MAIZE AND SORGHUM GRAIN IN THE PIG AND POULTRY INDUSTRIES

O.P. Ryan
NRM Feeds Ltd.
Auckland

Maize and sorghum are two high energy feed grains used internationally for the feeding of livestock. However, maize and particularly sorghum are relatively new raw ingredients for stockfeeds in N.Z. With the economic climate causing many people to consider the future of grain growing in N.Z. it is an opportune time to look at the use of maize and sorghum in N.Z. stockfeeds with particular reference to poultry and pigs.

Before the importance of maize and sorghum as a stock feed can be established we must look at the relative importance of each class of stock as a consumer of these grains (Table 1).

TABLE 1: Consumption of Stockfeeds in N.Z.

	Layer	Broiler	Pig	Stock	Total
N.Z. use in ('000 tonnes)	240	80	75	70	465
Proportional use by stock classes	52%	17%	16%	15%	
Distribution in North Island %	72	64	64	87	71
South Island	28	36	36	13	29

The usage of compounded feeds by stock (cattle, sheep and horses) consists mainly of dairy and calf meals. The figures in Table 1 do not include maize or barley fed in beef feedlots nor oats fed to horses. Although stock do not feature in the title of this paper they compete for grain and indeed utilise as much grain as pigs in New Zealand. A major surprise to many of you could be the relative importance of poultry as a consumer of compounded feeds in N.Z. (69% of the total) as compared to pigs (16% of the total). The distribution of poultry and pigs throughout N.Z. is closely associated with proximity of markets and with feed grain availability. Most compounded feeds (71%) are consumed in the North Island and this is important to remember in a discussion of the use of different feed grains.

NUTRIENT CHARACTERISTICS OF MAIZE AND SORGHUM

The nutrient characteristics of maize and sorghum can be compared with those of wheat and barley (Table 2).

Maize and sorghum, and to a lesser degree wheat, are considered as high energy grains. Barley is a lower energy grain. While the protein levels of the grains are similar the individual amino acid concentrations of these grains vary markedly. Maize and sorghum are both relatively deficient in lysine and tryptophan; two amino acids that are essential to growing animals.

MAIZE VERSUS SORGHUM

Maize has been used extensively in poultry rations in New Zealand for several years. Levels of up to 70% have been fed to all classes of poultry. Sorghum has been used as a direct replacement for maize in layer and broiler rations without any noticeable change in performance.

Maize has been used as the sole cereal in pig diets in N.Z. Research at Ruakura has demonstrated that protein supplementation requires special consideration. There is currently a research programme at Ruakura specifically studying the problems associated with the feeding of maize to pigs.

Sorghum has been used extensively as the sole grain for feeding to pigs in Queensland. The Queensland Department of Primary Industries reports that sorghum is unlikely to cause ill thrift if properly supplemented. There are some high tannin varieties (e.g. some fodder and parrot-resistant types) which may be less palatable than light coloured grains. The biggest problem associated with sorghum in Australia is contamination with Datura seed which at 0.1% reduces palatability. For the purposes of this paper we can consider maize and sorghum as nutritionally very similar.

TABLE 2: Nutrient analysis of feed grains (N.R.C.)

	Maize	Sorghum	Barley	Wheat
M.E. M cal/kg	3.42	3.33	2.64	3.07
D.E. M cal/kg	3.49	3.41	3.08	3.52
Crude Protein %	8.8	11.0	9.7	12.7
Fibre %	2.0	2.0	6.2	3.0
Lysine %	0.20	0.27	0.32	0.45
Methionine %	0.17	0.09	0.14	0.20
Tryptophan %	0.10	0.09	0.13	0.18

TRENDS IN THE USE OF MAIZE AND SORGHUM IN N.Z.

We can assume that the use of maize in stockfeeds in N.Z. has paralled the area of maize grown in N.Z. Sorghum has only been used in one year (1974) when Australian sorghum was imported to supplement the reduced barley and maize crop.

Area of Maize Grown in N.Z.

1960	2,500 hectares
1964	7,000
1968	20,000
1972	16,000
1974	23,000

The question will be asked "Why has there been a dramatic increase in the area of maize grown in N.Z."? The obvious answer to an agronomist is that the varieties of maize and the technology associated with growing maize have developed to the point where maize is a competitive crop.

From the animal nutrition viewpoint a simple answer as to why maize usuage has increased would be that per unit of energy it is the cheapest grain in many parts of N.Z. Maize usage has increased in poultry and pig rations since 1960 to the point where it is virtually the sole grain in North Island layer and broiler rations and its use in pig rations is increasing. Rations typical of those being produced are presented in Table 3. While they are not actual formulations they demonstrate the range of ingredients currently being used.

TABLE 3: Typical North Island rations

	Broiler	Layer	Pig
Maize	66%	60%	30%
Barley	-	-	54
Wheat Offals	4	15	-
Lucerne	2	5	
Meatmeal	8	14	8
Fishmeal	2	-	4
Bloodmeal	2	-	4
Soy/Pea/Lupin	14	-	-
Tallow	2	-	-
Lime	-	6	-

Rations are formulated in the main by the mathematical technique of linear programming. Such a procedure meets a set of nutrient constraints and a set of ingredient constraints to least cost. The nutrient contraints that are characteristic of these rations will highlight the nutrients that are important to these three classes of stock and demonstrate how the requirements of each class differs (Table 4).

TABLE 4: Nutrient specifications of rations

	Broiler	Layer	Pig
M.E. or D.E. Kcal/kg	3100	2700	3100
Crude Protein %	20.00	16.00	16.00
Lysine %	1.15	0.60	0.90
Methionine %	0.75	0.30	0.60
Tryptophan %	0.20	0.15	0.18

The advantage of linear programming as a technique for formulating rations lies not only in the least-cost aspect. As well as obtaining a solution giving the ration ingredient makeup the nutrient analysis and price, marginal values are given for raw ingredients. That is, if an ingredient is not included in a ration because the price is too high, information is produced which tells the formulator the worth of the ingredient in dollar terms. This information relates to that particular formulation when all other factors are held constant. This is a particularly valuable tool for agonomists who want to study factors affecting the value of a cereal.

The use of maize and sorghum in stockfeeds will primarily be related to their price. We will now look at some factors which will affect the value of maize and sorghum in pig and poultry rations in N.Z.

ANIMAL RESPONSES TO NUTRIENTS

One reason for the increase in maize usage in N.Z. is that per unit of energy it is the cheapest grain. Animals require energy for the maintenance of body function and for growth and production. The main sources of energy in stock feeds are the cereals which can be divided into high (maize and sorghum) and low (barley and oats) energy categories. We can manipulate the energy concentration of a stockfeed by changing the ratio of high to low energy cereals.

Energy is used as the example nutrient because it is the most important nutrient contained in cereals. The way animals respond to the energy concentration of the diet is well defined.

If the poultry, and to a lesser extent pigs, are fed **ad libitum** the following relationships hold.

(a) As the dietary energy level increases animals eat less.
(b) As the dietary energy level increases there is a positive growth/production response.
(c) As the dietary energy level increases feed efficiency improves.

If animals are control fed (i.e. restricted to a set daily intake) then as the dietary energy level increases less feed need be given to satisfy a daily energy allowance.

Once we have measured the way animals respond to the energy concentration of the feed, we can undertake an economic analysis to determine which energy level gives the most economic performance.

A simple example based on the use of barley and maize at costs of $80 and $100 per tonne respectively, illustrates the procedure (Table 5).

If we were interested in lowest cost per unit of energy then we would concluse that barley at $80 per tonne was too expensive to compete with maize at $100 per tonne.

What has been outlined using energy as the example nutrient also applies to other macronutrients such as the amino acids. This is similar to the agronomists three dimensional N.P.K. response.

If we consider energy independently we can conclude that the higher the energy content of the feed the greater will be the physical performance. The energy level that will provide the most economic performance will be related to the cost per unit of energy. Because feed grains are primarily an energy source it should be the prime objective of feed grain breeders to develop grains which will provide the greatest yield of energy per acre.

RELATIONSHIP BETWEEN PROTEIN AND ENERGY

Animal feeds are commonly formulated to some constant protein to energy ratio. This is because as the energy level increases the animal eats less. To enable the animal to obtain its daily protein intake when feed consumption is less, the protein concentration of the diet

TABLE 5: Economic analysis of rations differing in energy level

M.E. of diet	% Maize	% Barley	Ration Cost	Cost/Unit M.E.
3300	74	-	106.60	3.23
3200	65	-	102.60	3.21
3100	54	10	99.60	3.22
3000	46	18	97.40	3.25
2900	35	30	95.40	3.28
2800	24	42	93.20	3.33

is increased. High energy feeds therefore require higher protein levels. In times of high protein prices high energy diets can be rendered uneconomic on the grounds that it is too expensive to balance the protein to energy ratio.

Modern nutrition pays little attention to crude protein as a nutrient. Emphasis is now placed on the part individual amino acids play in growth and production. In practical diets there will be amino acids in excess of the animals requirements. Conversely some amino acids will be below the level required for optimal production. These amino acids are known as "limiting" amino acids. If a limiting amino acid is supplemented with its synthetic counterpart there will be a positive production response.

Using typical N.Z. feedstuffs the amino acids most limiting vary with the class of animal.

Layers	:	methionine
Broilers	:	lysine, methionine
Pigs	:	lysine, tryptophan, methionine

Taking account of the relative importance of each class of stock as a consumer of stockfeed the amino acids that require special attention, in order of importance, are methionine, lysine and tryptophan.

The most common protein source in N.Z. is meatmeal. Meatmeal will meet the methionine requirements of layers but will not meet the lysine or tryptophan requirements of pigs or broilers. In times of low meatmeal prices lysine and tryptophan are the amino acids plant breeders should concentrate on in breeding programmes. Because these amino acids are not as important in laying hen nutrition a high lysine maize would not necessarily be worth a premium in layer rations.

Whether it be energy or an amino acid, the nutrient that will be worth the most at any point in time will be constantly changing. This makes it impossible to give a categorical answer to any question relating to the relative values of grains or nutrients.

FUTURE TRENDS

The future of maize and sorghum as an ingredient in the feed of poultry and pigs will be dependent on the relative grain prices in New Zealand and the prices offered for competing products. I am not here to predict tomorrows market today.

From the earlier statistics one factor stands out, namely that 71% of N.Z.'s grain fed stock are in the North Island with ready access to maize. Indeed it could well be that in 1976 barley will represent a very small proportion (say 10%) of the grain fed to North Island poultry and pigs. This means it is not possible to increase the usage of maize in the North Island unless there is growth in the poultry and pig industries.

There is a current egg surplus which rules out any expansion in the industry which is the major consumer of maize. The outlook for broiler production is healthier, albeit an upturn form what was a drastic downturn. Pork production is below demand. The amount of maize fed to pigs in the near future will depend upon the results of research at Massey and Ruakura into the problems associated with maize feeding of pigs.

The future of poultry and pig production in the South Island has some bearing on the future expansion of maize or sorghum usage. Barley is no longer the important cereal it was in the production of poultry meat and eggs in N.Z. There is a broiler industry in the South Island which will not survive on barley based diets. Layer farmers using barley are paying as much for their feed as North Island farmers and see their hens consuming 10-20% more. Their only saviour will be a high energy grain such as feed wheat.

Only two or three years ago the feeling was that it was cheaper to produce pigmeat in Canterbury and export to the North Island. This resulted in a dramatic increase in pig numbers in the South Island. It may well be that in the very near future it will be more economic to produce pigs on Waikato grown maize.

CONCLUSION

In maize and sorghum we have two cereals which are ideally suited, energy wise, to the feeding of poultry and pigs. Any feed grain breeding programme in the North Island should be aimed at maintaining or improving these energy levels, whether it be per tonne or per acre. It would be ideal if the methionine, lysine and tryptophan levels of maize and sorghum could be increased. Emphasis in the South Island should be aimed at replacing barley with a higher energy feed grain such as wheat.