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# A PRELIMINARY ANALYSIS OF THE NEW SOUTH WALES PROTEIN FEEDS INDUSTRY

DAVID GODDEN



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# 1 INTRODUCTION

## 1.1 BACKGROUND

The disruption to the world trade in protein feeds following the collapse of the Peruvian fishmeal industry in 1972 and the poor U.S. soyabean harvest of the same year, has led to an upsurge of worldwide interest in the role of protein feeds and their associated products. The search for alternatives to wheat following the imposition of wheat quotas (1969/70) and high prices for oilseed crops in the years after 1972 has accentuated, for Australia, interest in the protein feeds industry. Australian interest involves both the production of protein feed materials, and also the use of protein feeds as alternatives to the traditional protein sources used in intensive livestock production.

For brief introductions to the market situation for protein feeds see [2, 5, 7, 13].

## 1.2 AIM OF THE STUDY

This study was concerned initially with collecting basic data about protein feed production in New South Wales. A sequel to this data collection was an attempt to create a statistical picture of the protein feeds industry in New South Wales.

Of basic concern were the flows of protein feeds from producers to consumers - how much of each feed is produced and what major factors influence the 'how much'. This study was conceived of at an aggregate level on the premise that, since little was known about the industry at the outset of the study, a greater initial return could be expected from a broad approach.

The concentration on aggregated data is not to be taken as implying the unimportance of firm-level analysis. Indeed it was expected that the study would show that the aggregative approach still leaves much unexplained.

## 1.3 PROBLEMS EXPECTED

The study has attempted, where possible, to make use only of data which is publicly available. It was expected that this would limit the accuracy of the view of the industry gained but that two factors would outweigh this shortcoming. As an initial study in the field the project would be considerable even if it only involved the collection and collation of published data. Additionally, the discussion of the findings would be hampered where considerable use was made of confidential data. Statistics privately collected are indicated. All other data is available in the publications referenced.

As well as probable inaccuracies arising from the aggregate nature of the approach, and the almost exclusive use of published data, there is a third source of probable error. Since the study examined the New South Wales industry, it follows that it would be necessary to be able to trace flows into, and out of, the State. Data on international flows are available. However, data on interstate flows is not available. It was not possible within the scope of this study to examine interstate flows. It may be desirable to examine whether interstate trade is important, the magnitude of this trade, and how such trade affects the New South Wales industry.

The structure of the New South Wales protein feeds industry is quite complicated - see Figures 1 and 2. Because of limited resources, it was decided to restrict the study to strategic areas of the industry. For example, since most protein feeds processed into stock feeds pass through abattoirs, oilseed crushers, or are imported, it was decided to ignore the stockfeeds sector. This could be expected to introduce further error, and also limit the applicability of the results. It was felt that such limitations were nevertheless justified.

Figure 1  Product pathways in the protein feeds industry

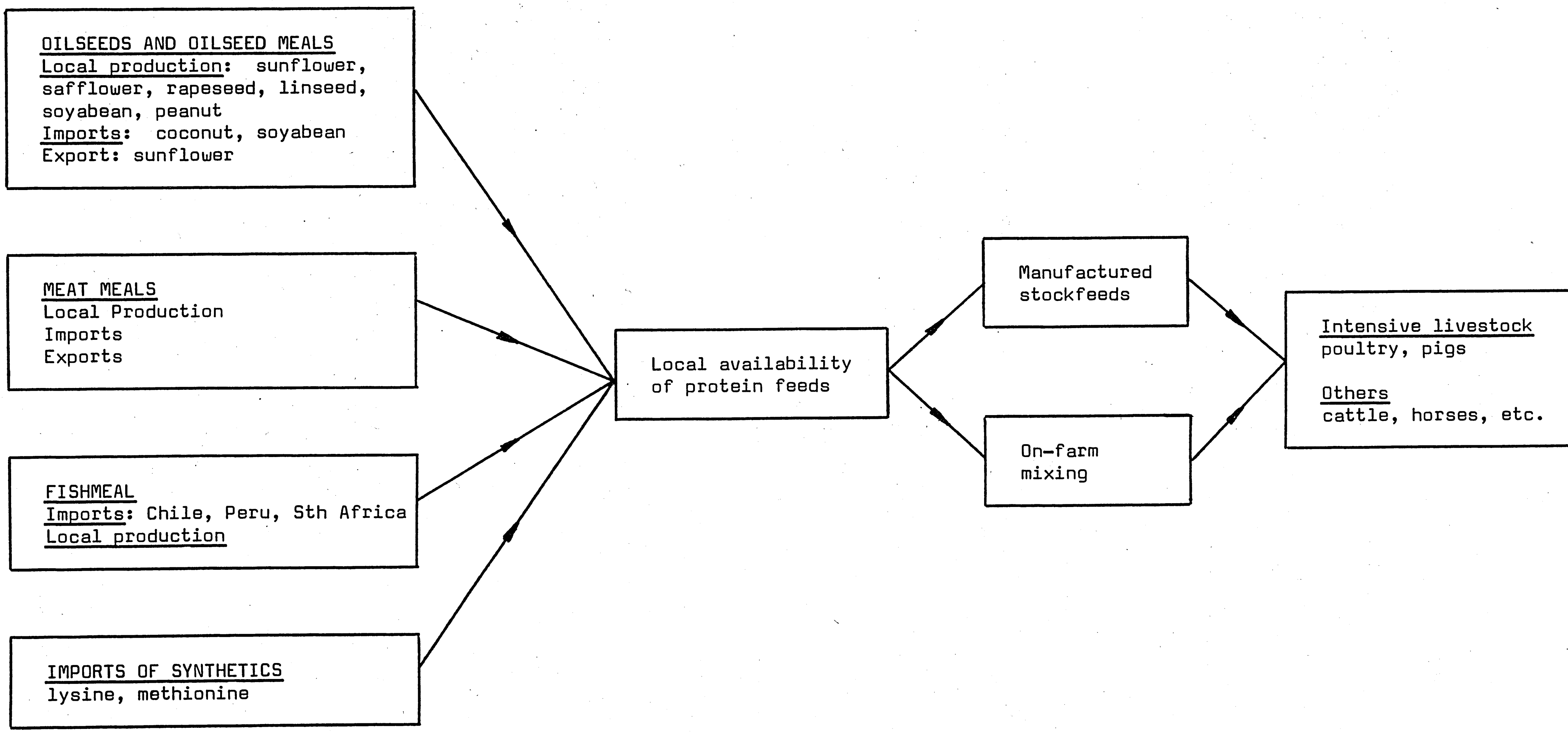
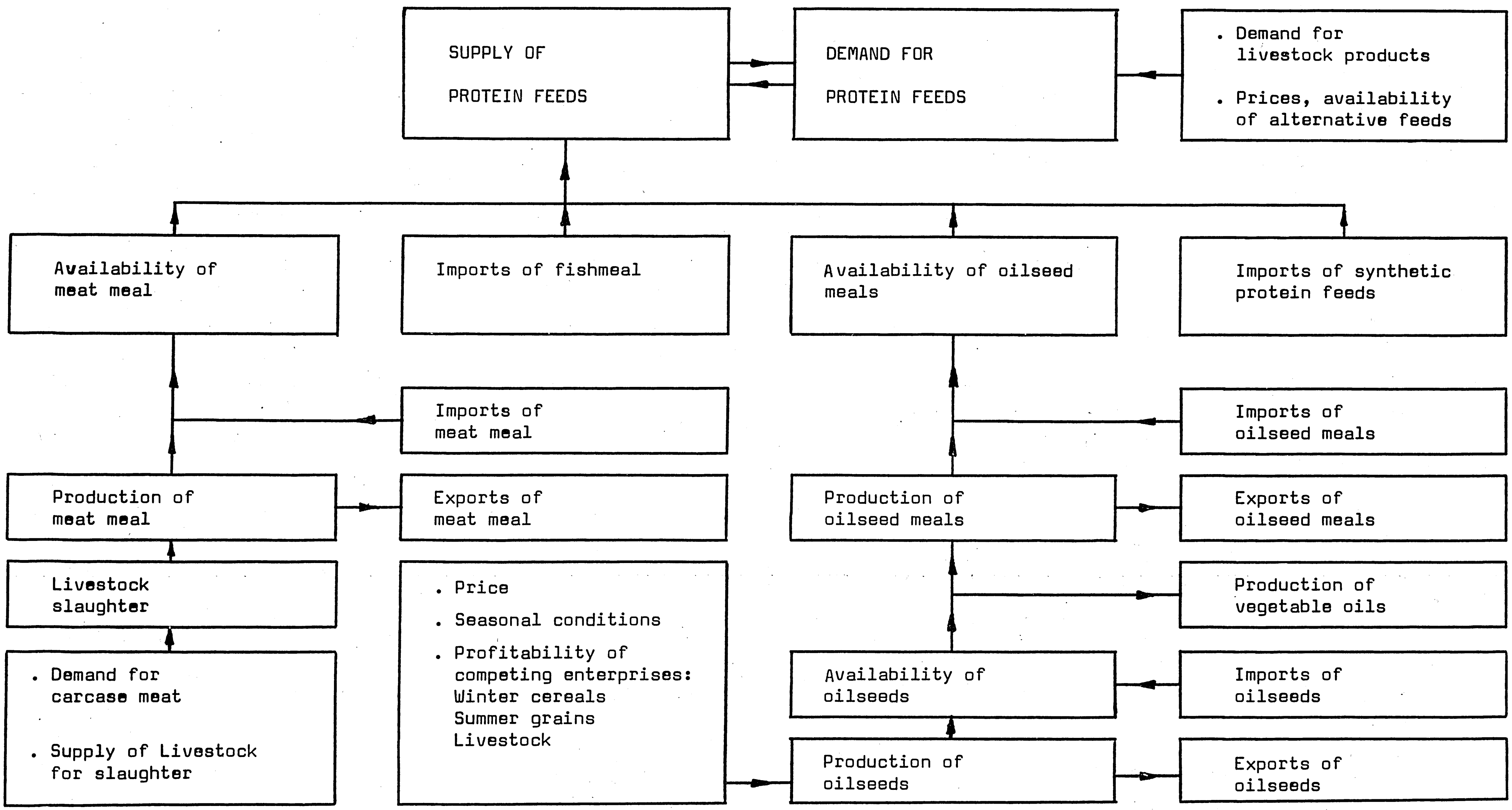


Figure 2  Detailed structure of New South Wales protein feeds industry



A further problem is encountered in the area of oilseed meals supply. Although three oilseed crops (linseed, safflower and cottonseed) have been grown in New South Wales for at least a decade, other oilseed crops are new - at least in a commercial sense. Thus it is impossible to estimate supply curves for these crops using historical data. Except in the case of cottonseed which is a joint product, no attempt has been made to estimate supply relations of New South Wales produced oilseeds.

## 1.4 OUTLINE OF THE STUDY

The qualitative aspects of protein feeds are examined in Section 2 where the various protein feeds, their modes of production, and the particular feeds this study emphasises, are briefly discussed.

Section 3 examines the supply of protein feeds where the qualifications noted in Section 1.3 are important - in particular, it is essential to note that estimated curves refer to a particular point in the industry, usually the processing sector.

Linear regression using ordinary least squares has been used to estimate supply. The assumptions of classical least squares were considered applicable.

Section 4 discusses the implications of the study. Discussion centres on the use of results for policy making, lines of future research, and the likely benefits of future research.

# 2 THE PROTEIN FEEDS

## 2.1 TYPES OF PROTEIN FEEDS

### 2.1.1 Animal Derived Meals

The traditional and most common forms of protein feed for livestock in Australia are meat meals. These meals are either by-products of the slaughter of meat for human consumption or are produced from animals not fit for human consumption. Meat meal forms part of the output of the rendering process which separates offals and condemned meat into fat and non-fat products. Tankage, the non-fat produce of the process is composed of fibre with a relatively high protein content. This material is dried and ground to produce meat meals. Where bone material is present in the ground meal, the resultant product is known as meat-and-bone meal. Meat meals vary in crude protein (CP) content. A frequently made distinction in data collection is between low protein meat meal (less than 50 per cent CP) and high protein meal (above 50 per cent CP).

Bloodmeal, with a crude protein level around 80 per cent, is manufactured from the blood of slaughtered animals.

### 2.1.2 Fishmeal

The small amount of Australian-processed fishmeal consists of processed fish offal. Imported fishmeal, especially that from Chile and Peru, and to a lesser extent South and South-west Africa, is a high protein, high quality meal manufactured from whole fish. The Chilean and Peruvian production comes from anchovies taken from the Humboldt current off the west coast of South America.

### 2.1.3 Vegetable oilseed meals

The crops soyabean, sunflowerseed, rapeseed, linseed, safflowerseed, peanut and cottonseed, all have fibres with a high protein level. Copra has a somewhat lower protein content. After the removal of oil by either mechanical or chemical processes, the resultant fibre or oilseed meal is palatable to most classes of livestock, although palatability varies among meals.

Average oilseed meal yield and raw protein (i.e., crude protein) levels for various oilseeds are shown in Table 2.1.

TABLE 2.1

OILSEEDS - CONVERSION FACTORS

| Oilseed | Meal Yield % | Raw protein in oilseed meal % |
|---|---|---|
| Cottonseed | 79 | 41 |
| Safflower | 70 | 41 |
| Sunflower | 65 | 43 |
| Soyabean | 83 | 46 |
| Peanut (in shell) | 50 | 52 |
| Linseed | 70 | 36 |
| Rapeseed | 61 | 36 |
| Copra | 35 | 22 |

Source: [5] No. 17 November 1972, p.96; the raw protein level for safflower (dehulled) is taken from [19, p.20].

2.1.4 Synthetics

Some of the amino acids which are the constituents of 'protein' can be manufactured by industrial processes [15]. The two most important are lysine and methionine. Although prices are high[1] it is sometimes economic for a feedmixer to include these synthetics in feedmixes, when either the constitutents of the mix are low in these amino acids, or when the prices of 'naturally occurring' meals containing these substances are relatively high.

2.1.5 Other protein feeds

Most naturally occurring feeds, including the cereals, contain some protein - for example, wheat from northern New South Wales can have a protein content as high as 16 per cent. Pastures and forage crops also have highly variable protein levels, as do hay and silage. Furthermore, ruminants can manufacture their own amino acids from non-protein nitrogen sources such as urea. Other products such as skim milk, and feedstuffs manufactured as dairy factory by-products, also form sources of protein.

A 'new' source of protein material which is beginning to excite considerable interest is single cell protein (SCP). As the name suggests, SCP is protein material contained in single cell organisms. Such material is produced by industrial processes in organic material cultures [10].

For the purposes of this study, the feeds listed in sections 2.1.4 and 2.1.5, that is feeds other than meat meal, fishmeal and the oilseed meals, have been ignored. This is more a matter of convenience than an indication that such feeds are unimportant. Cereals, forage crops and pastures have been ignored to limit the size of the project. A secondary reason is that they are used more as sources of energy (carbohydrate) than for protein, although of course the importance of the protein content cannot be discounted.

Nitrogenous materials such as urea have not been considered. The main use of protein feeds has been in the poultry and pig industries and pigs and poultry are monogastric and cannot make use of urea. Milk byproducts have been ignored principally because the move towards more intensive pig production, coupled with the move towards wholemilk supply in New South Wales, has profoundly reduced the importance of milk protein in pig nutrition. Single cell protein is still in the developmental stage and is not commercially available in New South Wales.

In summary this study is concerned with protein feeds of the following origins:

Animal byproducts; meat meal, meat-and-bone meal, and bloodmeal

Fishmeal

Oilseeds; soyabean, sunflower, safflower, rapeseed, linseed, peanut, cottonseed, and copra

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1 1974 prices of pure synthetic lysine were of the order of $4 per kg. This compares with $9.20/kg for available lysine in 50 per cent of CP meat meal ($230/tonne with a 2.5 per cent lysine availability). It must be remembered that meat meal contains other essential amino acids not in synthetic lysine.

## 2.2 STATISTICAL SUMMARY OF PROTEIN FEEDS IN NEW SOUTH WALES

TABLE 2.2

PROTEIN FEEDS IN NEW SOUTH WALES (tonnes)

| Year | Production[1] | | Consumption | | | Net Imports | | |
|---|---|---|---|---|---|---|---|---|
| | Meat Meals | Oilseed Meals | Meat Meals | Oilseed Meals | Fish-meal | Meat Meals | Oilseed Meals | Fish-meal |
| 1965/66 | 65605 | 38669 | 51906 | 43422 | 4433 | 2010 | 10881 | 4401 |
| 1966/67 | 55141 | 36001 | 54372 | 41837 | 7120 | -5763 | 16111 | 6926 |
| 1967/68 | 62840 | 44925 | 60077 | 52359 | 9105 | -1259 | 25062 | 10283 |
| 1968/69 | 61077 | 40434 | 61187 | 44785 | 12725 | -7212 | 16221 | 12921 |
| 1969/70 | 82971 | 56237 | 74479 | 61173 | 11559 | -25092 | 16810 | 10235 |
| 1970/71 | 88792 | 31155 | 81372 | 75506 | 14428 | -16545 | 18260 | 16159 |
| 1971/72 | 103565 | 37626 | 94492 | 68364 | 11570 | -19053 | 10286 | 13175 |

Note: 1 New South Wales production of fishmeal is negligible.

Sources: Production Aggregated from [14].

Consumption Monthly consumption, estimated as the difference between monthly availability in a month (see Appendix 2) and stocks in the succeeding month [14], aggregated for each year.

Net Imports Estimated from [20, 21].

Table 2.2 suggests that the protein feeds are of considerable importance to New South Wales. At average prices for the period of $60/tonne for the meat meals, $100/tonne for the oilseed meals, and $150/tonne for fishmeal the consumption of protein feeds is valued at some $8 million in 1965/66 and some $14 million in 1971/72. Since this value comprised either costs or returns for meat producers, abattoirs, cropping industries, importers, exporters, oilseed crushers, the stock feeds industry, and the intensive livestock industries, the flows of protein feeds are economically significant for many of the major agricultural industries of New South Wales. At March 1975 the price for high protein meat meal was about $120/tonne, 50 per cent CP soyabean meal $240/tonne, and 65 per cent CP fishmeal $325/tonne, giving an estimated value of approximately $20 million assuming protein feed consumption at the same level as for 1971/72.

## 2.3 NUTRITIONAL ASPECTS OF PROTEIN FEEDS

### 2.3.1 Poultry

Although energy is the principal requirement of all poultry diets, the presence of protein material is important in determining growth performance. The ratio between energy content and the crude protein level of the ration influences feed intake, feed conversion, growth rate, body composition and feather condition of growing broilers [12, p.129]. Where protein levels are low, birds attempt to obtain more protein by a larger intake, which results in a high energy intake and a higher fat deposition [12,pp.132-134].

Protein per se is not the important factor however. Since protein is an inclusive name for many amino acids, what is important in selecting so-called protein feeds in rations are the relative levels of the various amino acids.

Table 2.3 indicates typical variations in levels among four of the more important amino acids in 'protein' feeds.

TABLE 2.3

AVAILABLE AMINO ACID - PERCENTAGE COMPOSITION OF FEED

| Feed | Lysine | Methionine | Cystine | Tryptophan |
|---|---|---|---|---|
| Wheat | 0.36 | 0.15 | 0.32 | 0.12 |
| Fishmeal | 5.74 | 1.70 | 0.84 | 0.70 |
| Bloodmeal | 4.62 | 0.59 | 0.67 | 0.65 |
| Meat meal 54% CP | 2.47 | 0.54 | 0.53 | 0.33 |
| Soyabean (expelled) | 2.65 | 0.51 | 1.00 | 0.48 |
| Cottonseed meal | 1.61 | 0.35 | 0.79 | 0.37 |
| Sunflower | 1.30 | 0.47 | 0.78 | 0.45 |
| Linseed | 1.34 | 0.40 | 0.70 | 0.55 |
| Safflower | 0.47 | 0.13 | 0.30 | 0.17 |

Source: [19]

Although poultry have specific requirements for particular amino acids, these levels can be achieved through many mixes of different protein feeds. The optimum feed mix is based not only on physical characteristics of energy, amino acid, vitamin and mineral levels, but also on price. Work at the Poultry Research Station, Seven Hills, New South Wales shows how feed mix composition of protein feeds changes with price [4].

### 2.3.2 Pigs

Like poultry, pigs require 'protein' (that is amino acids) in the diet for healthy growth. Since amino acids cannot be stored, protein feeds must be fed on a daily basis. Pig diets are generally formulated to a crude protein content of about 16-18 per cent. As with poultry, this requirement can be met from a variety of sources, including the basic source of dietary energy such as wheat[3,pp.1-2].

### 2.3.3 Other Livestock

Protein feeds are used in many livestock industries other than pigs and poultry. For example, the stockfeed industry formulates special feeds for animals ranging from horses to rabbits. Most of such feeds include some protein feeds. On the basis of livestock numbers, the only class of livestock, other than pigs and poultry, of probable economic importance to the protein feeds industry is dairy cattle.

The major types of supplements fed to lactating cows are rich in digestible energy. It has been shown that even in environments relatively unsuited to milk production, fertilized improved pastures are generally capable of supplying necessary protein material to dairy cows [17, p.295]. Where pastures have an insufficient protein content, forage crops such as lucerne are frequently the most efficient protein sources. Prepared stock-feeds constitute the other common source of protein material.

Although calves up to an age of about four weeks need protein material it is generally accepted that the best form is either whole or skim milk or milk-derived meals. However for calves in the age range 4 weeks to about 12 weeks meat meals and vegetable protein feeds can be satisfactorily used. This is the period after milk protein becomes non-essential and before rumen micro-organisms in the calf can supply the calf's protein needs from pasture [15].

# 3 COMPONENTS OF THE SUPPLY FOR PROTEIN FEEDS

## 3.1 MODELLING THE PROTEIN FEEDS INDUSTRY

An ideal representation of the protein feeds industry would explain all the pathways illustrated in Figure 2. The model depicted describes a relatively open system, that is, there are a very large number of outside influences. Even with restrictions upon the number of protein feeds examined (see Section 2.1) there is still a vast complex of relationships to be investigated if the structure of Figure 2 is to be quantified. The approach taken below is to attempt to detail salient features of the industry, rather than examine the whole.

The following analytical steps were attempted: (a) an explanation of the determinants of meat meal production; (b) an explanation of the transition of annual oilseed crops into within-year availabilities of oilseed meals; (c) an explanation of other components of protein feed supply, namely imports, exports, and level of stocks. Even this simplistic approach encountered many difficulties the main one being data availability.

Until relatively recently, analytical interest in protein feeds appears to have been directly correlated with the price of meals. As prices rose, so did interest in how the prices of protein feeds were formed. As prices declined, so too did interest. Furthermore, as oilseeds have only been grown in large areas in the past few seasons, it is only recently that interest has arisen in the growing and use of such crops. Overall, these considerations have been reflected in a lack of sustained interest in protein feeds and adequate documentation of production, consumption, trade and prices. Much of the data is in the form of broad aggregates that make analysis practically impossible.

An additional difficulty for research in this area is that the Australian Bureau of Statistics (ABS) only publishes statistical information where there are more than three respondents in an industry group. In the oilseed crushing industry in New South Wales there are only three major crushers of oilseeds other than copra, and only two crushers of copra. Hence, despite any interest in analysing the production of oilseed meals in New South Wales, the only source of disaggregated date has been the crushers themselves.

Despite these difficulties, the following sections represent some progress in understanding the industry.

## 3.2 ANIMAL-DERIVED MEALS

### 3.2.1 Nature of Meat Meal Production Functions

Although the statistical evidence is scant, there seems good reason for considering the production of meat meals as independent of their market. That is, the level of production of these meals is independent of factors such as their price, and is related to economic variables outside the protein feeds industry.

The first evidence for this proposition is revealed through the role the meat meals play in the structure of the meat industry. Ownership of the offals from which a large proportion of the meat meals are produced is vested in the abattoirs, and proceeds from their sale are appropriated by them. Thus, the value of the meal meals to stock producers and stock sellers is the extent to which the sale of the meals reduces killing charges.

The second evidence for the assertion that the meat meals are substantially by-products of the slaughter of meat for human consumption comes from an analysis of the production of meat meal. Consider high protein (higher than 50 per cent CP) meat meal. For the period 1966/67 to 1971/72 the relationship between the production of this meal and the production of meat for human consumption was[2]

$$PR_{MH} = -3.03 + .160PR_H \qquad (3.1)$$
$$(.271) \quad (.006) \quad R^2 = .91$$

where $PR_{MH}$ is the monthly production in thousands of tonnes of high protein meat meal, and $PR_H$ is the monthly production in thousands of tonnes of meat for human consumption. Thus, for the period, for each tonne of high protein meat meal produced there were 6.25 tonnes of meat for human consumption produced.

The 1971 average monthly production of beef, mutton, lamb and pork were 22,718 tonnes, 12,558 tonnes, 10,514 tonnes and 4,010 tonnes, respectively [11], thus the weighted average wholesale value per tonne of total meat production, based on average wholesale values of these four classes of meat [6] was $576. The unweighted average price per tonne of high protein meat meal for 1971 was $92. Thus the value of $92 from high protein meat meal is associated with a value of $3600[3] from meat for human consumption. High protein meat meal therefore represents less than 3 per cent of the value of abattoir output.

### 3.2.2 Estimated Meat Meal Production Functions

If, as suggested above, meat meal production is a by-product of the livestock industry, the production functions of the three classes of meat meal will be most satisfactorily explained by slaughter statistics. The classes against which meat meal production figures were regressed were:

(i) Numbers of livestock slaughtered in the following classes; adult cattle, calves, sheep, lambs, pigs.

(ii) Meat production (in tonnes) of each class in (i).

(iii) Average slaughter weights.

In regression analysis, the average slaughter weights of the five classes of slaughtered animals were never significant. This is not because these variables do not affect the production of animal meals, but for the statistical reason that the data used show only small variations in average slaughter weights over the period analysed (1966/67 to 1971/72). This can be seen in Table 3.1.

TABLE 3.1

AVERAGE CARCASE SLAUGHTER WEIGHTS (KG) OF STOCK (N.S.W.)

| | Mean | Standard deviation |
|---|---|---|
| Adult cattle | 199.5 | 5.5 |
| Calves | 48.6 | 11.3 |
| Sheep | 18.4 | 0.6 |
| Lambs | 16.7 | 0.3 |
| Pigs | 46.3 | 1.2 |

Source: [11].

2 Numbers in brackets are the standard errors of the estimated co-efficients.

3 The product of (value per tonne of meat) x (number of tonnes of meat produced per tonne of high protein meat meal). $576 x 6.25 = $3600.

Tables 3.2 and 3.3 show that high correlations exist among livestock groups in the slaughter numbers and meat production groups, and for this reason, the best relationships between animal meal production and abattoir production are based on total meat production.

TABLE 3.2

CORRELATION COEFFICIENTS - SLAUGHTER NUMBERS

| | Adult cattle | Calves | Sheep | Lambs | Pigs |
|---|---|---|---|---|---|
| Adult cattle | 1.0 | | | | |
| Calves | -0.50 | 1.0 | | | |
| Sheep | 0.77 | -0.55 | 1.0 | | |
| Lambs | 0.70 | -0.53 | 0.65 | 1.0 | |
| Pigs | 0.62 | -0.40 | 0.53 | 0.82 | 1.0 |

TABLE 3.3

CORRELATION COEFFICIENTS - MEAT PRODUCTION

| | Adult cattle | Calves | Sheep | Lambs | Pigs |
|---|---|---|---|---|---|
| Adult cattle | 1.0 | | | | |
| Calves | -0.40 | 1.0 | | | |
| Sheep | 0.78 | -0.32 | 1.0 | | |
| Lambs | 0.74 | -0.37 | 0.65 | 1.0 | |
| Pigs | 0.69 | -0.29 | 0.54 | 0.82 | 1.0 |

The regressions below were based on monthly meat and meat meal production for the period 1966/67 to 1971/72. Figures in brackets beneath co-efficients are standard errors. Degrees of freedom in all cases is 70. All variables are in terms of thousands of tonnes.

$$PR_{BM} = -.135 + .008\ PR_H \qquad (3.2)$$
$$(.018) \quad (.004) \qquad R^2 = .85$$

$$PR_{ML} = .724 + .032\ PR_H \qquad (3.3)$$
$$(.167) \quad (.003) \qquad R^2 = .52$$

$$PR_{MH} = -3.03 + .160\ PR_H \qquad (3.4)$$
$$(.271) \quad (006) \qquad R^2 = .91$$

$$PR_M = -2.31 + .192\ PR_H \qquad (3.5)$$
$$(.293) \quad (.007) \qquad R^2 = .93$$

In equations (3.2) - (3.5) the variables are

$PR_{BM}$ monthly production of bloodmeal

$PR_{ML}$ production of low protein ($<$50% CP) meat meal

$PR_{MH}$ production of high protein ($>$50% CP) meat meal

$PR_M$ production of all meat meal ($PR_{ML} + PR_{MH}$)

$PR_H$ production of meat for human consumption

All the coefficients in equations (3.2) - (3.5) are significant at the 0.01 level. This, together with high $R^2$ values, suggests that these equations represent good estimates of the relevant 'production' functions and that a high degree of confidence is justified in the predictive ability of these equations.

The relatively low $R^2$ value in equation (3.3) is expected because although the production of most high protein meat meal is associated with the production of meat for human consumption, a significant amount of low protein meat meal is produced in manufacturing establishments which do not produce meat for human consumption. However, since the general level of livestock numbers, more or less reflected in meat production, can be expected to be reflected in livestock slaughtered in such establishments, equation (3.3) remains a reasonable predictor of such production.

### 3.2.3 Lagged effects in meat meal production

The regression of the production of meat meals on the previous month's production of meat for human consumption suggests that there is no significant lag in the production of meat meal. There appears to be no significant carry-over of offal from one month to the next, that is, meat meal is manufactured as the offal is produced.

For lags of one and two months, the coefficients remained substantially the same as in equations (3.2) - (3.5) but the $R^2$ values declined.

### 3.2.4 Production interrelationships

Relationships among the meat meals are also of interest as is shown in the correlation matrix, Table 3.4.

TABLE 3.4

CORRELATION COEFFICIENTS FOR PRODUCTION OF ANIMAL-DERIVED MEALS

| | $PR_{BM}$ | $PR_{ML}$ | $PR_{MH}$ |
|---|---|---|---|
| $PR_{BM}$ | 1.0 | | |
| $PR_{ML}$ | 0.68 | 1.0 | |
| $PR_{MH}$ | 0.88 | 0.65 | 1.0 |

$PR_{BM}$, $PR_{ML}$, $PR_{MH}$ and $PR_M$ are as defined above.

Regression equations for the 'independent' factors are[4]

$$PR_{ML} = \underset{(.103)}{1.45} + \underset{(.024)}{.173}\ PR_{MH} \qquad R^2 = .42 \tag{3.6}$$

$$PR_{BM} = \underset{(.012)}{.030} + \underset{(.003)}{.045}\ PR_{MH} \qquad R^2 = .78 \tag{3.7}$$

All variables except the constant term in equation (3.7) are significant at the 0.01 level of significance. The constant term is significant at 0.05.

[4] Equations (3.6) and (3.7) are not causal relationships, but merely illustrate the coefficients of the correlative relationships exhibited in Table 3.4.

These equations reflect the relatively constant proportions of meat offals produced which are used for the different types of meal.

The lower $R^2$ value in equation (3.6) illustrates the substitutability in production between high and low protein meat meal and also that the production of a proportion of these meals is carried out in different types of establishments. The higher $R^2$ in equation (3.7) shows that there is a strong constant relationship between the production of bloodmeal and high protein meat meal, which suggests that regardless of relative prices, the raw material of bloodmeal is not greatly directed towards the manufacture of high protein meat meal.

The foregoing analysis suggests that the production of the meat meals is largely a technical relationship dependent on livestock slaughterings which itself is independent of the market for protein feeds. Therefore, the production of the meat meals is an exogenous variable determined largely by the market for meat for human consumption.

### 3.2.5 Stocks

The stocks of protein meals of animal origin exhibit a cyclical pattern. Although this suggests that there could be a complex of factors determining the level of stocks, investigation suggests that stock levels can be estimated from previous stock levels. A simple explanation of this relationship is that processors and distributors attempt to maintain previous levels of stocks.

Simple autoregressive schemes of the form

$$S_t = a + b\,S_{t-1}$$

where $S_t$ is the stocks of meal in month t, show the following results

$$BM_t = \underset{(24.7)}{45.0} + \underset{(.052)}{.920}\,BM_{t-1} \qquad R^2 = .79 \qquad (3.8)$$

$$ML_t = \underset{(97.1)}{274.} + \underset{(.062)}{.816}\,ML_{t-1} \qquad R^2 = .68 \qquad (3.9)$$

$$MH_t = \underset{(190.)}{486.} + \underset{(.044)}{.891}\,MH_{t-1} \qquad R^2 = .84 \qquad (3.10)$$

where $BM_t$, $ML_t$, and $MH_t$ are the monthly stocks (in tonnes) of bloodmeal low protein meat meal and high protein meat meal respectively. These equations suggest a close correlation between the level of stocks in successive months.

### 3.2.6 Exports of meal meals

New South Wales has consistently exported protein meals of animal origin over the period 1965/66 to 1971/72, although in relation to consumption of meat meals these exports are relatively small. A problem in the analysis of these feeds is that the only quantity and value of export figures collected for meals of animal origin relate to "Flours and meals of meat, offals, fish, crustaceans or molluscs, unfit for human consumption".[5] Consequently any analysis of this data will at best be a crude interpretation of a series of relationships representing the component protein feeds.

Estimations of the export of meat meal in terms of the export price (f.o.b.) relative to the 'home' price of meals, proved non significant. In the absence of a general model of the protein feeds industry including both overseas and Australian demand, no other attempts were made to statistically explain meat meal exports.

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[5] Two other minor classes are also collected, but exports classified in these classes are insignificant.

### 3.2.7 Imports of meat meals

In the period July 1965 to July 1969, New South Wales had sizeable imports of meals of animal origin (other than fishmeal). Table 3.5 indicates the size of this trade.

TABLE 3.5

YEARLY VALUE OF IMPORTS OF ANIMAL-DERIVED MEALS

| Year | $ |
|---|---|
| 1965/66 | 244,000 |
| 1966/67 | 140,869 |
| 1967/68 | 213,190 |
| 1968/69 | 19,200 |
| 1969/70 | 0 |

Source: [21].

It would appear that these imports resulted from an inadequate supply of local meals as a result of reduced supply and increased demand stimulated by drought conditions in eastern Australia, especially in the years 1965/66 and 1967/68.

## 3.3 OILSEED MEALS

Of the oilseed crops, only cottonseed production can be predicted from other relatively independent variables, namely lint production. The other oilseeds - soya, rape, linseed, sunflower, safflower - are not joint products like cottonseed, but single products.

Estimation of supply curves for the oilseed meals other than cottonseed and coconut[6], would require the estimation of supply curves of the oilseed crops. However, estimations of oilseed supply curves using historical data are difficult because these crops have been grown only for a small number of years.[7] The only alternative means of estimating oilseed crops is to simulate supply using programming techniques. It was felt that such a study was beyond the scope of a preliminary analysis.

### 3.3.1 Cottonseed supply curve

It would be useful to predict the amount of cottonseed available for crushing from estimates of forthcoming crops. The relationships between annual cottonseed production and the crop of unginned cotton for New South Wales for the years 1965/66 to 1971/72 is

$$PR_{CS} = \underset{(1.01)}{-0.583} + \underset{(.015)}{.524}\, PR_{UC} \qquad (3.11)$$

where $PR_{CS}$ is the annual production of cottonseed in thousands of tonnes, and $PR_{UC}$ is the annual production of unginned cotton in thousands of tonnes. For statistical purposes, 'lint' is now preferred to 'unginned'.[8] The relationship is taken as lint = 0.37 unginned.

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6 Coconut meal is a product of the extraction from copra of coconut oil used primarily in margarine manufacture. See below for analyses of copra imports.

7 Some preliminary work likely to be of assistance in attempting to estimate these relations has recently been published regarding coarse grains [21].

8 Quarterly Review of Agricultural Economics, Vol. 26, No. 3, July 1973, p.211 fn.6.

Hence equation (3.11) becomes

$$PR_{CS} = 0.583 + 1.42\ PR_L \qquad (3.12)$$

where $PR_L$ is lint production in thousands of tonnes, and the statistical significance of relation is identical to that in (3.11) above.

Further, since cottonseed has a meal yield of 0.79[9] cottonseed meal production is related to lint production as follows

$$PR_{CM} = 0.460 + 1.12\ PR_L \qquad (3.13)$$

where $PR_{CM}$ is cottonseed meal production in thousands of tonnes.

### 3.3.2 Monthly availability of oilseed meals

Even if models can be constructed to predict annual harvest of oilseeds, a substantial problem remains in converting annual harvests into monthly meal availability through the year The most important component in predicting this availability is the rate at which an annual oilseed harvest is crushed. Tables 3.6 and 3.7 show oilseed crushing data for New South Wales.

TABLE 3.6

NEW SOUTH WALES AVERAGE MONTHLY CRUSHING RATES FOR ALL OILSEEDS 1965/66 – 1971/71

| Month | Rate (tonnes) | Standard Deviation (tonnes) |
|---|---|---|
| January | 3510 | 1430 |
| February | 4040 | 930 |
| March | 4080 | 630 |
| April | 4090 | 820 |
| May | 4530 | 920 |
| June | 3910 | 1330 |
| July | 4470 | 1190 |
| August | 4240 | 1520 |
| September | 4140 | 1430 |
| October | 4300 | 1370 |
| November | 3950 | 1430 |
| December | 3850 | 1260 |

Source: [14].

TABLE 3.7

NEW SOUTH WALES AVERAGE MONTHLY CRUSHING RATE FOR STATE GROWN OILSEEDS 1965/66 – 1971/72

| Month | Rate (tonnes) | Standard Deviation (tonnes) |
|---|---|---|
| January | 2480 | 1690 |
| February | 3030 | 1230 |
| March | 2580 | 1330 |
| April | 2970 | 1140 |
| May | 3140 | 1580 |
| June | 2110 | 1760 |
| July | 3270 | 1440 |
| August | 3070 | 1650 |
| September | 1620 | 1560 |
| October | 2620 | 1030 |
| November | 2520 | 1230 |
| December | 2460 | 1400 |

Source: [14, 18, 20, 21].

9 See Table 2.1

Because most oilseeds now crushed in New South Wales were not processed over the sample period 1965/66 to 1971/72, it is impossible to estimate the average amounts of the various crops which are crushed in different months of the year. Although data on the crushing of oilseeds is available from processors, it is not possible to model the rate at which oilseed is produced. This means that a major portion of the New South Wales protein feeds industry cannot be modelled and is a critical factor limiting the usefulness of analytic models of the New South Wales protein feeds industry.

### 3.3.3 Imports of oilseed meals

#### Soyabean meal

Consistently large amounts of soyabean meal entered New South Wales in the period 1965/66 to 1971/72 and the average monthly value of these imports for the period was $140,000.

A simple linear regression of soyabean meal imports on the import price of soyabean was statistically unsatisfactory. Results of fitting soyabean meal imports in multiple regression models are shown in Table 3.8 where each row represents a regression equation and the included variables are indicated by a zero (0).

TABLE 3.8

REGRESSION EQUATIONS ESTIMATED WITH SOYABEAN MEAL IMPORTS INTO NEW SOUTH WALES AS DEPENDENT VARIABLE

| Equation | Independent Variables | | | | | | | | | | | | | | $R^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k | l | m | n | |
| 1 | 0 | 0* | 0 | | | | | | | | | | | | .09 |
| 2 | | 0* | | 0 | 0 | | | 0 | | | | | | | .09 |
| 3 | | 0* | | 0 | | | 0 | | | | | 0 | | | .09 |
| 4 | | 0 | | | | | | | | 0 | 0 | | | | .07 |
| 5 | | | | | | | | | | | | | 0 | 0 | .08 |
| 6 | | 0* | | 0 | | | | | | 0 | 0 | | | | .09 |
| 7 | | 0* | | | | 0 | | | | | | | | | .07 |
| 8 | | 0* | | 0 | | | | | | | | | | | .09 |
| 9 | | 0 | | | | | | | 0* | | | | | | .29 |
| 10 | | | | 0 | | | | | | | | | 0 | 0 | .10 |
| 11 | | 0* | | | | 0* | | | 0* | | | | | | .39 |
| 12 | | 0* | | | | | | | 0* | 0* | 0 | | | | .32 |
| 13 | 0* | 0* | 0 | | | | | | 0* | | | | | | .33 |

Notes: Independent Variables

- a Price of fishmeal imports
- b Price of soyabean meal imports
- c Price of 50% CP meat meal
- d Stock of oilseed meals
- e Stock of animal-derived meals
- f Production of oilseed meals
- g Production of animal-derived meals
- h Stock of fishmeal
- i Availability of oilseed meals (see Appendix 2)
- j Availability of animal-derived meals (see Appendix 2)
- k Availability of fishmeal (see Appendix 2)
- l Fishmeal imports
- m Relative price of soyabean meal imports to fishmeal imports
- n Relative price of soyabean meal imports to meat meal 50% CP

#### Significance of Variables

Variables included in each equation are indicated by a zero (0). The variables marked with an asterisk were significant at the 5 per cent level.

Although equation 11 is the best estimator of soyabean meal imports both in terms of variation accounted for and number of significant variables, equation 9 indicates that by far the most important contribution to the explanation of variability is made by variable i (availability of oilseed meals). Since a correlation between soyabean meal imports and availability of all oilseed meals could be expected, little new knowledge is contributed by this analysis.

Coconut meal

Copra is imported into New South Wales primarily for the extraction of coconut oil, widely used as an edible oil. Simple linear regression between import quantities and import prices were not statistically significant. More complex import functions were not estimated because this would have required a study of the edible oils market.

Other oilseeds and oilseed meals

Soyabeans entered New South Wales in large quantities in only five separate months in the survey period. These months were July, September, October, and November of 1970, and March 1972. The total value of these five months of shipment was $1.04 million.

Large imports of linseed entered New South Wales on six occasions in the survey period. These were February, March, and April of 1968, and May, July, and September of 1969. The value of these shipments was $2.11 million. There were no other shipments in that period.

There have been continuing shipments of 'other', that is unspecified, oilseeds over the survey. Most shipments have been small, with seven exceptions. These months of large shipment were February, March, and May of 1968, May, September and November of 1969, and June 1972. The value of these shipments was $3.82 million.

Oilseed meal imports other than soyabean meal were sporadic over the survey period with some moderately large shipments. There were nine months with significant imports, which had a combined value of $155,000. No attempt was made to analyse statistically any of these infrequent importations of oilseeds or oilseed meals.

### 3.3.4 Exports of oilseeds and oilseed meals

Exports of New South Wales produced oilseeds or oilseed meals in the survey period 1965/66 to 1971/72 were mainly either trifling or sporadic, for example 'other' oilseed exports were practically non-existent until May 1971. In the thirteen months May 1971 to June 1972 $4.03 million of unspecified oilseeds were exported from New South Wales.

The aggregated export class 'oilseed meals other than soya' show a slightly different picture. Moderate amounts of these unspecified meals were exported from New South Wales from May 1967 to January 1972. A simple regression of export quantity $X_{OM}$ on average export price $P_X$ reveals the mildly significant relationship

$$X_{OM} = \underset{(185.)}{1123.} - \underset{(2.66)}{7.07}\, P_X \qquad R^2 = .14 \qquad n = 45 \qquad (3.14)$$

Both coefficients are significant at the .02 level of significance.

Two factors suggest that this result is not of great significance. The amount of these exported meals relative to New South Wales consumption is relatively small and the low $R^2$ suggests that little of the variation has been accounted for.

### 3.3.5 Stocks of oilseed meals

As with the meals of animal origin, a simple autoregressive scheme is useful in explaining much of the variation in levels of stocks. A scheme of the form

$$S_t = a + b\ S_{t-1}$$

where $S_t$ is the level of stocks in time t yields the following relation for total oilseed meal stocks

$$OM_t = 4453 + .504\ OM_{t-1} \qquad (3.15)$$
$$(.978) \quad (.098) \qquad R^2 = .26 \quad n = 76$$

where $OM_t$ is the stock of oilseed meals in tonnes for month t.

Since the oilseed meal group contains the two basic sub-groups of 'coconut' and 'other' meals, it is desirable to disaggregate the oilseed meal variable, which is possible for the latter part of the survey period. Disaggregation yields the two equations

$$COC_t = 78.5 + .873\ COC_{t-1} \qquad (3.16)$$
$$(59.3) \quad (.080) \qquad R^2 = .74 \quad n = 44$$

$$OOM_t = 1183 + .895\ OOM_{t-1} \qquad (3.17)$$
$$(614.8) \quad (0.65) \qquad R^2 = .84 \quad n = 37$$

where $COC_t$ is the stock in tonnes of coconut meal for month t and $OOM_t$ is the monthly stock in tonnes of oilseed meals other than coconut.

As for the meat meals there is a strong suggestion that the level of monthly oilseed meal stocks is closely related to the level of stocks in the previous month and that stock holders attempt to maintain monthly stocks at previous levels. A comparison between equations (3.16), (3.17), and (3.15) suggests a marked independence between the market for coconut meals and other oilseed meals.

## 3.4 FISHMEAL

### 3.4.1 Imports

Fishmeal imports have been consistently large over the period 1965/66 to 1971/72. A crude estimate of value of monthly import is $120,000. As with soyabean meal and copra, an attempt was made to estimate a simple relationship between fishmeal imports and the price of that meal (f.o.b. port of shipment) but it was not statistically significant.

Multiple regression models with fishmeal imports as the dependent variable were estimated and the results are shown in Table 3.9 where each row represents a regression equation and the included variables are indicated by a zero (0).

TABLE 3.9

REGRESSION EQUATIONS ESTIMATED WITH FISHMEAL IMPORTS INTO NEW SOUTH WALES AS DEPENDENT VARIABLE

| Equation | Independent Variables | | | | | | | | | | | | | | $R^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k | l | m | n | |
| 1 | 0 | 0 | 0 | | | | | | | | | | | | .03 |
| 2 | 0 | | | | | | | | | | 0* | 0 | | | .40 |
| 3 | 0 | | | 0 | 0 | | | | | | | | | | .004 |
| 4 | 0 | | | | | 0 | 0 | | | | | | | | .04 |
| 5 | 0 | | | | | | | | | | | | | | .01 |
| 6 | 0 | 0 | 0 | | | | | 0* | | | | | | | .14 |
| 7 | 0 | | | | | | | 0* | | | 0* | 0 | | | .51 |
| 8 | 0 | | | 0 | 0 | | | 0* | | | | | | | .14 |
| 9 | 0 | | | | | 0 | 0* | 0* | | | | | | | .17 |
| 10 | 0 | | | | | | | 0* | 0 | 0 | | | | | .13 |
| 11 | | | | | | | | 0* | | | | | 0 | 0 | .14 |
| 12 | | | | | | | | | | | 0* | | 0 | 0 | .42 |
| 13 | | | | | | | | | | | | | 0 | 0 | .01 |

TABLE 3.9 (Continued)

Notes: Independent Variables

a Price of fishmeal imports
b Price of soyabean meal imports
c Price of meat meal 50% CP
d Stock of oilseed meals
e Stock of animal derived meals
f Production of oilseed meals
g Production of animal-derived meals
h Stock of fishmeal
i Availability of oilseed meals (see Appendix 2)
j Availability of animal-derived meals (see Appendix 2)
k Availability of fishmeal (see Appendix 2)
l Imports of soyabean meal
m Relative price of fishmeal imports to soyabean meal imports
n Relative price of fishmeal imports to meat meal 50% CP

Significance of Variables

Variables included in each equation are indicated by a zero (0). The variables marked with an asterisk were significant at the 5 per cent level.

As Table 3.9 shows, no significant relation has been found between fishmeal imports and variables related to other protein feeds. The only significant relationships on the basis of $R^2$ values, are 2, 7, and 12. The relatively higher $R^2$ value in equation 7 is due to the high correlation between stocks of fishmeal and availability of fishmeal (the correlation between these variables being 0.85). In view of this, equation 7 does not provide a sound basis for understanding fishmeal imports. Since equations 2 and 12 have relationships between fishmeal imports and the independent variables that were expected,[10] no new insights are provided by the analysis.

Despite the wide range of estimations employed, no satisfactory statistical explanation for the level of fishmeal imports to New South Wales has been found.

### 3.4.2 Fishmeal stocks

A simple explanation of fishmeal stocks was estimated in terms of a simple first order autoregressive scheme as follows

$$FM_t = \underset{(225)}{637} + \underset{(.087)}{.725}\, FM_{t-1} \qquad R^2 = .53 \qquad n = 63 \qquad (3.18)$$

where $FM_t$ is the monthly level of fishmeal stocks in tonnes.

While this estimator of fishmeal stocks is obviously inferior to the corresponding relations for the meat and oilseed meals, it still suggests a high correlation between fishmeal stocks in successive months.

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[10] Since for fishmeals Availability = $Stocks_{t-1}$ + $Import_t$ (Appendix 2) there is an a priori relationship between fishmeal imports and stocks of fishmeal and availability of fishmeal.

## 4 SUMMARY

The preceding analysis has achieved two results. Firstly, much uncollated data relating to the use of protein feeds in New South Wales has been collected and condensed. Secondly, the analyses of this data have added to understanding production and supply relationships for protein feeds in New South Wales.

Regarding the data, two important areas of deficiency still remain. The first, the absence of data relating to interstate trade, is not a new problem, but is one which is a source of continuing frustration to the analyst. Secondly, data relating to the production of particular oilseed meals is not publicly available.

The attempt to construct a model of the protein feeds industry successfully achieved estimations of production relationships for meat and blood meals and an understanding of movements in the stocks of protein feeds. The deficiencies of this part of the study include the inability to model production of oilseeds and oilseed meals and also the inability to explain trade in any protein feed.

The research reported here has been useful for providing a partial description of the protein feeds market in New South Wales.

# APPENDIX 1

## DATA

As with most economic analyses, the scope of this study has been limited by the availability and quality of the data. This appendix sets out sources of, and reservations about, the data used in this study. Important sets of data used in the study are reproduced in appendices 2 and 3.

## 1 NEW SOUTH WALES PRODUCTION

### 1.1 Meals of Animal Origin

#### Quantities

Production and stocks of bloodmeal, meat meal, less than 50 per cent CP, and meat meal, more than 50 per cent CP, are available in [14]. Four individual months of production and stock figures were unavailable in this series and averages of previous and succeeding months were used to estimate the missing figures.

#### Prices

A sample of twenty-eight abattoirs were requested to provide monthly prices of meals which they produced. Of the replies, fourteen usable series of meat meal or meat-and-bone meal, 50 per cent CP, and six usable series of bloodmeal, 80 per cent CP, were obtained. From these series, arithmetic averages of monthly prices of 50 per cent CP meat meal and 80 per cent bloodmeal were generated. Prices of meat meal with less than 50 per cent CP were found to be correlated with those of 80 per cent CP meat meal (see Appendix 4).

### 1.2 Fishmeal

Production of fishmeal in New South Wales was obtained from [14]. Stocks of fishmeal were also established from this source. The import price series calculated from the import statistics [21] was used in analyses involving fishmeal prices, since no other price series was available.

### 1.3 Oilseed meals

#### Quantities

Annual productions of oilseeds in New South Wales were obtained from [18]. Crop statistics not covered in this publication were obtained from [ 1] and unpublished sources in the Division of Marketing and Economics, New South Wales Department of Agriculture.

Total monthly production of all oilseed meals, and total monthly stocks of all oilseed meals were obtained from [14].

Six months of data in 1969/70 and five months in 1970/71 were not recorded for reasons relating to confidentiality of data. An attempt to obtain production data from the firms involved proved impossible so production and stocks were estimated as the average of the recorded months on either side of the missing data.

#### Prices

Two series of oilseed meal prices were estimated. For the first, it was assumed that arbitrage amongst oilseed meals leads to fairly constant price relationships amongst these meals. An import price series for soyabean meal, calculated from import statistics [21] was used as an exogenous variable in analyses requiring the 'price' of oilseed meals.

For the second series of oilseed meal prices, price series of seven different oilseed meals (safflower, sunflower, soyabean, rapeseed, cottonseed, linseed and coconut) were weighted according to the estimated relative importance of these meals in New South Wales. The estimated relative importance was calculated from New South Wales production of oilseeds [18] and State imports [21] and exports [20].

## 2 TRADE

Monthly imports of meals and associated products for 1965/66 to 1971/72 were taken from [21]. Monthly exports of similar products for 1966/67 to 1971/72 were extracted from [20]. Export data was not available on a monthly basis for 1965/66. Both tables contain the quantity of the commodity traded and the value of this trade. These tables were used to construct time series of prices of imported and exported commodities associated with protein feeds (price = value of trade/quality traded).

## APPENDIX 2

**ESTIMATED MONTHLY AVAILABILITY OF PROTEIN FEEDS, IN TONNES, FOR N.S.W.**

(See explanatory notes following the data)

| | Bloodmeal | Meat Meal (less than 50% CP) | Meat Meal (more than 50% CP) | Fishmeal | Oilseed Meals |
|---|---|---|---|---|---|
| 1965 July | 317 | 2524 | 4693 | 1473 | 5730 |
| | 290* | 2305* | 4022* | 2853* | 5601* |
| | 234 | 2221 | 3446 | 945 | 4908 |
| | 264 | 2447 | 3760 | 1262 | 4925 |
| | 380 | 3103 | 4479 | 1022 | 6564 |
| | 448 | 2608 | 4942 | 1285 | 5845 |
| | 477 | 2915 | 5098 | 1039 | 8532 |
| | 569 | 3531 | 7284 | 920 | 12695 |
| | 771 | 3799 | 8586 | 934 | 41438 |
| | 811 | 3995 | 8792 | 1029 | 21397 |
| | 915 | 5560 | 9546 | 920 | 14951 |
| | 828 | 6387 | 9114 | 2117 | 10632 |
| 1966 July | 734 | 5956 | 8842 | 1437 | 12940 |
| | 535 | 5005 | 7482 | 693 | 9916 |
| | 495* | 3583* | 7570* | 1400* | 7842* |
| | 465 | 3418 | 7191 | 2190 | 6637 |
| | 442 | 3567 | 6718 | 985 | 7830 |
| | 445 | 3381 | 6051 | 1779 | 8714 |
| | 406 | 2733 | 5548 | 1844 | 8043 |
| | 437 | 2584 | 6005 | 1353 | 10847 |
| | 586 | 2909 | 6379 | 1559 | 11617 |
| | 548 | 2569 | 6367 | 1350 | 14550 |
| | 581 | 3082 | 6545 | 1662 | 12462 |
| | 559 | 2877 | 6689 | 1323 | 10238 |
| 1967 July | 518 | 2747 | 7212 | 982 | 10673 |
| | 610 | 2836 | 6157 | 774 | 11664 |
| | 557* | 3030* | 6203* | 2411* | 19109* |
| | 517 | 3094 | 6011 | 1321 | 19569 |
| | 514 | 3464 | 6879 | 2708 | 17706 |
| | 577* | 3519* | 7112* | 2954* | 16405* |
| | 580 | 3566 | 7543 | 2356 | 14986 |
| | 545 | 3407 | 8042 | 1023 | 13284 |
| | 649 | 3723 | 8687 | 2100 | 12513 |
| | 707 | 3598 | 8580 | 1494 | 11168 |
| | 814 | 3937 | 9338 | 2232 | 11733 |
| | 718 | 3248 | 9042 | 2265 | 9703 |
| 1968 July | 782 | 3500 | 9118 | 2175 | 9894 |
| | 694 | 3589 | 8836 | 1513 | 9596 |
| | 760 | 3016 | 8254 | 2833 | 9357 |
| | 646 | 3415 | 7845 | 1645 | 7589 |
| | 641 | 3205 | 7446 | 3371 | 6081 |
| | 673 | 3447 | 7011 | 2346 | 5774 |
| | 769 | 3463 | 7932 | 2120 | 6317 |
| | 803 | 2973 | 8005 | 2640 | 8877 |
| | 877 | 2907 | 8403 | 2313 | 9184 |
| | 854 | 3075 | 9245 | 5294 | 8993 |
| | 859 | 2910 | 8875 | 5346 | 10654 |
| | 823 | 3345 | 8916 | 3286 | 11612 |

| | Bloodmeal | Meat Meal (less than 50% CP) | Meat Meal (more than 50% CP) | Fishmeal | Oilseed Meals |
|---|---|---|---|---|---|
| 1969 July | 747 | 3089 | 8166 | 2245 | 12949 |
| | 639 | 2839 | 7862 | 1444 | 14851 |
| | 572 | 2964 | 7510 | 854 | 15750 |
| | 524 | 2646 | 7748 | 7111 | 15171 |
| | 475 | 2254 | 6558 | 2941 | 15979 |
| | 559 | 2745 | 7237 | 2461 | 17584 |
| | 664 | 2206 | 6822 | 1419 | 16278 |
| | 641 | 3658 | 6886 | 6353 | 17680 |
| | 574 | 2886 | 6348 | 3062 | 17463 |
| | 592 | 3127 | 8001 | 2284 | 17566 |
| | 570 | 2885 | 7673 | 2515 | 17979 |
| | 538 | 3324 | 7211 | 1969 | 17065 |
| 1970 July | 617 | 3338 | 7343 | 894 | 18060 |
| | 536 | 2823 | 7122 | 5160 | 17560 |
| | 601 | 2744 | 7231 | 7615 | 16419 |
| | 670 | 2639 | 6558 | 4319 | 16215 |
| | 647 | 2353 | 7042 | 3509 | 16080 |
| | 710 | 3031 | 8081 | 4157 | 16052 |
| | 670 | 2961 | 8145 | 3192 | 15981 |
| | 655 | 3418 | 8591 | 2284 | 17017 |
| | 852 | 3570 | 9519 | 10856 | 15936 |
| | 851 | 3555 | 9730 | 5360 | 16734 |
| | 913 | 3767 | 10150 | 4821 | 17934 |
| | 944 | 3511 | 10507 | 4522 | 15153 |
| 1971 July | 985 | 3886 | 10529 | 2614 | 15588 |
| | 844 | 3390 | 8790 | 2306 | 15653 |
| | 799 | 3235 | 8477 | 6854 | 17018 |
| | 714 | 3617 | 7969 | 4677 | 17714 |
| | 791 | 4106 | 9391 | 4465 | 15756 |
| | 828 | 4634 | 10476 | 3899 | 18710 |
| | 666 | 4272 | 9727 | 3037 | 17403 |
| | 810 | 4423 | 10114 | 7920 | 17665 |
| | 776 | 4572 | 11208 | 4609 | 16263 |
| | 965 | 4431 | 10481 | 4568 | 16648 |
| | 1151 | 4967 | 10291 | 3263 | 19688 |
| 1972 July | 1276 | 3787 | 10701 | 2811 | 19464 |

<u>Notes:</u> 1 Several months of data were unobtainable. Average of observations immediately preceding and succeeding data gaps were used as estimates and are marked with an asterisk.

2 Export data was not available for 1965/66 (see Appendix 1) and exports have been taken as zero in the construction of this appendix.

3 For any month t :

$$\text{Availability}_t = \text{Stocks}_{t-1} + \text{Imports}_{t-1} + \text{Production}_t - \text{Exports}_t$$

## APPENDIX 3

### PRICE SERIES (DOLLARS)

| | Bloodmeal | Meat Meal (50% CP) | Soyabean Meal (Import) | All Oilseed Meals | Fishmeal (Import) |
|---|---|---|---|---|---|
| July 1965 | 109.5 | 95.5 | 118 | 80.36 | 117 |
| | 111.5 | 99.7 | 160 | 91.99 | 270 |
| | 115.7 | 103.7 | 116 | 79.80 | 123 |
| | 117.2 | 113.7 | 143 | 87.28 | 113 |
| | 123.6 | 113.0 | 153 | 90.05 | 129 |
| | 131.8 | 113.2 | 108 | 77.58 | 118 |
| | 131.8 | 109.5 | 118 | 82.83 | 120 |
| | 129.1 | 107.8 | 120 | 83.38 | 121 |
| | 133.3 | 103.2 | 107 | 79.78 | 121 |
| | 133.3 | 102.0 | 140 | 88.92 | 140 |
| | 131.4 | 98.5 | 148 | 88.73 | 158 |
| | 129.3 | 95.0 | 102 | 75.02 | 165 |
| July 1966 | 130.0 | 94.3 | 138 | 75.25 | 125 |
| | 130.0 | 94.7 | 199 | 84.58 | 175 |
| | 129.1 | 96.6 | 168 | 79.54 | 147 |
| | 128.8 | 100.0 | 168 | 79.84 | 125 |
| | 128.0 | 99.8 | 168 | 78.35 | 174 |
| | 129.7 | 97.4 | 137 | 71.71 | 166 |
| | 132.1 | 95.3 | 115 | 68.35 | 160 |
| | 132.1 | 94.8 | 127 | 70.48 | 160 |
| | 133.0 | 96.4 | 118 | 69.10 | 102 |
| | 132.5 | 98.3 | 141 | 72.62 | 164 |
| | 136.7 | 100.6 | 129 | 70.79 | 129 |
| | 137.2 | 100.6 | 121 | 69.56 | 139 |
| July 1967 | 137.3 | 99.5 | 112 | 72.09 | 109 |
| | 138.7 | 99.7 | 115 | 72.63 | 133 |
| | 137.4 | 100.7 | 113 | 72.27 | 146 |
| | 135.8 | 100.1 | 119 | 73.36 | 115 |
| | 135.8 | 99.8 | 125 | 74.44 | 122 |
| | 136.5 | 98.1 | 111 | 71.91 | 124 |
| | 134.7 | 96.0 | 119 | 73.26 | 122 |
| | 133.7 | 96.7 | 146 | 78.14 | 119 |
| | 129.1 | 95.1 | 114 | 72.35 | 122 |
| | 125.7 | 94.5 | 110 | 71.96 | 108 |
| | 127.5 | 93.2 | 125 | 74.68 | 114 |
| | 127.3 | 93.7 | 127 | 75.21 | 128 |
| July 1968 | 117.8 | 93.0 | 130 | 70.00 | 115 |
| | 118.5 | 91.6 | 125 | 69.43 | 102 |
| | 119.1 | 91.4 | 119 | 68.73 | 114 |
| | 120.1 | 90.7 | 144 | 71.63 | 125 |
| | 118.1 | 90.0 | 132 | 70.24 | 117 |
| | 116.1 | 88.3 | 123 | 69.19 | 113 |
| | 119.7 | 87.9 | 109 | 67.50 | 114 |
| | 118.6 | 87.2 | 110 | 67.50 | 115 |
| | 118.1 | 85.6 | 110 | 67.61 | 98 |
| | 119.2 | 85.7 | 110 | 67.61 | 95 |
| | 120.2 | 84.5 | 108 | 67.38 | 89 |
| | 115.7 | 83.3 | 118 | 68.54 | 114 |

| | Bloodmeal | Meat Meal (50% CP) | Soyabean Meal (Import) | All Oilseed Meals | Fishmeal (Import) |
|---|---|---|---|---|---|
| July 1969 | 116.7 | 84.4 | 114 | 72.56 | 95 |
| | 118.3 | 85.1 | 112 | 71.65 | 113 |
| | 118.1 | 85.1 | 228 | 74.47 | 99 |
| | 118.5 | 85.8 | 142 | 77.45 | 113 |
| | 118.0 | 86.8 | 113 | 71.72 | 141 |
| | 120.2 | 87.4 | 124 | 74.94 | 123 |
| | 121.1 | 88.5 | 110 | 73.30 | 98 |
| | 121.1 | 89.1 | 121 | 76.30 | 99 |
| | 122.1 | 90.1 | 125 | 76.76 | 118 |
| | 122.1 | 91.3 | 120 | 77.66 | 137 |
| | 124.1 | 92.3 | 127 | 76.65 | 143 |
| | 127.5 | 94.0 | 126 | 76.71 | 164 |
| July 1970 | 127.3 | 94.1 | 119 | 65.53 | 184 |
| | 128.2 | 97.1 | 119 | 65.37 | 139 |
| | 129.4 | 98.3 | 115 | 65.63 | 158 |
| | 130.1 | 99.6 | 152 | 68.07 | 130 |
| | 130.3 | 101.2 | 155 | 68.42 | 154 |
| | 132.5 | 101.6 | 278 | 66.63 | 117 |
| | 135.0 | 102.5 | 108 | 63.77 | 192 |
| | 135.0 | 100.4 | 113 | 64.22 | 161 |
| | 133.4 | 95.0 | 112 | 63.98 | 163 |
| | 130.8 | 92.2 | 121 | 64.79 | 169 |
| | 134.4 | 89.2 | 165 | 68.95 | 207 |
| | 133.3 | 87.7 | 112 | 64.13 | 126 |
| July 1971 | 133.3 | 87.2 | 116 | 67.72 | 164 |
| | 133.3 | 88.1 | 119 | 68.09 | 133 |
| | 136.3 | 89.8 | 131 | 69.57 | 194 |
| | 132.7 | 91.1 | 107 | 66.62 | 95 |
| | 132.3 | 90.4 | 105 | 66.37 | 147 |
| | 126.7 | 98.4 | 103 | 66.12 | 159 |
| | 127.2 | 86.8 | 99 | 66.32 | 126 |
| | 123.5 | 85.2 | 149 | 72.57 | 163 |
| | 119.9 | 82.1 | 116 | 68.42 | 142 |
| | 120.8 | 81.3 | 133 | 70.51 | 84 |
| | 120.8 | 81.1 | 119 | 68.78 | 137 |
| | 126.6 | 80.6 | 102 | 66.69 | 161 |

Source: For sources of price series see Appendix 1

## Appendix 4

### Price series for low protein meat meal

Data was sought from meat processing organisations concerning monthly meat meal prices for the period 1965/66 to 1971/72 (see Appendix 1). However, no usable series were available relating to meat meals with a crude protein level below 50%. Since a significant proportion of meals of animal origin are meat meals with less than 50% CP (see Appendix 2), it is desirable to establish a price series for such products.

It would be convenient and interesting if the price of meat meals were related solely to CP levels. In order to test this hypothesis, prices of meat meals with 42% CP and 45% CP were regressed against prices of 50% CP meat meal.

The only series of prices for meat meals of less than 50% CP for the survey period were available from the files of the N.S.W. Department of Agriculture. These comprised two series for 45% CP meat meal and one series for 42% CP meat meal. Each of the series had some months data missing. For each series, the monthly prices which were available were regressed against the corresponding price of 50% CP meat meal produced by similar works.[1] Equations (1) and (2) below are the results for the two 45% CP series, and equation (3) is the result for the 42% CP series.

Results

45% CP meat meals (two series)

$P_L$ = price of 45% CP meat meal

$P_H$ = price of 50% CP meat meal

$$P_L = \underset{(6.98)}{-14.4} + \underset{(.072)}{1.11}\, P_H \qquad R^2 = .79 \qquad (1)$$

$$P_L = \underset{(4.64)}{34.3} + \underset{(.048)}{.514}\, P_H \qquad R^2 = .64 \qquad (2)$$

The constant term of equation (1) is significant at 0.05; and the constant of equation (2) and both coefficients of $P_H$ are significant at 0.01. At the mean of each series, the relative price of 45% CP meat meal is 0.96 and 0.87 respectively.

42% CP meat meals (one series)

$P_L$ = price of 42% CP meat meal

$P_H$ = price of 50% CP meat meal

$$P_L = \underset{(3.49)}{47.3} + \underset{(.037)}{0.281}\, P_H \qquad (3)$$

Both the constant term and coefficient of $P_H$ are significant at 0.01. At the mean of the series, the relative price of 42% CP meat meal is 0.77.

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[1] There is a noticeable difference in meat meal pricing policies between private and semi-government abattoirs. As data for prices of 45% CP and 42% CP meat meal was only available from private works close to Sydney, it seemed most reasonable to correlate these prices with prices for 50% CP meat meal produced in a private works close to Sydney.

If the relative prices of meat meals were solely governed by crude protein levels, 0.90 and 0.84 would be the prices of 45% CP and 42% CP meat meals relative to 50% CP meat meal. While the three relations estimated above do not exactly bear out this contention, they do lend some credence to the hypothesis.

The high correlations between low and high CP meat meal prices shown in this appendix were used in the estimation of protein feed supply relations. The series obtained by the arithmetic averaging of fourteen series of 50% CP meat meal prices (see Appendices 1, 3) was used as the price series for such meat meal. The <u>same</u> series was also used as the price series for meat meal less than 50% CP, and for all meat meal, because of the high correlations amongst all meat meal price series.

## REFERENCES

[1] Official Year Book of Australia, Commonwealth Bureau of Census and Statistics (or Australian Bureau of Statistics) Canberra (various issues 1964-1972).

[2] Bain, R.A., "Feed Grain Consumption and the Australian Stockfeed Processing Industry". The Coarse Grains Situation Number 16, November 1971, Bureau of Agricultural Economics, Canberra.

[3] Batterham, E.S., The Value of Meat Meal and Meat and Bone Meal for Growing Pigs. Reprint from The Pig Farmer Volume 5 (1970) - July (pp.71-78), August (pp.167-171), September (pp.259-265), October (pp.365-369), November (pp.459-462).

[4] Bi-monthly Least-Cost Feeds for Laying Hens, Poultry Research Station, Seven Hills (various issues) roneo.

[5] Coarse Grains and Oilseeds Situation (formerly The Coarse Grains Situation) Bureau of Agricultural Economics, Canberra (various issues).

[6] Griffith, G.R., Freebairn, J.W., and Whitelaw, R.A., "An examination of meat prices and marketing margins" Commodity Bulletin Volume 2, No.11, May 1974.

[7] Hodgkinson, S.A., "The protein meals situation" Commodity Bulletin Volume 2, No.2 August 1973.

[8] Ingredient retail prices for the metropolitan area, N.S.W. Department of Agriculture, Poultry Research Station, Seven Hills, N.S.W. (various issues).

[9] Leibholz, J., "The Source of Protein in Calf Diets : A Comparison of Dried Skim Milk and Meat Meal" Australian Journal of Agricultural Research, Volume 18, 1967.

[10] MacLennan, D.G., "Single Cell Protein", Commodity Bulletin, Volume 2, Number 6, December 1973.

[11] The Meat Industry : Australia Commonwealth Bureau of Census and Statistics (or Australian Bureau of Statistics), Reference No. 10.54.

[12] Morgan, J.T., and Lewis, D. (Eds.) Nutrition of Pigs and Poultry Butterworths, London, 1962.

[13] Oilseeds : Situation and Outlook, Bureau of Agricultural Economics, Canberra, (various issues).

[14] Production summary No. 43 : Stock and poultry foods and canned pet food : Australia. Commonwealth Bureau of Census and Statistics (or Australian Bureau of Statistics) Canberra. Reference No. 12.16.43 (various issues).

[15] Nitrogenous Products of Industrial Origin for Animal Feeding, Organisation for Economic Co-operation and Development, Paris 1974.

[16] Quarterly Review of Agricultural Economics, Bureau of Agricultural Economics, Canberra (various issues).

[17] Royal, A.J.E., and Jeffery, H.J. "Energy and Protein Supplements for Dairy Cows Grazing Tropical Pasture" Proceedings of the Australian Society of Animal Production, Volume 9, February 1972.

[18] Statistical Analysis of the Vegetable Oilseeds Situation in Australia 1965/66 to 1971/72, Department of Primary Industry, Canberra, 1972.

[19] Todd, A.C.E., and Luttrell, R.B. "Feeding Pigs - 1" Queensland Agricultural Journal, Volume 99, Number 1, January 1973.

[20] Trade Table 1A (Exports) Commonwealth Bureau of Census and Statistics (or Australian Bureau of Statistics) Canberra, (computer printout) (various issues).

[21] Trade Table 52A (Imports) Commonwealth Bureau of Census and Statistics (or Australian Bureau of Statistics) Canberra, (computer printout) (various issues).

[22] Trail, W.B., "Supply Responses in the Australian Grains Industries" Coarse Grains : Situation and Outlook, Bureau of Agricultural Economics, Canberra 1974.