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A PROTEIN UTILIZATION STRATEGY FOR SOUTH AFRICA

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(Sleutelwoorde: *Proteïenbenutting, strategie)*

We live during times when the world's leaders are becoming increasingly preoccupied with the problems of feeding the vastly increasing human population. Hardly a day seems to pass without some reference being made to this problem in our news media. Although many of these reports stem from ill-informed and sensation seeking sources, the fact cannot be denied that, with the world's present population destined to double itself before the end of this century, the need to increase food production from finite areas of land and sea has become a matter of dire importance. Small wonder, therefore that so many scientific symposia are being held to find ways and means of not only exploiting our planet's dwindling natural resources, but also to conserve these resources to their utmost.

If the foregoing applies to the world in general, then the problems facing South Africa are even more critical. Although this country is blessed with vast mineral resources, it is a land with a very limited and fragile agricultural potential. Less than ten per cent of the country's present land area has climatic conditions suitable for Agricultural crop production. Even in those areas with sufficient rainfall, the soils are invariably shallow, infertile and prone to erosion. These problems are further compounded by an erratic rainfall and extremes of climate. Such factors will make it particularly difficult for future agricultural enterprises to keep pace with the food needs of our rapidly expanding population and its growing purchasing power.

Accepting the limited Agricultural potential of South Africa the problem revolves round the optimal utilization of such resources. Where both future resources and consumer demand are subject to a multitude of external and internal influences one needs the wisdom of a Solomon to formulate a Protein Strategy for South Africa.

However, although it is said that there are lies, damned lies and statistics one has no option but to use statistical methods to take note of past trends to predict the future. The correctness of prediction will however depend on factors such as political stability to permit continued economic growth, availability of Investment Capital and no revolutionary invasion of a replacement product such as margarine for butter. An important assumption also is that there should be no drastic change in the cost to price ratio of Agricultural products as we know them today.

Based on predicted human population changes and the predicted consumption of animal products by the year 2000, the author will endeavour to outline a strategy to cater for the protein needs of South Africa.

The projected aggregate population for South Africa (Le Roux, 1976) for the 25 years from 1975 to 2000 is presented in Table 1.

Table 1

Projected aggregate population of S.A. '1000

Sector	1975	1980	1990	2000
Black	17 212	19 931	26 935	36 014
White	4 274	4 762	5 798	6 891
Coloured	2 432	2 818	3 756	4 890
Asian	734	825	1 018	1 215
Total	24 652	28 336	37 507	49 009

Source: Le Roux, F.H. (1976) J. Fert. Soc. S. Africa 3,13

The five year moving average per capita consumption of various livestock products from 1956 to 1976 are presented in Tables 2, 3 and 4 (Consumption took imports and exports into account).

Table 2

Consumption of meat, kg per capita
(Expressed as five-year moving average)

Year	Beef and veal	Mutton and goat	Pig meat	Poultry meat	Total
1955/56	30,1	8,8	3,5	–	–
1957/58	29,8	8,5	3,5	–	–
1959/60	29,5	8,5	3,3	–	–
1961/62	29,1	8,4	3,1	2,5	43,1
1963/64	28,1	8,2	3,0	2,7	42,0
1965/66	26,9	8,2	3,0	3,1	41,2
1967/68	25,3	8,9	3,3	3,8	41,3
1969/70	25,1	9,3	3,4	4,4	42,2
1971/72	25,6	8,1	3,6	5,4	42,7
1973/74	24,6	6,6	3,5	6,9	41,6
1975/76	23,6	6,3	3,5	8,6	42,0

Source: Abstract of Agricultural Statistics, 1978.

Table 3

Consumption of milk in litres per capita
(Five-year moving average)

Year	Per capita consumption
1956	140,6
1958	141,3
1960	138,7
1962	138,1
1964	139,1
1966	139,6
1968	138,0
1970	135,7
1972	126,4
1974	111,6
1976	94,7

Table 4

Consumption of eggs, number per capita

Year	Per capita consumption
1961	72,2
1963	72,0
1965	72,1
1967	72,6
1969	73,6
1971	74,8
1973	79,8
1975	87,8
1977	91,9

For comparative purposes, the American per capita consumption of meat, eggs and dairy products is given in Tables 5 and 6.

Having the projected human population in the year 2000 we must also determine what the consumption of the various livestock products would be. This can be done by taking the five-yearly moving average per capita consumption figures in Tables 2, 3 and 4 and computing regression equations. By extrapolating the regression lines the per capita consumption can be determined.

Table 6

Per capita egg and dairy product consumption in U.S.A.

Year	Eggs number per capita	Litres per capita
1973	294	149,9
1974	286	147,9
1975	278	149,5
1976	274	149,8
1977	272	148,5

The predicted per capita consumption as well as the livestock units required to produce the projected requirements will be discussed under separate headings. At the same time feed requirements will be indicated.

Poultry meat

From the regression Y = 0,8608 + 0,8476 T in Fig. 1 it would appear that the per capita consumption of Poultry meat in 2000 will be 17,81 kg per annum. For a population of 49 million people ± 870,000 tons of Poultry meat will therefore have to be produced.

Laying hen culls, turkey, ducks and broiler breeder culls could make a contribution of 90,000 tons per annum, by this time the remaining 780,000 tons will have to come from broilers. (600 million broilers at 1,3 kg each.)

It is interesting to note from Fig. 1 that the per capita consumption of Poultry meat from 1975 to 1978 exceeded the predicted consumption level. This could probably be attributed to the big expansion from 61 million broilers in 1971 to 138 million in 1976; a growth

Table 5

Per capita consumption of meat in U.S.A., kg per annum

Year	Beef	Mutton	Pig meat	Poultry meat (including Turkey)	Total
1973	36,86	1,09	26,05	22,36	86,36
1974	39,27	0,91	28,14	22,73	91,05
1975	40,41	0,82	23,18	22,23	86,64
1976	43,36	0,77	24,59	23,86	92,58
1977	42,18	0,68	25,41	24,59	92,86

Source: Feedstuffs July 20, 1978 – Vol. 50 No. 30 p. 10

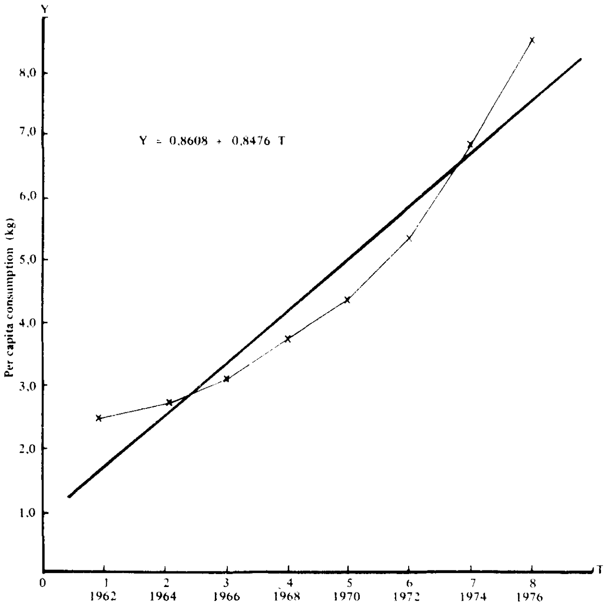

Fig. 1 Consumption of chicken (five-year moving average

of 126 per cent. Consumption therefore reached artificially high levels because supply outstripped demand leading to a widening of the price differential between poultry and red meat in the market place. It is therefore felt that in the short term per capita consumption may drop below the predicted regression line. However, when the economic climate improves increased consumption/production could again be expected.

Because of the capital intensive nature of the broiler industry (R20 million establishment costs currently to produce seven million broilers per annum) it is also predicted that future growth will still depend predominantly on the larger producers. They will however not make these investments unless the economic and political climate is sufficiently stable to allow a reasonable return on their investment.

Before an estimate is made for feed required to produce 780,000 tons of broiler meat per annum in the year 2000 consideration should be given to improved efficiency. Table 7 quoted by McCarthy (1977) clearly demonstrated the combined impact of selection and husbandry on increased bodyweight, reduced age to slaughter and feed efficiency.

Performances for 1970 quoted in Table 7 are consistently achieved in South Africa and genetic progress still continues. Indications are that a livemass of 1,7 kg and a feed conversion ratio of 1,85 kg at 40 days of age will be reached in the year 2000.

Table 7

Rounded estimates of annual test performance

Year	Age (weeks)	Weight (kg)	Food conversion (gms food/gm gain)
1947	12	1,3	–
1961	10	1,7	2,6
1967	9	1,9	2,4
1970	8	2,2	2,0

We can, for the purpose of this exercise, assume that the protein required to produce a ton of broiler meat in the year 2000 will be approximately the same as it is today. Although a feed conversion of 1,85 is indicated, it must be appreciated that the nutrient density of such diets will have to be improved. Slightly less protein however, will be required for maintenance (earlier slaughtering).

Similarly the number of day-old broiler chicks produced from broiler parent stock has improved in recent years. It is anticipated that the number of day-old broilers produced per broiler breeder will improve to 140 to 150. Very little or no additional feed will be required for this improved performance.

The livestock and feed required to produce 780,000 tons of Poultry meat will be as follows:

Livestock:

600 million broilers
4,28 million broiler parent stock
100 000 Grandparent stock

Feed:

	Tons
Broiler starter crumbles	600,000
Broiler finisher pellets	1 650,000
Chicken rearing mash	10,100
Restriction growers' mash	15,750
Pullet developers' mash	19,780
All mash laying for heavy breeds	194,000
	2 499,630

Egg production

To establish an accurate figure of the number of layers in South Africa is extremely difficult.

The feed sales figures published by the Department of Agricultural Economics and Marketing have been examined and it was calculated that the number of layers during the period 1968 to 1973 fluctuated between nine and ten million.

In 1974 the number of layers escalated to 12,5 million and since then it has fluctuated between 12,5 and 12,8 million. During 1976/77 industrial groups expanded their interests in the egg industry (Fig. 2).

As a result of the improved Management skills and improved genetic strains it can be postulated with reasonable certainty that egg production increased from 218 to 230 eggs per layer per annum today.

The supply of eggs to the local market began to exceed the demand to a greater extent and at the same time the intensity of competition on the export market increased.

The low floor prices and surpluses led to price wars and unco-ordinated distribution in the local market.

At the end of 1978 the Minister of Agriculture, therefore, accepted recommendations in respect of more stringent production control and re-instituted the permit system. The prime aim of this measure was to reduce the layer population by 6 and 12 per cent depending on the region. Also at this time, a National Egg Marketing Co-operative was founded, its objectives being:

(a) The orderly marketing of members' eggs
(b) Expanding the local egg market
(c) Rationalisation of packing and distribution.

It is an accepted fact that eggs are still sold at unreasonably high prices in Black areas. The establishment of chain stores, however, will no doubt reduce prices and stimulate demand. It can therefore be expected that despite a short term down-turn in consumption, the demand will then again ascend with the predicted regression line (Fig. 2) reaching 114,3 eggs per capita by the year 2000.

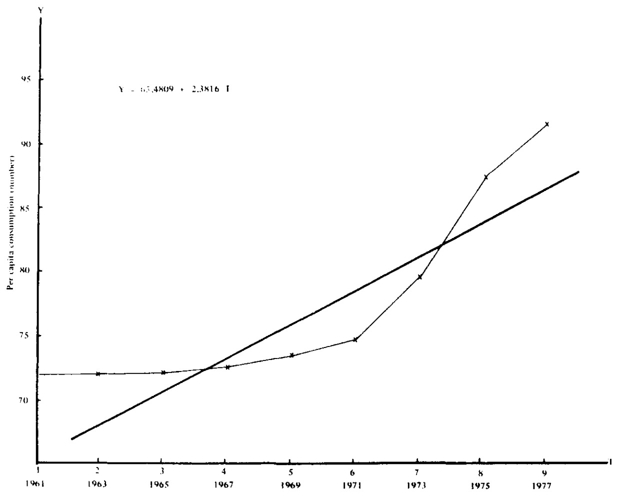

Fig. 2 Consumption of eggs (five-year moving average)

Thus 5 600 million eggs will have to be produced for a population of 49 million in the year 2000.

Warren (1978) at the World Poultry Science Congress in Brazil cited U.S.D.A. Random Sample Test figures showing an improvement of 27 eggs per layer/annum during the period 1958 to 1976.

With improved production techniques and genetic material it is not unrealistic to expect a production of 280 eggs per layer per annum at the turn of the century.

Based on this assumption, South Africa will then required 20 million layers. It is not expected that feed consumption will change to any great extent. Although the laying period may be slightly extended, the increased feed consumed during this period will be cancelled out by lower maintenance requirements for lighter birds.

The livestock units and feed required to produce 5 600 million eggs per annum will be as follows:

Livestock:

Grandparentstock	5,000
Parentstock	200,000
Layers	20 000,000

Feed:

Chicken rearing mash	43,600
Poultry growing mash	137,400
All mash laying mash	808,200

Dairy

From Fig. 5 it will be noticed that the per capita consumption of milk and milk products remained fairly static until 1968/69 when substitute products started to make an impact on the market.

Over the next ten years per capita consumption declined by more than 40 per cent.

Based on the assumption that substitution has reached its highest level and the distribution of milk, especially to the Black market, will improve, we estimate that the per capita consumption of milk will be 76 litres by the year 2000. This will mean a total requirement of 3 725 million litres per annum.

With improved productivity due to better management and feeding, this volume can be produced by the present herd of 900 000 dairy cows, i.e. 13,8 litres/cow/day over a lactation of 300 days. This compares with 8,1 litres per cow today.

In order to produce this volume from the same number of cows, the feed requirement is calculated as follows:

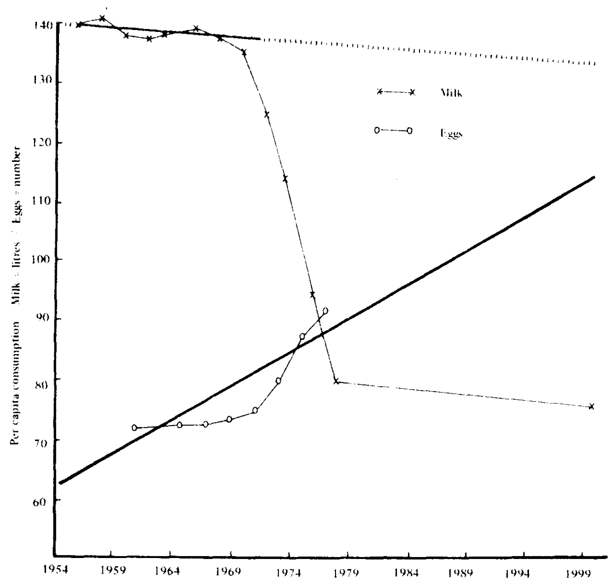

Fig. 5 Consumption of milk and eggs (five-year moving average)

According to the NRC, the average cow, with a live mass of 500 kg will require: 1,670 gms protein and 8 kg TDN per day in order to produce 13,8 litres of milk.

Accepting an average roughage quality of 50 per cent TDN and 7 per cent protein and a daily dry matter intake of 3 per cent of body mass, the daily requirement for nutrients can be met by feeding a 15 per cent protein concentrate with a TDN of 70 per cent in the ratio of 50:50 roughage to concentrate i.e. 7,5 kg concentrate.

Based on this calculation, the dairy cow will require 2,738 tons of concentrate per annum which is equivalent to a national herd requirement of 2 464 million tons.

The total feed requirement of dairy cows and replacement heifers can be summarised as follows:

Milk production	Per cow/heifer (tons)	Total ('000 tons)
Dairy concentrate	2,738	2 464
Replacement heifers		
(20 per cent herd replacement)	1,326	238
Milk substitute (21 days)	0,011	2
Calf meals: 1– 6 months	0,295	53
6–18 months	0,480	86
Gestation 18–27 months	0,540	97
Total requirement	4,064	2 702

Pigs

From Fig. 3 it is clear that of all red meats only pork has kept pace with population growth during the past two decades.

Traditionally the pig industry has been characterised by marked cyclical changes. These changes were brought about by fluctuations in supply due to the periodic entry and exit from the industry by small producers.

Increased sophistication in the industry coupled with a parallel increase in efficiency makes it more difficult for the smaller producer to compete.

The expectations are therefore that the industry will assume a more stable growth in the future. From the regression line (Fig. 3), it is evident as in the case of poultry produce, supply exceeded demand during the period 1970 to 1976. This forced prices down, resulting in increased consumption. It is interesting to note that from 1970 to 1975, producer price for pork increased by 110 per cent whilst that of beef and mutton increased by 121 and 137 per cent respectively.

The calculated expected per capita consumption of pork in the year 2000 is 3,62 kg. To meet these requirements, 177 400 tons of pork will be needed.

Based on the assumption that 70 per cent of pigs marketed are baconers and 30 per cent porkers, a National Herd of 200 000 sows will produce the rerequired amount of pork.

The annual feed required for this herd is as follows:

	Tons
Sow and board meal	214 500
Creep feed	55 100
Pig growth	570 000
	840 300

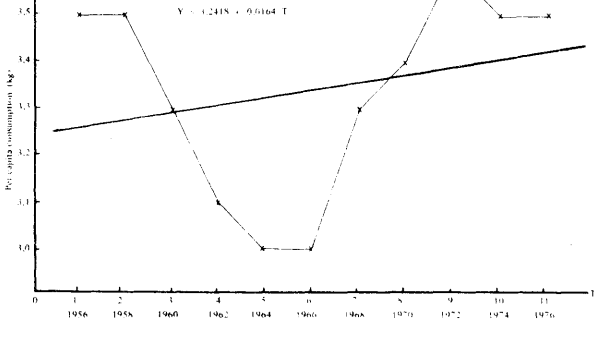

Fig. 3 Consumption of pork (five-year moving average)

Mutton

Over the past 20 years there has been virtually no growth in total mutton and goat meat production. This has been mainly due to a legislated stock reduction scheme applying to certain areas aimed at allowing the veld to resuscitate.

During the period of stock reduction, i.e. 1969 to 1973, supply outstripped demand and prices of mutton became more favourable versus other red meats. This is reflected in the rise in per capita consumption over this period (Fig. 4).

According to the regression equation $Y = 9{,}189 - 0{,}1709\ T$, the per capita consumption will decline to 5,2 kg per annum by the turn of the century, as compared to 6,2 kg in 1977/78.

From Fig. 4 it is obvious that the present per capita consumption is well below the predicted level. Unless the price of mutton becomes more competitive versus other available meats, it is unlikely that the predicted level of 5,2 kg will be reached.

For the purpose of this discussion, we will assume a per capita requirement of 5,2 kg or a total requirement of 255 000 by the year 2000.

Based on an average carcase mass of 15,2 kg, this means that 16,8 million carcasses will have to be produced.

Assuming that the maximum carrying capacity for sheep in South Africa is 35 million, the only solution lies in intensification of mutton production by:

(a) Changing the composition of the flock i.e. increase ewes in the flock from 45 per cent to 60 per cent by reducing wethers;
(b) Improving weaning percentage from 60 per cent to 80 per cent;
(c) Improving general feeding and husbandry practices.

We assume that currently an approximate ten million head of sheep are slaughtered annually from the veld and that any number in addition will have to be reared intensively i.e. the additional 6,8 million required by the year 2000.

Total sheep population	35 million
Number of ewes (60 per cent)	21 million
Lambs weaned (80 per cent)	16,8 million

	Per head (tons)	Per annum (1 000 tons)
Feed required for intensive rearing	0,088	598

Beef

Over the past 20 years beef/veal consumption, per capita, declined by approximately 22 per cent. Currently it is 23,9 kg per annum compared with 42 kg in the U.S.A.

Rising consumer prices of red meat have caused a demand shift from red to white meat and there does not appear to be evidence of a reverse in this trend. Therefore a per capita consumption of 15,3 kg by the year 2000 (Fig. 6) is predicted.

Whilst livestock numbers remained fairly static over the past decade, slaughter rates per head increased. However, compared to overseas countries, it is evident from Table 5 that the efficiency ratio of South African production will have to be improved substantially in order to meet future requirements.

This can be done mainly by intensified finishing of cattle i.e. feedlotting. Currently approximately 18 per cent (380 000) of total carcases reaching the market is derived from feedlots. By the year 2000 approximately 48 per cent will have to be finished intensively.

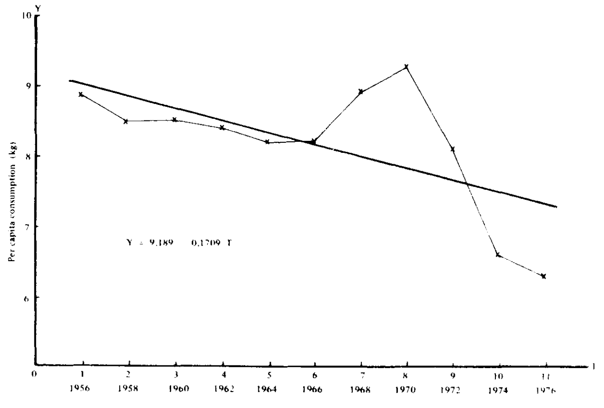

Fig. 4 Consumption of mutton and lamb (five-year moving average)

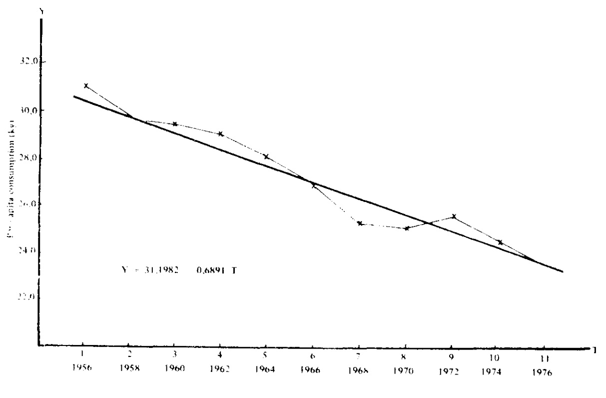

Fig. 6 Consumption of beef (five-year moving average)

Table 5

Comparative table of effective productivity expressed as meat production in kgs/head of livestock per annum

	South Africa (1976/77)	USA	EEC	South Africa (future)
Cattle (millions)	13	130	79	13
Beef production (1 000 tons)	539,9	11 300	7 300	750
Yield per livestock Unit (kg)	41,5	86,9	92,4	57,7

The calculated livestock and feed required to produce 750 000 tons of meat by the year 2000 are as follows:

	Million
Total beef population	13,0
Total breeding cows	4,4

Supply of beef/veal per annum	Million
Beef cows (20 per cent culling)	0,880
Feedlots – Dairy calves (1)	0,504
Beef animals (2)	1,260
Beef from veld (17 per cent)	0,463
Dairy cows (20 per cent culling)	0,180
Import	0,400
	3,687

At an average carcase mass (slaughtered) of 203,4 kg this will provide the required 750 000 tons of beef by the turn of the century.

Footnote

(1)

Total progeny (80 per cent calving		0,720
Less mortality 5 per cent	0,036	
Less replacement heifers	0,180	
		0,504

(2)

		million cows
Progeny @ 62,27 per cent calving from 4,4 million cows		2,740
Less 5 per cent mortality to two years of age	0,137	
Less replacement heifers	0,880	
Less calves finished on veld (17 per cent)	0,463	
		1,260

The estimated feed required is as follows:

			Per head (tons)	Total (1 000 tons)
Surplus dairy calves (504 000)			1,426	718
Milk subsitute (21 days)	0,011	5		
Calf meals 1– 6 months	0,295	149		
(i) Feed blocks 6–14 months	0,120	60		
Complete ruminant feed 14–17 months	1,000	504		
Beef animals, progeny from beef herd			1,000	1 260
Total				1 978

Footnote

(i) 40 per cent protein
40 per cent TDN
Average daily gain 300 gms.

From the foregoing, it would appear that the total feed requirements for the Republic of South Africa could be approximately 10 000 000 tons by the year 2000.

Raw materials required to produce 10 000 000 tons of the various classes of balanced rations in the year 2000 were, subject to certain restrictions such as inadequate local supplies of fishmeal, offered to a national computer to formulate least cost rations. As opposed to the practice in the past of using protein units to estimate further protein requirements, it is felt that this is the more accurate method since it takes into consideration the full nutrient composition of raw materials which will satisfy the recognised nutritional requirements standards of the various classes of livestock on a least cost basis.

Tables 6 and 7 give an indication of raw material required to produce 10 000 000 tons of feed using the current raw material price structure.

These two tables clearly show which protein rich raw materials should receive production priority in the immediate future.

However, just indicating raw material priorities for the future would be an incomplete strategy.

Perhaps of more importance are factors such as cultivar nutrient variation, the processing of raw materials, the storage of materials, and the control of inherent toxic substances.

Table 6

Raw material utilization by the year 2000
(No restriction on Soya in non-ruminant feeds)

Ingredient No.	Description	Available supply	Total usage
1	Yellow maize	Unlimited	6 198 221
3	Wheaten bran	550 000	550 000
5	Hominy chop	1 200 000	95 081
6	Barley DRGRN	7 000	7 000
8	Lucerne meal	Unlimited	301 551
9	Gluten FD 20	24 000	24 000
10	Gluten ML 60	7 500	7 500
12	Groundnut local	Unlimited	20 013
14	Sunflower local	Unlimited	506 867
16	Cotton local	Unlimited	228 923
18	Soya local	Unlimited	424 941
23	Fishmeal A	150 000	150 000
25	Fishmeal Imported	Unlimited	176 496
26	Blood meal	4 850	4 850
27	Carcase meal	12 000	000
28	Feather meal	2 000	000
29	Poultry BPDS	50 000	50 000
32	Monocal phos	Unlimited	74 508
33	Dical phos	Unlimited	34 892
34	Bone meal	16 000	1 714
35	Limestone	Unlimited	205 472
36	Salt	Unlimited	72 397
38	Roughage	Unlimited	549 499
39	Molasses	Unlimited	618 592
40	Urea	Unlimited	63 329
41	Tallow	Unlimited	22 505
44	Synth lysine	Unlimited	182
45	Synth meth	Unlimited	309
Grand total			10 388 842

Table 7

Raw material utilization by the year 2000
(Soya restricted to 10 per cent in non-ruminant feeds)

Ingredient No.	Description	Available supply	Total usage
1	Yellow maize	Unlimited	6 238 752
3	Wheaten bran	550 000	550 000
5	Hominy chop	1 200 000	95 081
6	Barley DRGRN	7 000	7 000
8	Lucerne meal	Unlimited	301 552
9	Gluten FD 20	24 000	24 000
10	Gluten ML 60	7 500	7 500
12	Groundnut local	Unlimited	34 742
14	Sunflower local	Unlimited	506 867
16	Cotton local	Unlimited	233 504
18	Soya local	Unlimited	346 109
23	Fishmeal A	150 000	150 000
25	Fishmeal Imported	Unlimited	213 450
26	Blood meal	4 850	4 850
27	Carcase meal	12 000	12 000
28	Feather meal	2 000	000
29	Poultry BPDS	50 000	50 000
32	Monocal phos	Unlimited	74 508
33	Dical phos	Unlimited	25 314
34	Bone meal	16 000	1 714
35	Limestone	Unlimited	205 548
36	Salt	Unlimited	71 312
38	Roughage	Unlimited	549 499
39	Molasses	Unlimited	618 592
40	Urea	Unlimited	63 329
41	Tallow	Unlimited	3 381
44	Synth lysine	Unlimited	238
45	Synth meth	Unlimited	000
Grand total			10 388 842

(a) Fishmeal

In the past, gizzard erosion in poultry has occurred sporadically in South Africa. Histamine in fishmeal has been incriminated as the causative agent. It is a well known fact that pelagic species such as herring, mackeral and tuna contain higher quantities of the amino-acid histidine than other fish species. Should fishmeal be allowed to decompose prior to processing, microbial action decarboxylates histidine to histamine. Serious attention should therefore be given to expedite processing after catching.

One of the main values of fishmeal in animal feeds continues to be its high available amino-acid content. Wessels (1975) concluded from trials that contact of fish with 0,2 per cent formaldehyde in the form of a 40 per cent solution in most instances depressed available lysine.

It is a well known fact that South African fishmeal manufacturing plants use up to 0,02 per cent formaldehyde to "firm up" fish before processing. The particular attention of the fishmeal producers should be drawn to the harmful effects of excessive formaldehyde and the correct inclusion level of this chemical should be stressed.

Spontaneous combustion of fishmeal has occurred in feed factories and in transit from time to time. Factors which contribute to the destruction of this valuable commodity are not as yet fully understood. However, ommission of anti-oxidants, high moisture content and improper storage and stacking could be considered as contributors.

Fishmeal should be stored in well-ventilated warehouses in a honeycombe stacking pattern to allow sufficient air circulation. Stack temperatures should be checked by temperature probes positioned at the time of stacking on a regular basis. If the stack temperature exceeds 48°C, the stack should be broken down and the bags cooled before restacking.

Fishmeal is of such importance as a raw material that good processing techniques and good housekeeping are of dire importance.

(b) Sunflower oilcake meal

According to Bothma (1979, personal communication) the average analyses of FH and F cultivars of sunflower seed received for the season 1977/78 from the northern and eastern Transvaal were as shown in Table 8.

Calculating the theoretical cake yield and percentage protein, it will be noticed that the protein could vary from 38,6 to 48,7 per cent. It must be appreciated that in modern feed plants where raw materials are stored in silos, the identity of various batches of cake is lost.

Feed formulations can therefore only be carried out on average analyses. Should the analysis of the material be in excess of the average; protein is wasted. On the other hand, if the protein content is too low, animal performance will suffer and more feed will be required. This is also wasteful and cannot be afforded in a country with limited agricultural potential such as South Africa. Furthermore, oil expellers are reluctant to compensate feed manufacturers for low protein materials, as they maintain that it is impossible to produce high protein cake from low protein seed. It should also be pointed out that feed manufacturers cannot absorb the additional cost of supplementing low protein cake either. More attention should therefore be given in future to promote the production of cultivars which are not only high in oil but also high in protein.

Table 8

Average sunflower seed analyses for 1977/78 season

	Northern Transvaal		Eastern Transvaal	
	FH Grade	F Grade	FH Grade	F Grade
Protein %	16,9	14,42	15,1	11,5
Oil %	42,6	29,6	41,8	32,3
Theoretical cake yield %	34,7	32,8	35,6	29,8
% Protein in cake	48,7	44	42,4	38,6

Theoretical cake yield = (0,955 D–H) 1,11
Where D = 75 for FH and 60 for F grade
H = Percentage of oil in seed

Perhaps incentives to the farmers for high oil, as well as high protein in seeds, should be considered.

Although sunflower oilcake meal is a better source of the sulphur containing amino-acids than other oilcakes, its lysine level is first limiting. A factor which is also often ignored, is the presence of chlorogenic acid in sunflower meal, which causes egg staining. These factors together with the high fibre levels in sunflower cake limits the use of this raw material as a protein. Thus it is clear that unlike soyabean meal, sunflower oilcake cannot be used as the sole protein source in animal rations.

(c) Maize

Maize is very often overlooked as a source of protein in the feeding of livestock, but because of its high inclusion level in rations, its contribution to the protein in the ration is substantial. It is therefore of concern to note that analysis figures show a decline in protein content from 9,2 per cent to 8,3 per cent in recent years. It would appear that the attention of agronomists in the past has been devoted to formulating new crop husbandry and developing cultivars aimed at yield increase. Although this is undoubtedly important, it is felt that portion of their efforts should be devoted to the chemical composition of cultivars. It is extremely gratifying to observe the work in recent years which has led to the production of the endosperm mutants opage 2 and Floury 2 with their high lysine, tryptophane and arginine content. Researchers in this field should be given the wholehearted support of all concerned with South African agriculture as the work of Du Preez *et al.* (1974) and Kemm *et al.* (1975) have already highlighted the nutritional merits of this product in the feeding of chickens and pigs.

(d) Poultry manure

From Table 9 it is clear that the present output of poultry manure in South Africa is 373 200 tons per annum. Should the broiler and egg industries expand as predicted, this output could increase to 800 000 ton by the year 2000.

Poultry manure and litter have been used as a fertilizer and a source of plant nutrients for many years. Only within the past few years has an interest developed toward using this product in livestock feeds.

Although this product has been used in feedlot rations by individual farmers, research at the Koos van der Merwe Research Institute could not confirm that poultry manure inclusion was economically warranted at this time. From Table 10 it will be noted that for each 6 per cent increment of poultry litter, average daily gain deteriorated and feed required per kilogram gain increased.

Table 9

Manure output from the National Broiler Flock (150 million broilers/annum)

Source	Output mt/Annum
Broilers (15% moisture)	165 000
Broiler mothers (12,5% moisture)	11 600
Broiler mother replacements (12,5% moisture)	5 500
Total broiler flock	182 100

Manure output from National Layer Flock (13 million layers)

Source	Output mt/Annum
Layers (19% moisture)	149 500
Pullet growers (12,5% moisture)	41 600
Total layer flock	191 100
Total broiler and layer flock	373 200

Similarly, broiler litter was used in layer rations at this same Institute and again performance was disappointing when compared to control groups. Young (1972) at Cornell adequately demonstrated that poultry manure is a low energy low protein material for layers with an apparent utilisation of not more than 30 per cent.

It would appear that the most efficient use for poultry manure would be as a fertilizer and a veld supplement for cattle and sheep. Tables 11 and 12 indicate its value as a fertilizer by comparing it price-wise to the current commercial inorganic fertilizers.

Table 11

Nitrogen, Phosphate, Potassium and Calcium values of poultry manure

Source	Nitrogen %	Phosphate %	Potassium %	Calcium %
Caged layers (10% moisture)	4,5	1,8	1,8	10,4
Broilers on shavings (15% moisture)	4,08	1,56	1,50	1,60

Table 12

Nitrogen, Phosphate, Potassium and Calcium prices

	Percentage =	R / mt	= cents/kg
Super phosphate	11,3 P	100,26	89 P
Urea	46 N	233,44	51 N
Potassium chloride	50 K	118,50	24 K
Agricultural lime	36 Ca	11,00	3 Ca
Fertilizer value of:			
Cage litter	R 46,41/mt		
Broiler litter	R 38,77/mt		

It must be appreciated that one ton of poultry manure will provide sufficient protein to supplement 1 000 head of cattle per day on natural grazing. Furthermore it has the advantage over urea that the ruminal release of ammonia from uric acid is much slower and thus far less toxic than urea on an isonitrogeneous basis. The other advantage of poultry manure is that it is a good source of phosphorous in which South African grazing is deficient, particularly in winter.

Table 10

The effect of various levels of untreated broiler litter on cattle performance

Treatment	Control	1	2	3	4
Level broiler litter (%)	0	6	18	24	30
Initial mass (kg)	225	224	224	225	224
End livemass (kg)	385	379	382	387	372
Days in feedlot	91	105	119	119	119
A.D.G. (kg)	1,76	1,47	1,33	1,36	1,34
Feed consumation (kg)	993	1 088	1 240	1 301	1 280
F.C.R.	6,2	7,06	7,85	8,03	8,65

Although it is generally recognised that potential disease problems due to bacteria in waste do exist, pathogens such as *Salmonella pullorum*, *Salmonella typhumurium* and *E. Coli* are destroyed by mild heat treatment. *Clostridia* however, are not destroyed and if poultry manure, particularly broiler litter is used, steps should be taken to inoculate stock against botulism.

Cases of copper toxity have been reported in sheep fed poultry litter. The high copper levels in the litter resulted from feeding of high levels of copper to broilers. However, the copper problem is unlikely to be as severe in cattle since they are not as sensitive to the effects of dietary copper as are sheep.

(e) Soyabean oilcake meal

From Tables 6 and 7 it is apparent that vast quantities of soyabean will be required by the turn of the century to optimally satisfy the nutrient requirements of the South African livestock population.

Attempts to encourage soyabean production in South Africa have thusfar met with limited success. According to Snyman (1979, personal communication) soyabeans could be very successfully produced in the Eastern Free State, South Eastern Transvaal, Northern Natal and East Griqualand. However, soyabean will have to compete with wheat in the Eastern Free State and maize in the South Eastern Transvaal. From Table 13 it is clear that soyabean at R180.00 per ton competes fairly favourably in terms of gross income per hectare with wheat and maize, particularly since this leguminous crop will save on high nitrogenous fertilizer costs.

To date, because of adequate fishmeal supplies in South Africa, pressure has not been exerted to promote the production of soyabean. The increasing feed requirements in South Africa coupled with the diminishing availability of fishmeal has caused nutritionists of the balanced feed association to bring to the notice of relevant authorities the necessity to encourage farmers to produce this crop. The problem at this stage however, is that the processing of soyabeans is not attractive to oil expressers due to the low oil content and additional cost to destroy trypsin inhibitors in soybean oilcake meal after oil extraction. It will be noticed from Table 14 that soyabean cake will have to realise R240.00 per ton to bring it to an equivalent basis with sunflower cake. There can be little doubt that sacrifices will have to be made by both the balanced feed manufacturers and oil expressers to enable this vital ingredient of outstanding nutritional merit to be placed on the market.

Of the various chemical tests performed on soyabean meal to determine its quality, the urease test is by far the most common; this test is used as a guide to proper cooking of the meal, to assure maximal nutritional value and trypsin inhibitor destruction. The assay is relatively easy to perform and does not require elaborate equipment.

Table 13

Gross income obtainable from selected cash crops in comparison with soyabeans

Crop	Yield range mt/ha	Unit price R/mt	Gross income R/ha
Wheat dryland	1	*	120
(Eastern Orange Free State)	1,5	120	180
	2		240
Grain sorghum**	1,5		117
(South Eastern Transvaal)	3	75	225
	4		300
Maize	3		240
(South Eastern Transvaal)	4	80	320
	5		400
Sunflower**	1		140
	1,5	140	210
	2		280
Soyabeans	0,9		162
(South Eastern Transvaal and	1,5	180	270
Eastern Orange Free State)	1,7		306

* Taken as an average price for an average grade

** Generally produced on heavy clay soils less suitable for maize, but suitable for soyabeans

Table 14

Price of soyabean meal to stimulate production

		1 000 kg Sunflower seed yields
365 kg oil @ R650/ton	=	R237,25
360 kg cake @ R118/ton	=	R 42,48
275 kg husk & losses	=	R 1,00
		R280,73
		1 000 kg Soyabean meal yields
160 kg oil @ R600/ton	=	R 96,00
800 kg cake @ R240/ton	=	R192,00
40 kg losses	=	–
		R288,00

Table 15

Effect of proper processing on the nutritional value of soyabean products

Relative protein efficiency	%	Urease increase in pH
Control – skim milk	100	–
Soyabeans raw	30	1,9
Soyabean meal – unheated	36	1,8
Soyabean meal – mildly heated	70	0,75
Soyabean meal – properly heated	89	0,2
Soyabean meal – overcooked	81	0,05

56-Day rat study
semi-purified diets with 10 per cent protein

One of the most complete experiments on the effects of cooking on protein efficiency of soyabean products was conducted by Hayward (1959). The relationship between relative protein efficiency and urease activity is shown in Table 15.

These results show that the quality of the protein is increase with protein denaturisation. However, excessive cooking results in a lower protein efficiency due to decreased amino-acid availability. It is therefore, suggested that a pH rise of 0,2 is considered as adequate cooking. As the cooking time increases the meal will eventually record a pH rise of 0. Since it is impossible to know whether a 0 rise in pH indicates a meal that is perfectly cooked to the point of destroying the trypsin inhibitor or whether it was overcooked and the proteins damaged, the lower value of 0,05 is included as a check against overcooking. As we will shortly enter the era of the soyabean, it is necessary to point out, even at this early stage, that precision cooking is of utmost importance and it must be the responsibility of each processor to see that his meal is prepared properly.

(f) Bloodmeal and carcase meal

As in the case of soyabean, excessive heat treatment of bloodmeal and carcase meal renders the protein less available. Bloodmeal is an excellent source of the first limiting amino-acid lysine. Unfortunately feed manufacturers cannot fully exploit the value of bloodmeal because of excessive heat treatment in the sterlising process. It is therefore suggested that nutritionists and veterinarians meet to evaluate the balance between sterilisation and nutritional qualities of these two products.

(g) Cottonseed oilcake meal

It must be appreciated that the use of cottonseed meal in non-ruminant rations is limited by the presence of the natural plant pigment – gossipol which is toxic. Gossipol, a polyphenol, will bind iron, depress growth, reduce feed intake and accumulate in body tissues. This pigment is a much more critical factor in the formulation of laying hen rations. Gossipol is fat soluble and can be transmitted into the egg where it can combine with iron to produce an objectable olive/green discolouration. These discolourations may occur soon after the egg is produced or may develop later during storage. Increased incidence of discoloured eggs will occur if the dietary-free gossipol level is greater than 50 ppm. In the case of pigs it would appear that free gossipol up to 100 ppm could be tolerated without affecting daily gains and feed intake.

(h) Groundnut oilcake meal

The amino-acid balance of groundnut meal limits its use in non-ruminant rations due to its deficiency in lysine, total sulphur containing amino-acids and threonine. The greatest obstacle, however, to greater use of groundnut oilcake in livestock and poultry rations is the possible presence of mould metabolites. Unless groundnuts are harvested, stored and processed under ideal conditions, there is the possibility of aflatoxin contamination. The results of excessive aflatoxin levels have been widely published.

(i) Urea

Urea, as a general protein saving agent, has become acknowledged as a normal ingredient in ruminant rations, and is incorporated for the purpose of securing a cost sparing effect. Thorough perusal of the literature on the utilisation of urea in production rations confirms that the specifications in the current farm feeds act are realistic. In production rations the non-protein nitrogen derived from urea in the diet should not exceed 30 per cent of the total nitrogen and in the case of finishing rations no more than 40 per cent. Based on these specifications, the total urea requirement in South Africa by the year 2000 for production feeds could be 63 329 tons. No consideration has been given to the use of urea in maintenance rations and licks. This task will no doubt be comprehensively undertaken by Dr Louw in his paper. This will be no mean task because of the complicating factors of poultry manure availability and the effect of the different ecological regions. As a matter of interest, the current urea usage in livestock feeds in South Africa is 32 000 tons.

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