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CHAPTER 10

CHANGES IN SUPPLY OF AGRICULTURAL PRODUCTS

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Many factors affect the output of agricultural products. Technological change and climatic conditions are obvious examples. In this chapter, however, the major focal point is the responsiveness of the outputs of commodities to changes in their prices - - price elasticities of supply for short.

Elasticity estimates from supply studies form an essential component of larger mathematical models of the agricultural sector. An accurate knowledge of responsiveness to commodity prices is especially critical in the case of commodities whose prices to producers are determined administratively (generally by government sponsored marketing boards) rather than by market forces. The success of such marketing arrangements more often than not depends on correct anticipation of the production response to the administered prices.

One elementary consideration underlies all of our discussion below. Following any particular stimulus affecting supply, the size of the response observed will depend on the length of the adjustment period allowed : the longer the period, the higher the elasticity. In the next section we

attempt where possible to indicate in general terms the length of the lags involved in production responses in the context of a brief discussion of each of the major factors responsible for changes in agricultural output. We follow in the third section with an historical account of the observed output responses of major Australian agricultural commodities over the last three decades. In the fourth section we focus on a given, short term, period of adjustment (one year). We report econometric estimates of the responsiveness of the output of commodities produced in the Pastoral, Wheat-Sheep and High Rainfall Zones to changes in the prices of these commodities. The chapter ends with a short conclusion which draws attention to the significance of changes in composition of the total output mix and the need to take account of competition between different rural products in studies of supply response.

FACTORS AFFECTING OUTPUT[1]

Factors influencing the level and composition of agricultural output may be classified in a number of ways. Influences such as weather and technological changes are often termed supply shift factors. That is, they result in more or less of a particular commodity being produced at the same set of product prices. They are distinguished from influences which govern the response in the output of a particular commodity to changes in its own price and in the prices of other farm products - - respectively the "own" and "cross" elasticities of supply. In this section, however, we use a simple descriptive classification, discussing the determinants of supply under the headings of technology, overall farm prices, relative product prices, and climate.

TECHNOLOGY[2]

A vigorous post-war programme of agricultural research and development has led to substantial gains in farm productivity. Technological developments of the 'fifties and 'sixties include an expansion in the use of introduced pasture species, higher yielding crop varieties, increased mechanisation in cropping and pasture management, improvements in rabbit control, and more efficient chemicals for pest and disease control. The observed increases in wool, crop and milk yields of the past three decades demonstrate the effectiveness of such innovations, although it should be noted that these gains could not have been so large without the increased use of purchased inputs. Although many of the new techniques of production demand increased managerial skills for their successful implementation, often they do not require substantial capital investment. Irrespective of the demands they may or may not create for additional inputs, all technological advances facilitate more efficient use of one or more of the 'primary' inputs land, labour and capital.

OVERALL FARM PRICES

When we speak about the overall level of farm prices, we have in mind an index number of the farm gate prices of agricultural products deflated by an index number representing purchased farm inputs. Buoyant overall levels of farm prices may inspire an entirely new level of confidence in the future and simultaneously provide the liquid funds necessary for investment. The result may be a spurt of developmental expenditure which, after a lag, lifts the aggregate level of farm output. Such was the economic environment of Australian agriculture in the early 1950's when real farm income increased dramatically as a result of the wool price boom occasioned by the Korean war. The responsiveness of aggregate agricultural supply to modest changes in the general level of farm prices, however, is not usually very large, nor very fast. Indeed, the most distinctive characteristic of agricultural

agricultural price level, at least in the short term. Factors generally considered important in maintaining output stability in the face of falling prices include :

(i) the high proportion of total farm costs that are fixed in the short to medium run, which is in part a reflection of

(ii) the importance of self employment in farming,

and

(iii) the tendency for the price of intermediate inputs generated within the agricultural sector itself to fall in line with falls in the price of outputs.

Similarly, factors considered important in restraining output expansion when product prices are increasing include :

(i) biological limitations (e.g., the gestation period of farm animals) and the long lags involved in bringing new land into production,

and

(ii) the relatively high variability of many agricultural prices at the farm gate. The associated uncertainty slows down the translation of higher current prices into more optimistic price expectations (and hence larger outputs) by farmers.

RELATIVE PRODUCT PRICES

Notwithstanding these limitations on the responsiveness of farm output at the aggregate level, farmers can nevertheless exhibit quite marked short run flexibility in their product mix in response to changes in the relative prices of different products. These changes

encourage producers to shift farm resources between various production alternatives. Thus there have been substantial movements in the relative levels of production of wool, wheat, coarse grains and beef in Australia in the post-war period in response to changes in their relative prices. Changes in price ratios for the major commodities - - wool, wheat and beef - - are shown in Figure 10-1. Prior to the 1973-74 commodities boom, the prices of both beef and wheat increased relative to wool and the price of beef increased relative to wheat. The range of production alternatives confronting a farmer in a particular region and the ease with which he can switch resources between them as relative prices change will depend essentially on the agronomic characteristics of that region, and the individual technological features characterizing the production processes of alternative products.

Biological factors such as length of growing season are of central importance in determining the time profile of substitution among products. For most commodities, current production is strongly influenced by past production decisions; just how far this influence extends into the past depends on the particular product. For horticultural crops, an interval of six to eight years may elapse between planting and full bearing potential. The area sown to annual crops, however, can be changed significantly between one season and the next. But even in this case it may take more than one year for farmers to change from one cropping programme to another because (among other things) of the time required to acquire the equipment necessary for a substantial enlargement in crop area. For meat production the time lags between decisions to change the level of output and the actual attainment of the new level are more complex. Since current meat output can be increased at short notice at the expense of future production, the production level at any one time will depend not only on the present effects of past decisions about the

FIGURE 10-1

ABOUT HERE

in the future. In this case the important relative product price expectations are current beef versus future beef.

CLIMATE

Farm output is, of course, heavily influenced by climatic conditions during the crop year. Australia has at times experienced severe widespread continental droughts which have resulted in shortfalls in the planned outputs of all major products. Droughts more typically are local in character. Because few of Australia's major agricultural products are confined to one or a few regions or States, local droughts rarely exert a major influence on the aggregate product mix. Weather also affects the incidence of fungal, insect, and other pests. The classic example is the plague locust.

Climatic conditions in other countries also can affect Australian supply, although only indirectly, and with a lag. This is because the prices of Australia's major rural exports are determined in world markets. A crop failure in Canada or a drought in pastoral Argentina can affect the levels of world prices for wheat and meat respectively, and subsequently lead to changes in the amounts of these commodities produced by Australia.

THE HISTORICAL RECORD

Table 10-1 gives estimates of the average annual percentage growth rates in total farm output, and in the outputs of nine commodities which are important in terms of value of production, for the financial years 1952/53 to 1978/79. Separate growth rates for the fifties, sixties

and 'seventies are also shown. The growth rate estimates were obtained by fitting semi-logarithmic trends to Bureau of Agricultural Economics (BAE) data on individual commodity production volumes and an index of total farm output.

TABLE 10-1 TO GO ABOUT HERE

Aggregate farm output has increased at an average annual rate of about 3 per cent over the past three decades. The rate was higher in the 1960's than in the 1950's and has tailed off in the 1970's, partly as a result of the lower pre-tax profitability of farming and fewer tax incentives for farmers to expand production. The figures in the table conceal the substantial year to year output fluctuations that have occurred -- primarily as a result of drought -- in 1957/58, 1965/66, 1966/67, 1972/73 and 1977/78.

The expansion in Australian farm output in the post-war period has been particularly rapid compared with earlier periods in the 20th century. This growth in output was helped by a modest expansion in the land base (which grew at slightly less than one per cent per year), but occurred despite a steady and substantial decline since the mid 1950's in the farm labour force.[3] The expansion has resulted from a high rate of developmental expenditure (encouraged by concessional government taxation policies) and the use of increasing quantities of purchased inputs such as fetilizers, chemicals and fuels in association with improving production technology.

WOOL AND SHEEP MEATS

Wool output increased by about 4 per cent annually in the 1950's, 2 per cent in the 1960's then declined by an average annual rate of 3 per cent in the 1970's. Mutton and lamb outputs also followed roughly the same pattern : comparatively high annual growth rates in the 1950's, lower rates in the 1960's, and output contractions in the 1970's.

The Bureau of Agricultural Economics in its continuous grazing industry survey classifies farms into three broad zones according to rainfall : the Pastoral, Wheat-Sheep and High Rainfall zones. The Pastoral Zone, which is the area located towards the centre of the continent, accounts for a declining proportion of the Australian sheep population. In this zone, prospects for replacement of wool by other products are at best fair. However, some substitution between wool, cattle and crops does occur. In the other zones, technical prospects for substitution are more favourable. In the Wheat-Sheep Zone, wheat, coarse grains (barley, oats, maize and sorghum), prime lambs and cattle are possible alternatives, while in the High Rainfall Zone prime lambs, grains and beef can be substituted for wool.

There is evidence of considerable substitution between wool and competing products in the post war period. High wool prices in the early 1950's encouraged farmers to expand wool production to some extent at the expense of wheat. However, during the late 1950's and throughout the 1960's the price of wool declined in relation to both wheat and beef, encouraging farmers to expand both wheat and beef production at the expense of wool.

Growth in wool output can result from an expansion of sheep numbers or an increase in fleece weights. A semi-logarithmic trend fitted to Australian aggregate data on the latter for the period 1949/50 to 1976/77 revealed an average annual increase in fleece weight of 0.41 per cent. National yield figures such as these are, however, affected by changes in the location of production. For example, part of the increase in yield could be attributable to a decline in the relative importance of a woolgrowing region in which fleece weights are traditionally low. Fortunately it is relatively

easy to isolate the effect of a changing geographic distribution on the national yield. We do this by asking the following question : if the distribution of flock numbers had remained as in 1949/50, but yields in the States had taken the individual, different values actually observed since then, what would have been the rate of growth of the average fleece weight at the national level? To answer this question we fitted a semi-logarithmic trend to an index number for Australian fleece weights constructed using base period (1949/50) shares of sheep in each State in the national flock combined with fleece weight data at the State level. This calculation led to a growth rate of 0.38 per cent per year, suggesting that changes in location of supply have been of only minor significance in explaining the increase in fleece weights. Sheep numbers climbed steadily from 118 million in 1952 to a peak of 180 million in 1970. They have since declined sharply to a level of 131 million in 1978.

Changes in mutton production have followed reasonably closely the changes in wool production. Demographic features of the sheep population can be used to explain differences between the two series. Under the price regimes for most of the post-war period, the production of mutton, being essentially a by-product of wool, has responded to changes in wool prices rather than to changes in its own price. In recent years the middle east live carcass meat trade has provided some stimulus to mutton prices independently of the fortunes of the wool market. Nevertheless, mutton output still remains essentially tied to wool production. Mutton production rose from 253,000 tonnes in 1952/53 to 376,000 tonnes in 1959/60. Production peaked at 596,000 tonnes in 1971/72, then declined to 220,000 tonnes in 1978/79.

Lamb production also contracted sharply in the 1970's following continued expansion in the 1950's and 1960's. Production has ranged from 148,000 tonnes in 1952/53 to a peak of 360,000 tonnes in 1971/72. In 1978/79, estimated production was 260,000 tonnes. Increases in the relative profitability of competing enterprises such as beef in the High Rainfall and Wheat-Sheep zones has contributed to lamb's production decline in the 1970's.

CEREALS

Of the main cereal grains - - wheat, barley, oats, maize, sorghum and rice - - wheat is by far the most important, accounting for about 70 per cent of the total area sown to cereals in recent years. Wheat output contracted over the 1950's but expanded by about 5 to 6 per cent per year over the 1960's and 1970's. During the 1950's the wheat/wool price ratio was generally unfavourable to wheat. A decline in the price of wool relative to wheat after the 1950's stimulated the swing towards wheat. Furthermore, wheat growing became sufficiently profitable to cause an expansion in the arable land base through clearing and cultivation of land not previously cropped. This together with yield improvements resulted in a fairly rapid expansion in wheat production. The figures of Table 10-1, however, obscure the contraction in wheat output that occurred between 1969/70 and 1973/74. Over this period, the quantity of wheat that growers were permitted to deliver to the Australian Wheat Board (the sole purchaser of wheat under Australian legislation) was determined by delivery quotas imposed following the large carryover of wheat stocks from the record 1968/69 harvest. The aggregate quota differed somewhat in each of the five years, as did the extent to which the quota rather than

conditions operated to restrict the planned output of wheat. Area sown dropped from 10.9 million ha. in 1968/69 to 6.5 million ha. in 1970/71.

Changes in wheat production may be caused by changes in yield and/or in area sown. While yields have fluctuated markedly from year to year (primarily in response to weather conditions), they have shown an upward trend. A log linear trend fitted to Australian data on wheat yields for the 1949/50 to 1976/77 period indicated an average annual yield increase of 0.38 per cent. To ascertain the importance of the changing distribution of the national wheat acreage among the States, we carried out a side calculation similar to the one discussed above for fleece weight. A log linear trend regression fitted to a fixed weight national yield index (constructed by weighting State yield data by base period (1949/50) State shares of wheat in total wheat receivals by the Australian Wheat Board) gave a growth rate of 0.45 per cent. In both regressions, however, the time trend was capable of explaining only a very small proportion of the fluctuations in yield. Nevertheless the figures suggest that changes in the distribution of production across States since 1949/50 have had a dampening effect on national yield increases. Part of the fall is attributable to the opening up of new wheat lands. While average wheat yields in Western Australia are typically only about 60 - 80 per cent of average yields in New South Wales and Victoria, the share of Western Australian wheat in total wheat deliveries has increased from around 20 per cent in the early 1950's to around 30 per cent in the late 1970's. The national area sown to wheat ranged from 3 to 5 million ha. in the 1950's to 11 million ha. in 1968/69.

In 1978/79, area sown exceeded 10 million ha. and the volume harvested set a record of some 18 million tonnes.

Production of coarse grains (barley, oats, maize, sorghum) increased by an average of nearly 5 per cent in the 1950's, 3 per cent in the 1960's and less than 1 per cent in the 1970's. The slower rate of growth of coarse grain output reflects the increased plantings of wheat. Substantial changes in the relative importance of individual commodities within the coarse grain group have occurred. To a large extent these changes reflect changes in the relative prices of these commodities.

The production of barley fluctuated between 0.6 and 1.4 million tonnes annually over the 1950's and reached 1.7 million tonnes by 1969/70. During the period of wheat quotas barley was in many areas the most profitable alternative crop to wheat. Area sown jumped from 1.3 million ha. in 1968/69 (the year before quotas were introduced) to 2.5 million ha. in 1971/72 (yielding 3.1 million tonnes). In the 1977/78 and 1978/79 seasons, comparatively high barley prices have encouraged record plantings.

Oats is a dual purpose crop, providing both grazing fodder and grain. Hence area sown responds both to pasture fodder needs as well as to relative prices of competing crops. There has been no discernable trend in area sown and production in the post-war period. Area sown was highest in 1966/67 (1.7 million ha.) and has been around 1 million ha. in recent years.

The area sown to sorghum rose from around 80,000 ha. in the 1950's to 200,000 ha. in the late 1960's. During the wheat quota period sowings increased dramatically to reach 700,000 ha. in 1972/73. In areas where climatic conditions are unsuitable to the production of high quality barley, sorghum became the next most profitable cropping alternative to wheat. With the relaxation of quotas in the second half of the 1970's, sorghum sowings appear to have stabilised around half a million hectares.

Apart from weather induced variations in yield, the production of rice is determined by the administrative control of both irrigation water and area sown. Area sown has grown from 14,000 ha. in 1952/53 to 20,000 ha. in 1959/60, 40,000 ha. in 1969/70 and 100,000 ha. in 1978/79. Since rice is a highly profitable crop in irrigation areas (considerably more so than alternative enterprises), the growth in area sown reflects the response of the authorities to growth in both domestic and export markets.

BEEF AND DAIRY CATTLE

Production of beef and veal increased at just under 3 per cent annually in the 1950's and 1960's, then at 8.5 per cent per annum in the 1970's. In terms of quantities, output increased from around 700,000 tonnes (carcass weight) in the early 1950's to 1 million tonnes by the late 1960's and 2 million tonnes by the late 1970's. Australian beef cattle are produced using two management systems :

(i) an intensive beef grazing industry in which cattle are grazed in conjunction with sheep, particularly in the Wheat-Sheep and High Rainfall zones;

(ii) an extensive northern specialist beef industry covering the Northern Territory, the Kimberley region of Western Australia, and the coastal central and peninsular gulf regions of Queensland.

The high quality product of southern areas is more oriented to the domestic market than the lean manufacturing grade carcass of northern areas which is essentially for the export trade.

Beef cattle numbers rose steadily from 10 million in 1952 to 12 million in 1960, reaching 18 million in 1970. Numbers then increased rapidly to reach 30 million in 1976. At first a slow and later a rapid build-up resulted from the generally satisfactory beef prices (which steadily increased with generally small fluctuations about the upward trend). This build-up was also associated with increasingly attractive relative prices of beef, especially in relation to wool and sheepmeats. The increase in cattle numbers was greatest in the southern industry, with northern cattle numbers falling from 64 per cent of the total in 1960 to 45 per cent in 1973. Beef prices fell dramatically in 1974, causing serious financial problems for specialist producers.[4] Despite the price collapse, demographic characteristics of the breeding herd and seasonal factors ensured that beef cattle numbers continued to increase to reach their 1976 peak. Numbers have declined to 26 million in 1978 although production continued to increase through higher slaughtering rates to reach 21 million tonnes in 1977/78. The current outlook is a buoyant one. Export quantities and receipts are at record levels. The longer term prospects of the industry, however, are closely tied to

our access to overseas markets, which in turn is largely determined by foreign politics.

Total milk production (including milk used for butter manufacture) increased by an average of 2 per cent annually in the 1950's and 1.6 per cent in the 1960's but contracted by an average of nearly 5 per cent annually in the 1970's. The volume of production rose from 5,500 million litres in 1952/53 to 7,500 million litres in 1969/70. Production has since declined more or less continuously, reaching 5,300 million litres in 1978/79. Dairying has traditionally been a problem industry, with a comparatively large tail of chronically low income producers whose bare economic survival relied heavily on protection from imports. However, the industry has undergone substantial structural adjustment since the mid 1960's, in terms of location, herd size and product mix.

Stagnating domestic sales and loss of traditional export market outlets have intensified the downwards pressures on income despite large increases in productivity on individual farms. The result has been a large exodus of farmers from the industry, particularly in Queensland and New South Wales.

Between 1959/60 and 1970/71 about 34 per cent of dairy farmers left the industry. The increase in milk yield per cow averaged 1.7 per cent per year in the 1950's and 3.5 per cent per year in the 1960's. The national statistics indicate that gains in milk yields over the 1970's, however, have been minimal. The earlier rapid increases can be attributed to a number of factors, including advances in pasture quality, animal husbandry and disease control, changes in the breed

composition of the national herd (with a larger proportion of the higher milk yielding friesians being used) and the concentration of manufacturing milk production in the more favourable dairying regions of south eastern Australia.[5,6]

Substantial changes in the end product composition of manufacturing milk have also occurred in recent years. The proportion of whole-milk used for butter has fallen from 62 per cent in 1969/70 to 35 per cent in 1978/79. Over the same period, the proportion used for cheese has risen from 10 per cent to 20 per cent. These trends have coincided with increased penetration of the domestic market for table spreads by margarine, and with changed conditions in the export market for dairy products.

SUGAR

Sugar output rose at an annual rate somewhat under 3 per cent per year in the 1950's, then at 7 per cent in the 1960's and at 3 per cent in the 1970's. Raw cane production is under tight Government control via a system of assigned areas and "mill peaks." Changes in output therefore reflect in the main administrative decisions taken in the light of prospective export market developments. With domestic sugar consumption more or less stable, the expansion of the industry has occurred largely in response to securing long term bilateral contracts and supply quotas with various countries. International Sugar Agreements (ISA's) have been negotiated from time to time in an attempt to achieve stability in world production and prices. Under the latest ISA, Australia's export

entitlement for 1978/79 has been reduced somewhat from the actual level of exports in 1977/78, which were sold outside of any multi-lateral agreement.

OTHER PRODUCTS

Table 10.2 gives production figures (in selected years) for some of the more important products not mentioned so far. Of these, pigmeats are the largest in value terms.

TABLE 10-2 TO GO ABOUT HERE

Output of pigmeats expanded gradually in the 1950's, then rapidly in the 1960's, but has declined slightly in the 1970's. Industry sales are heavily oriented to the domestic market. Since cross price elasticities in consumption between the different types of meat are high, domestic demand for pigmeats is strongly related to the relative prices of pigmeats, beef, lamb and poultry. Furthermore, pigmeat production costs are closely related to the price of feed grains. The comparatively high grain prices and low beef prices of recent years has not been conducive to the expansion of pigmeat output.

For fruits, annual changes in production results, in the main, from variations in yield. The area of bearing trees normally changes only slowly and with considerable lags in response to expected changes in economic returns. There is evidence that the proportion of fruit channelled into various end uses (such as canning, drying and to supply the fresh fruit market), responds fairly readily to changes in the prices offered in the various markets.

Substantial contractions have occurred in the area and volume of production of apples, peaches and pears over the 1970's. These can be attributed to a decline in the competitive position of Australian growers vis-á-vis other southern hemisphere growers (e.g. South Africa) on European markets. This decline has resulted from a number of factors including: (i) unfavourable movements in the value of the Australian dollar compared with the currencies of competing countries; (ii) rapid Australian wage increases (fruitgrowing industries are labour intensive); (iii) large increases in export freight charges (freight charges represent a high proportion of returns and are particularly damaging to Australian growers because of the large distances involved); and (iv) the growing availability during the 1970's of controlled atmosphere storage fruit from within Europe itself. Following the loss of previously profitable export markets, government 'tree-pull' schemes have operated to provide financial encouragement to growers to remove apple, canning peach and pear trees.[7]

MULTIPRODUCT SUPPLY ANALYSIS IN THREE REGIONS

In this section we focus on short run (i.e., year-to-year) supply responses. Such responses are dominated by changes in the product mix as a result of relative price changes, rather than by expansions in overall farm output in response to changes in the general level of farm prices. We have attempted to measure the short run effect on output of changes in expected prices for six of the most important rural products; namely, wheat, wool, lambs, meat cattle (beef and veal), barley and 'other' products.[8] These products account for the major part of the crop-livestock complex of Australian agricultural production and are highly interdependent in that they compete in a very real way for the same resources.

Australia's climate and geography are such that the range of profitable rural production alternatives differs between regions, as does the ease with which the farmer can change his product mix in response to changes in the relative prices of competing commodities. We have therefore carried out our supply analysis in each of the three major regions recognized in the BAE continuous survey of the grazing industry; namely, the Pastoral, Wheat-Sheep and High Rainfall zones. The product categories distinguished and their relative importance in total revenue for each zone are shown in Table 10-3.

TABLE 10-3 TO GO ABOUT HERE

In the structural form of our supply model[9] the percentage change in the planned output of a particular product depends on the percentage change in overall farm activity and on the percentage change in the relative price of that product. To determine the latter relative price movement, a weighted average of the percentage changes in the prices of all competing products in the region is subtracted from the percentage change in the absolute price of the product in question. In these calculations, the weights used (β_{ij}) depend on the relative shares of the different products in the gross value of production at the farm gate and on parameters reflecting the ease of transformation (viz., product-product substitution) between products. In algebraic terms, our basic model for any selected zone is

$$y_i = y + \alpha_i \left(p_i - \sum_j \beta_{ij} p_j\right) ,$$

where y_i is the percentage change in the production of product i; y is the percentage change in aggregate farm output of the zone in question; p_i (p_j) is the percentage change in the expected price of product i (product j); and the α's and β's are parameters, with the latter playing the role of weights and summing to 1. In a zone in which it is difficult to rearrange the output mix when relative prices change, the first term on the right of the equation will dominate, the α_i value for every product being close to zero. Under such circumstances, no matter how large the percentage change in relative (expected) product prices (measured by $(p_i - \sum_j \beta_{ij} p_j)$), the percentage changes in the outputs of all products will be approximately the same, and about equal to y. If i is a product in a zone where i can substitute (or be substituted for) other products with ease, then the α_i value will be a relatively large positive number. In this case we would say that the average 'elasticity of transformation' between i and each of the other products is 'high'. If this is so, then whenever the expected price of i increases by a percentage p_i which exceeds the appropriately weighted average $(\sum_j \beta_{ij} p_j)$ of the percentage increases in the expected prices of all products, the production of i will increase at the expense of a contraction in one or more of the other products. Large elasticities of transformation among the alternative products of a zone thus result in a flexible product mix for that zone.[10]

In order to apply this model, suitable indicators of planned output and expected price were required. Planned output was expressed in units such as crop area sown and number of sheep shorn. This had two purposes: first to remove some of the influence of weather fluctuations on output; and second to remove some of the effect of 'autonomous' trends in

productivity (e.g., of factors reflected in the secular upward trend in wheat yields per ha. or fleece weights). Because we were unable to modify the variables representing outputs of sheep, cattle and 'other products' to abstract from weather influences, a 'weather' variable was constructed and used where appropriate. In addition, a set of dummy variables to reflect the influences of wheat quotas on planned outputs of wheat and competing products were used for the Wheat-Sheep Zone supply system. Expected price series were generated by means of the Koyck-Nerlove 'adaptive expectations' model.[11]

Estimates of the short run (i.e., one-year) supply elasticities of the various products with respect to changes in the expected own price of each of these products and with respect to changes in the expected prices of other competing products are given in Table 10-4 (Pastoral Zone), Table 10-5 (Wheat-Sheep Zone), and Table 10-6 (high Rainfall Zone).

TABLES 10-4, 10-5 & 10-6 TO GO ABOUT HERE

The tables are read as follows. In Table 10-5 the diagonal entry for wheat is 0.766. This indicates that for every 10 per cent increase in the expected price of wheat (with other prices held constant), planned output of wheat in the Wheat-Sheep Zone is estimated to increase by 7.66 per cent in the next crop year. The off diagonal elements in the wheat row indicate that this increased production occurs with the following contractions in the outputs of competing products: wool, 1.52 per cent; sheep, 1.18 per cent; cattle, 2.69 per cent; barley, 2.70 per cent; and 'other' products, 6.87 per cent. Similarly a cross-price elasticity of

- 0.332 for the supply of cattle with respect to the price of wool (Table 10-4) indicates that for every 10 per cent increase in the expected price of wool (other prices remaining constant), planned output of cattle in the Pastoral Zone will fall by 3.32 per cent.

Planned production of wool in the Pastoral Zone is considerably less responsive to its expected price than are cattle or 'grains etc.' output to their respective prices. This result reflects the traditionally wool-oriented activities of the Pastoral Zone (see Table 10-3). Cross-price responsiveness between wool and alternative products in this zone is comparatively high. As noted above, the degree of cross-price responsiveness in each zone depends on the ease of transformation between products, as measured by the pairwise product transformation elasticities; it also depends on the relative scales on which the competing enterprises are conducted (Table 10-3).[12]

In the Wheat-Sheep Zone both own and cross elasticities of supply are high. This is consistent with the view that in the Wheat-Sheep Zone there is considerable scope for farmers to change their output mix in response to relative price changes. The transformation elasticities between products which underlie these cross-price elasticities are smallest between the livestock enterprises (wool-sheep, sheep-cattle and wool-cattle), intermediate in magnitude between product pairs involving a crop enterprise and a livestock enterprise, and largest among the grains. In the Wheat-Sheep Zone one can envisage few technical problems in changing the relative areas of different types of grain in response to changes in relative product prices. On the other hand, there are obvious limits on the extent to which one type of livestock may be replaced by another throughout a zone over a one year period.

In estimating the own and cross price elasticities of supply for the Wheat-Sheep Zone, it was important to see [illegible]

imposed on the production of wheat between 1969/70 and 1973/74. As mentioned above, we used a set of dummy variables for this purpose. Coefficients on the dummy variables indicated that in the Wheat-Sheep Zone, the imposition of wheat quotas caused a sharp decline in the planned output of wheat which was offset by very small expansions in the planned outputs of wool and sheep, and by much larger expansions in the planned outputs of cattle and barley. For the period between 1972/73 and 1973/74 when wheat quotas became more or less inoperative, the results indicated a large expansion in planned output of wheat, a large contraction in the planned output of barley, and moderate contractions in the planned outputs of wool and cattle.[13]

In the High Rainfall Zone (Table 10-6) - - a predominantly wool growing region for most of the post war period - - own supply elasticities for wool and sheep are considerably less than those of the two other product categories distinguished. Similarly, cross price effects are lower for wool output with respect to changes in the price of competing products than for other product and price combinations. Traditionally the zone has been dominated by sheep grazing for both wool and sheepmeats. The emergence of a beef cattle industry on a significant scale took place only in the latter part of the time period of the study. Comparatively low cross price responsiveness between sheep and cattle in this zone is perhaps due to the 'adoption lag' of the relatively new cattle enterprise, a lag which is progressively overcome as cattle gain greater acceptance among sheep men.

CONCLUSION

A distinction has been drawn between the growth in the aggregate level of farm output and the trends occurring in its composition. Australian farm output has grown at around 3 per cent annually in the 1950's and 1960's and at around 2 per cent in the 1970's. Substantial changes have occurred in the rate of growth of output of individual products. The growth in wheat and cattle output has accelerated while growth rates of wool and dairying have declined.

Our discussion has emphasised the multi-product nature of the farms producing the bulk of the major commodities, wool, meat and cereal grains. Consonant with this view, we have carried out our supply analysis within an economic framework sufficiently comprehensive to capture the essentials of product-product competition in response to changing relative prices. We were able to do this in each of the BAE's three major multi-product zones.

The results indicate that own price elasticities are lowest for wool in all zones. In the Pastoral and High Rainfall Zones (which have been traditionally dominated by wool production), wool supply elasticities are lower than those of the Wheat-Sheep Zone (where wool is less dominant). Cattle supply elasticities are comparatively high (≥ 0.3) in all zones. So too are 'other' product supply elasticities (≥ 0.6) in all zones, and supply elasticities for wheat and barley in the Wheat-Sheep Zone (0.8 and 0.5 respectively). In the other zones, wheat and barley are components of 'other' products. In all zones the extent of cross price responsiveness is generally high. However, cross price responses for wool output are generally low.

Our estimates of one year own and cross-price elasticities of supply are considerably higher in absolute value than the estimates from previous Australian agricultural supply studies, which have for the most part not been geared to capture the influences of competition among products.[14] We suspect that unless the supply system is designed to capture the multi-product features of the cereals-livestock regions, estimates of product price responsiveness are likely to be considerably understated, with possibly serious consequences for agricultural policy analysis.

FOOTNOTES

1. For an excellent, more detailed, discussion of these issues, see Keith O. Campbell, Agricultural Marketing and Prices, Cheshire, Melbourne, 1973.

2. For in-depth treatments of innovation and research in Australian agriculture, see chapters 3 and 4 above. [EDITOR : PLEASE CHECK]

3. ABS figures indicate that the number of males permanently or temporarily engaged on rural holdings climbed from 438,000 in 1952 to 447,000 in 1958. Numbers have declined more or less continuously since then to 290,000 in 1977.

4. A report containing a good summary of the characteristics of the Australian beef cattle industry was prepared by the Industries Assistance Commission on the question of short-term assistance for beef cattle producers following the price collapse. See Industries Assistance Commission, Report on Beef, A.G.P.S., Canberra, September, 1975.

5. A log linear regression fitted to national yield data for the period 1963/64 to 1973/74 gave an annual increase in whole milk per cow of 2.73 per cent. A similar regression fitted to a national yield indicator constructed by weighting State yield data with base period (1963/64) State shares of cows in the national herd indicated an annual yield increase of only 2.06 per cent. That is, since 1963/64 a substantial component of Australian yield increases can be attributed to the increasing proportion of Australian milk being produced in the higher yielding States.

6. Institutional marketing arrangements for dairy products are currently undergoing substantial changes. These changes could affect significantly the location of production. For an outline of new marketing proposals for the industry see Industries Assistance Commission, Report on Dairying Industry Market Arrangements, A.G.P.S., Canberra, September, 1976.

7. The loss of export markets has caused severe financial problems for export oriented growers. An excellent summary of the economic conditions in the fruit growing industries is contained in Industries Assistance Commission, Fruitgrowing Reports A, B, C, and D, A.G.P.S., Canberra, January 1976.

8. The 'other' products category is a heterogeneous one consisting mainly of other cereal grains. The exact commodity composition of the 'other' category differs somewhat between the three regions.

9. For a detailed explanation of the analytical tools used, see (i) Peter B. Dixon, David P. Vincent and Alan A. Powell, "Factor Demand and Product Supply Relations in Australian Agriculture : the CRESH/CRETH Production System," Impact of Demographic Change on Industry Structure in Australia, Preliminary Working Paper No. OP-08, Industries Assistance Commission, Melbourne, November, 1976; (ii) David P. Vincent, Peter B. Dixon and Alan A. Powell, "Estimates of the CRETH Supply System in Australian Agriculture", Impact of Demographic Change on Industry Structure in Australia, Preliminary Working Paper No. OP-17, Industries Assistance Commission, Melbourne, October, 1977 and (iii) David P. Vincent, P.B. Dixon and Alan A. Powell, "The Estimation of Supply Response in Australian Agriculture : the CRESH/CRETH Production System", International Economic Reveiw (forthcoming).

10. The elasticity of transformation between two products is the percentage change in the product mix ratio due to a one per cent change in the relative expected price ratio when overall production capacity is fixed. The sign convention employed means that these elasticities are negative. When we speak of a 'large' elasticity, we mean one whose value differs from zero by a relatively large margin.

11. This assumed that $P^*_{it} = \gamma_i P_{it-1} + \gamma_i(1-\gamma_i) P_{it-2} + \cdots + \gamma_i (1-\gamma_i)^{n-1} P_{it-n} + \cdots$

where P^*_{it} is the price expected to prevail in period t for product i from the viewpoint of $(t-1)$;

P_{it-1} the price actually received in period $t-1$ (and similarly for other subscripts) ,

and γ_i is a constant labelled 'the coefficient of expectation' for product i .

Expected price series were generated from the raw price data for various arbitrary assumptions about the coefficients of expectation. In order to limit the range of possibilities, fixed ratios between the coefficients of expectations for the various products were adopted, the ratios depending on the relative variabilities of the price series for the different products. For pragmatic reasons, the infinite lag series was truncated after seven years, lag coefficients being adjusted upwards to sum to unity. The coefficients of expectation used were as follows: for Wool, 0.50; for Sheep, 0.53; for Cattle, 0.39; for Barley, 0.87; and for Other Products, 0.83. In the case

of Wheat we considered the distributed lag model to be inappropriate because of the greater confidence in, and stability of, wheat prices (reflecting the wheat stabilization arrangements). For Wheat, the price series used was based on the actual price received with a two-year lag for the 1952/53 to 1953/54 period and a single year lag thereafter. See Alan A. Powell and F. H. Gruen, "Problems in Aggregate Agricultural Supply Analysis", Review of Marketing and Agricultural Economics, Vol.34, No.3, September 1966, p.10 for a discussion of the reasons underlying this approach.

12. Estimates of the pairwise product transformation elasticities for each zone are contained in Vincent, Dixon and Powell, "The Estimation of Supply Response ...", op.cit..

13. See Vincent, Dixon and Powell, "The Estimation of Supply Response ...", op.cit., for further details on the effects of the wheat quotas.

14. The 'traditional' approach to agricultural supply analysis is a more or less ad hoc one in which equations are specified independently for each commodity. Typically the dependent variable represents commodity output and independent variables include the price of that commodity and variables to reflect the influences of weather, technology and perhaps the relative price of a competing product. While this approach has the advantage of simplicity, it does not provide any systematic framework for capturing the cross-price responses between competing products. The ad hoc approach is more appropriate in the case of commodities produced on specialist farms such as for example horticultural crops and tobacco than for the cereals-livestock commodities. Examples of supply studies using the ad hoc approach include, T.J. Mules, "Supply and Cost Equations for Australian

Agriculture and Applications to Income Determination" (mimeo); University of Adelaide, Department of Economics, July 1973, and A.W. and R.L. Smith, "A Model of the Australian Farm Sector : a Progress Report", Economic Record, Vol.52, No.140, 1977 pp. 462-482.

Exceptions to the ad hoc approach are the multiproduct supply models of Powell and Gruen in the mid 1960's (See Alan A. Powell and F.H. Gruen, "The Estimation of Production Frontiers : The Australian Livestock/Cereals Complex", Australian Journal of Agricultural Economics, Vol.11, No.1, June, 1967, pp. 63-81), and more recently the University of New England's aggregate programming model of Australian agriculture (APMAA). See Long Run Supply Response of Australian Wool Production Relative to the Price of Wool, Beef and Wheat; A Report to the AWC Wool Economics Research Committee by the APMAA Research Team, University of New England, Armidale, February, 1977.

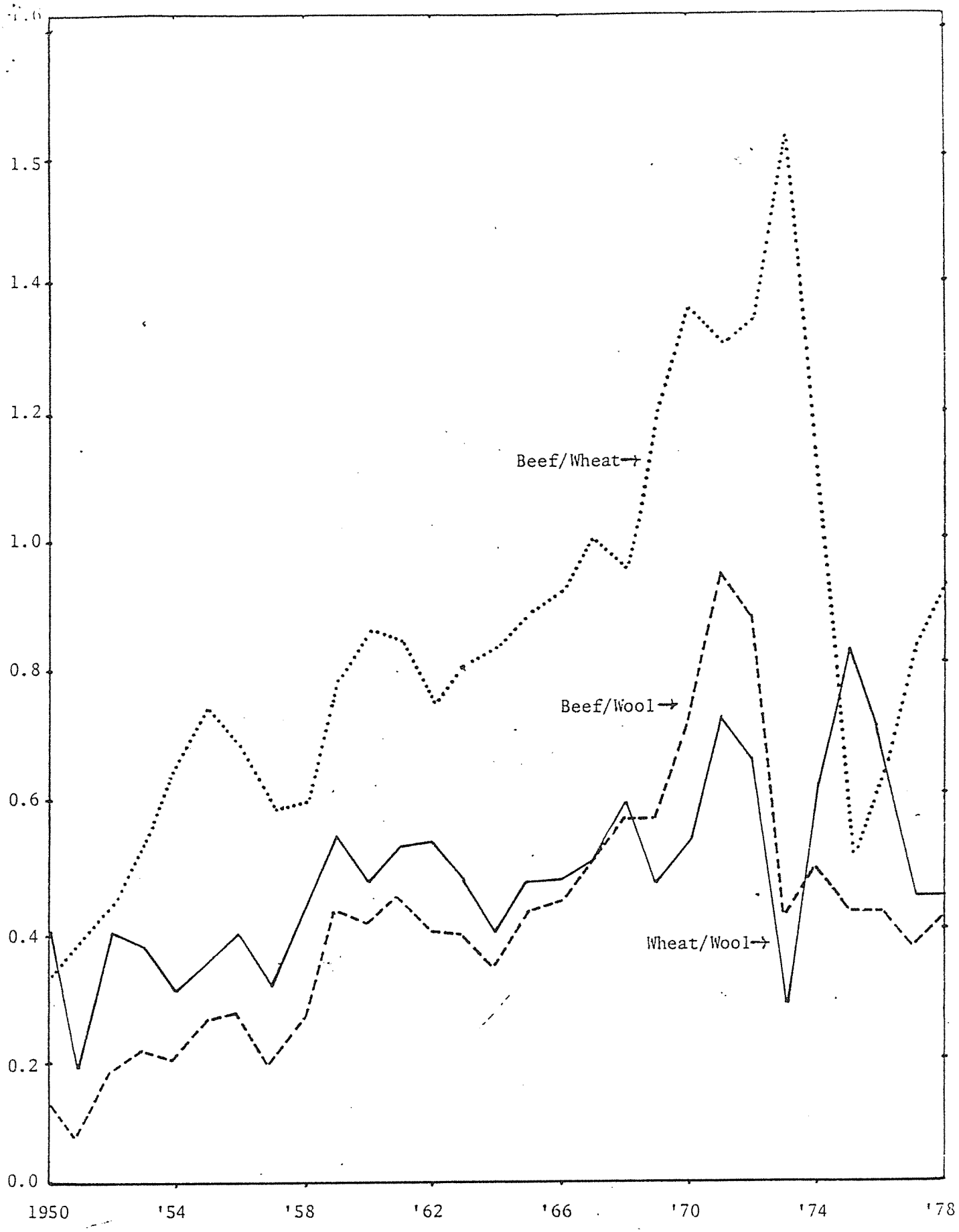

Figure 10-1 : Relative Prices of Major Commodities

Source : Bureau of Agricultural Economics, Quarterly Review of Agricultural Economics (various issues).

TABLE 10-1

COMMODITY OUTPUT GROWTH RATES : 1952/53 TO 1978/79*

(per cent per annum)

Commodity	1952/53 to 1959/60	1960/61 to 1969/70	1970/71 to 1978/79	1952/53 to 1978/79
Wheat	-1.8	5.4	6.1	4.1
Sugar	2.6	7.0	3.1	4.4
Wool	4.2	1.9	-3.0	0.8
Beef and Veal	2.8	2.7	8.5	3.9
Mutton	5.3	1.2	-9.1	0.8
Lamb	5.0	3.8	-4.3	2.8
Whole Milk	1.9	1.6	-4.5	0.2
Pigmeats	2.8	5.0	-0.2	3.7
Rice	7.5	9.3	10.0	7.8
Coarse Grains:				
Barley, Oats, Maize, Sorghum	4.6	2.7	0.6	4.7
Total Agricultural Output	2.9	3.4	1.9	2.9

* Figures in the table were estimated by a semi-logarithmic trend regression fitted by ordinary least squares to data contained in Bureau of Agricultural Economics, Trends in Australian Rural Production, Exports, Income and Prices (various issues).

TABLE 10-2

OTHER PRODUCTS : PRODUCTION AND AREA IN SELECTED YEARS

		1952/53	1966/67	1972/73	1978/79*
Pigmeats	'000 tonne	84	142	236	200
Apples	'000 bearing trees	n.a.	7768	7215	4900
	'000 tonnes	175.8	370.0	412.3	290.0
Pears	'000 bearing trees	n.a.	2039	2168	1350
	'000 tonnes	71.7	152.9	185.0	105.0
Peaches	'000 bearing trees	n.a.	2452	2099	1220
	'000 tonnes	54.7	112.5	113.5	67.5
Citrus	'000 bearing trees	n.a.	4983	5807	5546
	'000 tonnes	131.9	278.3	423.7	444.0
Grapes - all purposes					
	'000 ha.	50.5	51.5	59.7	66.2
	'000 tonnes	569.1	694.7	598.3	786.6

* Subject to revision.

n.a. = Not available.

Sources: Bureau of Agricultural Economics, Trends in Australian Rural Production, Exports, Income and Prices (various issues).

TABLE 10-3

COMPOSITION OF OUTPUT BY ZONE
(1952/53 to 1973/74)

Product	Average Share in Value of Output		
	Pastoral Zone[a]	Wheat/Sheep Zone	High Rainfall Zone
Wool	0.858	0.353	0.545
Sheep	-	0.120	0.158
Cattle	0.102	0.063	0.150
Wheat	Grains, etc. 0.040	0.346	0.147
Barley		0.053	
Other		0.065	

(a) In the Pastoral Zone, wool and sheep (i.e., sheep-meat) are modelled as a single product, whereas in the Wheat-Sheep and High Rainfall Zones, they are treated separately. Sheep are grazed in the Pastoral Zone entirely for wool production. Income from the sale of old wool sheep for slaughter accrues to the wool enterprise. However, in the other zones, climatic conditions are such that two distinct types of sheep are grazed; sheep bred for wool growing and sheep bred for their meat.

TABLE 10-4

PASTORAL ZONE : ESTIMATED OWN AND CROSS PRICE ELASTICITIES[a]

Percentage response one year later in the planned output of: [b]	Product whose expected price changes by 1 per cent		
	Wool	Cattle	Grains, etc.
Wool	0.083	- 0.039	- 0.043
Cattle	- 0.332	1.008	- 0.676
Grains, etc.	- 0.929	- 1.724	2.654

(a) Results based on BAE time series data from 1952/53 to 1973/74.

(b) Actual output may differ from planned output due to droughts, etc.

TABLE 10-5

WHEAT/SHEEP ZONE :
ESTIMATED OWN AND CROSS PRICE ELASTICITIES[a]

Per cent response one year later in the planned output of (b):	Product whose expected price changes by 1 per cent					
	Wool	Sheep	Cattle	Wheat	Barley	'Other'
Wool	0.256	-0.012	-0.020	-0.152	-0.014	-0.044
Sheep	-0.031	0.225	-0.015	-0.118	-0.011	-0.034
Cattle	-0.077	-0.023	0.483	-0.269	-0.025	-0.078
Wheat	-0.254	-0.075	-0.114	0.766	-0.080	-0.245
Barley	-0.078	-0.023	-0.036	-0.270	0.497	-0.078
'Other'	-0.204	-0.061	-0.092	-0.687	-0.064	1.111

(a) Results based on B.A.E. time series data from 1952/53 to 1973/74.

(b) Actual output may differ from planned output due to droughts, etc.

TABLE 10-6

HIGH RAINFALL ZONE :
ESTIMATED OWN AND CROSS PRICE ELASTICITIES[a]

Per cent response one year later in the planned output of (b):	Product whose expected price changes by 1 per cent			
	Wool	Sheep	Cattle	Grains, etc.
Wool	0.060	-0.002	-0.005	-0.053
Sheep	-0.006	0.112	-0.010	-0.097
Cattle	-0.019	-0.010	0.343	-0.314
Grains, etc.	-0.196	-0.104	-0.320	0.620

(a) Results based on B.A.E. time series data from 1952/53 to 1973/74.

(b) Actual output may differ from planned output due to droughts, etc.