assets such as buildings and land.

universities who were both expanding their applied research and basic research capacity respectively. International agencies such as the International Wool Secretariat provided extension and processor information while the selling and promotional generated organisational innovation. In addition, there were a number of supporting governmental agencies and regulation as well as the private sector research and extension activity.

*CSIR.*

The CSIR experienced a metamorphosis both in the size and the scope of the activity undertaken. Whereas before the war it had concentrated on solving the problems of agriculture, the war had necessitated a change in focus to industrial and manufacturing work. From this came the establishment of the National Standards Laboratory, the Aeronautics Laboratory and the Division of Industrial Chemistry. Tensions surrounding the question of maintaining national security led to a breaking up of the organisation in 1949. As a result, the defence, medical, and atomic research components were removed from CSIR and located in separate research organisations.[26] With the restructure in 1949, CSIRO developed into a larger national research organisation with increased government support and financial commitments. The CSIRO acquired its own field stations, or utilised those of the universities or state departments of agriculture in a collaborative way.

A number of wool-related CSIRO centres were established with the direct financial assistance of the WRTF. [27] While the land and infrastructure of the Divisions of Entomology and Plant Industry were paid for out of the CSIR budget, a large part of the research infrastructure was paid for either from contributions either form woolgrower donations or from grants out of the WRTF. Others such as the Division of Animal Nutrition started as a small offshoot of the Waite Institute, situated at the University of Adelaide and were the result of individual donations. While there have been name changes over the years, the divisions of the CSIRO directly and substantially involved with wool research in the postwar era were those of Wool Technology, Animal Production, Animal Health and in research related to all grazing and farming enterprises Plant Industry and Entomology.

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[26] CSIRO staff were also all moved under the Commonwealth Public Service Act for reasons of greater security and financial control.

[27] Textile research facilities were at Belmont in Geelong and at Ryde in Sydney. The pastoral research side facilities the "Ian Clunies Ross" Animal Research Laboratory (57 hectares) at Prospect, Sydney, the complex of research farms in Armidale, NSW: including "Arding" Field Station (325 hectares); "Chiswick" Field Station/Research Laboratory (655 hectares); and "Longford" Field Station (947 hectares). Three other field stations are also still held by the WRDC in 1992 were: the "Falkiner Memorial" Field Station (2499 hectares) in Deniliquin, NSW; the "Glenthorne" Field Station (75 hectares) in O'Halloran Hill, SA, and the "Yalanbee" Experiment Station (840 hectares), at Baker's Hill, WA. *WRDC Annual Report 1991-92*, p.55.

*McMaster Laboratory and Prospect.*

The earliest CSIR facility to be established with woolgrower funds was the McMaster Laboratory at Sydney University. Sir Frederick D. McMaster, a member of the State Committee of the NSW Pastoralists Association, donated £20,000 for the erection of a laboratory in the grounds, for which work started in 1930. It was one of the few private gifts of substance that the CSIRO received. This became the first permanent home of the Division of Animal Health. By 1938, the programme of research was well underway and teams of two or three scientists worked on problems such as fellmongering, the chemistry of wool fibre, wool yield, and the composition of wool wax. Research, was also conducted into fertility problems, coloured fibres and the inheritance of wrinkles in Merinos. One early outcome was to scientifically refute the reasons advanced for breeding with Vermont Merinos. Not only were the Vermont fleece weights and quality proven to be inferior, but the flystrike problems associated with wrinkles and shearing made the whole exercise costly. Ian Clunies Ross worked at McMaster, fostering the animal breeding work, and the Animal Breeding Section also conducted sheep breeding experiments at Cunnamulla. Clunies Ross employed R.B. Kelly to lead the work. Kelly insisted everything be measured, and was responsible for the establishment of CSIRO's Fleece Analysis Laboratory under the leadership of N.F. Roberts. After the review of the industry in 1944, components of the work done at McMaster were transferred into other centres such as Prospect, which allowed the McMaster to focus more on parasitology and genetics.

In 1954, Frederick McMaster made another gift of £54,000 to add a wing to the laboratory in memory of his only son, Captain Ian McMaster, who died in the battle of El Alamein. It was also from the McMaster bequest that the 'Ian McMaster Fellows and Scholars Fund' was set up to finance work at the laboratory.[28] The McMaster laboratory's interest in sheep biology and genetics produced a number of leading researchers who went on to establish many of the schools of genetics in other Australian universities. By the late 1980s, the laboratory had been hemmed-in by the growth of University of Sydney, and in the interests of rationalising research facilities, the decision was made to move the laboratory to the Ian Clunies Ross Animal Research Laboratory.[29] The Prospect research laboratory provided diagnostic support for much of the work conducted in the field stations, the only difference between it and McMaster being the latter's focus on training students. Both facilities were an essential part of the research network, with scientists moving between the laboratories and the field stations.

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[28] Gordon, H.McL., 'CSIR Partnership of Industry and Science', *Historia Medicinae Veterinriae*, 1983, p.62.

[29] Details here from personal interview with Dr. H. McL Gordon, 27th April, 1993, McMaster Laboratory. Dr Gordon, had been at the McMaster since 1931, and had worked with Ian Clunies Ross in the 1930s.

Much of CSIR's laboratory work on sheep disease, parasites, genetic improvement and pasture improvement relied on information and data generated from the experimental flocks located at field stations. Long-term large-scale experiments, were required so properties were acquired or leased. These were located in Cunnamulla (Queensland), Deniliquin, and Armidale (both in New South Wales), "Glenthorne" Field Station at O'Halloran Hill, in SA, and the "Yalanbee" Experiment Station, at Baker's Hill, in Western Australia. In each case, local interest was important in the establishment of the research station.

The Cunnamulla station was created in 1939 after agitation from local pastoralists to the Queensland government. The state made a parcel of land of around 40,000 acres available to CSIR at 'peppercorn rental' and the land was developed with the installation of bores and fencing. The CSIR were then financially assisted in setting up basic infrastructure for the 'National Research Station', by the Wool Board. In the following few years, further funds were invested to develop what became known as 'Gilruth Plains Research Station'. Research work at Gilruth Plains focussed on wool problems such as flystrike (mules operation), pizzle rot, and external and internal parasites. Later, attention turned to breeding programmes, and strain comparisons were made between five Merino types (fine, medium Peppin A and B, medium non-Peppin, and strong), and the blowfly research programme moved to Cunnamulla. In 1942, research at the station was examining the accuracy of sheep-classing by fleece weighing and wool testing, to measure the degree of inefficiency in classing routines.[30] Although such work was valuable, extreme seasonal variation and recurring droughts disrupted the accuracy of measurement of genetic gains within the breeding research programmes. As a result, the lease was not renewed, and in 1967, the research station at Gilruth Plains was closed, with research staff distributed to other locations of the CSIRO, and the merino flock transferred to Chiswick.

A second pastoral research facility was created in the NSW Riverina located between Canargo and Deniliquin, ultimately covering an area of 2400 hectares. Known as the Falkiner Memorial Field Station title was held by the CSIRO, but with a stipulation from its original benefactor (Falkiner who donated 1700 acres in 1944), that if CSIRO should ever wish to relinquish their use of the property, ownership would revert to the wool research organisation. Conducting similar research to other centres, and having fully explored research work on irrigated pastures, the research work at the station dwindled in the early 1980s.[31]

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[30] Riches, J.M., and Turner, H.N., *Australian Journal of Agricultural Resources*, Volume 6, 1955, p.99. J.H. Riches was Officer-In-Charge of the station at this time.

[31] From 1985, the station was leased to the UNSW for breeding work, but in 1993, neither CSIRO nor the WRDC had any further use for it so consideration was given to selling the property.

The field stations on the Northern Tablelands of NSW, were particularly important to wool production research outcomes. The research connection with Armidale extends back to before the Second World War, when research was conducted at the New England University College of the University of Sydney on internal parasites, and the effect of supplementary feeding of oat crops or trials on improving pastures. In the gardener's shed of the historic home "Boolaminbah" CSIRO veterinary scientist Dr. Gordon created an "outpost" of the McMaster Animal Health Laboratory in 1938. The early field work relied on the support of local graziers to provide paddocks and stock to conduct experiments, in an involvement similar to that enjoyed by the Waite Institute.[32] However, to maintain better control over field experiments and achieve scientific conditions of replication and control over pasture management and stock health, meant it would be better for CSIR to have its own field station.[33] It was during a discussion between a CSIRO scientist, Ian Johnstone, and local grazier Colonel F.J. White, that the need for more permanent land-access to conduct grazing experiments was discussed and decided upon. At first it was proposed to lease the necessary land, but with the availability of wool funds, the opportunity to purchase land was afforded. Three properties were purchased: Chiswick and Arding, (purchased together in 1947) and Longford (purchased in 1964). Together they comprised 2811 hectares, and the overall purchase price was around £61,500, mostly from the WIF. WRTA funds were used to supply fencing, water and stock. The 'Chiswick Regional Research Station' was established although the main laboratory facilities were later built on the campus at the University of New England.[34] The Division of Animal Health was also housed at the university (until 1990): the joint facility was known as the 'University of New England Laboratories'. The relationship between the university and the CSIRO fostered positive interaction between staff, although some at the time thought the Laboratories should be built at Chiswick rather than on the university campus.

*Wool processing research and the C.S.I.R.O. Wool Division.*

An important link for the Australian textile research effort was the contact with the British textile research facilities and in particular the relationship with the Wool Industries Research Association. The CSIR did not undertake wool textile research until the late in the 1930's and

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[32] Gillbank, L., "CSIR comes to Armidale", *Armidale and Dumaresq Historical Society Journal,* 1991, p.103. Rotational grazing experiments were conducted at "Gostwyck Station", winter feeding trials at "Cherry Hill" on the western side of Uralla, sheep rugging at "Saumarez", near Armidale, sheep drenches and drenching programmes at "Kentucky Station", "Abington" and others; liver fluke studies were conducted at "Mihi", and blowfly observations at "Salisbury Plains". This high level of cooperation showed the degree of grazier enthusiasm, partly because the scientists stationed at Armidale were from local grazing families.

[33] ibid., p.105.

[34] It was Dr Ian Johnstone who suggested the name "Chiswick", and in 1947 the "Chiswick Regional Research Station" was established from wool funds.

then only informally. In 1930, A.C.D. Rivett the first Chairperson of the CSIR, outlined the international division of labour that would be adopted:

> *No attempt will be made in Australia to touch the manufacturing side of wool work. That belongs to, and as far as we are concerned will be left entirely to, Great Britain.*[35]

By 1937, income flows for WIRA were around £18,000, one half being contributed by the textile industry, and the other half by the British government. Support was flagging at this time and the facility was in danger of closing. At this time WIRA was financially assisted by the newly created IWS, who committed £10,000. This funding continued for many years and given that the IWS was (and still is) predominantly funded by Australian wool growers. WIRA was to a significant extent indirectly funded by growers in Australia for most of the period 1937-1950.[36]

Before the second world war, though better than anything in Australia, the WIRA facilities were not adequate for handling the in-depth exploration of the physics, mechanics or the chemistry involved with wool processing. Immediately after the war, WIRA lost a number of its senior scientists to the synthetics industry, which delayed and disrupted work. This contributed to the willingness of WIRA to receive the flow of highly regarded Australian graduates. Despite the difficulties at WIRA at this stage, two important pieces of work were undertaken. These were the greater understanding of moisture regain in wool and what controls its variation. The other involved the fundamental studies surrounding the chemical composition of wool, which laid the foundation for many subsequent and current finishing processes, developed in Australia and elsewhere. It became apparent that the Australian research needed to be done. It was assumed that the benefits would flow to producers through greater demand and increased prices.

The Wool Division of CSIR was created in response to the Secondary Industries Commission's Textile Advisory Panel report on research needs of the wool textile industry.[37] The report was largely the work of Ian Clunies Ross, and it laid down the justifications for funding the move

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[35] R. Rivett, op.cit., p.116.

[36] In 1950, a statutory levy was imposed on British and Scottish textile manufacturers, and during the fifties WIRA expanded rapidly and constructed a new complex of buildings. The British textile industry increased its own funding arrangements in 1959, and with the establishment of textile research in Australia the income flow from WRTF was redirected to the Australian research. Even so, some funds were still going directly to WIRA well into the 1960s, in addition to any IWS funds so allocated. The IWS funding also continued, though it was reduced to between £1000-3000.

[37] Lipson, M., 'Wool Textile Research - The Early Years', Paper for the *Australian Academy of Science Workshop*, Canberra, August 1982, p.7. The panel in 1944 consisted of G.A. Davis, Director of Clothing and Textiles (Chairman); Sir David Rivett, Chief Executive Officer, CSIR; D.T. Boyd, Chairman, AWB; R.J. Vicars, Controller of Woollens; R.J. Webster, Controller of Cottons; D. Lark, Federal Secretary, Australian Textile Workers' Union. Coopted were I. Clunies Ross, Dean of the Faculty of Rural Science, University of Sydney, and K. Brodribb, woolgrower.

into textile research. It was argued that the U.S.A. was spending £6 million a year on synthetic fibre research, and in the U.K., Courtaulds was spending £2 million, whereas Australia spent only a total of £11,300 on wool textile science to protect the wool industry against its synthetic competitors. On the suggestion of J.B. Speakman, a British textile research expert, the Australian government decided to permit the development of a textile research effort. The CSIR then invited several overseas advisers to visit and report on how this might be done.[38] The consensus was for the establishment of a Wool Research Division within CSIR. Speakman suggested the creation of four distinct laboratories for (a) protein research (b) textile engineering (c) textile technology and (d) wool grease research, with laboratories all on the same site, preferably at Geelong. Some of the recommendations suggested ways of integrating product development, marketing and consumer information, and standards which predicted the directions for textile research and promotion subsequently taken in the twenty or so years that followed.

By entering into wool textile research the imperial link was crucial for providing leading British scientists, well trained graduates, as well as a training ground for Australian scholars.[39] Contact with the British textile research facilities and in particular the relationship with the Wool Industries Research Association fast-tracked the Australian effort. Apart from training for Australian textile researchers the access to research done by WIRA invaluable. Such collaboration accelerated the establishment of the CSIRO textile research programme, which grew as the demise of the British industry occurred, and the scientific research capacity at WIRA faltered. In this way many of the leading scientists working in Australia in the post-1950 period gained their early experience at WIRA and returned to Australia to continue the work. [40] From the mid 1960s the IWS research facility at Ilkley continued as an important link for Australian textile research.

After attempts to find a single director were unsuccessful, Dr F.W.G. White, Deputy Chairman of the CSIRO, formed wool textile research into three divisions. The first was the Division of

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[38] ibid. These were J.B. Speakman, Professor of Textile Technology, Leeds University; A.C. Goodings, Director of Textile Research, Ontario Research Foundation; B.H. Wilsdon, Director of WIRA, Leeds; and F.T. Peirce, Director of Research, School of Textiles, North Carolina State College. Pierce was an Australian who had worked at the Shirley Institute for cotton research in Manchester before going to the USA.

[39] Rivett, op.cit., Chapter Six & p.121.

[40] Lipson, M., 'Wool Textile Research - The Early Years', Paper for the *Australian Academy of Science Workshop*, Canberra, August 1982. In 1946, the Wool Working Party at WIRA recommended replacing the existing makeshift buildings with a new research station. A progressive building plan started, and in 1947 the first buildings were opened by Lord Swinton. The raising of a statutory levy in 1950 (see above) made more funds available, and in 1961 the worsted processing block was opened by the Rt Hon R G Menzies, then Prime Minister of Australia. In 1966, the 'Longfield Block' was opened by Lord Barnby. The centre still had organisational problems, so a consultant was called in in 1967 to reorganize the internal structures. However, the decline of the textile industry in Britain meant a declining income base from which to draw research funds. For many years the income shortfall was made good by government research contracts and by sales of testing equipment, and a research and consultancy operation on water and effluent problems related to scouring. Income in 1977 from testing equipment alone approached £100,000 .

Textile Industry headed by Dr Lipson in Geelong, the Division of Protein Chemistry in Melbourne headed by Dr Lennox, and the Division of Textile Physics in Sydney with Mr. Burgman in charge. Geelong was selected as the administrative centre because of the existence of an active local manufacturing industry and the proximity of the Gordon Institute. To provide facilities, around 1949, the AWB purchased three properties and made them available to CSIR/O: West Ryde in Sydney (The Hermitage), Belmont in Geelong, and Royal Parade, Melbourne (Parkville Laboratories).
The Geelong purchase comprised 15 acres of land in Belmont, and the erection of four ex-army huts began in 1949.[41] Until these were ready, research work commenced in the laboratories of the Gordon Institute. To attract quality scientific staff in the next dozen or so years, the new centre offered a number of studentships overseas, and provided low cost accommodation in Geelong for scientific staff. In this way, good scientists were attracted and it became a feature of the staff development programme that the retention-rate was very high.

The Division of Protein Chemistry, was created in 1947 by taking over the premises occupied by the Central Wool Committee Testing House in Flinders Lane, Melbourne. By 1949, the research team had grown to twelve, which forced a move to larger premises, and in the same year a property in Parkville, Melbourne, was secured and renovations begun. The new laboratory was occupied in 1951-52, and with various extensions and new buildings, protein research continued at the Parkville site until 1991, when the laboratory was moved to a new building at the Geelong location.[42]

In Sydney, the research components for the Division of Textile Physics came together more slowly than the other divisions. Staff involved with wartime testing houses were in one location, whereas others were doing fleece analysis at another centre in the National Standards Laboratory (Division of Animal Health). These cells of research were eventually pulled together and located initially in the Coal Research Section at Ryde and then, during 1951-2, in a property purchased in Ryde. Comprising an old home with space around it for expansion on top of a hill, over time more land was acquired and further buildings erected.

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[41] Personal inteview with M. Lipson, 1993. These first buildings were promptly demolished by a cyclone, and from the wreckage enough was salvaged to erect three again. These went on to serve the facility for many years. The first permanent building was not ready until 1954, so more huts and an 'unofficial' building were constructed in the interim. The Belmont location also became the headquarters of the Wool Divisions.

[42] In the late 1980's space difficulties at the Melbourne Laboratory, and the sharing of wool-funded facilities with the Division of Biotechnology, proved disruptive so in 1989, it was decided to construct a new building at the Belmont site to house the laboratory. The sale of equity in the building in Parkville, Melbourne, paid for the infrastructure development at Belmont. Unfortunately, moving the Melbourne Laboratory to the new seven million dollar facility in Geelong, in 1991, brought about the loss of eighteen of the twenty staff involved with the research.

In 1950, total staff for the three textile divisions was twenty nine.[43] By 1955, expansion was well under way, and research staff had increased to forty-two. The 1950s were productive with many of the significant lines of research begun during this decade. A measure of the enthusiasm was the good reception Australian textile research activity received at the first International Wool Textile Research Conference, held in Australia in 1955.[44] The Wool Divisions either maintained or increased staffing levels until the around mid-seventies, when higher wage costs forced cutbacks, and research programmes and priorities were adjusted. As a result of this infrastructure expansion and new research structure, within a short space of time the CSIRO became a significant player in the world wool research effort, a position it retained, even though the contribution from the higher educational establishments and departments of agriculture also increased proportionally during the 1960s and beyond.

CSIRO's involvement in 1949 into textile research began a long-term commitment. Results could be expected to be slow because of the Australian research system's lack of experience, a factor accentuated by the distance of the research effort from the main processing centres. There was also little indigenous private R&D to build upon or assist. Companies such as Berlei, the Australian Knitting Mills, H.B. Dickie (towels), Holeproof (Prestige), and other overseas firms who had set up in Australia during the interwar period, often to get behind the tariff wall, generally imported their technology and had little incentive to conduct or fund local research.[45]

In the period after the second world war, many of the local wool processors closed down, as reductions in tariff protection during the 1970s and 1980s took effect. As a consequence, the testing ground and commercial contact for Australian researchers was dwindling. However, the separation from large processing centres meant research staff were less likely to be employed by wool processors or the synthetic industries thereby ensuring research staff continuity and the capacity for worldwide dissemination of new technology. Working in such conditions, the CSIRO research link with the IWS was an essential avenue for product information and the IWS provided the mechanism for further developing, testing and then disseminating new textile technology. Australian textile research was tackling lines of research which were too difficult or costly for others and which required long-term approaches.

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[43] Each laboratory was provided with an Officer in Charge, pending the appointment of a Director of Wool Textile Research. In the absence of a suitable person being found to take the directorship, these were later upgraded to Chief of Division status. The three involved were Dr. M.Lipson at Geelong, Mr. V. Burgman, at Ryde, and Dr. F.G. Lennox at Parkville.

[44] Lipson, M., loc.cit.

[45] The level of wool processing was comparatively small. Scoured wool used by mills in Australia went from 40 million lbs before the second world war, to 85 million during the war, and dropped back to 70 million after the war. *Concerning Wool*, AWB, Melbourne, 1951, p.42.

*International Wool Secretariat*

The external link for the Australian wool innovation system was provided by the IWS which, in world terms, was an unusual organisational structure. It was formed after woolgrowers in the southern hemisphere recognised that to promote wool in the northern hemisphere, where most of the markets existed, they needed a specialist non-profit organisation located in the heart of the processing industry and wool markets. In creating an advertising structure to compete against synthetics a large part of the motivation was the strengthening of the Imperial/Empire links.

The setting up of the IWS only occurred after considerable debate during the thirties. The Empire Wool Publicity Conference was convened in Melbourne on 14-20 January, 1937, as the first step in organising international wool publicity. The AWB, the South African Wool Council and New Zealand Wool Publicity Committee, called the new structure the International Wool Publicity and Research Secretariat. The Secretariat was responsible for promoting the wider use of wool throughout the world on behalf of the three boards, but it was agreed that each board should be responsible for promotion (and pastoral research) in its own country. Contributions from member countries to the IWS were pro-rata based on total production levels. Australia's first representative, Dr Ian Clunies Ross, from the McMaster Laboratory in Sydney, was elected as the first IWS Chairman.

*State departments of agriculture.*

It was during this period that the R&D/extension capacity of the state departments expanded and for a while rivalled that of the CSIR or universities. When combined with handling regulatory matters related to product and health control, marketing and commodity transportation, control of noxious weeds, pests and diseases, and environmental management aspects such as soil and water conservation, they were in a strong position to transfer technical knowledge. The research was primarily of an applied nature and concentrated on assisting extension work and adjusting technologies to regional circumstances although states developed particular research expertise.[46] Most departments established veterinary officer positions to conduct and oversee diagnostic and quarantine activities, the misuse of veterinary chemicals and other potentially dangerous substances.

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[46] McDowell, G.H., 'A View on Allocation of Resources for Agricultural Research in Universities' SCA Workshop on Research Priorities and Resource Allocation for Rural R&D, Canberra 2-3 November 1989, *BRR Proceedings No.7*, AGPS, Canberra, pp.78-9.

*Trangie research facility.*

An important example of the kind of research undertaken in state departments was the breeding research work carried out by the New South Wales Department of Agriculture at Trangie in the mid-west of northern New South Wales. Selection experiments for the genetic improvement of sheep and the maintenance of profitability through improved fleece weights and evenness of style were first conducted at Trangie. In the middle 1930s, research at Trangie looked to confirm that sheep with wrinkles had a higher incidence of flystrike.[47] Research using selected groups of Merinos investigated whether it was possible to reduce skin folds while maintaining or increasing fleece weights. Evaluating various means of flystrike control was a significant part of the research programme. Some of the studies over the years looked at comparing jetting and crutching as control methods. An early outcome of this work was disproving the alleged fly-repellent properties of blue colouration around the breach area. The effects of arsenical poisoning to shearers and wool sorters were studied and reported on, as was the effectiveness of B.H.C.'s (benzene hexachloride) as a preventative to poll strike in rams.

In 1943, F H W Morley took over the Trangie research flocks, and from 1945 began to collect detailed measurements of greasy and clean fleece weight, body weight, staple length and crimp frequency, average fibre diameter, body folds on selected lines and compared with a randomly-bred flock.[48] From this data long-term responses to selection were monitored, and the physiology of direct and correlated responses to selection studied. Research at Trangie confirmed the midside-sample site as the best indicator of overall average fibre-diameter. Work here also established the basis for estimates of phenotype and genetic parameters for Merino sheep, as well as establishing measuring techniques for estimating the genetic differences between strains of Merino sheep or the variation within a strain and outlining the implications for selection methods was established.[49] Having collected data on more than ten generations of continuous selection in these flocks they constitute a unique resource for reference and interpretation. The data collected from this period was the foundation for much of the research associated with the development of national performance-recording schemes created during the 1970s and 1980s such as Woolplan and Lambplan and better understanding the effect on commercial processing from characteristics such as yellowness, or yield and the extent to which such qualities are heritable.

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[47] Belschner, H.G., and Carter, H.B., *Australian Veterinary Journal,* April 1943, p.43.

[48] Fibre measurement were made once the laboratory ability first became available in 1945.

[49] Morley, F.H.W., *NSW Department of Agriculture Scientific Bulletin* No.73, 1951, & various articles in the *Australian Journal of Agricultural Resources* between the years 1952 and 1956.

Other research at Trangie included work on dentition and age in sheep, maintenance rations for drought feeding, rate of growth of Merino wool throughout the year, and tests on the rugging of sheep. Trangie has also conducted research into the reproductive capacity of rams and flock fertility, breeding resistance to flystrike and fleece rot, the relationship between fleece rot and fly strike, and the resistance to insecticides of blowflies. Later work evaluated the ways in which changes in environment affect spinning quality of wool, whether sheep would remain in good health without salt, trials of bloodless castration (crytorchids), different methods of tailing lambs, the efficiencies of feed conversion by sheep, and work relating to the inheritance of pigmented fibres in Merino sheep. Apart from animal and genetic work on sheep, pasture research of interest to western lower-rainfall country was conducted at Trangie. These studies included work such as legume research, seed production levels and the effect of insect pollination.

The work at the NSW Department of Agriculture was indicative of what was occurring in sheep areas across Australia in terms of infrastructure development and research activity but on a more modest scale elsewhere. The other DA's had in common efforts to improve land management, pasture improvement, animal breeding, fleece measurement programmes and animal health strategies. Both South Australia and Western Australia have strong traditions of pasture and cultivar research. For example, in the years 1937 to 1947, Wogan Hills Research Station developed for the improvement of 'light lands' with low rainfall of around 12-22 inches, a package of pasture improvement programme which included superphosphate, Dwalganup subterranean clover, trace elements and weed control. It was following this expertise that in the early 1950s, clover-ley systems of farming were developed and introduced into Western Australia. Late in the same decade, the clovers Woogenellup and Geraldton were released for medium rainfall areas. This was followed in the 1960s by the commercial release of the Cyprus strain of Barrel Medic and the pelleting of legume seeds with lime.

*Univerversities - Waite Institute.*

Contributions towards research came universities was not substantial except for some important exceptions such as the Waite Institute and the University of New South Wales. The Waite Institute, was established on the 'Rothamsted' model. It was an early example of institutional cooperation having strong links between University of Adelaide, the State Department of Agriculture in South Australia and the CSIRO.[50] The work conducted at the Waite included soil research, climatology, entomology, agronomy, plant pathology, animal nutrition and physiology, soil maps and soil classification. The specialties of Waite were pasture

[50] Since 1924 the Waite has had four Directors, namely: A.E.V. Richardson (1924-1938), J.A. Prescott (1938-55), J. Melville (1956-73), and J.P. Quirk (1974-).

research including the study of grasses, pedology and mineral deficiencies of soil. Australian research is renowned for its research on ruminants, and the Waite contributed to this through work on ruminant nutritional requirements and the biochemical pathways involved in the nutritional processes of sheep. The CSIRO Division of Animal Nutrition was also created at the Waite which strengthened the pasture soil and plant research effort. It was one of the first Divisions of the CSIR, it had outstanding researchers such as Sir Charles Martin, L. Bull and H.R. Marston, and was accorded academic recognition with the creation of a Chair of Animal Physiology in 1964.[51] In the field of entomology the work at Waite was a forerunner to the CSIR/O Division established in Canberra, and many of the graduates from Waite/University of Adelaide went on to become CSIR/O staff.

*Colleges*

Other tertiary institutions such as colleges of advanced education provided good training, even though they did not have the opportunity to conduct much research. The Gordon Institute in Geelong, Lincoln College in New Zealand, and the Melbourne Institute of Textiles were industry-oriented training centres blending academic training with an industry apprenticeship. They also developed useful research specialties. For example, the Gordon Institute conducted a research programme related to wool measurement and woolclassing from the 1940s, under the guidance of W.R. Lang. The Textile College started in 1945 was an extension of the wool school which had been training wool classers since the beginning of the century. Created to train people in textile matters, it provided a range of courses and developed a number of outstanding technologists before it was incorporated into the Deakin University in the 1970s. Investigating tender wools, style and character, fineness distribution at different points along the fibre, and processing relationships they provided the local textile processing industry with general advice on wool processing and solved milling problems. Other colleges such as Hawkesbury Agricultural College (University of Western Sydney) provided a wide range of farm management training, while Roseworthy did research work on fat lambs, and in the early 1950s, and built a laboratory to do wool testing work.

*Coordinating and regulatory agencies.*

There were a number of support organisations created to assist the innovation system and focus research on national priorities. Those with a more regulatory focus included those with task-specific focus such as the Prickly Pear Board, the Joint Blowfly Committee, the Australian Plague Locust Commission, and forerunners to the Murray Darling Basin Commission. Within

[51] Australian Research Council, *External Review of the Waite Agricultural Research Institute*, Commissioned Report No.3, July 1990, p.8.

these, each state cooperates and provides resources and the organisational liaison as required. For example, although each state is responsible for locust outbreaks confined to its own state, the role of the Australian Plague Locust Commission was to monitor and forecast population movements and control outbreaks which move interstate.

To coordinate the activity in each of the states, the Standing Committee on Agriculture (SCA) and the Australian Agricultural Council (AAC) provided a forum for debating research or extension issues, as well as for negotiating elements of agricultural policy between the states and the Commonwealth. The SCA was first formed in 1927 under the auspices of the CSIR to resolve demarcation/coordination issues between the states who were concerned the CSIR was duplicating the activity they should be funded to perform (the universities were not included) and to discuss issues and problems as they arose. The increasing autonomy of the CSIR lead to the necessity to make the SCA independent also and with increased powers. The SCA was later reconstituted to comprise the permanent heads of the state departments of agriculture, members of the executive committee of the CSIRO, and various government representatives. Its role was also to protect and extend standards in agriculture, as well as reporting to the AAC (the forum for commonwealth ministers and the bureaucracy). This was an effective arrangement, enabling CSIR to pass on and coordinate research or extension. It was also a forum for airing grievances and organisational matters, so that information and accountability problems were resolved. Coordination of R&D, and the long-range planning of national policies towards national development, were seen as important issues, but the constitutional barriers involving states' rights formed an ongoing impediment. As a result, the AAC was active in arriving at national decisions or coordination than was first hoped.

## 4. INNOVATIONS DURING THE 1930-1950 PHASE.

At the same time as the research facilities we being set up or expanded results were flowing and CSIR in particular made some important breakthroughs which vastly improved the reputation of what science could contribute to the wool industry. The following table summarizes the innovations covered in this period.

**TABLE 3.1 Innovations During the 1930-1949 Period:**

| Type of innovation | Provider | Research phase or introduction | Main adoption period | Est. Time taken to full usage |
|---|---|---|---|---|
| Early Drenches | All | 1910-ongoing | Ongoing | 1-3 Years-any |
| Disease | Private/CSL/CSIR | 1910-1935 | 1920-1950 | 10-15 Years |
| Flystrike-Chemical | All | 1923-ongoing | 1930-ongoing | 2-5 Years |
| Copper Trace | CSIR | 1930+ | 1950+Various | 10-15 Years |
| Poll Merino | Private | 1930s+ | 1950-1980 | 25-30 Years |
| Min. Def. | CSIR | 1935-1950 | 1950-1970 | 15-20 Years |
| Mulesing | CSIR | 1935-1940 | 1945-1975 | 20-25 Years |

| | | | | |
|---|---|---|---|---|
| Siromark | CSIR | 1935-1945 | 1945-1960 | 5-10 Years |
| DDT | Private | 1940-5 | 1947-1958 | 2-5 Years |
| Super- Pasture | Priv/CSIRO | 1950-1970 | 1960-1975 | 10-15 Years |
| Woolpacks | Private | 1930+ | 1960s+ | 1-3 years |
| Rural Electrification | State | N/A | 1930-1970 | 30-40 Years |
| Telephones | Comm | 1930+ | 1950-1970 | 20-25 Years |
| Hand Coring | CSIR/O | 1940-1955 | 1957-1969 | 5-10 Years |
| Siroset | CSIR/O | 1945-1955 | 1957-1965 | 5-10 Years |

Source: This table is based on information and calculations collected during the course of the research for this thesis.

*Flystrike control through mulesing.*

Mulesing was also an early development although it was extended much later, after further research. First devised in the 1930s, it became an integral part of a fly-management strategy, which included jetting against blowfly with improved arsenic based compounds. At this time some relief from internal parasites was provided with various drenching solutions, and the seasonal problem of liver fluke was better understood.

In the early years of the wool research effort, flystrike research was coordinated by the Joint Blowfly Committee (JBC), which gave its first report in 1933. The research indicated a link between wrinkled sheep and higher susceptibility to breech strike. The CSIRO was concentrating on the possibilities of an entomological answer to the problem. Wanting to arrive at a solution more quickly, the JBC offered a reward of £10,000 for anyone who came up with a solution to the fly problem. One of only two applications for the JBC reward was the operation devised by J.W.H. Mules, which alleviated breech-strike by cutting fleece-bearing skin from around the breech.[52] He first registered that he had a solution to the fly problem in a letter to the *Adelaide Advertiser*. Seeing this, Sir Charles Martin and Dr. L.B. Bull, of the Waite Institute, visited Mr Mules and reported favourably on the procedure.[53] Farmer-reaction to the procedure was mixed because for many it was cruel, and many opted for jetting which was being promulgated by the NSWDA. Others considered mulesing was an acceptance of fault in the sheep which should otherwise be dealt with by selection and culling, so they would not contemplate using the procedure.

The first large-scale trial of mulesing was by Euston Young, general manager of the Australian Pastoral Company. Testing the procedure at "Noondoo" in Queensland, the results were mixed

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[52] Detailed history of the mules operation, its development and dissemination was written by Morley, F.H.W., and Johnstone, I.L., 'Mules operation - A review of development and adoption', unpublished notes, (no date). According to Dr Ian Johnstone - a leading CSIRO researcher on the mulesing operation - the other application was from Mr Manchester, who was Stock Inspector of the Queensland DPI at Charleville. His method was to use a caustic solution and destroy the wool-producing follicles around the crutch, leaving the skin bare. This achieved a result similar to the Mules operation, but it was severe and took time to heal. Mules received the reward.

[53] The technique promulgated by Mules required the 'Burdizzo' instrument normally used for the bloodless castration of horses. The device was clamped onto the breech wrinkles to be severed, and the skin was removed, using roll-cut secateurs.

at first, so further research and modification of the technique by officers of the CSIRO was required. It was found that careful attention had to be paid to both the length of tail and the area of skin removed. After much trial and error, the best procedure for minimizing tail strike was derived and recommended to graziers.

Subsequent research found that the removal of more skin was required: the new variant became known as the Modified Mules Operation (MMO). After further research into tail lengths and removal of skin over the tail, yet another modification was suggested with even better results which became known as the Radical Mules Operation (RMO). In adopting the mulesing procedure, the grazing community dispensed with the Burdizzo instrument used by Mr Mules and employed 'dagging' shears to perform the operation. A worker at Noondoo, Mr B.B. Brett, developed and patented a mulesing cradle, with a tipping device which landed the animal on its feet after treatment, with quick-release catches for hind legs. The patent was bought by Moffat Virtue and marketed as the 'MV' or 'Noondoo Cradle'.

In 1941, the AWB endorsed the use of the MMO and funded schools of instruction for extension officers. A major extension programme then took place, and the MMO was soon disseminated through the sheep districts of Queensland and parts of NSW. In 1945, the AWB made two films on the procedure, showing work conducted at the CSIR. With hundreds of demonstrations and with the active support of George Moule of the Queensland DPI, it only took a few years for the technique to become widespread in Queensland, although in other states the rate of adoption was much slower. In NSW the Department of Agriculture was committed to breeding strategies by classifying breech-wrinkles as a guide to culling, so they took the view that mulesing undermined this medium-term answer. In time, the advent of 'mulesing contractors' facilitated the adoption of the procedure into NSW and elsewhere. A survey in 1976 found that an 83 per cent adoption of the technology had been achieved in Queensland over thirty years. The rates in other states were much lower, but they continued to rise steadily.

Fine-tuning research has investigated the problem of cancer on the exposed skin and the application of the Mules operation to other breeds of sheep, as well as the effect of age at mulesing and the most suitable dressings for the wounds. Some of this later research was driven by concerns from animal welfare groups over what they saw as the severity and brutality of the procedure. This has also led to reactivated research on chemical mulesing to remove fleece permanently from the breech.

In the 1930s and 1940s trace element research was well advanced in both Western Australia and the eastern states although the impact was yet to be felt and acknowledged. Although

investigations had already been done on imported grasses and clover species, pasture improvement for broad-scale grazing enterprises had come up against some geographic and technical problems. The results were often poor, and the reasons needed to be fully explored. The capacity of the farmer to improve pastures was restricted until after the war either by limited funds or too few tractors. Therefore, it was not until after the World War Two when the extensive phase of land settlement was long past, that land improving (land-saving) innovation came into its own.

*Pasture improvement.*

Apart from uncovering the characteristics and diversity of Australian soil, vegetation, and climate, it was also necessary that pasture establishment techniques and grass species brought from overseas be adjusted and suited to the circumstances of each region. The first need for specific information came with the expansion of irrigation horticulture. To lay the foundation for horticulture and cropping, activity and investment pedological work was undertaken before the start of the century. Although it remained small-scale and basic before 1930, between 1900 and 1910 the first use of standardized soil and land descriptions appeared, using UK and USA methods. At this time soils were first classified on their geological parent materials rather than on their pedological characteristics. The only confirmed widespread soil deficiencies known about at this time was that of nitrogen and phosphorous. In 1914 the NSWDA published *The Soils of New South Wales* which was the first of its kind in Australia. While national soil surveys were mooted at various times, pressing specific needs and a shortage of skilled manpower precluded this happening.[54]

*Trace element deficiencies.*

Australian soils are generally shallow, infertile and with high salt storages. This was because the weathering of bedrock can be to a great depth and, unlike the rest of the world, Australia has generally not been subjected to processes that renew the land, such as mountain building or recent volcanic activity. Australian soils are therefore old, leached, easily depleted and they tend to be deficient in one or more trace elements. Before pasture improvements could be made, these trace element deficiencies had to be fully uncovered and resolved. Therefore, running in conjunction with the pedological research, and fundamental to the success of pasture

[54] A prominent pedologist in the early years was J.A. Prescot of the Waite Institute, who established many of the approaches and went on to become part-time head of the Soils Division of the CSIRO in what became known as the Darling Soils Laboratory.

improvement work, was the research into soil nutrients and trace elements.[55] The productivity and profitability of the Australian grazing industry has gained much from the mineral and nutrition research in the last forty years, because trace element discoveries have opened up large areas of land which were previously unproductive and assisted large areas that were underproductive. This was also one of those areas in which a fundamental discovery could translate very quickly into an applied innovation. Wool research funding contributed to much of this follow up research especially in the 1970s after many of the big discoveries had been made.

Australian soils were found to be commonly deficient in phosphorous, with large areas also deficient in sulphur, potassium, nitrogen. In the case of trace elements, manganese deficiency was found in the black soils of Mount Gambier in South Australia, and zinc and copper deficiencies were evident in South Australia, Victoria and Western Australia. Other trace elements researched were calcium, magnesium, sulphur, potassium, boron, selenium, zinc, cobalt, molybdenum.[56] These were all important links in efficiently developing improved pastures through much of Australia's high rainfall zone. Molybdenum, in particular, was important because it is a trace element essential for fixing nitrogen in legumes and it was lacking in extensive areas of Victoria and NSW. Molybdenum encouraged clover growth by helping the rhizobium in soils, which in turn raises the level of nitrogen in the soil. By the late 1950s molybdenum deficiencies were found to exist over large parts of the hilly coastal regions right down the eastern seaboard. As a result, previously stunted clover and grasses grew normally when topdressed with molybdenum superphosphate.

A celebrated example of what was achieved through mineral deficiency research was the development of the Ninety-Mile Desert in South Australia.[57] The problems of the area were studied in the late 1930s, after researchers had uncovered copper deficiency in many pastoral areas of South Australia, and Esperance Downs in Western Australia, where zinc responses were also shown to exist. A research scientist involved with the research summarised the sequence of fundamental discoveries as:

> *The trace element story in South Australia began in 1928 with the discovery by Samuel and Piper (1928) of the Waite Institute that small amounts of manganese would correct grey speck disease of oats. This was followed in the 1930s by the work of the CSIR's Division of Animal Nutrition on coast disease, which showed this disease of sheep was due to a deficiency of copper and cobalt. The disease was associated with the coastal areas of Kangaroo Island and the South East, principally*

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[55] An survey of the early research work on various aspects of pasture improvement and trace element deficiencies in Australia is provided by McLachlan, K.D., 'The Nutrition of Pasture Plants' in Barnard, A., *The Simple Fleece: Studies in the Australian Wool Industry,* MUP, Melbourne, 1962, pp. 195-209.

[56] Dr. A.J. Anderson of CSIRO was credited with locating and showing the importance of molybdenum deficiencies, which occurred in most states, in 1942.

[57] This was done jointly by the CSIR, Waite Institute, South Australian Department Agriculture and the AMP Society.

> *Robe, where the predominant soils were calcareous sands. Many CSIR research officers within the Division of Animal Nutrition, including Hedley Marston, Ted Lines, Ian McDonald and John Lee, were involved in this work. David Riceman, a pasture agronomist in the Division, was working on crops and pastures in association with his animal nutrition colleagues at Robe. He decided to investigate the copper clue provided by their work and enlisted the help of two other agronomists, Colin Donald and later Alf Anderson. Responses of pastures and cereals to trace amounts of copper were established, both in the field and in plot experiments at the Waite Institute, and under some circumstances further benefit was obtained with zinc as well as copper.*[58]

This opened the way for more extensive trace element research elsewhere. It also identified the necessity for the agronomist to tailor pasture species with fertiliser options to create the correct soil conditions for good pasture establishment and growth.

However, it was to be many years before the economic circumstances, the necessary detailed information and lower costs for establishing pasture would allow sheep farmers the opportunity to utilize the pasture improvement packages that scientists were developing for more intensive industries such as dairying. In the meantime, many were introduced to the world of pasture improvement through the use of fertiliser on native pastures and only later embarked on the full programme of establishing new grasses and legumes either in a sown soil-bed or by broadcasting seed when applying fertilisers.

*Pasture management.*

Australian research into improved or pasture management strategies was first conducted during the 1940s, and has been more or less ongoing ever since. Grazing management involves finding the optimum level of stocking rates, pasture measurement, fodder conservation, containing the spread of noxious weeds, soil imbalances, dryland salinity, as well as ensuring good pasture establishment strategies which includes considering paddock sizes, regeneration techniques (such as allowing pasture to seed), weed control techniques, moisture stress (which is a major cause of pasture establishment failure) and seasonal factors. It was especially important to assess the commercial viability of pasture improvement before establishing a pasture improvement programme.[59] Once established, examining the effects of overgrazing, tailoring seasonal stocking levels to maximise the nutrient value of grass or providing supplementary feeding routines and animal licks to aid digestibility (by-pass protein techniques) were very

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[58] Tiver, N.S., 'Desert Conquest', *Agricultural Science,* Vol.1, No.5, 1988, pp.12-17.

[59] *Sown Pastures for the Nyngan and Cobar District*, NSW Department of Agriculture, pp. 23-28.

important to maximising the productivity from pasture.[60] A great deal of research went into the relative benefits of set-stocking, or rotational grazing in differing circumstances and fodder availability. Although the possibilities were nearly endless because of seasonal factors, differing land types and enterprise combinations, researchers argued the productive differences were marginal and that worm burdens were more related to seasonal conditions rather than stocking system. Nevertheless, rotational stocking was practised by many woolgrowers in conjunction with increased stocking rates on improved pastures. Growing winter crops and providing generous feeding conditions for weaners were very important to the productivity of the animal over its life. Similarly, hand-feeding practices, especially the handfeeding of ewes late in pregnancy, were developed. These were first based on British research and the techniques flowed across Australia in the 1940s and 1950s.

*Vermin.*

The first studies of plague locusts were initiated during the major plague experienced between 1933-35. The intention was to understand the insect, its habits and migratory patterns, including effect of meteorological conditions, so that in the event of a large swarm outbreak-pattern, estimates of direction and speed could be made. Predictions of swarm sizes and outbreaks likely in following years also enabled provision of the correct level of resources as cost effective ways of controlling outbreaks. The main form of control was to apply chemicals to migrating swarms as they appeared with aerial spraying. Other insects such as clover mites reduced pasture efficiency.

Of the larger native fauna to cause disruption to woolgrowers, wombats were declared vermin in Victoria in 1909, and a bounty was paid well into the 1950s. Dingoes were systematically destroyed with poison since the 1860s but they continued to be a problem in some areas and even in the 1940s some 600,000 acres in the Pilliga Scrub needed to be cleared of dingoes. High wire fences to exclude re-entry after they had been trapped, shot or poisoned were the main form of control and these traversed large areas of Australia, being maintained by the states under various Dog Fence Acts. Dingoes continued to have a bounty well into the 1950s, but by then they were only troublesome in isolated pockets in temperate zones. In settled areas domestic dogs that had turned feral are much more of a problem than dingoes. Kangaroos, wallabies, wallaroos and emus were similarly dispatched where they were approaching plague numbers.

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[60] Although the average fibre diameter of the wool increased, this was more than compensated for by the increased income from more stock per unit of land. See *Economic Aspects of Pasture Improvement: A Case Study in the New England Region of N.S.W.*, BAE Wool Economic Research Report No. 25, AGPS, Canberra, 1974, p.4.

*Textile research.*

The Australian textile research programme followed three directions: firstly, understanding the attributes of wool and using this knowledge to create effects that would enhance its performance; secondly, developing wool specific processing equipment or improving wool processing efficiency; and thirdly, creating new end-uses or products. Where work was most needed was to secure competitiveness in finishing processes such as washability, permanent creases, dyeing, printing, and creating new products to compete with the branded synthetic products.

*Structure and nature of wool fibres.*

To better understand the structure of the wool fibre researchers studied the formation of the wool follicle and its chemical composition, as well as the details of the wool 'root' and the follicle in which wool fibre grows. These investigations were highly specialised, which meant progress often occurred in tandem with improvements in techniques and the equipment to examine wool fibres.[61] For example, the electron microscope assisted in the collection of morpholical evidence, whereas the study of cell migration in the follicle used autoradiographic techniques. In conjunction with improved methods of chemical analysis, were microscopic examinations involving special equipment which applied pressure on the dermis or tension along the length of the fibre. Researchers also employed 'chromatography', to examine the amino acid compositions, and this investigation was extended using 'high-voltage paper electrophoresis'.

The outcome of these studies in the 1930s and 1940s was the appreciation of wool's long-chain molecular nature and the spacing of the amino-acid residues. This was further explored in the late 1960s with the use of infra-red data.[62] An outcome from the work during the 1930 to 1960 period was the diagrammatic representation of the wool fibre components presented in many textbooks today. From such research details of the keratinization process of wool-growth and the general nature of the wool fibre was more fully understood (but not completely) which assisted the development of new textile processes and products. Information flows between animal nutrition and protein chemistry studies also provided useful insights into the feed requirements of sheep, and the likely effect changes in diet could have.[63] in particular, the

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[61] Ryder, M.L., 'The production and properties of wool and other animal fibres', in *Textile Progress*, Vol. 7, No. 3, 1975.

[62] Fraser, R.D.B.,MacRae, T.P., Parry, D.A.D., and Suzuki, E., *Polymer*, 1969, 10, p.810.

[63] Darskus, R.L., Gillespie, J.M., and Lindley, H., 'The Possibility of Common Amino Acid Sequences in High-Sulfur Protein Fraction From Wool', *Australian Journal of Biological Science*, Vol. 22, No. 5, October 1969, pp 1197-1204. Sulphur content of wool can vary from 2.7 to 7.2%, depending on the diet of the sheep. The first complete sequence of the amino acid sequence of any wool protein was determined by Haylett, T., and Swatt, L.S., 'Studies on the High-Sulfur

fundamental studies assisted early-stage wool processing and improved the understanding of what happens to wool during scouring.

*WIRA CSIR and fleece branding fluids.*

An impressive achievement in the early years between WIRA and CSIR involved the management tool of branding sheep. In this instance science provided an alternative which was commercially beneficial, easy to adopt, and it achieved almost total acceptance in a short period of time. As a carryover from the time when fences were non-existent the recurring problem of 'boxing' led to the practice of placing a mark of ownership on the fleece using a brand. Many homemade concoctions used included petrochemicals, which left either black or green stains. This caused unscourable staining which led to a downgrading in the value of the wool by manufacturers. In the early 1930s, substitute preparations were developed by WIRA at Torridon and trialed in Australia, South Africa, and New Zealand. These tests were satisfactory, but the brands were not very legible or sufficiently long-lasting so it was not commercialised. After the second world war, the CSIRO tackled the problem again developing a new set of alternative solutions. Starting in 1945, over fifty preparations of various colours, totalling 153 types, involving different layers of thinner and thicker liquors, were trialed.[64] In all, sixteen properties helped with the trials and the best preparation, No. 130, was trialed on its own. Later that year, the branding fluid was directly compared with those from WIRA and the Imperial Chemicals Industries (ICI) brands and solution 130 was found to be superior. This provided the spur for further work and the Lanolin-Based Emulsion (LBE) was superseded by an even better formulation that became known as 'Siromark'. The production of Siromark in 1990 exceeded 400,000 litres, and was estimated to have achieved a two percent saving to the industry from avoidance of fleece downgrading.

> *It is heartening to note that the cost savings accruing to the wool industry through this* ***one*** *development have paid many times over for the* ***total*** *investment made in Australian textile research.*[65]

*Central Wool Committee (Mark II) and the Joint Organisation.*

In July, 1938, Sir Earle Page made an 'in principle' agreement with the British government that in the event of war, Australia would sell the whole clip to England.[66] On the 12th September,

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Proteins of Reduced Merino Wool (Part III: The Amino-Acid Sequence of Protein SCMKB - IIIB2)', *Textile Research Journal*, Vol. 39, October 1969, pp 917-29.

[64] These solutions were prepared by M. Lipson and trialed by M.R. Freeney. Sheep were marked in various locations. Around 80% of these brands faded completely, while many others smeared whilst dipping.

[65] Taylor, D.S., 'Australian innovation in textile technology', in Eyre, E., (ed), *Technology in Australia 1788-1988*, Australian Acedemy of Technological Sciences and Engineerings, 1988, p.278.

[66] Les White, op.cit., p. 61.

1939, the Governor-General proclaimed that the exportation of wool during war would be subject to government control (under the Customs Act 1901-36). In a verbal agreement the respective governments determined that all the wool in Australia would be purchased by the British Government. The negotiations were thus never transferred into a written agreement, - the exchange of a few cablegrams was all the deal comprised. Australia was the only country not to have a written contract. The price to be paid would be set at the seasonal average the year before the war of 10.75d Sterling per pound, or 13.4375d Australian per pound. This was a flat-rate payment which again required wool appraisement, so that distributions could reflect differences in wool-quality.[67] Each year it was intended that the price would be revised, but the British would not countenance this until 1942. On the 1st July, 1942 a 15% increase to 12.36d Sterling or 15.453125d Australian was achieved on the basis of increased costs of production since the war had started. The 0.75d Australian previously paid to cover F.O.B. costs, appraisement, insurance and warehousing, was maintained at the same rate.

As with the first world war, a set of limits was created and growers were paid an adjusted price depending on wool-quality. Australian processors obtained the wool for slightly less than the U.K. flat rate. By the end of the war, growers were bitter about the prices received, because they had been substantially below those of the first world war. Over six years, growers had averaged a price 22% less than in World War I.[68] Clearly, the wartime experiences were unlikely to endear woolgrowers to those advocating similar marketing schemes, with the successful disposal of the stockpile after the war that established the possible merits of the scheme were highlighted.

*Post-war selling structures, and grower referendums.*

By the conclusion of the second world war, there was stockpiled over six million bales of Australian wool. In 1945, at the London Wool Conference, the U.K.-Dominions Wool Disposal Plan was negotiated, and the Australian Wool Realisation Commission was set up as a subsidiary of the United Kingdom Dominion Wool Disposals Ltd. This disposal arrangement included South Africa and New Zealand, and the collective charged with selling around 10.5 million bales was known as the Joint Organisation (J.O). The agreement stipulated that the operation of the scheme would be reviewed in 1950 by the four governments concerned. In 1946, the auction system recommended, with sales occurring alongside offerings from the

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[67] The first appraisements took place in October, 1939. The payment of .75d for shipment, storage and insurance was later contested, and a currency confusion saw this fee reduced to .6d sterling, with the sharing of profits should this prove to be too much. Any profits on the civilian use of wool by English manufacturers during the war were not to be shared (the source of extra profits after World War One), but profits from wool sold outside the U.K. would be shared.

[68] On a per-bale basis, the return was £19:0:7 for a bale that was on average heavier than one during World War One which received £24:14:0.

stockpile. The Australian Wool Realisation Commission (AWRC) had to dispose of accumulated stocks, as well as provide reserve prices to support the market for all new wool entering the market. It was expected it would take thirteen years to clear the total 10.5 million bales held by the three countries. Things went well and by 1950, these stocks had been sold and a considerable profit (approx. £80 million) had been realised from buoyant postwar demand. While many wanted to maintain the marketing arrangement, the low prices during the war and rising input costs had squeezed profit margins, so suggestions for using the profits from stockpile sales to fund the marketing scheme were seen by many as foregoing much needed past income.

The 'London Conference' of 1950 was called to discuss international market issues, the factors influencing price and the practicality and desirability of limiting price fluctuation.[69] Through controlled marketing the initial proposal included the British government, which made growers suspicious of who would be the ultimate beneficiary from the introduction of marketing. Existing commitments to international free trade agreements needed to be considered. Further complicating negotiations at the time was the secret move by the United States to preemptively purchase wool from Australia at the beginning of the Korean War. In the end, it was the wool boom of 1950/51 which skittled plans for controlled selling structures. By the time the proposal for a Post-J.O. Reserve Price Scheme (RPS) was put to a woolgrowers' referendum in August, 1951, the high prices being achieved led growers to support enthusiastically the auction system; they voted the proposal down by a four-to-one majority. Despite the Australian decision, marketing schemes were established in New Zealand, England and South Africa.

*Early wool promotion.*

In the period before the war, only preliminary market research and establishing a headquarters in London was achieved. In the first two years, no large-scale advertising expenditure was made and the programme only consisted of educational displays at events such as the Empire Exhibition at the Glasgow, Milan and Leipzig Trade Fairs, the New York World's Fair, and many shows and fashion parades in Australia. In 1938, a three-year plan was drawn up to spend £50,000 each year, beginning in 1938-39. This programme was short-lived, as the war intervened and disrupted the flow of textile products and the interest in fashion. Nevertheless, a small research team was funded by the IWS continued, providing services to British processors.

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[69] Commonwealth Wool Conference, London 1950: Summary of Interim Report, ANU Archives of Business and Labour, E256/1401.

One bright spot during 1939-40 was the decision of the USA to join the IWS, after a visit there by Dr. Ian Clunies Ross and Mr R.J.F. Boyer. As a result, much of the war period was spent developing the office in New York, although once the USA entered the war in 1941, activity was also curtailed. The IWS spent the rest of the war developing relationships and preparing structures for the time when larger expenditures would be possible. At the end of the second world war, wool was still in a fortunate market position because the price of synthetics relative to wool was much higher, but it was recognised that this wouldn't last. Rapidly expanding textile markets could not be satisfied by the cotton and wool industries without inducing large price-increases, which would only stimulate an even greater shift of resources into substitutes. Therefore, although the intrusion was viewed by the industry with unease, it was also accepted as an inevitable new phase in the expansion of the textile market. The real concern came when the price of polyester and other synthetics fell well below that of wool and the increased capacity of synthetic textile production held the prospect of totally eclipsing the demand for wool.

In the immediate postwar period, promotion expenditures centred on the British Isles and Dominions, although paper shortages and power difficulties made advertising space difficult to obtain. The IWS network then spread with new offices created in many countries. By and large, promotion still consisted of information and educational forums, fashion parades, and market surveys in various countries. The first postwar slogan 'There is No Substitute for Wool' was released in 1947 in over twenty countries. Trade assistance began to form a larger part of activities and technical information was transferred without charge. A setback was the decision of U.S. woolgrowers to withdraw their financial support in 1959 (because of ongoing disputes), to establish their own promotion organisation.