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THE POTENTIAL FOR ANIMAL PRODUCTION IN THE TEMPERATE ZONE

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I have been asked to take a long term view of the potential for animal production in the temperate zone and to stress the biological potential rather than short term economic prospects. For statistical convenience, I have taken the temperate zone to comprise the 71.4 million hectares of the wheat-sheep and high rainfall zones of the Grazing Industry Survey (B.A.E. 1976) (excluding Queensland) of which 49.2 million hectares is used as pasture.

Of the 165,000 commercial farms in the temperate zone only 31,000 are primarily concerned with crop production; the remaining 134,000 have animal production as their principal activity, illustrating the dominant position of animal production in the rural economy (Table 1). The turnover in Australia from the sale of livestock and livestock products in 1973-74 was $m3741 compared with $m1600 from crops (A.B.S. 1976a).

TABLE 1: Agricultural establishments classified by principal activity. Temperate zone 1974-75.

Animal Industries	No. of Establishments	Plant Industries	No. of Establishments
Meat cattle	39,289	Cereal grains	9,781
Milk cattle	29,240	Orchard and other fruits	6,895
Sheep - cereal grains	21,460	Grapes	4,863
Sheep	17,906	Vegetables - other than potato	4,409
Sheep - meat cattle	17,072	Potatoes	1,655
Meat cattle - cereal grains	3,848	Nurseries	1,420
Pigs	2,848	Plantation fruits	1,105
Poultry for eggs	1,366	Tobacco	543
Poultry for meat	617	Multi-purpose farming	363
TOTAL	133,646	Oilseeds	219
		Cotton	81
		TOTAL	31,334

Source: Calculated from A.B.S. 1977, B.A.E. 1976.

The biological potential for animal production can be expressed in terms of individual capacity, production per unit area or total production. The potential land for animal production in the temperate zone is already largely used for this purpose. Twelve million hectares of crops in the zone, principally cereals, are largely used in association with livestock which graze stubbles or temporary legume pastures sown to restore soil fertility for crops.

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Further expansion of cropping in the temperate zone is restrained by soil, terrain and climate (Nix 1974) but the complementary nature of cereal and animal production indicates that such expansion is not necessarily at the expense of animal production.

In the present and projected economic climate for the animal industries, our interest in biological potential obviously lies not in the expansion of total or unit area production. Rather we are concerned with individual biological potential and the possibility that its greater realization could be achieved without a proportional increase in per head costs of production and without a substantial decrease in total production,, per farm.

The topic I have been given is broad and it is impossible to treat it evenly in the limited space available except very superficially. I decided to omit consideration of the pig and poultry industries which are largely restricted to supplying domestic markets and do not draw on land resources to a significant extent. Also, I have dealt with wool production in more detail to indicate an approach to the assessment of biological potential which could be developed for the other forms of animal production.

WOOL PRODUCTION

Wool growth is proportional to feed intake (Ferguson 1972; Langlands and Donald 1977) so that feed intake is an important restraint on the biological potential for wool production. Feed intake, given sufficient availability and acceptability of pasture, largely reflects the energy demands for growth, fattening, pregnancy or lactation in addition to those required for maintenance, locomotion and adaptation to cold conditions in the grazing environment. Such energy requirements stimulate an appropriate increase in appetite. There does not appear to be any stimulus to appetite related to a sheep's propensity to grow wool.

Energy demands determine the potential intake but competition for nutrients and endocrine adjustments associated with particular demands may decrease the wool growth response to the enhanced intake. This is especially so for lactation where the decrease in nutritional efficiency more than offsets the substantial increase in intake so that wool growth per head declines and production per unit area is even more reduced because of the reduction in carrying capacity (Langlands 1977). The energy demands for growth and fattening are not offset by reduced efficiency to nearly the same extent as during lactation.

The efficiency of the fat sheep at constant bodyweight is similar to that of the thin sheep maintained at half the bodyweight and requiring half the intake so that production per head is approximately double in the fat sheep. At pasture, rapid growth and fattening and the maintenance of constant bodyweight of sheep in good condition can only be achieved by a reduction in grazing pressure and a reduction in the pasture harvested and wool produced per unit area unless supplementary feeding is practised.

The selection of sheep for increased mature size provides a similar means of increasing intake and wool growth. There is also evidence that the maintenance requirement of the Merino is greater than that of other breeds (Doney and Russell 1968; Langlands and Hamilton 1969; and Arnold 1975) and selection for fleece weight within the Merino has resulted in an increased maintenance requirement and intake in addition to an increase in efficiency of wool growth (Hamilton and Langlands 1969).

Maintenance requirements can be increased by thyroxine administration and the resulting increase in feed intake has been shown to increase wool growth (Ferguson 1958; Lamboume 1964). The procedure is dangerous if feed supplies are not assured but merits re-investigation in the light of the pressure on per head costs of wool production.

Pasture availabilitv and acceptability

The relation of digestible organic matter intake (DOMI) to digestibility, availability, proportion of green pasture, leaf length and plant density has been investigated for pure swards of a number of pasture species and some mixtures of species (Arnold and Dudzinski 1967). The influence of these factors was found to vary with each pasture, illustrating the danger of simple generalizations on the pasture 'factors influencing intake. Selective grazing of more acceptable plant material guided by smell, taste, sight, touch and past experience makes the composition of the ingested material often very different to that on offer. A dramatic effect of phosphate fertilizer on the acceptability and digestibility of pasture has recently been described (Ozanne and Howes 19.71; Ozanne et al 1976).

Seasonal variation in pasture availability or acceptability severely restricts DOMI especially during summer in the southern region with a Mediterranean climate and during winter on the eastern table-lands. Adjustment of energy demand to the nutrient supply from pasture by choice of lambing date or sale of stock coupled with a flexibility of feed supply from conserved fodder ameliorates the restraints on production imposed by seasonal variations in pasture growth.

The widespread phosphate, sulphur and nitrogen deficiency of the temperate region has now been partially corrected by superphosphate fertilization of about two-thirds of the pasture in the region. After adjustment of stocking rate to the increased carrying capacity, improved pastures do not provide substantially increased levels of intake per head nor much improved quality of the intake for wool production (Langlands and Bowles 1974).

Feed quality for wool growth

A unique feature of wool production is the very high proportion of the net energy of the diet required in the form of available protein of appropriate amino acid composition to achieve maximum nutritional efficiency. Such a requirement can only be achieved where the digestible crude protein is nearly 50% of the DOM content of the diet and is largely protected from fermentation in the rumen. The wool growth value of a feed thus depends on the DOM content, the fraction provided by protein, the resistance of this fraction to fermentation and its available amino acid composition (Ferguson 1975).

There is only limited information on the wool growth value of pasture, considering its role as the major nutrient source for the wool industry. Estimates principally from the work of Langlands and his colleagues (Langlands 1977; Langlands and Hamilton 1969) indicate an average value of approximately 1.0 g of clean wool per 100 g DOMI for the fine wool Merino and 1.4 g for strong wool Merinos. These values are considerably lower than those I have reported for a variety of diets fed to medium wool Merinos in pens where values up to 3.5 were recorded (Ferguson 1975). Apparently little of the protein in pasture escapes fermentation in the rumen because the wool growth value of pasture is close to the wool growth value of the non-protein fraction of the DOM found in pen experiments (Ferguson 1972). However, direct comparisons between grazing and pen conditions with the same diet are impossible and one cannot rule out non-nutritional factors contributing to the low efficiency of grazing sheep. If pasture species could be found with wool growth values similar to those for some high protein diets in pens, the wool growth of the grazing sheep could be increased by 2.5 times.

Little attention has been paid to the value of various pasture species for wool growth in plant introduction and breeding programmes. Possibly selection for increased tannins in legumes already agronomically adapted to the temperate zone may increase the natural protection of their protein and enhance their value for wool growth. A shorter term approach is the use of legume grain or forage crops as supplementary feeds after protection of the protein. Lucerne is the most widely grown legume forage crop in the temperate zone and requires 'less cultural energy per unit of protein yield than any other crop (Heichel 1976). Drying affords some protection to the protein and lucerne hay has a wool growth value of 1.9 g per 100 g DOM (Ferguson 1975) considerably above the value for pasture.

Genetic restraints on wool growth

The average fleece weight of the national flock including crutchings and lambs shorn in 1975-76 was 4.26 kg (A.B.S. 1976b)'and has increased by only 0.02 kg per year since 1946 (Ferguson 1976). Shearing and other per head costs have risen by a much larger margin (B.A.E. 1976). Fleece weights of sheep and lambs for the upper and lower quartiles of sheep properties classified by fleece weights for the State zones of the Grazing Industry Survey range from 2.62 to 6.35 kg per head (Table 2). The range of values for individual properties in the sample population was 1.64 to 7.57 kg. While the upper quartile figures may be influenced by lower stocking rates, lower proportions of breeding ewes and better pastures, the distribution undoubtedly reflects some genetic influence.

TABLE 2: Distribution of greasy fleece weights on sheep specialist properties* 1975-76

	ZONE					
	Pastoral		Wheat-sheep		High Rainfall	
	lower 25%	upper 25%	lower 25%	upper 25%	lower 25%	upper 25%
N.S.W.	3.47	5.29	2.81	4.87	3.31	6.35
Vic.	-	-	3.27	5.84	2.78	4.49
Qld.	3.22	4.95	3.82	4.72	-	-
S. Aust.	3.90	5.61	3.03	5.42	3.41	5.32
W. Aust.	3.66	5.65	3.10	4.97	3.14	5.35
Tas.	-	-	-	-	2.62	4.62

* Properties with more than 50% of income from the sheep enterprise.
Source: B.A.E. 1977, personal communication.

The national wether trial conducted by the Mungindi Pastoral and Agricultural Association gives an indication of variance in fleece characteristics between properties where inter-property nutritional effects are largely removed although the sample of properties is not random and is probably biased towards the upper side of the population distribution. The distribution of mean greasy fleece weight for the 66 teams of 8 wethers run together and shorn in May 1977 ranges from 4.50 to 8.50 kg. The range for individual wethers was 2.1 to 9.7 kg. Fleece value depends on fleece weight and price which reflects mean fibre diameter, yield, length, colour, soundness and amount of vegetable fault, The mean wool price of the teams ranged from 164 to 220 cents per kg and the resultant distribution of fleece values for the teams ranged from \$9.53 to \$17.02 per fleece (D. Hickson, personal. communication).

Multiple regression of the value of the fleece (y) on greasy fleece weight (x_1), yield (x_2) and mean diameter (x_3) was

$$y = -3.191 + 2.019x_1 + 0.260x_2 - 0.573x_3$$

which accounted for 97% of the variance in fleece value. The coefficients for yield and fibre diameter indicate contributions to price greater than the direct influences of these characteristics.

Disease restraints

The cost of materials for disease control is about 6% of total costs on sheep properties in the temperate zone (B.A.E. 1976) but this does not include the labour costs of drenching, jetting, mulesing, dipping and crutching. At the level of control achieved there is still a considerable loss of wool production especially from internal parasites and blowfly (B.A.E. 1972).

The identification and selection of sheep resistant to these parasitic diseases is a possible approach towards more effective and less expensive control. Systems of rotational grazing based on more detailed epidemiological information on the survival of eggs and larvae seem'to be worth consideration for the control of internal parasites.

The deaths of sheep on farms excluding the loss of lambs before marking averaged 8.2% p.a. for 1972-76 (A.B.S. 1976b). This is a further loss of biological potential since few of the skins and little of the wool is recovered.

SHEEP MEAT PRODUCTION

The specialist prime lamb producer tends to occupy more favourable parts of the temperate zone where an adequate period of pasture growth for finishing lambs is reasonably assured. However, he constitutes less than 20% of sheep producers and his markets are raided by other sheep farmers who move in when market prices and seasons are favourable. The poor biological efficiency of prime lamb production as a whole reflects the large opportunistic component of the industry which produces lamb under less than optimum nutritional conditions and often with less than optimum genetic material. Under more favourable pasture conditions supported in some areas by irrigation and supplementary cereal feeding, lamb production from Border Leicester x Merino ewes by Dorset Horn rams is reasonably efficient since green pasture more nearly meets requirements for lamb growth than it does for wool growth although amino acid requirements are not always met (Black, Faichney and Graham 1976).

Genetic improvement by selection is difficult to achieve with the present breeding structure of the prime lamb industry where the breeding of the Merino ewes, the Border Leicester rams, the Merino x Border Leicester ewes, the Dorset Horn rams and the resultant prime lambs may be carried out on five different properties. Due to heterosis, none of the purebreds has matched the performance of the Merino, Border Leicester, Dorset Horn cross system predominantly employed. The introduction of genes for increased ovulation rate into the Merino component by use of the Booroola strain would increase the fertility of the first cross ewes. However, the industry draws on Merino ewes distributed throughout and beyond the temperate region and there is a reluctance of Merino breeders to breed for multiple births due to increased losses from exposure and predation.

BEEF PRODUCTION

Between 1860 and 1972 the ratio of sheep to cattle in Australia varied between 6 and 10 but since 1972 the ratio has fallen, reaching 4.45 in 1976. The expansion of the beef cattle population has occurred largely in the temperate region displacing sheep and dairy cattle but also increasing the grazing pressure on the region. Like the lamb producer, the specialist beef producer has been prejudiced by the ease with which the sheep and dairy farmer can move into beef production.

New export markets for beef stimulated the growth of the beef cattle population and extended production to less favourable areas. The period of pasture growth required to produce prime beef is much longer than that required for lamb production. Consequently many beasts are not finished before 12 months or even two years leading to a biological efficiency considerably less than the potential. Beef production may be expected to contract to its traditional share of about half the pasture resources and to concentrate in areas in which the nutritional restraints are less severe. The British and Continental breeds of cattle are well adapted to the temperate region and genetic restraints are not as severe as the nutritional ones.

MILK PRODUCTION

The diversity of dairying conditions throughout Australia has been well described (Hayman and Radcliffe 1973; B.A.E. 1975). Practices vary from highly capitalized dairy farms with irrigated pastures or complete handfeeding on purchased, well-formulated diets to small, under-capitalized farms utilizing the seasonal flush of unimproved pastures with a, short lactation period and without supplementary feeding.

Economic pressures have squeezed many of the latter farmers whose production per cow may be less than a fifth that of the most efficient producers. There has been a marked reduction in the number of smaller dairy farms, a fall in the dairy cow population and a rise in production per cow. The trend has been accompanied by a progressive removal of nutritional restraints, improved pastures providing an increasing share of the nutrient supply (Table 3).

TABLE 3: Source of nutrients for dairy cattle in Australia.

	1963-64	1967-70	1971-74
	%	%	%
Native pasture	43	27	23
Improved pasture	29	44	57
Cropping	8	16	10
Other	20	13	10
TOTAL	100	100	100
Irrigated area	3	9	11

Source: B.A.E. 1975.

Per head productivity is still low by world standards and variable between regions of Australia, Queensland showing levels little over half that of Victoria or South Australia. The lower digestibility of tropical pastures accounts in part for the difference (Minson and McLeod; Stobbs and Thompson 1975).

The breeds of dairy cattle reflect the diversity of dairying conditions and the use of milk for direct consumption or processing. Between 1961-64 and 1971-74 the proportion of total milk production used for butter fell from 40 to 7% with an accompanying trend from the Jersey to Friesens (B.A.E. 1975).

Under conditions of intensive land use milk production is the biologically most efficient form of food protein production being more efficient in this respect than cereal or legume grains per unit land area (Duckham and Masefield 1970). The biological potential for milk production per head is considerably above present levels. Dairying may be forced to contract from less favourable areas but its place in areas where there is a long growing season for improved pastures seems secure.

CONCLUSION

The biological potential production per head is considerably above present levels in the grazing industries-of the temperate region of Australia. Individual productivity varies severalfold between farms mostly due to differences in nutrition but genetic and disease restraints also contribute. Costs such as shearing, crutching, dipping, drenching, jetting, lamb marking, branding, milking and stock handling are proportional to stock numbers. These costs are diluted by an increase in production per head.

After pastures are fully improved the nutritional restraints could be reduced further by a greater degree of supplementary feeding of forages conserved on the farm with more regard to the nutritional requirements for different forms of production. This would allow the carrying of sufficient stock to fully utilize pastures during their growth period.

The utilization of more of the temperate region by crops for direct use by man without the use of livestock to graze stubbles and to restore fertility with temporary legume pastures would be an increasingly energy expensive alternative. I foresee a secure role for the ruminant but also economic pressures enforcing an increase in productivity.

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