
THE PROCEEDINGS OF THE
NEW ZEALAND SOCIETY
OF
ANIMAL PRODUCTION
VOLUME 62 2002

Milk Production in the Sow

D. M. SMITH, Ruakura Animal Research Station, Department of Agriculture, Hamilton.

Sows are kept to produce pigs that can be fattened to marketable weights. The efficiency of the process from mating the sow to the marketing of the resultant litter will largely determine profit, and this can best be measured by the feed input, meat output ratio. The two phases, reproduction and fattening, must each contribute to the overall efficiency.

The object of milk production studies is to find methods of feeding sows over the reproductive cycle that will provide the highest output of meat at weaning for the lowest feed expenditure. These studies involve the measurement of feed intake during gestation and lactation, milk yield and composition, the consumption of supplementary food and the weight gains made by the litter, and the loss or gain in sow bodyweight.

The aim of this paper is to briefly review the published results of work on sow milk production and to draw what conclusions we can from them. The subject will be dealt with under the headings of (a) techniques, (b) yield results, and (c) comparison results.

The Technique of Measuring Yield.

The method used by all investigators has been to separate the litters from the sows and allow them to suckle at pre-determined intervals. The piglets, either individually or as a litter, are weighed before and after suckling, the gain in weight being the weight of milk suckled. This process is repeated at set intervals, such as 5 days, Vinogradsky (1939); 7 days, Bonsma and Oosthuizen (1935), Schneider (1934) and Smith (1952); or 14 days, Hughes and Hart (1935). Weighings are continued over 24 hours and the quantity measured is multiplied by the appropriate time interval to give the total production for the period. There are, as Bonsma has suggested, obvious deficiencies in this method, but it is probably the only practical means at our disposal.

The interval separating the sucklings during the period of experimental weighings has varied widely with investigators. Hughes and Hart (1935) used a 2-hour interval early in the lactation, 4 hours in the middle period and 6 hours at the latter end. Schneider used an interval of 2-3 hours, while Donald (1937) allowed 2 to 5 hours to elapse between sucklings.

Observations have been made of the suckling frequency of litters and the results show substantial agreement.

TABLE I.

Suckling intervals observed by five investigators.

Authority.	Interval. Early in Lactation	Late in Lactation
Vinogradsky	72	90
Schneider	60	90
Wells et al	60	More variable than in early stages.
Shepperd	62	No difference.
Smith	60	75

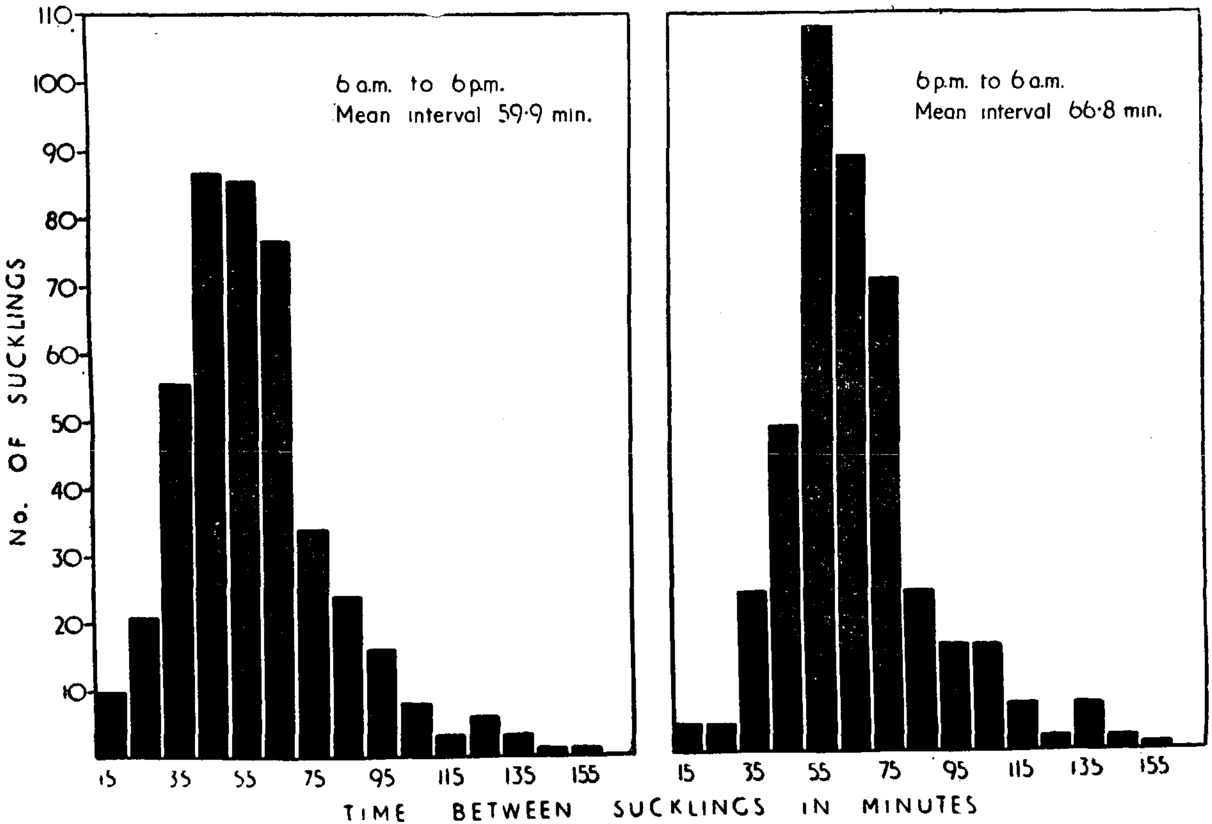
6 a.m. to 6 p.m.
Mean interval 59·9 min.
6 p.m. to 6 a.m.
Mean interval 66·8 min.
No. OF SUCKLINGS
110
100
90
80
70
60
50
40
30
20
10
15
35
55
75
95
115
135
155
TIME BETWEEN SUCKLINGS IN MINUTES

FIG. 1.

Shepperd observed that the interval during the day was similar to that at night, Albig (1940) states that the night interval is longer, while Ruakura results show that the night interval is slightly but not significantly longer, Smith (1952).

The significance of these observations is that the number of sows that can be used in milk yield studies is dependent upon (1) the interval separating weigh days, (2) the period over which weighings continue each day, and (3) the suckling interval used.

If yield investigations are to be part of the normal operations in a piggery, either the observation days must not be too close together or a special staff must be employed. From the published results, it would appear that 7 day intervals are quite satisfactory.

The time over which weighings are extended will affect not only labour requirement but the accuracy of the recording. A period of 24 hours when the suckling interval is maintained constant does cause extreme fatigue, even when short shifts are worked. Ruakura data (unpublished) show that the weighings may be confined to 12 hours without greatly reducing the accuracy of the results.

The suckling interval used will determine the number of sows that can be dealt with on any one day. The time spent on the routine of weighing, suckling, and reweighing, multiplied by the number of sows used, must fit within the interval used. Our experience is that, using a 60-75 minute interval, five or six sows are the most that can be satisfactorily observed. There is no satisfactory evidence to justify the extension of the experimental suckling interval beyond that pertaining under natural conditions.

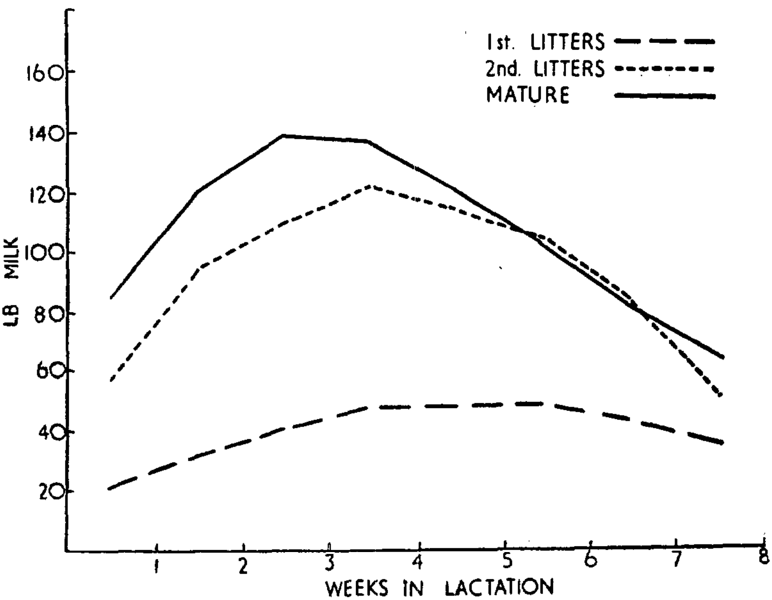

FIG. 2.

The Results of Yield Studies.

These are listed in Table II.

Production results from 304 lactations are available for review (Table II). These show variations from 3.4lb. per day to 12.1lb. per day. The litter sizes involved vary from six to nine pigs.

Two weaknesses in the present system of recording data become obvious:—

(1) There is no indication in the data as presented above of the proportion of lactations due respectively to first, second or more litter sows.

(2) There is no attempt to correct production figures for the effect of litter size.

Both these factors do affect the level of yield. On the other hand, a large number of lactations under reasonably similar conditions will have to be observed before these corrections can be made.

When, as pointed out above, the number of sows involved in an experimental design is physically limited by the manpower and time available and as yet no correction can be made for such factors as litter size and litter number, the difficulty of obtaining treatment differences that are significant becomes obvious.

TABLE II.

Milk Production of Sows (mainly from Turner, C. W.)

No. of lactations.	Av. No. of pigs in litter.	Daily Prodn. lb.	Prodn. during lactation 8 weeks.	Authority.
1	—	3.4		Van Gohren (1865)
4	6.8	5.2		Henry & Woll (1897).
12	7.2	5.4		Carlyle (1903)
1	7.0	5.6		Davies (1904)
3	—	11.4	638.4	Ostertag & Zuntz (1908)
1	9.0	10.2		Schmidt & Lauprecht (1926)
1	7.0	11.6		" " " "
1	9.0	7.2	404.9	" " " "
1	8.0	8.2	460.5	" " " "
1	6.0	10.7	600	" " " "
36	8.3	6.9	388.2	" " " "
4	—	6.9		Oligmacher †
7	—	6.5		Oligmacher
2	7.5	7.7		Huges & Hart (1935)
43	—	11.7		Wells, Beeson & Brady (1940)
22	8.57	7.1	401	Schneider (1934)
25	7—8	7.4		Borowsky & Kwasnitsky (1932)
52	6.67	6.55	366.7	Bonsma & Oosthuizen (1935)
4	8.5	10.34	508.5*	Olafsson & Larsson (1930)
22		7.35	411.6	Hempel (1928)
61	7.1	12.07	674	Ruakura
304				

* Seven weeks only.

† Quoted by Schmidt & Lauprecht (1926)

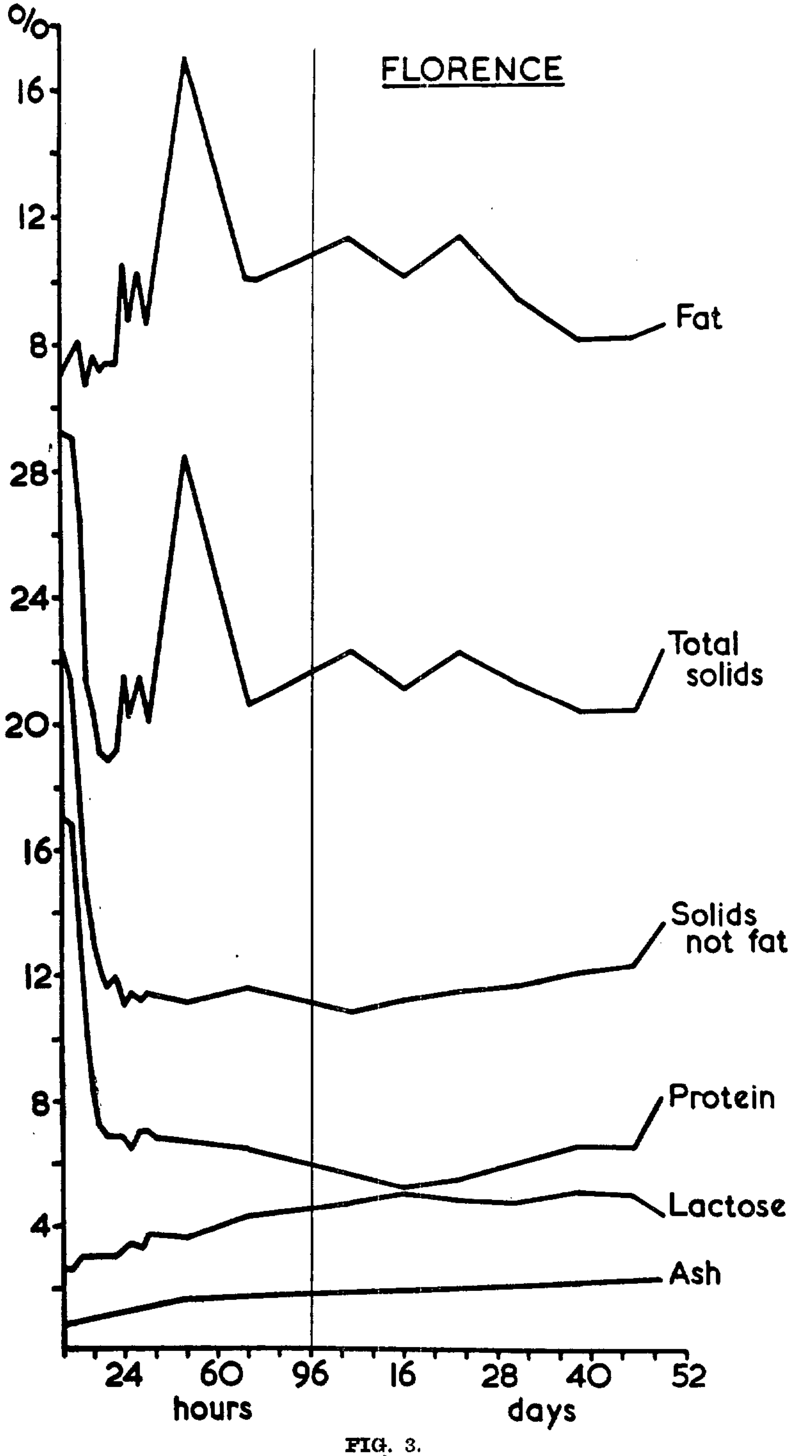
FLORENCE
%
16
12
8
28
24
20
16
12
8
4
Fat
Total solids
Solids not fat
Protein
Lactose
Ash
24
60
96
16
28
40
52
hours
days

FIG. 3.

Most investigators mention the shape of the lactation curve and relate this to the weekly gains made by the litters. Henry and Woll (1897) report maximum yield about the middle of lactation (which is taken as being the fourth week); Davies (1904) observed a gradual increase to the 6th week; while Schmidt and Lauprecht (1926) state that sows with small litters reach their peak at 3 weeks, sows with larger litters at 4 weeks. Hughes & Hart reported maximum production between the second and fourth weeks. Ruakura data show maximum production in the fourth to fifth week. Here again, there is no distinction made between the shape of the lactation curves of sows of different ages. Ruakura data show that maiden sows differ markedly from older sows in this respect. The importance of these distinctions will be mentioned later.

Milk Composition.

Various studies have been made on the composition of the colostrum of sow's milk as shown in Table III.

In addition, a study has been made by Perrin (unpublished data). The average values shown in the above table do not emphasise the important fact of rapid change in the various constituents. These are shown in Fig. 3.

In addition, there have been many studies made of the composition of normal milk. The main results are shown in Table IV.

Again the mean values for fat, protein and lactose are perhaps of less interest than the changes that take place over the lactation. These have been demonstrated by Graude et al. (1947) and Smith (1952). The general trends are shown in Fig 4.

The mean values shown here disguise the weekly variation that occurs within sows during a lactation. To date this fact has not been emphasised in the work reviewed.

TABLE III.

Composition of Sow's Colostrum

Number of Sows	Total Solids %	Fat %	Protein %	Lactose %	Ash %	Solids Not Fat %	Remarks	Authority
11	29.87	9.53	15.56	3.84	0.85			von Gohren (1865)
2	24.66	4.04	15.86	1.77	0.71			Ostertag & Zuntz (1908)
19		6.43						Hempel & Ohligmacher
11			16.27					Ohligmacher
13	31.86	5.14	16.64		0.61		during parturition	Hughes & Hart (1935)
7	23.50	6.47	12.58		0.69		10-40 hrs. postpartum	Hughes & Hart
	25.20	4.60	16.50		0.70			(Albig (1940)
18	23.90	3.40						Braude et al. (1946)
18		5.9					dry concentrate	Willett & Maruyama (1946)
18		7.7					garbage	Willett & Maruyama (1946)
6			17.77	3.46	0.63			Thomas et al. (1947)
	24.54	6.45	14.01		0.73	18.09	dry-lot.	Bowland et al. (1948)
	22.90	6.73	11.43		0.76	16.17	pasture	Bowland et al. (1948)
	22.81		14.29	3.42	0.73	17.21	dry-lot	Bowland et al. (1949)
	22.81		11.25	2.89	0.72	15.92	pasture	Bowland et al. (1949)
		4.80						Whiting et al. (1949)

TABLE IV.

Composition of Sow's Milk

No. of Sows	Specific Gravity	Total Solids %	Fat %	Protein %	Lactose %	Ash %	Remarks	Authority
2		13.87	1.48	7.91	2.65	1.14		Scheven
1		15.15	2.98	9.29	2.19	0.79		von Gohren (1865)
1		17.07	6.88	6.89	2.01	1.29		Lintner
2		18.23	5.59	5.89	5.58	0.87		Cameron
1		17.54	9.23	5.09	1.68	1.53		Ivon
7		15.45	4.75	6.44	3.16	1.10		Dietrich & Konig (1891)
12	1.0412		7.56					Petersen & Oetken (1896a)
8	1.0396		5.03					Petersen & Oetken (1896b)
22	1.0411		6.59					Petersen & Oetken (1897)
4		19.08	7.06	6.20	4.75	1.07		Henry & Woll (1897)
5		17.72	5.97	5.12	5.81	0.82		Ramoot & Braun
1		14.58	4.55	5.60	3.34	1.09		Carlyle (1903)
12		19.49	6.89	6.06	5.64	0.98	Razorback	Carlyle (1903)
		19.59	7.25	5.74	5.63	0.97	Berkshire	Carlyle (1903)
		19.19	6.79	5.94	5.74	0.98	Poland China	Davies (1904)
1		16.74	5.41	4.76	5.49	1.08		Ostertag & Zuntz (1908)
2		15.84	5.01	5.54	4.59	0.63		Folin, Dennis & Minot (1919)
1			3.68	7.93	4.00			Hempel & Ohligmacher
			6.99	6.25				Ohligmacher
13		18.39	5.50	5.57		0.77	4 - 7 days	Hughes & Hart (1935)
8		16.58	4.90	5.95		0.99	5 - 45 days	Hughes & Hart (1935)
7		18.76	5.61	8.13		1.20	50 - 80 days	Hughes & Hart (1935)
		18.80	7.00	6.10	4.10	0.90		Albig (1940)
35		16.35	5.29	4.86	5.28	0.92		Wells et al. (1940)
			6.30				Dry Concentrate	Willett & Maruyama (1946)
			11.50				Garbage	Willett & Maruyama (1946)
6				5.79	4.81	0.94		Braude et al. (1947)
		20.79	7.45	7.62		0.97	Dry-lot	Bowland et al. (1948)
		19.50	6.12	7.12		1.00	Pasture	Bowland et al. (1948)
		20.69		7.42	5.08	0.98	Dry-lot	Bowland et al. (1949)
		19.47		7.09	5.18	0.99	Pasture	Bowland et al. (1949)
32		20.57	9.11	6.26		0.89	5th day	Heidebrecht et al. (1950)
25		19.01	7.70	5.28		0.88	15th day	Heidebrecht et al. (1950)
22		20.20	7.09	6.85		1.27	55th day	Heidebrecht et al. (1950)
			6.27	6.85				Schneider
3	1.0362	17.1	6.17	5.01		0.82		Vinogradsky (1939)
3	1.0374	16.8	5.80	5.12		0.80		Vinogradsky (1939)

The method of obtaining a sample for analysis is worth mention. Colostrum samples are usually easy to obtain, at least in the early part of farrowing, until the sow commences to control let-down. Subsequently, it has become standard practice to use "pitocin" to make the sow let down her milk. The sample can then be withdrawn by hand or by machine. In our work three facts have emerged:—

(a) The quantity taken by the litter at any suckling is only 30% to 50% of that held in the gland at the time of suckling;

(b) The fat percentage of proportionate samples taken separately and sequentially throughout a milking, to the point where the gland has been completely evacuated, does not rise markedly. The changes in fact show little set pattern. Representative data are shown in Table V. (From Dawn R. Perrin, Ruakura—unpublished data.)

TABLE V.

Variation in Fat Content During Milking.

Sow	Days in Milk	% Fat Sequential Samples 1	2	3	4	5	Amount taken during sampling	Average amount taken by litter
A	11	8.60	7.75	10.55	9.55		13½ oz.	6 oz.
	39	7.40	7.45	7.60	7.70	7.95	14 oz.	7 oz.
B	23	13.55	12.70	13.80	11.95		24 oz.	11 oz.
	50	7.80	7.80	8.30	8.25	7.45	11½ oz.	11 oz.
C	14	7.25	7.65	9.00	9.40		6¾ oz.	3 oz.
D	56	7.35	7.35	7.45	7.50	7.45	—	6 oz.

(c) From work on a restricted number of sows we have concluded that there are significant differences between the functional glands in any one sow. We have recorded values of 7 and 12% fat content from the same teat on successive days and 9 and 15% between teats on the same day. It is essential, therefore, that all functional glands be milked when samples are taken.

From this brief review, the following conclusions can be drawn:—

(1) There is not sufficient data available to calculate correction factors for litter size or the age of the sow.

(2) The technique of yield measurement severely restricts the number of sows that can be used on any experiment.

(3) The behaviour of the various milk constituents over a milking suggests that the size of the sample taken is of less importance than the withdrawal of milk from all functional glands.

The work so far published calls for the following comments. To the author's knowledge only Vinogradsky and Ruakura have carried out experimental work covering the effect of varying treatments upon both milk yield and composition. Others have conducted investigations on the effect of treatments upon either yield or composition, while the vast majority have recorded the normal yields or composition of milk of from 1 to 20 sows. It may be fairly said that the study of sows' milk is in a similar state to studies of cows' milk 50 years ago.

The reasons for this are simple. The measurement of yield is laborious and, if done on any scale, requires specialised equipment, while a full study of milk composition has not been possible until "pitocin" was made available in very recent years.

The foregoing is merely a description of the mechanics of milk production studies. What is the reason for going to all this trouble when it may be argued that the growth rate of the litter is a fair index of the yield and composition of the dam's milk?

In the first place, litters differ in their efficiency of feed utilisation, so that growth alone is not necessarily a true index of the milk energy output of the sow.

Further, we wish to find what effect ration changes will have upon both the yield and composition of milk. Do some litters grow fast because their dams' milk is higher in fat or protein? It has often been suggested that large whites are very high yielding sows, but their milk is low in fat. If this is so, can we by any means at our disposal increase the fat percentage of sow's milk There is evidence (Willett and Maruyama, 1946) that this can be done. What, then, is the effect of changes in fat percentage upon litter growth? Is there a maximum beyond which litter growth will be reduced rather than increased?

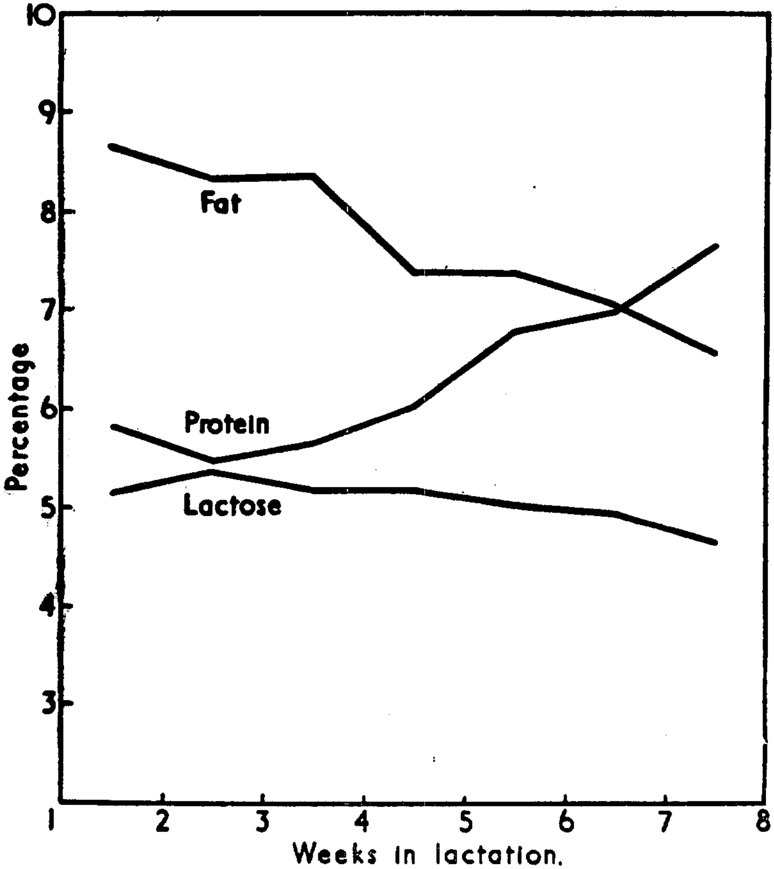

FIG. 4.

We wish to know what is the effect of a high level of feeding as against a low level of feeding. If litter growth is affected, is this due to changes in yield at some particular stage in the lactation, or changes in milk composition?

We wish to know, in fact, what are a sow's requirements to produce litters most economically.

It is obvious that, by doing a relatively few studies in which all the fundamental data are collected, we can intelligently plan our research along the lines that will yield the greatest results.

It may be added that there are supplementary lines of research opening up as a result of our studies. The differences exhibited between the behaviour of the fat percentage of sequential samples taken during a sow milking as compared with those drawn from the cow, plus observations on fat globule size, have led other members of the staff of this Station to reconsider the current theories upon the mechanics of the secretion of milk and fat. In addition, the sow has, as a result of our initial work, proved a valuable animal in the assaying of various hormones.

The point made, that the accumulation of basic data enables more intelligent planning of experimental work, can be illustrated by a practical example.

Our accumulated data from 62 lactations have been divided to show the total sow and litter intake for three of the first four weeks of lactation, omitting the first and the last four weeks. We have related this intake to the nett gain in weight of the sow and litter by subtracting or adding to the litter weight the gain or loss in sow weight over each period. We have found that it requires 3.9 feed units fed almost entirely through the sow to produce one pound gain in the first period, and 2.7 units in the second period.

The sow's milk energy production over the two periods is almost identical, the daily ration the same and the weight losses in the order of 8 lb. and 7 lb. per week respectively. It follows, therefore, that the sow herself is equally efficient over the two periods. It is suggested that the increase in efficiency shown over the last four weeks is due to the fact that meat production resulting from food fed through the sow, and converted into milk which is in turn suckled and digested by the litter, is less efficient than that production from food taken by the litter directly from the trough.

We have observed that the shape of the lactation curve, measuring as it does the progressive level of production, conditions the intake of supplementary food by the litter. This is allustrated in Fig. 5.

In addition, our data on the gross digestible energy intake by the litter from sow's milk and creep respectively over the last four weeks of lactation show more precisely the compensating effect that the creep has on decreasing milk energy yield.

TABLE VI.

MEAN INTAKE.

Sow Ration*	lb. G.D.E. per pig from Sow's milk	Creep	Total
1	18.0	13.4	31.4
2	13,2	19.4	32.6
3	14.3	17.5	31.8
4	18.1	12.9	31.0
5	16.8	15.8	32.6

* groups of five sows on each ration.

It may be suggested that the drop in production is a result of creep intake. We have found, however, in the course of a study on litter behaviour, that the litter almost invariably, in the fifth, sixth,

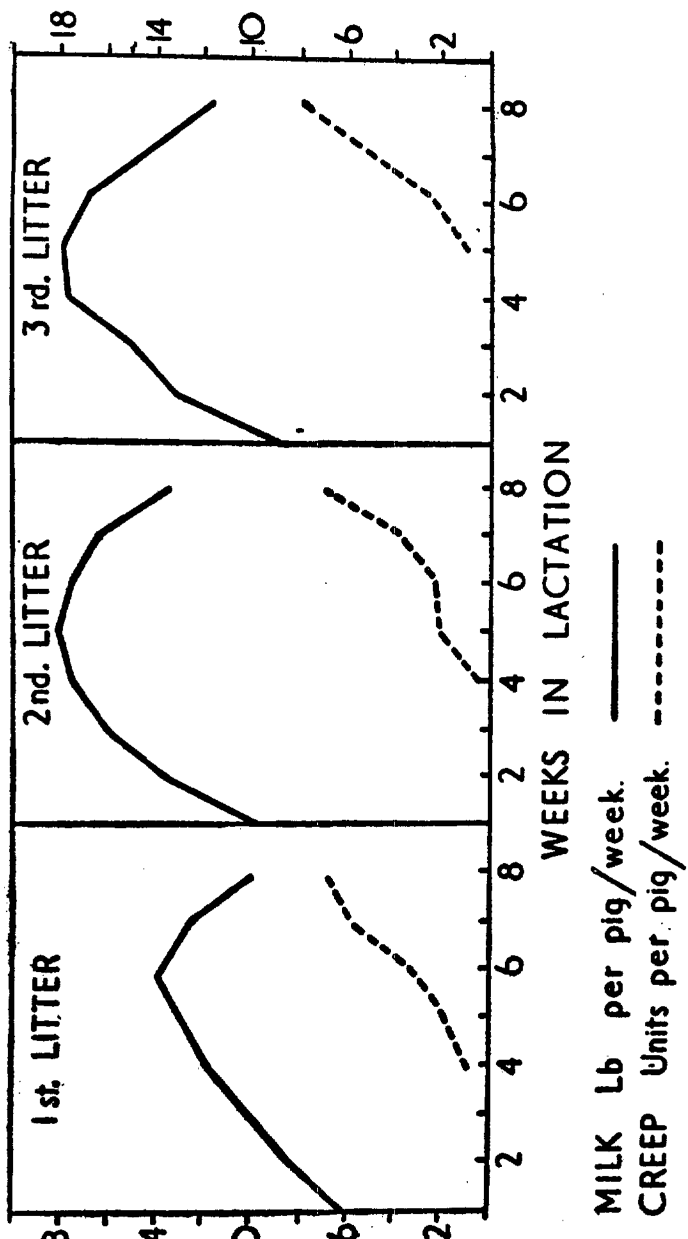
1st. LITTER
2nd. LITTER
3 rd. LITTER
18
14
10
6
2
WEEKS IN LACTATION
MILK Lb per pig/week.
CREEP Units per pig/week.

FIG. 5.

seventh and to some extent in the eighth week, first suckles the sow, then goes to the creep, and then goes to sleep until the time for the next suckling. Our conclusion is therefore that the piglets eat the additional meal and milk because they are not receiving sufficient from the sow, rather than take less from the sow because they are eating supplementary food.

If, then, the consumption of supplementary food results in overall increased efficiency of food utilisation, the obvious step is to deliberately change the shape of the lactation curve so that the effect can be exploited to the full. This should result in increased meat output per food unit, which is, in fact, the aim of milk production studies.

REFERENCES.

(1) Albig, A. Z. (1940): Quoted by Turner, C. W. (1952).

(2) Braude, R., M. E. Coates, K. M. Henry, S. K. Kon, S. J. Rowe, S. Y. Thompson and D. M. Walker (1947): A study of the composition of sow's milk. British J. Nut. 1, 64.

(3) Davies, L. R. (1904): Yield and composition of sow's milk. Wisc. Agr. Expt. Stn. Rept. 41.

(4) Donald, H. P. (1937): Milk consumption and growth of suckling pigs. Empire J. Expt. Afi. 5.

(5) Henry, W. A. & Woll, F. W. (1897): On the yield and composition of sow's milk. Wisc. Expt. Stn. 14th Annual Report. 10.

(6) Hughes, E. H. & Hart, H. G. (1935): Production and composition of sow's milk. J. Nut. 9: 311.

(7) Schmidt, J. & Lauprecht, E (1926): On the milk of the improved Landschwein. Zuchtungskunde 1. 50-62 (Title translation).

(8) Schneider, K. T. (1934): The milk production of German high quality breed pigs and the weight development of the piglets during the eight weeks suckling period. Landw. Jahrbucher, Heft 3, 80 Band.

(9) Smith, D. M. (1952): The yield and composition of milk of New Zealand Berkshire sows. N.Z. J. Sci. Tech. In Press.

(10) Turner, C. W.: The Mammary Gland. Lucas, Columbia Mo. (1952).

(11) Vinogradsky (1939): The influence of yeastised food on the milk production of brood sows. Proceedings of the research institute of Pig Breeding. People's Commisariat of grain and animal state farms of the U.S.S.R. No. 14.

(12) Willett, E. L. & Maruyama, C. (1946): The effect of intake of Garbage upon the fat content of sow's milk. J. Anim. Sci. 5 : 365.

Discussion

Mr. LONGWILL: The difference in the efficiency of food conversion between the first and second four weeks periods is different from that previously reported. Have the pigs been treated in the same way or were steps taken to increase creep consumption?

Mr. SMITH: No attempt was made to increase creep consumption. The difference is due to the fact that in the previous figure no account was taken of the body weight loss of the sow during lactation.

Dr. TURNER: I wish to congratulate the Ruakura workers on the amount of data that has been collected, on milk production in the sow. Mrs. Perrin has also collected a lot of data on the composition of sow's milk. I also have a word of praise for the pig as an assay animal for "let-down" hormone as it is one which is not greatly disturbed even when given injections.