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ACTION : BROILER PRODUCTION–2003

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The South African broiler industry has changed, grown and improved its efficiencies more rapidly than any other segment of the food industry. It has been a leader in applying production technologies, in developing efficient business – production structures and in meeting consumer preferences. It is an industry with an exciting past, an exciting present and an exciting future.

Data taken from an integrated broiler operation in Maine U.S.A. clearly illustrates the significant and continued improvement in market age, market body-mass and feed efficiency for the period 1952 to 1982 (Tables 1 & 2). The improvement of broiler efficiency in South Africa has followed a very similar pattern.

Table 1

Comparison of broiler performance in Maine (1952 - 1982)

	1952	1962	1972	1977	1982*
Market Age (days):	80	65	60	53	46
Market Mass (kg):	1,52	1,71	1,82	1,84	1,82
F.C.R.	3,17	2,15	2,03	1,95	1,80
Livability:	**	96,5	96,5	96,5	97,0

* Projected.

** Figure not available.

(Dansky – 1980)

Table 2

Effect of improved performance on yield of broiler meat per sq. metre of housing (1952 – 1982)

	1952	1962	1972	1977	1982*
Birds/Sq. Metre:	10,76	11,96	15,37	15,37	17,93
Market Age (days):	80	65	60	53	46
No. Flocks/Year:	4,1	5,0	5,6	6,3	7,0
No. Birds/Year:	44,12	59,8	86,07	96,83	125,5
Live Mass/Year (kg):	67,06	102,1	156,3	178,1	227,9

* Projected.

NOTE: 1. Through 1972 – approximately 50% more broiler meat obtained from identical footage with each 10 year cycle.

2. Figures for 1982 are estimates.

(Dansky – 1980)

The broiler industry has without doubt established itself as a major supplier of good quality protein to the South African consumer. Table 3 shows the phenomenal growth of this young industry, achieving 192 million processed broilers in 1981. At an average dressed mass of 1,3 kg each, this industry therefore contributed over 250,000 tons of meat to the consumer, or the equivalent of 1, 250,000 beef carcasses of 200 kg each.

Table 3

Total estimated broilers processed

Year	Broilers processed
1969	55 947 611
1971	61 282 360
1973	87 311 586
1975	127 727 580
1977	155 272 931
1979	163 370 199
1981	192 317 645

S A P A Bulletin (1977) & Personal Communication

Taking the aggregate population of South Africa at 29,2 million in 1981, it would appear that the per capita broiler meat consumption during this period was 8,56 kg. Taking the broiler breeder culls, spent layers, egg strain cockerels, ducks and turkeys into consideration the total per capita poultry meat consumption was 10 – 10,5 kg.

This figure is still relatively low when compared to the consumption in other Western Countries, (Table 4). The increased earning power of the black sector of the population will no doubt accelerate the South African *per capita* consumption in future. The black consumer has emerged as an important consumer of poultry meat. In 1970 black buyers bought 12,5% of total poultry meat, whereas this figure increased to 39% in 1975 (Nel, 1981).

The growth in the S.A. broiler industry did not take place without any hitches. During the early seventies there was a rapid expansion of the industry coupled with increased *per capita* consumption of broiler meat. However, with the decline in the South African economy during the late seventies, local poultry consumption showed an alarming decline. Because of the very capital intensive nature of the industry a cutback in production did not present itself as the best solution. Therefore export markets were developed to enable continued production.

Table 4

Poultry meat consumption in selected countries (kg/person/year)

Country	1977	1979	1981
United States	24,8	27,9	29,5
France	15,1	16,2	17,3
United Kingdom	13,0	13,3	14,1
Israel	38,8	36,6	34,7
Japan	8,4	10,1	10,5
Australia	15,8	18,9	21,8

Poultry International – Jan., 1982

It was felt that exporting would provide a better solution, since it achieved the same results as a cutback in production with the added advantage of increasing foreign revenue. Griessel (1979) has predicted that the broiler industry will produce 600 million broilers by the turn of the century. It must be expected that many problems will occur in achieving this expansion during the next two decades and the purpose of this paper therefore, is to draw attention to potential problems and to offer possible solutions in an action programme.

Feed costs prior to processing and distribution today represents about 65 percent of the production costs. This important cost item warrants prime attention and it is therefore proposed to consider this aspect at the outset.

Feed

Griessel (1979) reported that the feed requirements for the various classes of livestock could reach a figure of 10 million tons by the year 2000. The broiler industry will demand approximately 25 percent of this large volume. It must be appreciated that high density diets will be required to fully exploit the genetic potential and shorter finishing capability of the modern broiler. In other words it can be expected that higher demands will be placed for available maize and proteinaceous materials such as fishmeal, soyabean oilcake meal, sunflower oilcake meal, cottonseed meal, and groundnut oilcake meal.

In Table 5 the protein rich materials available in 1981 in South Africa is compared with the requirements estimated by Griessel (1979) for the year 2000.

Table 5

Available and projected protein requirements

	Availability of local Proteinaceous materials in 1981 (mt)	Protein materials required in the year 2000 (mt)
Fishmeal	167 000	326 496
Soyabean oilcake meal	13 000	424 941
Fullfat soya	6 000	–
Sunflower oilcake meal	154 000	506 867
Cottonseed oilcake meal	44 000	228 923
Groundnut oilcake meal	45 000	20 013

Even prior to these projections Cloete (1978) drew attention to the serious protein shortages facing South Africa. The Balanced Feed Industry is extremely concerned that so little attention has been given to research on alternative sources of proteinaceous materials. A levy of R4,00/ton is paid on all purchases of proteinaceous materials to a fund already amounting to R8,15 million at the end of January 1982, and the question may well be asked as to why this fund is not being utilised more effectively to encourage research and development of new varieties of protein materials suitable for cultivation in the Republic. It is clear that immediate and urgent attention is required to ensure adequate supplies of protein rich materials for the future. The urgency of the problem is substantiated by the fact that already during

1981 the following protein rich materials were imported at an estimated cost to South Africa of R26 500 000.

Fishmeal	31 500 ton
Soyabean oilcake meal	29 000 ton
Sunflower oilcake meal	7 000 ton
Cottonseed oilcake meal	7 000 ton
Full fat Soyabean meal	2 000 ton

It must however be emphasised that it would probably not have been necessary to import such large quantities of oilcake if it had not been for the low world price of plant oils. After the local requirements for 175 000 tons of oil had been met there was a surplus of 90 000 ton Sunflower seed which could not be crushed because of uneconomic returns. This 90 000 ton at a yield of 38,5 percent cake would have provided 34 500 ton of cake, which would considerably have alleviated the situation. It would therefore seem appropriate that South Africa would have to move in the direction of producing an oilseed, having a lower oil content but a higher cake yield as found in the Soyabean. Indications are that South Africa will have to import 60 000 tons of fishmeal and 60 000 tons of oilcake meals during 1982 which will cost the country approximately R43 million. The droughts presently being experienced can only worsen the situation.

Some of the more important raw materials used in the South African broiler diets which warrant more attention are the following:-

(i) *Soyabean*

Notwithstanding the fact that frequent recommendations have been made to encourage soyabean production in South Africa it would appear that little progress has been made in this regard. The Balanced Feed Industry is already paying a 14% premium for soyabean meal based on its calculated nutritive value. Farmers nevertheless are still producing alternative crops, such as maize, which would appear to be more profitable. Either maize is priced too highly or the Republic does not possess the correct varieties or production techniques to ensure sufficiently satisfactory yields. Instead of further increasing premium payment for local soyabean meal it is suggested that it would be more in South Africa's interests in the short term, to import Soyabeans which could be converted to full fat soyabean meal. In the meantime it is of the utmost importance that agronomists should devote their energies to producing cultivars which will equate with the returns of producing maize.

(ii) *Sunflower*

Although Sunflowers can be produced economically with ease in South Africa, only limited quantities can be used in broiler feeds due to its high fibre content. A short term solution would be to fractionate the sunflower meal to lower the fibre content from 13 percent to 4 – 5 percent and increase the protein from 40 to 50 percent. Larger quantities of this improved material can be used in broiler feeds but this will not be satisfactory in the long term as it will result in an increased oil surplus on the local market which because of fluctuating world oil prices will make the crushing of the seed uneconomic for the oil expressing industry.

(iii) *Fishmeal*

The yield of fishmeal from South African and Namibian waters has probably reached its peak at 150 000 ton. From Table 5 it is obvious that for least cost broiler diets, substantial quantities of fishmeal will have to be imported in the future. However an interesting development arising from the last South African importation of fishmeal has been the occurrence of Gizzard Erosion in broilers fed diets containing the imported fishmeal. The resulting substantial losses incurred by broiler producers from this condition has caused many of them to opt for more expensive diets where large quantities of imported fishmeal are replaced by Soyabean oilcake meal. The aetiology of gizzard erosion is still obscure although it has been speculated that causative factors could include histamine levels in the fishmeal, fineness of the material and processing temperatures. As fishmeal is an important ingredient of broiler diets and large quantities will still have to be imported in future it is essential that research be immediately devoted to establishing the exact cause of this condition. Feed manufacturers will then be in a position to draw up suitable specifications for future importations of this raw material.

(iv) *Single cell protein*

In order to be independent from fishmeal importations alternative protein sources have been investigated. Single cell protein is such a raw material. This is an excellent source of protein, energy, calcium and phosphorus with a suitable aminogram. Indications are that certain heavy metals and toxic substances may be present in this material. However, workers in Japan have developed Assessment methods for the safe use of SCP for animal feeding including pathogenecity, mutagenicity, toxicity (mycotoxins and heavy metals) and carcinogenicity (Fudjimaki, 1981). Results have been generally negative when tested on livestock (Yu, Da Chen and Kang-Lin, 1981). Evaluation of SCP for inclusion in animal feeds suggests that the acceptance price could vary between R335 – R350 a ton based on existing prices of available raw materials. Production costs for SCP appear in the region of R500 a ton in South Africa which makes the use of this material uneconomic for inclusion in broiler diets. At current fishmeal prices (R470 per ton) and at an importation requirement of 176 000 tons by the turn of the century the debit in balance of payments for South Africa could be R83 000 000 per annum. The production of SCP in South Africa holds the advantage of the creation of work opportunities and can save on foreign exchange and it is suggested that the authorities investigate the possibilities of subsidising such an industry, and/or making it an integral part of the development of Sasol 2 and Sasol 3.

(v) *Maize*

As broiler diets contain 70 – 75 percent maize it is clear that a successful broiler industry in the future must of necessity be closely tied to adequate supplies of maize at competitive prices. Fortunately all projections indicate that South Africa will be in a position to produce sufficient quantities of maize to meet all requirements of its livestock industry until the turn of the century. In fact as a result of transport problems and a lack of suitable markets the Maize Board is presently experiencing problems in disposing of its large surplus of maize. It would appear that export losses on this commodity could amount to R260 000 000, in 1981/82. At this stage it would thus not be out of place to investigate the possibility of including maize at world market prices in broiler diets for birds destined for the export market. At the higher external maize price the South African broiler industry is placed in a totally uncompetitive position against other exporters in the European Economic Community who obtain their maize at considerably lower world market prices. It must be appreciated that maize converted to broiler meat creates job opportunities; these workers in turn having the purchase power to buy more eggs, meat and milk produced from maize based diets. In addition South Africa will earn more foreign currency if it is considered that one ton of maize can produce 400 broilers of 1,3 kg each for export. This means an income of R624-00 against an income of R120-00 per ton for maize at present prices.

One of the basic problems of the South African broiler industry until now has been the unstable market prices and the quantity which the local market could absorb. During times of surplus, prices are depressed which forces the industry to export at uneconomic prices. Should exports become more economic it would stabilise the local market which in turn would encourage future investment in the industry. A small surplus of any agricultural commodity creates many problems as it is difficult to change consumption habits in the short term in order to absorb surpluses.

The National Association of Maize Producers (NAMPO) recently stated that the market outlet for maize should be expanded. The exports of maize via the broiler presents just such an opportunity. Furthermore it is gratifying to observe the work in recent years on maize which has led to the production of the endosperm mutants Opaque 2 and Floury 2 with their high Lysine, Tryptophan and Arginine content. Since the Maize Board is presently unable to store those cultivars separately from the normal maize it was decided that the new varieties could be purchased by the feed companies directly from the producers. However, the feed manufacturer will also have to bear the cost of storing high Lysine maize separately. Although high Lysine maize has a R10-00 greater value per ton than normal maize, the feed manufacturer must offer less than the R10-00 premium per ton in order to cover the cost of the additional storage facilities. Nevertheless in the long term, if yields of the new varieties are comparable to normal maize this development must benefit both the feed manufacturer and broiler producer.

Pelleted broiler feeds

It has been known for some time that pelleting effectively reduces the microbial population in feed and probably reduces the risk of bacterial infection (Jones, 1979). Calet (1965) reviewed a number of publications concerning pelleted feeds for all types of poultry. He was unable to arrive at a satisfactory explanation as to why the performance of young birds fed pellets was usually superior to those fed mash. One explanation was given by Jensen *et al* (1962) who observed that mash fed birds spent more time feeding than those receiving pellets and suggested that chicks utilise pellets more efficiently than mash because they expend less energy consuming the feed.

Table 6 summarizes some of the research on the performance of broilers fed pelleted feeds versus meal.

It will be noted from these results that there is a consistent improvement in bodymass and feed conversion in birds receiving pellets as opposed to meal. It is also obvious from the data that results from feeding pellets can be quite variable probably due to factors such as diet formula, age of bird, sex and strain of the bird, the conditions under which the feed is pelleted and farm management conditions. The economic benefit of pelleted feeds versus meal is therefore difficult to evaluate. However, if an average figure of 8,6% improvement in bodymass and 4% in feed conversion is accepted it would appear that pelleted feed is worth in the order of R17–18 per ton more than meal using present market prices (Table 7).

This calculation is based on the assumption that in order to produce the same broiler biomass using a mash diet instead of a pelleted diet

Table 6

A summary of some research on pelleted broiler feeds

Year	Study length (wks)	% Improvement Body mass	F.C.R.	Reference
1951	12	– 1,4	+ 5,9	Poultry Sci. 30:63
1955	10	+ 8,6	+ 6,9	Poultry Sci. 34:234
1957	4	+ 4,9	+ 2,1	Poultry Sci. 36:517
1957	4	+ 9,5	+ 3,7	Poultry Sci. 36:1388
1958	9	+ 5,7	+ 6,2	Poultry Sci. 37:117
1958	9	+ 12,5	+ 6,2	Poultry Sci. 37:189
1960	9	+ 8,7	+ 2,8	J. Agr. Sci. 55:141
1961	4	+ 11,0	+ 2,5	Poultry Sci. 40:854
1962	4	+ 25	+ 10,0	Poultry Sci. 41:1489
1968	4	+ 4,7	– 4,7	Poultry Sci. 47:677
1976	8	+ 5,0	+ 1,9	Poultry Sci. 55:1958
Mean		8,6	4,0	

Table 7

Cost effect of using meal as opposed to pellets to achieve the equivalent biomass

	Pellets	Mash
Facility	10 000 m^2	10 000 m^2
Livemass @ 49 days	1,80 kgs	1,647 kgs
Broiler Density (terminal)	19 Birds/m^2	20,76 Birds/m^2
Number Day-old Broilers	198 953	219 682
Livability	95,5%	94,5%
No. Broilers to Process	190 000	207 600
No. Kilos at 49 days	342 000	342 000
CALCULATION OF D.O.C. AND FEED COSTS.		
Day Old Chicks (assumed at 25 cents)	R 49 738	R 54 921
Overheads (assumed equal)		
FEED COST	R 250/Ton	R 250/Ton
F.C.R.	2,050	2,135
Kgs of Feed	701 100	729 993
TOTAL FEED COST	R 175 275	R 182 498
COST OF CHICKS PLUS FEED	R 225 013	R 237 419
ADDITIONAL COST OF MASH Per Ton of Feed	(R 237 419 – R 225 013) / 701,1 Tons = R 17 – 70	

(a) relatively more day old chicks are placed

(b) allowance is made for higher mortality (due to increased stocking density)

(c) allowance is made for growth depression (due to increased stocking density)

(d) deterioration in feed efficiency due to mash feeding.

Although it can be expected that pelleting costs will rise because of energy costs rises in the future it can also be expected that raw material costs will rise at a greater rate, making the pelleting of feeds for broilers more attractive.

Nutritional Research

Least-cost broiler diets have been a major tool of feed companies and of integrated broiler farms for improving broiler performance and maximising profits. Although the least-cost diets minimise the cost of diets of pre-specified nutrient content, they do not determine which nutrient levels are most profitable.

The looming protein shortage in the South African context, ever increasing and variable feed ingredient prices, and fluctuating broiler meat prices stresses the importance of developing broiler performance models which could be used in future to determine the most profitable diets for a given set of circumstances. This implies abandoning the idea of a "fixed requirement" for a nutrient and replacing it by data relating the cost of nutrient inputs to the value of outputs.

In this field the Poultry Department of the University of Natal under the guidance of Dr. R. Gous has carried out pioneering work and should be congratulated for their contributions. It is felt that this work carried out on our most limiting amino-acids should be extended to cover other important nutrients such as vitamins to determine optimum response levels in broiler diets.

An example of such a response curve showing lysine input to egg output for layers is illustrated in Figure 1.

The expected mortality figure in a broiler operation varies form 3 to 5 percent of which it would appear that 30 – 50 percent can be ascribed to the socalled "flip-over" syndrome associated with heart failure. It is interesting to note that it is invariably the fastest growing broiler that succumbs to this conditions.

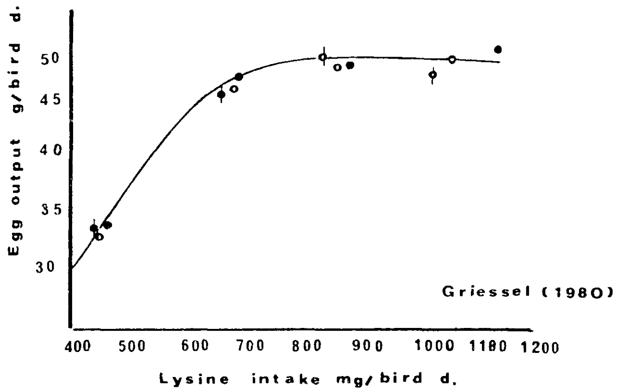

Fig. 1 *The relationship between egg output and Lysine intake*

The question may be posed as to whether the time has come to pay attention to the important micronutrients since in the restricted feeding programmes applied to breeder parent stock only the macronutrients are normally considered. The other possiblity is that the amount of feed required to produce a given mass has declined substantially in recent years and in these diets again only the macronutrients have received the overwhelming attention.

More attention in the future should be devoted to the synergistic or antagonistic relationships between various raw materials and other nutrients in diets. A prime example of this phenomenon is found in the work of Morris (1980) who established that the effective requirement for lysine is higher when wheat is used as the major dietary component (Figure 2).

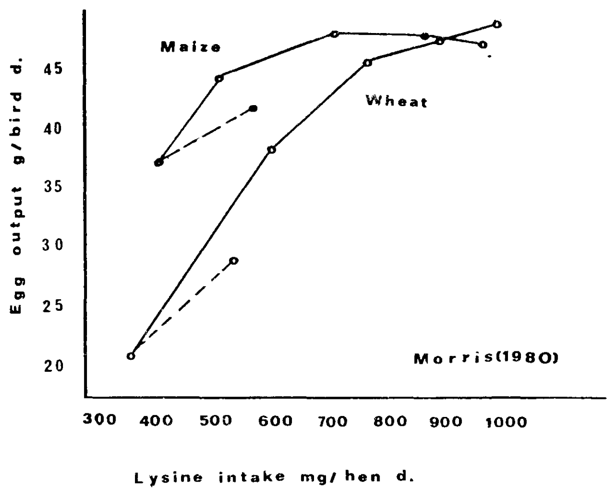

Fig. 2 *Response of laying pullets to lysine supplied from wheat and maize diets*

Finally our current knowledge of amino-acid availability is inadequate. A thrust in this direction is required since it is well known that processing methods can affect the availability of amino-acids in raw materials.

The ultimate goal will be the development of a rapid chemical method to determine amino-acid availability, but this will be preceded by a biological method.

Genetics

Van den Eynden (1978) reported at the World's Poultry Congress in Rio de Janeiro that the improvement in annual growth rate of broilers over the past years has been between 4 and 5 percent while the feed conversion efficiency has improved by approximately 0,02 points or one percent per year. The breeding programme followed in South Africa shows that our annual broiler growth progress was 70 – 80 grams which is remarkably similar to that reported by Van den Eynden.

This worker extrapolated the data of improved performance in the past and from Figure 3 it will be observed that he predicts that broilers will have a mass of 2 kg at 35 davs of age by the turn of the century.

Because of the negative correlation between high female parent mass and reproductive performance there is an interesting conflict of opinion between breeders as to whether our present genetic progress will be maintained. It is however felt by some that this problem will be partially overcome by the use of sex-linked recessive dwarf females.

Problems are presently being experienced in that broiler breeder parents are overfat. This must be overcome to ensure good production and this could provide a further incentive for the future introduction of the dwarf female.

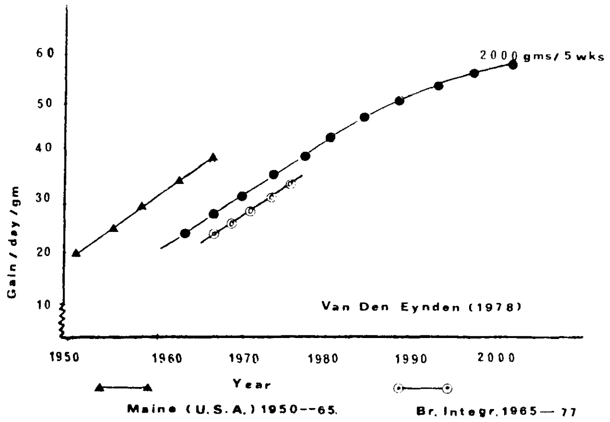

Fig. 3 *Realized broilergrowth improvement and future trend*

Early results have shown that when commercial Cornish Game male lines are crossed with dwarf females the broiler male progeny are 2% lighter than when normal commercial White Rock female lines are used. Results from a recent French random sample test did not however confirm any difference in broiler masses (Brock, 1982 personal communication). The dwarf female possesses the advantage in that, as it is 30 percent lighter than the conventional White Rock female, it is not only requires less feed during the rearing period but also requires less feed for maintenance during the laying period (approximately 40 grams/day). The approximately 12 kilograms less feed it requires during its lifespan lowers the cost of producing hatching eggs and day-old broilers. The 12 kilogram less feed required on 130 day-old broiler chicks produced would mean a saving of 1,5 cents per chick. The concern that the commercial Cornish Game males will be too heavy for the dwarf females can be overcome by using artificial insemination, a practice that has been used for many years in the turkey industry.

Artificial insemination in itself has the advantage that no floor eggs are laid and thus cleaner eggs are produced which in turn will limit bacterial infection to a minimum. Furthermore, if correctly applied, it will enhance fertility and hatchability.

Despite impressive accomplishments through the use of the principles of classical genetics by poultry breeding organisations, Jensen (1981) is of the opinion that it is quite possible to produce a 1,8 kilogram broiler at 25 – 28 days of age during the next decade. This revolutionary improvement could be accomplished by the application of recombinant D N A (deoxyribonucleic acid) techniques. D N A is the functional unit of memory storage present in the nucleus of all cells and determines all of the functions of the cell and organisms, such as broilers, made of the cells. Studies by molecular biologists have revealed that it is possible to bring about the efficient synthesis of almost any polypeptide or protein by taking the D N A from one organism and putting it into another (gene splicing). There are a host of proteins and low molecular weight polypeptides that are involved in the control of appetite, growth and metabolism of animals. The possibility of cloning these polypeptides and proteins by use of recombinant D N A techniques provides the opportunity of having these compounds economically available for altering the performance of broilers and other animals.

It has long been known that various organs in the body of chickens and other animals elaborate hormones which markedly affect the physiology and metabolism of the animal. Decades ago when these hormones were being discovered, it was anticipated that they would be a panacea for altering the performance of animals. This hope for poultry has not been realized and the only practical application was the short-lived use of diethylstilbestrol. This synthetic estrogen was banned by the Food and Drug Administration. With the advent of recombinant D N A techniques, the future again looks bright for the use of hormones in animal production. Hormones of a protein or peptide nature should have less difficulty with F D A approval since these compounds are inactivated by cooking. Furthermore, the quantities needed to alter the physiology and metabolism of broilers may be extremely small.

Jensen (1981) furthermore points out that the modern broiler has been genetically selected for a good appetite, but that the physiological basis for feed intake control was still not clearly understood. There appears to be peptides produced both by the stomach and intestines of animals and the central nervous system which markedly influence feed intake. Cloning of these peptides provides an opportunity of a possible application of recombinant D N A to improving rate of broiler meat production. Compounds that reduce feed intake may be useful in reducing the rate of growth of broiler breeder pullets without "skip-a-day" feeding.

A study from Norway with rabbits and mice showed a dramatic increase in rate of muscle protein synthesis by the injection of a small molecular weight – peptide into these animals. The peptide had been isolated from the urine of patients with a hereditary condition, called lipodystrophy, a disease in which fat is not deposited in their body. Three-week old rabbits given daily injections of the compound over a three-week period grew much more rapidly than controls and had very little fat deposition. After one month, the control animals weighed approximately 1,55 kilogram while those injected with the peptide from the lipodystrophic patients weighed over 2,7 kilograms. Such a study reveals the tremendous potential for manipulating the performance of animals by exogenous peptides or proteins.

Recent work at Iowa State has also shown that rate of food passage in chickens is slowed by adding fat to the diet. This appears to explain part of the so-called extra-caloric effect of fats in poultry diets because slowing of passage time allows for better utilisation of the non-fat components of the diet. The mechanism for this is unknown, but if it could be unravelled, it might be possible to slow passage time by mechanisms other than added fat to result in more efficient use of dietary nutrients.

If the genetic progress overseas through the use of classical methods and/or possible revolutionary D N A breakthroughs are considered, it would appear to be unnecessary for South African researchers to devote too much attention to broiler genetics. The policy adopted by the South African broiler industry of importing improved genetic material from time to time has appeared to be satisfactory since results obtained in the Republic have equated to the best obtained in the world.

It must be appreciated that the market potential in South Africa does not warrant a complete genetic programme. Such a programme would require the setting up of a priority programme of selection parameters such as mass gain, feed conversion efficiency, feather sexability, dwarf genes etc. The only companies that run a genetic programme have a world-wide marketing organisation and even such a large market can only support the present few left. Should boycotts be instituted against South Africa we already have pure lines in the country from which genetic programmes can be established if necessary. These would and are being updated by regular importations which means that at worse we would at that point in time be one year's genetic programme behind the rest of the world. The cheapest research is when someone else pays for it. An example of this is the current interest being shown in dwarf genes and should this prove to be of economic advantage in the South African context then pure lines will be available for immediate importation.

It must be appreciated that if a genetic breakthrough is achieved by overseas workers through the use of recombinant D N A techniques the genetically improved material will immedately become available for importation to South Africa.

Housing

It would appear that because of the high cost of petroleum gas (LPG) and increasingly higher feed costs, the days of the convection type broiler house are numbered and that preference must be given to the controlled environment house. It is generally found that because of poorer feed conversion and higher gas consumption, particularly in winter, the cost of producing a kilogram of poultry meat is higher in the convection type house. It is intersting to note that the cost of liquified petroleum gas (LPG), the predominant fuel used for brooding poultry, has increased by 266 percent since 1974. This drastic increase has focused attention on a previously insignificant cost in poultry production and has resulted in efforts to determine the magnitude of fuel use in the poultry industry and methods of reducing fuel requirements. Partial house, or limited area brooding, where the chickens are restricted to a portion of the house during the 3 to 4 week brooding phase, is an effective method of reducing fuel requirements (Reece, 1976). A field demonstration by Haynes and Smith (1980) resulted in a

50 percent reduction in fuel used to grow broilers when birds were restricted to one-half of the house for the first half of the growing period.

Another fact that we should take cognisance of is that a new labour era in South Africa is fast seeing the light of day. Organised labour today demands improved conditions of employment and working conditions. For example, issues such as total remuneration, housing, rations, transport and other related fringe benefits are the most pressing issues raised by trade unionists. Conditions such as long working hours, dusty environment etc. are points of contention. As a result of escalating costs of labour, fuel and feed it can thus be expected that in the future many organisations will seriously consider the merits of a broiler cage rearing system versus controlled environment litter housing.

The advantages of the cage rearing system over floor rearing are the following:

(a) Dust and wet litter are eliminated, which reduces spread of bacterial and viral infection.

(b) Most poultry people agree that cage-grown birds will not require a coccidiostat in their feed. This would save approximately two cents per bird produced. Feed troughs and waterers should however be kept clean to prevent coccidiosis in cage grown birds.

(c) To save labour, we can expect to see a cage design in future that will permit the entire cage to be transported to the processing plant, empied, sterilized and returned to the house.

(d) Available shavings are becoming more difficult to obtain and because of its bulky nature, transport and storage of this material is becoming increasingly expensive. Cage rearing eliminates the use of this material and the rationale for using this system becomes much more economic.

(e) Manure disposal can be done mechanically which contributes to the minimisation of labour costs for cleaning purposes.

(f) The use of a 2 or three-tier cage system allows for more birds to be kept per unit area which reduces the liquied petroleum gas (LPG) requirement for brooding purposes per bird.

(g) In heated cages the bird's mobility is limited reducing energy costs and accordingly lowering feed costs per unit output.

According to Shpektorov (1981) at the Enterprises of the Poultry Farming Department of the Soviet Ministry of Agriculture the growing period of broilers have been reduced by 12% and feed costs cut by 13% when broilers are reared in heated cages. Besides this, more livemass is obtained from a square meter of usable area than when rearing broilers on deep litter. Due to these advantages, rearing of broilers in cages has become widespread in the U.S.S.R.. In 1975, the Soviet Union raised 14 million or 10,5% in cages, in 1980 this figure topped 140 million or 34%. When broilers are raised in heated cages, breast blisters may develop in some chickens, which detracts from the outward appearance of birds. The use of high pressure polyethylene mats with round holes on metal netted floors makes it possible to get broilers of 1,4 kg livemass without breast blisters while, if the livemass reaches 1,7 kg, the number with breast blisters does not exceed 3 to 4%. The high capital investment cost to install a cage-rearing system is certainly a drawback but on the other hand it must be accepted that the decreased cost of production through higher capital investment has characterised the broiler industry all along.

Flowing from the above arguments (capital vs. labour intensive units) it must be borne in mind that should South Africa move toward the more efficient mechanised cage rearing system unemployment will be increased and this in turn will create political problems. To overcome or combat the resultant socio-economic and high unemployment features that can stem from increased applied technology a possible solution lies in the establishment of more capital intensive units in the major metropolitan areas and more labour intensive units in the newly established growth points, rural areas and/or homelands. To ensure the feasibility and competitiveness of these types of operations, particularly in the growth and rural areas it will require similar tax concessions from the Government as is applicable in the homelands to encourage and maintain employers to invest and operate successfully in these areas.

Diseases

The poultry industry has developed with amazing rapidity, and many diseases which used to be common problems are now no longer observed. The type of disease with which the veterinarian is faced today is somewhat different to that which used to be a problem. Conditions such as Newcastle disease are typical of the acute infection with high mortality caused by a single unidentifiable agent. Such infections fulfil the conditions laid down in Kochs Postulates. These are a set of rules suggested at the end of the last century, for determining whether or not a particular infectious agent caused a particular disease. To meet the requirements, the agent had to be isolated from an animal showing symptoms of the disease. The isolate then had to be purified and inoculated into healthy animals which had to show symptoms of the disease. It then had to be possible to reisolate the organism from the experimental animals and show that it was the same as the original agent. It is becoming increasingly clear that many of the diseases of poultry with which we are concerned today do not comply with Kochs Postulates. This is because the diseases are often subclinical, are often caused by more than one disease agent working in combination, and are often initiated or exacerbated by environmental and management factors. An example of this is Gangrenous Dermatitis. There is evidence that this condition is associated with a primary immunological defect in the young bird due to early infection with Infectious Bursal Disease, followed by infection with an Adenovirus. The disease manifests itself as acute mortality with gangrenous muscle lesions from which Clostridia or Staphylococci can be isolated, at about seven weeks of age. If experimental groups of birds are exposed to infection with Clostridia, the disease is not reproduced. Even when groups of experimental birds were infected with all three agents, Infectious Bursal Disease, Adenovirus and Clostridia, at the appropriate ages, the disease as seen in the field was not reproduced. This could have been because the experimental birds were housed with 20 or 30 in a room of 20 square metres. Commercial broilers, stocked at 15 – 18 birds/square metre are probably subjected to bruising and minor skin injuries, to which the experimental birds were not exposed. It would be prohibitively expensive in both birds and buildings to conduct laboratory experiments under commercial conditions within research institutes.

A further example of the complex nature of the diseases currently prevalent in broilers is the "Malabsorption Syndrome" (Van der Heide, 1981). "Malabsorption Syndrome" is a clinical disease in broilers and broiler breeders that is characterised by one or more of the following signs or lesions: enteritis, proventriculitis, pale birds, encephalomalacia, rickets, osteoporosis, osteomyelitis, abnormal feathering and growth inhibition. Because of the variation in signs and lesions, this complex disease has been named alternately: "Malabsorption Syndrome", "Infectious Proventriculitis", "Helicopter Disease", "Femoral Head Necrosis", "Brittle Bone Disease", "Pale Bird Syndrome", and "Runting Disease". Early enteritis and ensuing malabsorption of essential nutrients is supposed to be the sequence of events and in a number of cases Reoviruses, as well as Corona and Adenoviruses, have been isolated by workers at the Universities of Connecticut, Delaware and Georgia, as well as in Europe (Van der Heide, 1981). In these institutions, some or all of the typical signs of "Malabsorption Syndrome" could be reproduced with some of the Reovirus isolates.

The presence of mycotoxins is another factor which further complicates problems experienced today. We grasp the importance of mycotoxins only when we realize how widespread they are. They are found in feeds, feed ingredients, in the litter, in bins, trucks, tanks, troughs and in the air. Although we hear the most about aflatoxins, its only one of more than 120 mycotoxins that have their origin from moulds. The ability of small amounts of aflatoxins not only to increase the susceptibility of broilers to bruising but also reduce the performance of broilers is shown in a study by Smith and Hamilton (1970). This work indicated that the greater the amount of aflatoxin fed, the greater the depression in mass gain (Table 8).

A further effect of aflatoxins in the body is that birds are more susceptible to other diseases. This is because the infected chicken's reduced ability to remove foreign matter from the blood – just one of the many functions of the reticuloendothelial (R.E.) system impaired by the effects of aflatoxin.

Michael *et al* (1973) of North Carolina State University found the body's immune system was damaged by aflatoxin when levels of the toxin were well below the amount known to cause growth depression. Aflotoxin levels of 1,25 parts per million reduced the function of the R.E. cells by about one-third of that of the non-infected controls.

Table 8

Growth depression of three-week-old broiler chicks when fed measured amounts of aflatoxin

Amount of Aflatoxin (p.p.m.)	Grams Bodymass
None	470
0,65	475
1,25	468
2,50	375
5,00	285
10,00	200

The reason for enumerating these three examples is that the diagnostician today must consider a broad range of factors in assessing the importance or impact of disease syndromes or complexes arising in the poultry industry. It follows, then, that accurate diagnostic work today is more costly, difficult and time consuming. It is also clear that in order to continue to have poultry as a competitive food in the future for the consumer, the combined coordinated research efforts of nutritionists, physiologists, biochemists and veterinarians is necessary.

Many of the diseases encountered today have both metabolic and pathologic aspects which emphasises the importance of close cooperation between the veterinarian and the animal scientist. Diseases such as Ascites and Gizzard Erosion currently plagueing the broiler industry, resulting in considerable economic losses to South Africa could have both a metabolic or pathologic origin. These two diseases with which the industry has lived for many years require urgent solution. It is obvious that the scientists are either unaware of the economic importance of these diseases or that fragmented research is delaying the solution to obviate these diseases. Furthermore, it can be expected that further intensification will bring new problems. It must be appreciated that there is a limit to the number of vaccines to which young chicks can respond. If too many live vaccines are given to the young bird there is likely to be competition or interference with a poor response to some or all of the components. As new diseases arise it is not realistic to think in terms of adding a new vaccine to the already long list of those to be administered to the young bird. The alternative approach seems to be the production of very high levels of immunity in parent birds. This may be achieved by immunising them with multicomponent oil-based vaccines. Serum antibody of the parent bird is present in the egg yolk, and confers immunity to the chicks. Recent work (Cullen & Pattison, 1980) has shown that such immunity to Infectious Bursal Disease for example can last up to 4 weeks of age. With further improvements to oil-based vaccines and the reducing age at slaughter of broilers, it should be possible to provide the birds with sufficient maternal antibody to protect them for their entire lives. It therefore seems necessary that research must be coordinated in some manner and that industry must enlighten the research worker on the economic implication of disease effect. It is suggested therefore that a body be established having membership from industry and government who's function it will be to assess priorities for future research projects.

Separate sex rearing

Colour sexable and feather sexable broilers have been available for several years and because raising of broilers separately by sex has many economic advantages it can be expected that this practice will be applied to a great extent in the future. The advantage that separate sex rearing holds include the following:

(a) With the present trend in automated processing equipment, the advantage of size uniformity is becoming more of an important asset or necessity.

(b) Excessive abdominal fat is often observed in females when sexes are reared together. This abdominal fat not only affects consumer acceptance but also yield and operating cost of processing plants. The work of Heath (1981) clearly demonstrated that when males and females are reared together, the females have approximately 0,7 percent more abdominal fat than males based on livemass at 8 weeks and approximately 0,4 percent more at 7 weeks of age (Table 9).

Table 9

Effect of ration, sex and age on abdominal fat

	7 Weeks		8 Weeks	
Dietary energy MJ/KG	Female %	Male %	Female %	Male %
12,9	3,4	3,1	3,9	3,2
14,05	3,9	3,4	4,1	3,4
15,20	3,8	3,4	4,3	3,7

From the above work it will be noted that if females are slaughtered at an earlier age the deposition of excessive fat, can to a large extent be controlled. Work carried out at the Koos van der Merwe Research Institute (unpublished) also clearly demonstrated that not only was carcass fat reduced but an improved feed conversion rate was achieved when females were slaughtered at an earlier age (Tables 10 and 11).

Table 10

Weekly feed intake and gain of broiler males fed a commercial broiler diet

Week	Mass Gain (GMS)	Feed intake (GMS)	F.C.R.	Accumulated Mass (GMS)
1	103	123	1,19	139
2	209	311	1,49	348
3	322	501	1,56	670
4	391	746	1,91	1061
5	382	837	2,19	1443
6	376	940	2,50	1819
7	354	949	2,68	2173
D.O.C. (gms)	36			
TOTAL (gms)	2173	4407	2,03	

Table 11

Weekly feed intake and gain of broiler females fed a commercial broiler diet

Week	Mass gain (GMS)	Feed intake (GMS)	F.C.R.	Accum
1	101	120	1,19	137
2	189	291	1,54	326
3	254	433	1,70	580
4	314	627	2,0	894
5	339	737	2,17	1233
6	330	847	2,57	1563
7	307	881	2,87	1870
D.O.C. (gms)	36			
	1870	3936	2,10	

(c) Separate sex rearing has the added advantage of reducing the costs of diets fed to females. Sherwood (1975), Kubena *et al* (1972), Thomas *et al* (1977) and Anderson (1979) have reported differences in Lysine requirement between female and male broilers. In general, the above reports indicated that females needed 90 – 95 percent of the Lysine level needed to optimise male broiler performance. The work of Minear and Marion (1981) showed, that not only Lysine but also the Methionine and Total Sulphur Amino-Acid requirements of females are considerably lower than those of males. Their observations are presented in Tables 12 and 13.

Table 12

Lysine requirement – %/1 MJ/KG

	0–28 Days	28–42 Days	42–49 Days
Females	0,0786	0,0674	0,0514
Males	0,0915	0,0798	0,0643

Table 13

Sulphur amino acid requirement – g/1 MJ/KG

	0 – 21	21 – 42	42 – 49
	Females (Days of age)		
Methionine	0,033	0,0306	0,0301
Sulpur amino Acids	0,0595	0,0554	0,0476
	Males (Days of age)		
Methionine	0,0368	0,0351	0,0337
Sulphur amino Acids	0,0612	0,0600	0,0514

Comparing the growth rate of males and females fed a common diet at the Koos van der Merwe Research Institute (Table 10 and 11) it would appear that there would be much merit in formulating diets to specific male and female requirements in a separate sex rearing programme by reducing Lysine and Methionine levels in practical broiler diets by 5 and 10 percent. This reduction in amino acid content could effect a saving of R3-60 and R7-10 respectively under present South African conditions. The accelerating costs of raw materials in future can only increase these savings. When males and females are raised separately under the present "All In All Out" system, and the females are slaughtered a week earlier than the males, fifty percent of the facilities will be vacant at a particular time. Under these circumstances the present saving in feed cost will not justify the biomass lost through unutilised space. However, the considerable saving on feed cost will encourage large organisations to develop separate farms for separate sexes in future to utilise facilities to maximum advantage.

Marketing

It is predicted that the traditional Sunday dinner with fried chicken and the entire family gathered around the table will rapidly disappear in the future. Meals will be geared more to the individual in size and taste and the time normally spent in preparation of meals at home will be exchanged for outside interests and more convenient, faster food preparation, utilizing prepared, nutritious quality foods. Therefore, rather than marketing whole broilers the poultry marketer of the future will be marketing poultry food products based on consumer lifestyle values, personal tastes, appetite appeal, cost, convenience and nutrition. Cutting chicken into portions will continue to grow.

Moore (1980) of the U.S.D.A. reported that 663 761 tons of poultry meat in the United States went into further processing during 1980. This large tonnage represented 13% of the total chicken meat (5 105 854 tons) produced in the United States during 1980. Chicken franks are becoming more prevalent in the U.S.A. supermarket meat departments backed by chicken bologna, pimento, liverwurst and pickle loaf. It can be expected that the American experience will be shortly repeated in South Africa and will gain steady momentum.

Animal rights and animal welfare movement

Unfortunately there are some organisations and people in some countries of the world, "the welfarists", who are in no way concerned with the poultry industry but think of bringing about radical changes in the methods of poultry management, not only to the disadvantage of the producers, but also to the dismay of biological scientists who worked for many years to improve these birds.

Even the Governments in some of the European countries seem to be carried away by the arguments of the "welfarists" that birds in cages are subjected to heavy stress in order to increase production and reduce costs to the advantage of the producers. They even suspect the qualities of the products produced under intensive methods. It is possible that rearing of birds in cages may be banned in at least some of the European countries where sentiments have the upper hand over scientific knowledge and sound husbandry practices.

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