Service, for permission to publish the figures giving the geographical distributions of poultry in England and Wales, and Mr T. Whittle, West of Scotland Agriculture College, for permission to publish those relating to Scotland.

The future of animals as sources of human food

Pigs—whither?

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The production of food for man always has been, and always will remain, the biggest industry and also the biggest challenge to man's ingenuity.

Efficient animal production, with the emphasis on 'efficient' will remain an important integral part of agriculture, and I have no difficulty in foreseeing a rosy future for it, particularly for pig production. If the pig industry is capable and willing to exploit its potential to the utmost, then no other meat-producing animal, or bird and, most probably, none of the synthetic challengers (whenever they come) would be able to dislodge the pig from a dominating position.

On this occasion, I need only put forward the case for the pig, and can leave comparisons with other species to others. The tables which follow are self-explanatory and require only a few comments. Tables 1 to 6 are based on official sources.

In Table 1, information is given on the past, present and expected pig population in this country, as related to the human population. The prediction for the next two decades assumes that the increase in requirements caused by the increase in human population will be totally covered by home production. A small decline, 10% per decade, in imports of pork and pork products appears to me a desirable development. The arguments supporting it cannot be expanded here.

Table 1. *Human and pig populations (millions) in the United Kingdom*

		Pig	
Year	Human	Actual	Slaughtered per year
1934–8	46·8	4·6	
1958	51·7	6·5	
1968	55·0	7·8	12·5
1978*	57·5	9·2	14·7
1988*	60·0	10·7	17·1

*Assumptions for each decade: (1) to cover population increase of 250 000 per year; (2) to cover 10% increase in consumption of pork and pork products; (3) to cover 10% reduction in imports; (4) calculations of number of pigs slaughtered per year are based on proportion slaughtered in 1968.

In Table 2, the pig population in the United Kingdom is related to that in the world. It will be seen that during the last 30 years the world pig population increased at a faster rate than in the UK. It is expected that this trend will continue.

Table 2. *Pig population (millions) in the United Kingdom and in the world*

Year	UK	World	UK as % of the world	Increase per year UK	Increase per year World
1934–8	4·6	249	1·85		
				2·1	4·1
1958	6·5	455	1·43		
				2·0	3·3
1968	7·8	605	1·29		
				1·8	3·0
1978	9·2*	786†	1·17		
				1·6	2·5
1988	10·7*	982†	1·09		

*See Table 1.
†Assumptions: until 1978, world population will be increasing at the rate of 3·0% and in the subsequent decade at 2·5% per annum.

Table 3 gives information on the geographical distribution of the pig in the world, comparing the position at present with that in the middle of this century. It is interesting that, while the grand total has doubled, the smallest increase, about 10%, was in North and Central America, and the largest, nearly 200%, in China.

Table 3. *Pig population (millions) in the world*

	Average of 5 years ending 1952	1968	% increase
Europe	69·3	123·5	78
(UK)	(3.4)*	(7·8)	(140)
USSR	19·7	50·8	158
North and Central America	75·5	83·4	10·5
South America	35·6	80·5	126
Asia	20·6	44·8	115·5
China	73·7	213·0	190
Africa	4·4	6·1	39
Oceania	1·9	2·9	52·5
Total	300·8	605·1	101

*Low numbers following the reduction during and after the Second World War.

Tables 4 and 5 give details concerning the pattern of meat consumption in the UK. It can be seen that in the last 30 years there has been a slow decline in beef, mutton and lamb consumption, and an increase in the consumption of poultry, pork, offal and canned meat, and in total meat consumption. I expect the grand total to increase further, and to include at least a 10% increase in the consumption of pork and pork products in the next decade, followed by a similar increase in the subsequent decade. From Table 5, it can be seen that pork and pork products are already the most frequently eaten meats in this country, and I expect this situation to continue, and the total percentage to increase.

Table 6 gives comparative values on per head consumption of carcass meat in ten countries for which recent data were available. It can be seen that the UK is at the bottom of the list for beef and veal, in the middle for pig meat, third for mutton

Table 4. Per capita *annual consumption (kg) of meat in the United Kingdom*

	1934–8	1958	1964	1968	Increase or decline in 30 years
Pork	4·8	8·7	10·3	10·6	+5·8
Bacon and ham	12·8	11·5	11·5	11·5	−1·3
Total pork, bacon and ham	17·6	20·2	21·8	22·1	+4.5
Beef	25·0	23·5	21·5	20·4	−4·6
Mutton and lamb	11·5	10·3	10·7	10·5	−1·0
Poultry	2·3	4·3	7·2	9·1	+6·8
Offal and canned meat	5·4	8·9	9·5	8·2	+2·8
Total meat	61·8	67·2	70·7	70·3	+8·5

Table 5. Per capita *annual consumption of meat (% of total) in the United Kingdom*

	1934–8	1958	1964	1968
Pork	7·8	13·0	14·6	15·1
Bacon and ham	20·7	17·1	16·2	16·3
Total pork, bacon and ham	28·5	30·1	30·8	31·4
Beef	40·4	35·0	30·4	29·1
Mutton and lamb	18·6	15·3	15·2	15·0
Poultry	3·8	6·4	10·2	12·9
Offal and canned meat	8·7	13·2	13·4	11·6

and lamb, and second from the bottom for total carcass meat. In the future, I believe that the world pattern will be similar to that of the recent past and predicted future in the UK, namely, a slow increase in consumption of pig meat and a decline in other carcass meat.

Table 6. *Annual per head consumption (kg) of carcass meat in certain countries in* 1967–8

	Pig	Beef and veal	Mutton and lamb	Total
United Kingdom	22·1(6)*	20·4(10)	10·5(3)	53·0(9)
Canada	24·5	42·3	1·8	68·6
New Zealand	13·6	48·6	39·5	101·7
Australia	10·0	41·4	38·4	89·8
USA	30·0	51·4	1·8	83·2
Argentina	8·6	82·7	5·5	96·8
Denmark	38·6	21·4	—	60·0
France	30·9	37·3	2·7	70·9
West Germany	35·0	23·2	—	58·2
South Africa	3·6	28·2	9·1	40·9

*Figures in parentheses point to the position of the United Kingdom in the list of the ten countries included in this table.

Tables 7 and 8 summarize information on the past, present and future performance of the pig. The values are based on many assumptions, which are stated. In Table 7, a considerable increase is predicted in both the number of pigs reared per sow per year and their weight at 8 weeks which is ultimately dependent on the successful introduction of artificial rearing (see later). The considerable improvement in rate of

Table 7. *Past, present and future annual production per sow*

		Present pig			Future pig		
	Wild pig	Average	Good	Excellent	Without artificial rearing	1st decade	2nd decade
No. of pigs	4	14	18	22	24	28	30
Weight at 8 weeks (kg)	7	16	18	20	23	32	32
Daily gain (g) from 8 weeks to slaughter at 91 kg	(225)	550	650	730	860	860	1000
Days to reach 91 kg	(429)	192	168	153	135	125	115
Killing out %	—	72	75	78	80	80	80
Lean in carcass %	—	50	54	58	62	62	62
Total lean meat (kg) per sow per year	—	459	663	906	1083	1264	1354

growth and efficiency of feed utilization are dependent on better genetic stock and improvements in the environment, including feeding. All calculations are based on a slaughter weight of 91 kg live weight. However, no magic should be attached to this figure. In the future, a pig may be developed capable of producing lean meat without storing excessive amounts of fat at higher weights. By the end of the second decade, the optimum slaughter weight may reach 105 kg. Should this happen, then without altering any of the assumptions on which the values in Table 7 are based, the heavier pig would take 129 d to reach slaughter weight, and the total lean meat per sow per year would increase to 1563 kg. It is, of course, impossible to time, accurately, progress in this field, but I expect a slow but continuous improvement. The values for the future are meant to indicate realistically the direction, rather than to predict the time of any specific attainment.

In Table 8, I have selected several situations that may materialize, culminating in an attainment of a fivefold increase, over that produced on average at present, in the amount of lean meat produced daily by the offspring of a sow. The ultimate annual production by offspring of one sow of 2730 kg of live weight, of which 1354 kg will be lean meat, or 303 kg of very high quality protein, will be an attainment very hard to equal. Following the argument on slaughter weight, these values could possibly be increased to 1563 kg lean meat or 350 kg protein. (If anybody should wish to indulge in species comparisons, perhaps I should just remind them that broilers contain about 25% bone, while milk has only 12·5% total solids.) If one assumes that, by the end of the second decade, the yield of cereals per hectare may be twice that at present, then about 5000 kg of pigs' live weight could be produced per ha.

Table 9 deals with the efficiency of feed utilization, and here again great improvements are expected. The data make it clear that the amount of feed required by breeding stock contributes less and less to the sum total with the increasing number of offspring per sow. The performance expected at the end of the second decade may appear rather high, but I am confident that these levels can be reached. My confidence is boosted by the values presented in Fig. 1 in which I have brought together performance data from published papers from Shinfield during the 30 years of my own work there. It is impossible to summarize briefly all the factors which were involved, but the general picture is certainly very encouraging. From

Table 8. *Live weight, dead weight and lean meat produced per d by offspring of one sow within 1 year*

Standard of production		Live weight of offspring (kg) At birth		Live weight of offspring (kg) At 8 weeks			Weight of offspring at slaughter at 91 kg (kg)				
Rearing period	Growing period	Individual	Total	Individual	Total	Gain/d	Individual	Total	Live-wt gain/d	Dead wt/d	Lean meat/d
Present average (14 pigs)	Present average (192 d)	1·4	19·6	16·0	224	4·0	91·0	1274	6·7	4·7	2·4
Present excellent (22 pigs)	Present excellent (153 d)	1·4	30·8	20·0	440	7·9	91·0	2002	13·1	10·2	5·9
Present excellent (22 pigs)	Future 1st decade (125 d)	1·4	30·8	20·0	440	7·9	91·0	2002	16·0	12·8	7·9
Future 1st decade (28 pigs)	Present excellent (137 d)	1·4	39·2	31·8	890	15·9	91·0	2548	18·6	14·5	8·4
Future 1st decade (28 pigs)	Future 1st decade (125 d)	1·4	39·2	31·8	890	15·9	91·0	2548	20·4	16·3	10·1
Future 2nd decade (30 pigs)	Future 2nd decade (115 d)	1·4	42·0	31·8	954	17·0	91·0	2730	23·7	19·0	11·8

Table 9 it is clear that eventually we should be able to reduce the amount of feed required to produce 1 kg of live weight, dead weight or lean meat to 2·28, 2·85 or 4·60 kg respectively, a very high efficiency of conversion.

In Tables 10 and 11, estimates are made for future requirements for breeding stock and feed related to production standards that may be achieved. If the present average standards are maintained, and the expected increase in human population

Table 9. *Present and future efficiency of feed utilization, based on requirement of feed* of offspring of one sow in 1 year*

	Present pig			Future pig		
	Average	Good	Excellent	Without artificial rearing	1st decade	2nd decade
No. of pigs	14	18	22	24	28	30
Weight at 8 weeks (kg)	16	18	20	23	32	32
Efficiency during rearing† (kg meal/kg live weight)	5·73	4·36	3·76	3·02	2·51	2·44
Efficiency during growing period (kg meal/kg live weight)	3·5	3·2	3·0	2·7	2·5	2·2
Weighted mean efficiency over the whole period:						
kg meal/kg live weight	3·89	3·44	3·17	2·83	2·5	2·28
kg meal/kg dead weight	5·40	4·58	4·06	3·54	3·13	2·85
kg meal/kg lean meat	10·79	8·49	7·00	5·70	5·04	4·60

*Standard diet containing 68–70% total digestible nutrients and adequate protein.
†Includes feed of sow and boar and of litter up to 8 weeks of age.

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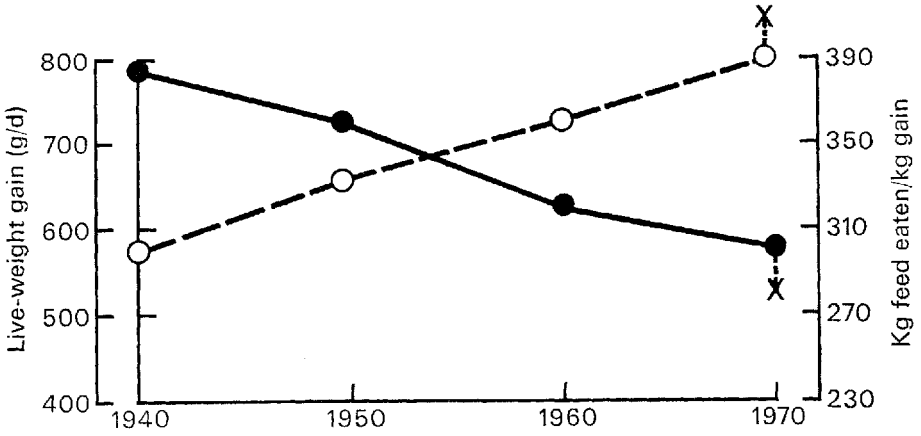

Fig. 1. Improvement in live-weight gain and feed conversion efficiency of Large White pigs at the National Institute for Research in Dairying during 1940 to 1970. ○ — — — ○, daily live-weight gain; ●———●, feed conversion efficiency. Values for 1940 from Braude & Foot (1942); for 1950 from Braude, Mitchell & Robinson (1950); for 1960 from Barber, Braude & Mitchell (1960); for 1970 from Braude, Mitchell, Newport & Pittman (1970). ×, average for the best six pigs in an experiment now in progress.

and its pork consumption occur, then at the end of the second decade about 55% more sows and feed would be needed than at present. On the other hand, if the specified targets are attained by the end of the second decade, 28% fewer sows and 10% less feed will be required.

Table 10. *Estimate of sows required to produce the specified* per capita *requirement in the United Kingdom of pork and pork products*

Year	Standard	Human population (millions)	*Per capita* consumption (kg)	Total* required (Gg(thousands of metric tonnes))	Sows annual production, dead weight (kg)	No. of sows† required, (thousands)
1968	Average	55	22	677	917	924
1978	Average‡	57·5	24·2	853	917	1163
1988	Average‡	60	26·6	1050	917	1431
1968	Excellent	55	22	677	1561	542
1978	Excellent§	57·5	24·2	903	2038	554
1988	Excellent§	60	26·6	1145	2184	667

*Less imports, and products from breeding stock.
†25% added to cover reproductive cycle.
‡Average 1968 standards.
§With reduction in imports of 10% by 1978 and a further 10% by 1988.

It is also of interest to compare the actual cost of production when different standards of efficiency are involved. In Table 12, relevant values are given for cost per kg live weight or dead weight calculated for three different prices of feed (average for feeds consumed at different stages of production). It can be seen that eventually the cost of production could be nearly half of what it is at present, and even if the price of feed is very substantially increased, the improved efficiency standards

Table 11. *Amount of feed required to cover the requirement of the pig population in the United Kingdom*

Year	Standard	Human population (millions)	*Per capita* consumption (kg)	Pork products required, (Gg(thousands of metric tonnes))	kg meal eaten/ kg dead weight	Amount of feed required (Gg(thousands of metric tonnes))
1968	Average	55	22	677	5·40	3656
1978*	Average	57·5	24·2	853	5·40	4602
1988*	Average	60	26·6	1050	5·40	5670
1968	Excellent	55	22	677	4·06	2749
1978	Excellent†	57·5	24·2	903	3·13	2826
1988	Excellent‡	60	26·6	1145	2·85	3263

*Average 1968 standards.
†The first decade standards with reduction in imports of 10%.
‡The second decade standards with reduction in imports of 20%.

would more than cover the increased production costs. The retail price of pork and pork products could eventually be lower than it is at present without sacrificing the legitimate interests of the producers.

Table 12. *Cost* per kg live weight (L) or dead weight (D) of pigs*

Price of feed per ton (£)		Present pig			Future pig		
		Average	Good	Excellent	Without artificial rearing	1st decade	2nd decade
35	L	3s. 5d.	3s. 1d.	2s. 9d.	2s. 6d.	2s. 2d.	2s. 0d.
	D	4s. 9d.	4s. 1d.	3s. 8d.	3s. 0d.	2s. 10d.	2s. 6d.
45	L	4s. 5d.	3s. 10d.	3s. 7d.	3s. 2d.	2s. 10d.	2s. 7d.
	D	6s. 1d.	5s. 2d.	4s. 7d.	4s. 0d.	3s. 6d.	3s. 2d.
55	L	5s. 4d.	4s. 9d.	4s. 3d.	3s. 11d.	3s. 5d.	3s. 2d.
	D	7s. 5d.	6s. 4d.	5s. 7d.	4s. 10d.	4s. 4d.	3s. 11d.

*Assumption: cost of feed = 75% of the total cost.

The potential is tremendous, but there is still a long way before all the problems which stand in the path of attainment of the targets for the future are resolved and the many difficulties overcome. Wishful thinking and loose talk will not get us there, and much too much of it is around us at the present time. Because of limitations of space, I will briefly refer to a few examples to explain what I mean. My targets for the late 1980's can only be attained if artificial rearing of pigs from birth or soon afterwards becomes possible. I believe that the potential is there, but several major problems will have to be solved before artificial rearing can be satisfactorily applied under practical conditions of pig keeping. In the recent past, considerable progress has been made, particularly in the field of baby pig nutrition but several major difficulties still bar successful application. Immunological and disease problems in baby pigs and problems of reproduction in the early weaned sow are now the major stumbling blocks, and a lot of active research will be needed to remove them before real progress can be made.

There can be no doubt that the suggested targets can only be attained subject to considerable improvement in the genetics of the pig. Here again, there is too much loose talk at the present time. For example, I know of no evidence to indicate that real progress can be made in the application of cross-breeding, as so many of the supporters of the present cult of 'hybrids' would wish us to believe. There is so much sales talk on the subject and very little sound evidence. Because of this, I thought it appropriate to refer to impressive evidence from Sweden which shows no benefit from cross-breeding on the number of pigs born and reared and their weights at 3 weeks of age (Table 13). It is true that there is a lot of evidence pointing to benefits from cross-breeding under poor conditions of production, but there are no data at all to indicate advantages from cross-breeding at the levels of production which will be essential if the future targets, referred to in this paper, are to be attained. Again, research is badly needed, and on a scale much larger than hitherto attempted. One

Table 13. *Effect in Sweden of cross-breeding on numbers of pigs born and reared, and on their weights (from Anonymous, 1969)*

	No. born	No. at 3 weeks	Weight of litter at 3 weeks (kg)
Landrace	11·1	9·1	52·8
Large White	10·9	9·1	53·3
Landrace × Large White	11·0	9·1	51·6

could perhaps argue that more effort should be directed to genetical improvements of characters hitherto neglected, such as, for example, factors influencing efficient utilization of energy or protein, or both.

There is also the problem of health. Emphasis in the future will have to be on freedom from respiratory diseases. It can be said now that the potential of the pig will not be attained in herds which harbour enzootic pneumonia. Other diseases, particularly some enteric ones, will also have to be brought under control. Genetic improvement must go hand in hand with improvement in health. It just does not make sense to establish genetically-superior herds which harbour infectious diseases, and thus may be responsible for their transfer to herds which purchase stock from them.

Recently heralded genetical improvements in the quality of cereals may be pointing to an important breakthrough but, again, a lot more research is needed before one will be in a position to assess the real value of this development.

Finally, I would like to comment on two general points which are currently widely discussed in connection with meat production. We hear so much about the so-called 'humanitarian aspect' of meat production. In some people's view it is immoral to kill animals in order to produce food for man. I consider this nothing but hypocrisy, particularly when such views are expressed by people who are quite happy to keep pet animals for no other purpose than the enjoyment of man. I have nothing against pets, but I cannot accept the argument that production of pets for subsequent destruction (with or without veterinary intervention) has a higher moral

escape clause than production of animals to provide food for man. It has become a highly emotional issue and one must be careful not to allow emotions to overrule reason.

Table 14. *Relative cost of soya bean raw materials (from US Department of Agriculture*, 1969)

Spun protein fibre	100
Protein isolate	37
Protein concentrate	18
Grits	9
Flour	7

Table 15. *Proportion of boned meat in poultry end-product (from US Department of Agriculture*, 1969)

Roast turkey	100
Canned chicken	85
'Dinners' turkey	20
Pies	15
Soups	4

The second point deals with meat substitutes. I can visualize that a time may come when a pill could provide all the nutritional requirements of *Homo sapiens*. In practice, I am certain that because he is *sapiens* it will never come to this. Viable substitutes are bound to be developed, but they will have serious limitations, not only economic, but perhaps even more important, culinary and organoleptic. I would like to refer to two points which have a strong bearing on this problem. In Table 14, I have given relative costs of the raw materials at present most widely used by producers of meat substitutes. It is important to realize that high-quality substitutes can only be produced from spun protein fibre and obviously the economics are not very promising here. There may be room for orthodox substitutes in sausages and pies which use the cheapest raw materials, i.e. soya flour and grits, or for the newer products, as for example, ham bits or mince meat fillers, which may use the medium priced raw materials, but I see no real competition for pork, bacon or ham. Certainly not if the production targets mentioned in this paper are even only partially attained. However, I see a bigger danger from the unethical competition of tinned goods which are masquerading as meat products. In Table 15, I have reproduced a few recently quoted figures giving the actual meat content of these products. The two products heading the list are genuine, but expensive and not bargains, the other three hardly deserve the description of meat products, and are certainly not substitutes for real meat.

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