Is the Appetite of Swine a Reliable Indication of Physiological Needs?

John M. Evvard

Iowa Experiment Station
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The pig is farrowed with a fairly definite set of specifications for development all wrapped up in their mystery in a two to three pound bundle of throbbing, active "stuff." And yet before the pig sought the outer life apart from the womb of his dam, these specifications were enclosed in the minutest bit of protoplasm, the impregnate ovum resulting from the union of two germ cells, one from the male and the other from the female.

These specifications may be likened unto the specifications for a house—the fulfillment is altered only upon provocation, and not then if avoidable. Certain materials are needed for this developing piglet: water; proteins, really amino-acids, perhaps such as tryptophan, lysin, cystin, tyrosin, and many others; carbohydrates, probably of different sorts; fats of the effective kind; minerals such as calcium, iron, magnesium, sodium, potassium, perhaps manganese, arsenic, and others; acid elements such as chlorine, sulphur, phosphorus; vital substances, perhaps vitamins or "accessory diet factors" or "akzessorische nahrstoffe" and in reasonable probability other essential unknowns.

There must not only be enough of these various nutrients at the right time in the alimentary tract, but likewise not an overdose if optimum development is to be attained. Then too, the happy combination of these various factors in diet is a problem for the wisest of sages of all ages.

Who will take the contract to figure out the bill of materials from the mostly unknown specifications? This has been attempted as will be shown shortly.

That appetite is not to be depended upon in the formulation of rations is insisted upon by Jordan who, in speaking of cattle, puts the proposition thus: "Once in a while some one talks..."
wildly about leaving food valuations to the 'old cow.' It is considered sometimes a telling argument against the chemist's wisdom to declare that he and the old cow do not agree. Certainly the cow knows better than the chemist what she likes to eat, and it is little use to offer her foods she does not relish. Even a chemist knows that. If, however, a dozen commercial feeding stuffs were spread around on a barn floor it would be much safer to trust an agricultural chemist, especially one experienced in stock feeding, to select a ration than any cow ever grown—Holstein, Ayrshire, Jersey, long-horned, dishorned, or what not. The cow would probably get at the corn meal and stay with it until well on the way to a fatal case of indigestibility. Her judgment is just about as good as that of a child with a highly cultivated 'sweet tooth'.

Sherman on the other hand, has well said, in speaking of man: "A well-ordered appetite may not only serve as an indication of the amounts of food needed over long periods and under different conditions of activity, but also when the conditions of life are fairly uniform may be highly efficient in determining a regular intake of calories from day to day."

Faith in the ability of man to balance his own diet is very emphatically expressed by Sir James Crichton-Browne: "The nutrition of man involves an intelligent appreciation of the needs of the body, under different conditions of existence, and constant modification and adaptation to changing environment, and states of activity, and health. There is no finality about it". To which might be added an appreciative, Amen!

After all when we come to consider the matter we are forced to admit that in spite of the quite impressive teachings of Chittenden and his school, mankind keeps on eating just about in the "same old way," namely, according to appetite, and not according to the chemical scales. This is not evidence, of course, that what the vast majority does is the best, but it does signify that the new scheme of "Limitation" does not appeal sufficiently to affect a change in established habits of the people.

Many well-meaning and enthusiastic individuals, among whom the author is included, who have tried the low protein standards of Chittenden soon lose their interest and revert to what appears to them, the "good old appetite way."

But let us not get too far astray. Crichton-Browne: "It is not on a purely laboratory experiments—although these may be—that the scientific and common observations and one's experience of life are guided."

And now the emphasis is placed more than man to choose their rations. According to development: "The lower animals, as long as they are in a condition, as long as they are in a natural environment, will choose their materials around them those best suited to their needs. We do this by distinctive discernment of their final consumption by a sense of what is nourishing. We hesitatingly infer that the appetite factor in the development and natural selection of ancestors was a guiding principle in the consumption of nutrient material accessible to the special needs of their economic situation, and that this consumption is proportioned to the needs of his body. This is, as regards his bodily habits, as those which govern the selection of the materials around him. There is no doubt that in the formation of the diet the animal economy is guided by the same kind of final consumption as animals from throughout the animal creation have always selected as their food."

And those of us who have been convinced of the merits of domestic animals find much to their credit. Among the well-expressed convictions of Chittenden and his school is the following: "The nutrition of man involves an intelligent appreciation of the needs of the body, under different conditions of existence, and constant modification and adaptation to changing environment, and states of activity, and health. There is no finality about it".

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^Crichton-Browne, Sir James: Delusions in Diet or Parsimony in Nutrition, op. cit. pp. 21, 22, 23.
^Chittenden, Russell H.: Physiological Economy in Nutrition, also the Nutrition of Man.

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But let us not get too far afield, but return to Crichton-Browne: ‘It is not on a priori physiological data, nor yet on laboratory experiments—elucidative and educational though these may be—that the science of dietetics is based, but on common observations and on the hereditary customs of mankind’.

And now the emphasis is placed on the ability of animals other than man to choose their rations quite in keeping with their development: ‘The lower animals select with unerring precision, as long as they are in a natural environment, from the materials around them those best fitted for their wants, and they do this by distinctive discernment inherited from a long line of naturally selected ancestors, while they are checked in their consumption by a sense of repletion of coeval origin. We unhesitatingly infer that the articles they choose are, of all nutritious material accessible to them, those best adapted to the special needs of their economy, and that their consumption of them is proportioned to their needs for the time being. But man is, as regards his bodily functions, subject to the same laws as those which govern the lower animals, and we cannot doubt that in the formation of his dietetic habits he has been guided by the same kind of influences which have been operative throughout the animal creation in the choice and consumption of food’.

And those of us who have had experience with the feeding of domestic animals find much of solace and of truth in the well-expressed convictions of Crichton-Browne. The temptation to quote one more passage of Crichton-Browne in order to emphasize the ‘appetite factor’ is yielded to: ‘Natural instinct or primitive experience has guided the different varieties of our species in their selection of viands suitable to their geographical situation and modes of life, has restrained them within proper bounds in their consumption of these, and has even taught them to combine and balance the different constituents of these in a way on which chemical science can scarcely improve’.

While hardly agreeing entirely with all the quotations made, yet it is quite important that the somewhat unusual viewpoint of Crichton-Browne be kept clearly in mind.

Pavlov has very entertainingly and instructively called our attention to the appetite and its manifestations in the normal

body physiologic. The "psychic" or "appetite" juice from the Pavlov angle has a new and broadening influence. After all the forces potent and the reactions and actions evident within the living organism have more significance than most of us have dreamed.

The feeding of children according to their appetite has a champion in a popular lecturer and writer, Hutchinson,\textsuperscript{10} who presents the proposition in this vein: "We recognized, years ago, that instinct, craving, an untaught preference for a particular thing or action always means something; indeed, we might almost say in Browning's phrase, that it 'means intensely and means good,' in nine cases out of ten. It is the crystallized result of the experience of thousands of generations and while like all other impulses, it must take its place in the parliament of instincts and submit to the rules of order of reason, in the main it is a safe and invaluable guide." This statement is stimulated largely in discussing the child's instinct or cravings which lead sugarward.

Very interestingly, he pursues the subject further, telling of the appetite of the normal child, speaking of it in this wise: "The appetite of a healthy child of the kindergarten age is something appalling. He is a walking famine, a hunger incarnate. All is grist that comes to his mill; and all hours of the day or night are alike to him. But he needs every ounce that he will devour, and not one penny's worth of it will be wasted. Don't bother about the child: Just be sure that his food is right, pure, sound, and of the best quality, then let him go ahead! His wisdom is of the ages; yours where it clashes with his, is of the almanacs, of the catechisms and copybooks, of the silly chatter of the street and the kitchen".

Certainly this argument of Hutchinson's is quite sensible and well worth our while to consider seriously. Those of us who have children realize that there is, to all intents and purposes, more truth than fiction in these things talked about. The idea of allowing children to eat when they will, which we have found to work admirably with pigs, is expressed by Hutchinson thusly: "The notion that the stomach requires a certain definite interval or rest between tasks in order to get up its supply of gastric juice has been completely exploded".\textsuperscript{10}

\textsuperscript{10}Hutchinson, Woods: We And Our Children, pp. 65, 70, 81, 84, 98.

Then a little later, we findings of children for sweet them properly in all ways. They manifest their appetite and As Hutchinson says: "When adequately fed, they can be true fruit-basket and the nut jam closet, or the pantry."

Somewhat farther on we "judgment" philosophy concerning to eat like a pig, of course, pigs is to appreciate this right. Fletcher\textsuperscript{11} in his system the 'erism' bases his entire interpretation of a normal appetite means to this end. Now list the most important factor in normal state, Appetite is a personal nutrient and moisture, botanical elements required at the can be easily comprehended satisfaction understood by brief period (Vide Someren) than we can assimilate is we examine the right quantity? If normal appetite often leads effect if her laws are obeyed'.

Mendel\textsuperscript{12} and Osborne have animals (rats) tend to make their growth'. These rats between foods comparable in and (b) between foods protein-free milk respective.

The question of variety (advantage of) in the diet we finds a champion in Sir Horace Mendel.\textsuperscript{13} The logical rule of life in regard enforcing limitation of the

\textsuperscript{11}Fletcher, Horace: "The A B C", pp. 5-7.
\textsuperscript{12}Mendel, p. 29.\textsuperscript{13}Unpublished data, personal communication.
\textsuperscript{14}Thompson, Sir Henry: "Diet in
Then a little later, we find the remedy for curbing the cravings of children for sweet stuffs, and this remedy is to feed them properly in all ways. In other words, give them a chance to manifest their appetite and an equal opportunity to satisfy it. As Hutchinson says: "When children are properly and adequately fed, they can be trusted with the candy box, the open fruit-basket and the nut bag, to say nothing of the key to the jam closet, or the pantry."

Somewhat farther on we find this facetious "seasoned with judgment" philosophy concerning the child: "He ought not to eat like a pig, of course, but he should want to." To know pigs is to appreciate this rich bit of sentiment.

Fletcher, in his system which is widely known as "Fletcherism" bases his entire system upon a proper and intelligent interpretation of a normal appetite. All his schemes appear as means to this end. Now listen to what is said: "Appetite is the most important factor in nutrition." * * * "In its normal state, Appetite is a perfect indicator of the bodily need of nutriment and moisture, both as to quantity and as to the chemical elements required at the moment." * * * "Appetite can be easily comprehended and read and the degrees of its satisfaction understood by simple attention and study for a brief period (Vide Someren) * * *

That we all eat more than we can assimilate is unquestionable. How can we determine the right quantity? Instinct should guide us but an abnormal appetite often leads us astray. Nature's plans are perfect if her laws are obeyed".

Mendel and Osborne have noted indications "that the animals (rats) tend to make choices which are advantageous to their growth". These rats were "allowed * * * a choice (a) between foods comparable in every respect except the proteins, and (b) between foods containing the natural and artificial protein-free milk respectively".

The question of variety (which the average appetite takes advantage of) in the diet upon which we shall dwell but little, finds a champion in Sir Henry Thompson: "The great practical rule of life in regard to human diet will not be found in enforcing limitation of the sources of food which nature has

3Thompson, Sir Henry: "Diet in Relation to Age and Activity," 1908, p. 28.
abundantly provided. 'On the contrary, that rule is fulfilled in the perfect development of the art of adapting food of any and every kind to the needs of the body according to the very varied circumstances of the individual, at different ages, with different forms of activity, with different inherent personal peculiarities and with different environments'. Certainly Sir Henry would exhaust the possibilities in so far as source of food is concerned to gain or secure all of those simple and medium simple, and complex things that go to make up the body physiologic and to enable this living bundle of sinew, fibre, bone, nerve, and what not to work (live) to the fullest advantage. Most assuredly, the wider the variety the greater is the possibility of including in the diet or ration all of the essential nutrients; when the appetite is completely followed there is ordinarily a wide range of choices made, and thus the likelihood of physiologic satisfaction is the greater.

Mendel has recently emphasized the great importance of the correct selection of efficient nutritive units, calling attention particularly to the fact that 'we must know what nutrient units of any nature are indispensable, and further, whether a complete lack or deficit of them in the intake can be made good by direct synthesis'. The stupendous task of balancing the diet, or the ration is clearly evident to students who scrutinize the evidence critically.

In formulating dietaries for the feeding of humans as well as standards for animals in general there must be considered the great complexity of the ordinary food or feed constituents—proteins, carbohydrates, fats, and ash, of which, in addition to water, diets and rations are composed. Discussion concerning recent developments and newer viewpoints in nutrition, based upon a study of these food constituents is quite in place. That there are manifest differences and differences in the proteins, in the fats, in the carbohydrates, and in the ash of different foods is made clear in recent researches.

Protein metabolism may be rightly studied and interpreted nowadays on the basis of the amino-acids present. Or as Mendel puts it: 'the protein requirement, we shall not err in identifying it today with the specific amino-acid needs of the growing organism'. Osborne and Hirsch offer a very frank study.

When it is realized fully that their various possible combinations of proteins, no two of which are the same, are evident to make one rather problems involved in the assimilation of the many sorts. The appetite quickly tells us more about what is present in his ration and in what than long, laborious, standards of physiological research. At any rate it can come nearer selecting his diet for technically trained men.

Peculiarly enough, the pig and for meat, the amino-acids present in this reason why growing pigs readily, and why after they are most cease eating the meat in maize?

The carbohydrates, which is designated as the Nitrogen-Free 3 reality a very intricate mixture and diverse proportions. These starches, dextrans, sucrose, mannans, and a multitude of other substances appear in various quantities, and the very great development in


The development of a diet according to the very varied nutritional needs of different ages, with different inherent personal peculiarities is quite in place. That there must be considered the many sorts. The appetite of the pig possibly may fairly quickly tell us more about which of these amino-acids should be present in his ration and in what amount much more effectively than long, laborious, standard, ordinary chemical and physiological research. At any rate, the indications are that the pig can come nearer selecting his protein diet naturally, than can technically trained men.

Peculiarly enough, the pig shows great preference for milk, and for meat, the amino-acids of which are quite efficient. Is this a reason why growing pigs take to the milk and the meat so readily, and why after they are quite well-grown they may almost cease eating the meat in the presence of the Indian corn or maize?

The carbohydrates, which in general chemical work are designated as the Nitrogen-Free Extract plus Crude Fibre, are in reality a very intricate mixture of various compounds, in many and diverse proportions. There are lactose, the milk sugar, the starches, dextrins, sucrose, maltose, glucose, cellulose, the pentosans, and a multitude of others. The mono- and poly-saccharides appear in various quantities and proportions. In view of the very great development in protein physiological research the amino-acids present. Or as Mendel stated, we shall not err in identifying the amino-acid needs of the growing organism". Osborne\textsuperscript{16} and Mendel have done classic research along these lines, as have Abderhalden\textsuperscript{17} and others.

Proteins, being built up of some eighteen or more amino-acids or building stones, offer a very complicated subject for specific study.

When it is realized fully that these eighteen amino-acids in their various possible combinations can form millions upon millions of proteins, no two of which are alike, we stand astounded. The great possibilities of combination and recombination that are evident make one rather pause before the stupendous problems involved in the assimilation and functioning of proteins of the many sorts. The appetite of the pig possibly may fairly quickly tell us more about which of these amino-acids should be present in his ration and in what amount much more effectively than long, laborious, standard, ordinary chemical and physiological research. At any rate, the indications are that the pig can come nearer selecting his protein diet naturally, than can technically trained men.

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field for study among the carbohydrates appears very fruitful, and it may be that large differences in the nutritive effects of these various sugars, starches, and other carbohydrates will develop when thorough exploration is made. That physiological research already indicates these differences is manifest in a paper by Mendel and Mitchell. That the unmistakable appetite of pigs for "milk" whey, skim-milk, and buttermilk may be in part accounted for by the superior value of lactose, the sugar of milk, is not beyond the pale of reasonable expectation.

Why is cane-sugar, in its absence, but in the presence of an abundance of starches in general, so much craved by small growing children, and by men fatigued?

The problem of "balancing the diet or ration", respectively, of men and other animals on the basis of known physiological and chemical knowledge deepens as the intricate and involved elements of nutrition are carefully scrutinized.

The fats, heretofore thought to be interchangeable, are now commanding considerable attention because of their specific effects. It is demonstrated that there is a marked difference in the ordinary fats such as butter-fat, cod-liver oil, beef fat and oils, cottonseed oil, olive oil, corn oil, and so on.

McCollum and Davis have shown with rats that nutritive failure "sooner or later supervenes" when they have been brought through a period of successful growth on diets of purified food constituents, but containing no fats.

Now Osborne and Mendel, practically simultaneously, were carrying on similar rational research with these "high carbon and hydrogen with low oxygen" (compared to proteins and starches) compounds, demonstrating likewise that the fats, or some unknowns associated with them, possess peculiar but absolutely essential nutritive properties.

Strikingly enough, McCollum and Davis secured positive favorable nutritive results with "butter-fat, egg yolk fats, kidney fat (ether soluble portion of kidney free from visible fat), and the

ether extract of the ripe testicles,ings being evident with commensurate and tallow. Osborne and Mendel secured the effective fat feeding—is not so almond oil.

Recently McCollum and Davis found the effective fat, or rather the effective fat feeding—is not so almond oil. Seemingly, the lighter oils of beef fat to have a definitely mixed of food components, a portion of the ration, it being few months, these rats appeared after these preliminary days of gain in weight,—in truth short disaster being death if the laröd, with an effective fat or oil. So cottonseed oil, and the results with a butter-fat or cod-liver oil, and traveling the "downward road", and begin to mend, their weight if the decline is not carried to again into good, healthy, active.

Stepp has likewise pioneered his studies are interesting in triolein were not effective in "declined" mice back to health. Effective substances, soluble Cooper has recently shown the absence of lipoids from Stepp (Stepp) suggested, but to the

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Marguerite: Jour. Biol. Chem., 1913, XV, 641; and 1915, XXI, 179.

Lafayette B.: Jour. Biol. Chem., 1912, the Chemical Constituents of the Diet, the Influence of Butter-Fat on Growth, the Influence of Cod-Liver Oil and some Chem., 1914, XVII, 401; see also Proc. IL, 92.

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ether extract of the ripe testicle of the cod fish”,—negative find-

ings being evident with commercial lard, olive oil, cottonseed oil, and tallow. Osborne and Mendel found cod-liver oil and the lighter oils of beef fat to have the special effective virtues, but not so almond oil.

Recently McCollum and Davis21 have demonstrated that the favorite substance—or rather similar effects as produced from the effective fat feeding—is noted in the feeding of corn grain (fed in toto). Seemingly, the other grains such as wheat, rye, and oats are not nearly so effective although the separated wheat embryos give quite marked results.

To make this “Fat” matter a bit more elucidative a representa-tive concrete example may be in order: Certain rats are fed on a definite mixture of food constituents of which lard comprises a portion of the ration, it being the lone source of fat. For a few months, these rats appear to prosper; but lo! and behold! after these preliminary days of apparent success they cease to gain in weight,—in truth shortly begin to decline—the ultimate disaster being death if the lard or a portion of it is not replaced with an effective fat or oil. Substitute the lard with olive, or cottonseed oil and the results are absolutely negative, but use butter-fat or cod-liver oil, and the rats take on new life, cease traveling the “downward road that leads to earthly oblivion” and begin to mend, their weight increases, and sooner or later, if the decline is not carried to the point of bodily collapse, grow again into good, healthy, active, nimble, sleek-looking rats.

Stepp23 has likewise pioneered in these fat investigations and his studies are interesting in that tripalmitin, tristearin, and triolein were not effective in bringing his “experimentally declined” mice back to health. Stepp affirms that the particular effective substances, soluble in alcohol-ether are not fats. Cooper23 has recently shown that this decline is not due to the absence of lipoids from Stepp’s alcohol-ether extractions, as he (Stepp) suggested, but to the transfer of the vitamins of the


material to the extract of alcohol-ether which is not fed. At any rate, our point is made—namely, that there is a marked dissimilarity in fats (or what they specifically carry) as regards their nutritive value.

It appears reasonable that inasmuch as there is such a marked and peculiar difference in the nutritive effects of different fats difficulty would be experienced in attempting to ideally balance an animal’s ration in these respects. Now, it is not altogether certain, but it seems entirely reasonable if we base judgment on our general physiological knowledge of nutritional problems, that not only should there be a difference in the actual amounts of total general fat given but that the quantities of the specific effective unknown or unknowns necessary may vary considerably as animals of different species go through the cycle from egg to egg.

When one must take into consideration the quantity as well as the quality of the food constituent in question and likewise balance this resultant with various altering demands of the animals used, and the general environment during the investigation it is readily perceived that the difficulties involved are stupendous. The “fat” unknowns are of sufficient magnitude to rather discourage those with even iron hearts.

To attack this problem from the standpoint of appetite, in other words, from the standpoint of giving the pigs or other animals worked with, an opportunity to express their choice, would certainly be a logical method of attack. Let it be granted that the appetite may sometimes “go wrong”, yet is it not excellent policy to give the appetite an opportunity to show wherein it is right or wherein it is wrong?

The great role played by the ash, as determined in the regular chemical routine of feeding-stuff analyses, is almost untouched. The effects of the phosphorus compounds alone, so well reviewed by Forbes, are certainly extensive.

Then there is the calcium, which comprises more of the minerals of the ordinary body than any other, and about which we know comparatively little. Egvard, Dox, and Guernsey have

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found that calcium added to a control ration for swine affected the dams as well as the offspring, making them larger and stronger.

Recent results of Egvard and Dox who choose most optimum amounts of calcium is allowed at free-choice, this being allowed mixed with the feed. This being done, the carbonate continuously before the experiment was otherwise, than where none was allowed. Forbes 24 showed that the ash of Indian corn (maize) and Linseed oil (most of the oil) and Wheat Middlings.

Hart and McCollum 25 in some instances showed that: “When swine are restricted to little or no growth can be secured by making the entire ash content equal to that of milk, growth a curve was secured to at least 275.5 in harmony with the theory that corn alone is due entirely to the inorganic content.”

These investigators clearly allowed access to the great out-of-the-ordinary thing that is quite indispensable for all being. Just what these substances or the present unknown, but it is sure of the pig guides him rightly in his

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REFERENCES

found that calcium added to a corn ration fed to young pregnant swine affected the dams as well as the farrowed pigs favorably, making them larger and stronger.

Recent results of Evvard and Dox\(^26\) indicate that young swine choose most optimum amounts of calcium carbonate when same is allowed at free-choice, this being compared to theoretical allowances mixed with the feed. The Free-Choice-Fed pigs having the carbonate continuously before them made better growth likewise, than where none was allowed; the basal grain ration of Indian corn (maize) and Linseed Oil meal (flax grain minus most of the oil) and Wheat Middlings being constant in all respects.

Hart and McCollum\(^27\) in some observations with swine find that: "When swine are restricted to corn meal and gluten feed little or no growth can be secured, but with an addition of salts, making the entire ash content of the ration very similar in quality to that of milk, growth approximating that of a normal curve was secured to at least 275 pounds. These results are not in harmony with the theory that the failure of swine to grow on corn alone is due entirely to the incomplete nature of its protein content."

These salts consisted of a mixture of secondary potassium acid phosphate and calcium lactate. The effect of these mineral additions was pronounced. It is quite suggestive to quote further from this paper concerning the ability of swine to select from their normal environment some of the materials which they are not given when fed by man: "Restriction to mixed grains and distilled water did not allow normal growth with swine. This emphasizes again the very great importance of either the mineral side of the ration, or as yet unknown factors operative in the normal environment of this species, namely, soil rooting, natural water, etc."

These investigators clearly recognize that the pig, when allowed access to the great out-of-doors, evidently secures something that is quite indispensable for his normal physiologic well-being. Just what these substances are, of course, are largely for the present unknown, but it is sufficient to say that the appetite of the pig guides him rightly in finding that which enables him

\(^{26}\)Unpublished data from Animal Husbandry and Chemical Sections, Iowa Experiment Station.

to grow, and thrive, and live to good advantage, or as Hart and McCollum well put it: "These results are extremely important, indicating what a large factor in the growth curve must lie in those extraneous conditions usually surrounding the animal, but to which so little heed is given and concerning the details of which we understand so little. The salts carried by natural water or obtained by the animal from the soil are evidently very important factors in promoting growth when the ration is restricted to the grains."

It is hardly necessary or advisable to go into greater detail concerning the part played by the ash, especially the mineral nutrients in nutrition, and the wonderful maze of factors, with all their possible combinations involved. The fact that in practice progressive swine men have observed the "appetite" of the pig a better guide as what to supply, and how much to supply, and when to supply the mineral nutrients than their own "estimated mixtures" is quite to the point. In practice there is often allowed such mineral feeds as limestone, (calcium carbonate preferably), charcoal, wood ashes, phosphatic rock meal (used as a plant food), common salt (commercial sodium chloride), cinders, coal screenings, sulphur, sandstone, and others, giving the swine free access and free-choice to these in individual trough compartments; the futility of "guessing" as to the "optimum mixture" for swine of all classes and ages is quite evident.

The specific effects of various foodstuffs in changing the resistance of animals to certain poisons has been well brought out by Hunt*®. The specificity of different foods as regards their action in the body is of great importance, and it is very essential indeed that the meagre information we now have concerning the action and reactions of the known constituents be greatly increased before we attempt to apportion out the daily food allowance over the chemical balance. There are too many unknowns to "play the game" of arbitrarily controlling the diet.

There are those who suggest that swine are not intelligent, hence would not be very successful in "balancing their rations". This is a bit beside the point but it is well to quote Robinson**, who has written very thoughtfully about the dog, horse, donkey, ox, sheep, goat, cat and other domestic animals. He sounds his praises of the domestic pig in the following way: the pig is by no means the greatest supposed to be by many people to be certain points in his character or appraise without using terms appropriate to the highest human on to tell about the "inexplainable stores of food" which certain people have, when one is astounded to do so. "Apparently, however, the hog, ourselves, perhaps the most very existence, does not possess any more order".

Robinson intimates that the pig is a very swift coming into the world is the actions may be a bit labored but established. A subsequent move in made,—the piggie makes his "mouths" the nipple, and begins did the pig know enough to do that. Others may say the pig does not cold facts are that the pig finds without guidance, unless it so placent but uncertain grunting often finds the "nectar of life of his dam, for many times the tuition performance. We are


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praises of the domestic pig in these flattering lines: "* * * * "

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are certain points in his character which it is difficult to describe

or apprise without using terms which we generally consider ap­

propriate to the highest human virtues". This naturalist goes

on to tell about the "inexplicable faculty for discovering hidden

stores of food" which certain mammals, such as the squirrels,

have, when one is astounded to come upon this tribute to swine,—

"Apparently, however, the hog, although, with the exception of

ourselves, perhaps the most versatile and resourceful mammal in

existence, does not possess any mental faculties of this mysterious

order"

Robinson intimates that the pig naturally does not hide stores

of feed like the squirrel, or bee, inasmuch as he puts the surplus

of stores in the form of fat on his back; hence the need for the

development of the faculty is not apparent. This is seemingly true:
The pigs quite readily learn from experience to differentiate

between pleasurable and displeasurable reactions.

That the newly farrowed piglet should know that "dinner" is

awaiting him is, on deep thought, somewhat baffling and sur­

prising. The very first action noticeable on the part of the piglet

that comes into the world is the breathing. The first few respira­

tions may be a bit labored but the natural rhythm is soon estab­

lished. A subsequent move in which we are now interested, is

made,—the piggie makes his way to the mammary glands,

"mouths" the nipple, and begins to take milk nourishment. How

did the pig know enough to do that? Some may say, "Instinct!"

Others may say the pig does not "know" it—but at any rate the

cold facts are that the pig finds the place of suckling and suckles

without guidance, unless it sometimes be guided by the com­

placent but uncertain grunting of the sow. The piggie most

often finds the "nectar of life" without the beckoning grunts of

his dam, for many times the grunts are omitted in the par­

tition performance. We are reminded of Samuel Butler's10:

"There is no sign of 'Fluke' about the circulation of a baby's

blood. There may perhaps be some little hesitation about its

earliest breathing, but this, as a general rule, soon passes over,

both breathing and circulation, within an hour after birth, being

as regular and easy as at any time during life. Is it reasonable

10Butler, Samuel: Life and Habit, 1878, pp. 55, 54, 8.
to say that the baby does these things without knowing how to do them, and without ever having done them before, and continues to do them by a series of lifelong flukes. And again: “It is such those who do not know that they know so much who have the firmest grip of their knowledge”. Or this: “Perfect ignorance and perfect knowledge are alike unconscious”.

The Butler argument is forceful, because it seems so logical and true.

“APPETITE” STUDIES WITH SODIUM CHLORIDE.

It has been demonstrated in a recent investigation, 1914, by Evvard that well-grown young swine of approximately 150 pounds average weight make better use of common salt (sodium chloride) when it is fed ad libitum, it being accessible all of the time, than where it is mixed with the daily ration in varying proportions. The young swine in question received a basal ration of corn and oil meal (the flax grain from which a large portion of the oil had been extracted with heat and pressure). This basal mixture was constant, as regards quality, throughout the period; it being composed of 6.1 parts corn to 1 part linseed oil meal. There were 40 individuals in the experiment. These were divided, or rather distributed into five lots of eight each. These were fed as follows:

Lot I Basal Ration (as given).
Lot II Basal Ration plus 36 grams of salt daily, mixed.
Lot III Basal Ration plus 72 grams of salt daily, mixed.
Lot IV Basal Ration plus salt ad libitum. (The average consumption throughout the period on the average was 27.46 grams, which is midway between Lots II and III; the amount eaten varied, however, being as high as 42.6 grams early in the period and gradually reducing to less than 8 grams daily at the close.)

In brief, it may be said that there was a check period of 90 days preliminary run in order to determine just how the individual lots would gain. During this period the feed quantity and quality was kept constant in each lot, and no salt was allowed. Following this preliminary there came 71 days, however, in which salt was given to each lot of 8 hogs as stated.

In these 71 days, comparing the first preliminary 90 days, we find:
Lot I gained 84.24 per cent.
Lot II gained 94.02 per cent.
Lot III gained 96.97 per cent.
Lot IV gained 94.13 per cent.
Lot V gained 97.23 per cent.

It is thus readily seen that “salt ad libitum lot” was greatest. It is well to note that the “36 than either “18” or “72 grams was more closely approximated with 4.5 grams per head daily; less was more. The striking feature of the group ate on the average just indicate that this was more nearly an allowance of Lot III which is exactly.

Now, let us look to the feed required of gain in these 71 days as compared to the period of 90 days as before:
Lot I required 101.88 per cent.
Lot II required 94.29 per cent.
Lot III required 91.56 per cent.
Lot IV required 89.92 per cent.
Lot V required 89.36 per cent.

The requirement for a hundred per cent less, therefore, in the “salt than where the salt was omitted (Lots II, III, and IV). It is quite salt in varying amounts results the gain; the feed required less. It is quite received salt according to their apparent economical gains of any group. This to the “no salt group” in the required only 89.36 in contrast with that as in the preliminary.

Evidently the salt requirement throughout the experiment. The operation of their appetite, clearly a constant demand for salt makes it
does these things without knowing that ever having done them before, a series of lifelong flukes!" And who does not know that they know something of their knowledge? Or this: "Knowledge is all alike unselfconscientious, because it seems so logical.

WITH SODIUM CHLORIDE.

In a recent investigation, 1914, by feeding swine of approximately 150 pounds, the daily ration in varying proportions received a basal ration of 1000 grams of swine of approximately 150 pounds. It was found that the basal ration of 1000 grams of swine of approximately 150 pounds, being equal to approximately 1000 grams of swine of approximately 150 pounds, was the basal ration of 1000 grams of swine of approximately 150 pounds.

Lot I was fed 23.5 grams of sodium chloride daily, mixed.
Lot II was fed 36 grams of sodium chloride daily, mixed.
Lot III was fed 45 grams of sodium chloride daily, mixed.
Lot IV was fed 60 grams of sodium chloride daily, mixed.
Lot V was fed ad libitum.

In these 71 days, comparing each lot to what it did in the first preliminary 90 days, we find that:

Lot I gained 84.24 per cent as much feed.
Lot II gained 94.02 per cent as much feed.
Lot III gained 96.97 per cent as much feed.
Lot IV gained 94.13 per cent as much feed.
Lot V gained 97.23 per cent as much feed.

It is thus readily seen that the proportionate gain of the "salt ad libitum lot" was greater than any of the other lots. It is well to note that the "36 grams lot" seemed to do better than either "18" or "72 grams", in other words, an optimum was more closely approximated with an allowance of 36 grams or 4.5 grams per head daily; less salt than this was not so good, nor was more. The striking feature of this is that the free-choice group ate on the average just 3.45 grams daily, which would indicate that this was more nearly optimum than the 4.5 gram allowance of Lot III which is excelled.

Now, let us look to the feed requirement for a hundred pounds of gain in these 71 days as compared with the check preliminary period of 90 days as before:

Lot I required 101.88 per cent as much feed.
Lot II required 94.29 per cent as much feed.
Lot III required 91.56 per cent as much feed.
Lot IV required 89.92 per cent as much feed.
Lot V required 89.36 per cent as much feed.

The requirement for a hundred pounds of gain was comparatively less, therefore, in the "salt ad libitum" group (Lot V) than where the salt was omitted (Lot I) or mixed with the feeds (Lots II, III, and IV). It is quite evident that the pigs received salt according to their appetite and the amount of salt in varying amounts results, in every instance, in a cheapening of the gain; the feed required for a hundred pounds of gain was lessened. It is quite evident that the pigs which received salt according to their appetite made relatively the most economical gains of any group. The free-choice group compared to the "no salt group" in the 71 day salt feeding period required only 89.36 in contrast with 101.88 per cent as much feed as in the preliminary.

Evidently the salt requirement of these pigs was not constant throughout the experiment. This is manifested in the exhibition of their appetite, clearly shown in the data. The inconstant demand for salt makes it very difficult to apportion the
same in the diet with any large degree of satisfaction. It
would seem that it is well to allow common salt to pigs just
as average humans like to take it, namely,—ad libitum accord-
ing to appetite.

THE FREE-CHOICE SYSTEM OF SWINE FEEDING.

To determine whether or not pigs have the ability to balance
their own rations preliminary investigations have been made
in the laboratories of the Animal Husbandry Section, Iowa
Experiment Station.

Three groups of five pigs each were fed in dry lot practically
from weaning time, July 7, 1914, until they were more than
eight months of age. One of these groups (II) was continued
until almost a year old, or until April 14, 1915. Lot I was fed
from separate self-feeders these specific feeds: whole corn
grain, meat meal (containing 60 per cent of protein), whole oats, char­
coal (made from maplewood), limestone (finely ground and
running very high in calcium carbonate), salt (common rock)
and water (from the ordinary College wells). Lot II was fed
practically the same, the only difference being that linseed oil
meal was added to the list of feeds. Lot III was fed differently
from Lot I in that both oil meal and wheat middlings were
added in separate compartments. All
lots had free-choice,
there­
fore, as to what they should eat
and as to how much:
they should
drink. Every pig was
"law unto itself"
and progress
was
made in the experiment
on the basis
of "free and equal oppor­
tunity:" for each individual in every lot concerned.

One lot only, namely, Lot II, which is entirely representative,
is presented in so far as the feeding record is concerned (the
charcoal, limestone, salt, and water figures are not included in
this paper). Plate XLI shows the corn, meat meal, oats, and oil
meal eaten daily, on the basis of ten day periods, throughout
the experimental life of that group, or from the time they were 83
days of age until they were almost a year or exactly 350
days.

Evidently the palatability of the various feeds changed
considerably (consult Plate XLI) as the feeding period progressed;
in the beginning these pigs ate a ration composed practically of
less than 80 per cent corn. The percentage of the different feeds
eaten is given for the representative 3d, 10th, 18th, and 25th
periods, or when the animals were respectively 108, 178, 258
and 328 days of age respectively.

The striking feature of the charts show the very marked change manifested by what they eat and fattening. When the animal
mand for high protein feeds, the proportion of meat meal (in the
"hydrate-fat" feed) is very high to the growth impulse begins to
manifestations, in so far as growth is care of, the amount of meat
increases until it reaches a low point (see Plate XLI), at which time
is to be noted in this connection; furnishing most of the protein
223d to 303d day), is consumed,
creasing quantity, thus making
crease the amount of high-protein intake is to be kept for him to eat more, as well as if he would keep up the prot
daily. In other words, with the quite necessary to increase the protein in order to secure the reamino-acid mixture” constitutes
clearly shows that the actual amount pounds live weight continual that the richness in protein o
It is well known that pigs have the ability to balance their diet and consume what is available to them, namely, ad libitum according to their needs. Investigations have been made in the Animal Husbandry Section, Iowa State College, to determine what differences in appetite are exhibited by pigs beginning at the age of 82 days and growing to a weight of 255 days. The pigs were fed in dry lot practically from the time they were more than 82 days old, until they were more than 255 days old. Lot I was fed the following rations: whole corn grain, 60 lbs. per day; meat meal, 20 lbs. per day; oats, 30 lbs. per day; limestone (finely ground and carbonate), salt (common rock), and water ad libitum. Lot II was fed the same rations as Lot I, except that linseed oil was added to the meat meal at the rate of 5 lbs. per day. Lot III was fed differently from Lots I and II, the specific feeds being whole corn grain, 60 lbs. per day; meat meal, 20 lbs. per day; oats, 30 lbs. per day; limestone, 10 lbs. per day; salt, 5 lbs. per day; and water ad libitum. All lots had free-choice rations. The data obtained were analyzed to determine the percentage composition of the rations fed in the four lots, and to determine the changes in the appetite of the pigs as the feeding period progressed. The table below shows the percentage composition of the rations fed in each lot at different periods of growth:

<table>
<thead>
<tr>
<th>Ten Day Period</th>
<th>Age In Days</th>
<th>Corn Grains</th>
<th>Whole Oats</th>
<th>Meat Meal</th>
<th>Oil Meal</th>
<th>Charcoal</th>
<th>Limestone</th>
<th>Salt</th>
</tr>
</thead>
<tbody>
<tr>
<td>3rd</td>
<td>108</td>
<td>76.58</td>
<td>8.42</td>
<td>13.38</td>
<td>3.33</td>
<td>.10</td>
<td>.16</td>
<td>.02</td>
</tr>
<tr>
<td>10th</td>
<td>178</td>
<td>99.66</td>
<td>None</td>
<td>5.96</td>
<td>.35</td>
<td>None</td>
<td>None</td>
<td>.02</td>
</tr>
<tr>
<td>18th</td>
<td>258</td>
<td>99.47</td>
<td>None</td>
<td>.15</td>
<td>.05</td>
<td>.10</td>
<td>.07</td>
<td>.16</td>
</tr>
<tr>
<td>25th</td>
<td>328</td>
<td>94.42</td>
<td>None</td>
<td>3.27</td>
<td>.03</td>
<td>2.25</td>
<td>None</td>
<td>.03</td>
</tr>
</tbody>
</table>

The striking feature of these tabulated data is that they show the very marked changeability of the pigs' appetites as manifested by what they eat throughout the period of growth and fattening. When the animal is young there is a great demand for high protein feeds, during which time we note that the proportion of meat meal (in comparison with corn, a "carbohydrate-fat" feed) is very high. After a time, however, when the growth impulse begins to slacken and the inherited specifications, in so far as growth is concerned, are quite largely taken care of, the amount of meat meal in the ration gradually decreases until it reaches a low point at about the age of 255 days (see Plate XLI), at which time it gradually begins to increase. It is to be noted in this connection that the corn, which has been furnishing most of the protein (practically all of it from the 223d to 303d day), is consumed after the 223d day in rapidly decreasing quantity, thus making it necessary for the pigs to increase the amount of high-protein meat meal eaten if the total protein intake is to be kept from diminishing markedly. Thus the increase in meat product is due primarily to the limitation of capacity on the part of the pig, which makes it necessary for him to eat more, as well as a larger per cent of meat meal, if he would keep up the protein per unit weight in his ration daily. In other words, with the capacity for feed lessened it is quite necessary to increase the richness of the mixture in protein in order to secure the requisite amount of this complex "amino-acid mixture" constituent.

Published by UNI ScholarWorks, 1915
increased. Note that the corn increases from 76 per cent of the entire ration on the 108th day to 99.47 per cent on the 258th day, and then gradually decreases to “make room” for the increasing meat meal and charcoal. As the pigs unfold in their development they vary their intake of food nutrients. In other words they vary the daily “Bill of Materials”.

The charcoal consumption, although Plate XLI does not show it, is well to note in passing, was at a minimum during the larger part of the feeding period, but when the pigs persisted in eating largely of corn, decreasing to a low point on the 108th day to 99.47 per cent on the 258th day, and then gradually decreases to “make room” for the increasing meat meal and charcoal. As the pigs unfold in their development they vary their intake of food nutrients. In other words they vary the daily “Bill of Materials”.

Herein the appetite of the pig gives us a clue for further investigations: Is it true that pigs receiving corn alone require charcoal for optimum development; whereas those on corn and meat meal diet do not necessarily require it, at least not to such a marked extent?

The oats and oil meal eaten are seen gradually to decrease (see Plate XLI), the animals tending to visit the oats compartment but very, very seldom after the age of five months; whereas oil meal was scarcely touched after the seventh month. The great preference of the pig for corn grain and meat meal is demonstrated.

The pigs in Lot II weighed 316 pounds when they were eight months and four days of age, a very unusual record. Lot I, heretofore spoken of, weighed 304 pounds at the same age; whereas Lot III lifted the weigh beam at 303 pounds. It can thus be seen that, in so far as weights are concerned, all three lots did very creditably. As compared to ordinary systems of feeding these weights are really exceptional. While this is not direct evidence that these “Free-Choice” fed pigs were fed to the maximum of advantage, yet the indications are favorable.

It is to be emphasized that the feed consumption of Lots I, II, and III, not given, is in general in very close accord with that of Lot II. This is impressed by careful reference to Plates XLII, XLI, and XLIV.

By the use of his Illinois standard (see Plates XLII, XLI, and XLIV), worked out after a number of years of careful investigation, Dietrich was able to produce in all those years 251 days old, or really eight pounds. These were the heaviest pigs produced in all those years. The “free-choice” fed pigs we are discussing that they weighed eight pounds with the best lot (II); the following lot was slightly heavier for their age mentioned. Then too, it is well to mention that Dietrich at the Illinois Experiment Station, November, 1914, a considerable part of the female swine enjoyed by the “appetite” fed pigs are simply given to show that a fair opportunity to eat a variety of feeds allowed and encouraged an animal to grow and develop to his best advantage.

A free-choice fed pig (see Figures) is a wonder record in so far as we have had of the free-choice fed groups, for these feeds ad libitum: shelled whole oats, limestone, charcoal, female swine weighed 405 pounds; the average pig this old usually weighs one, 300, and the exceptional case in weight is about 250 to 275 pounds; very satisfactory indeed. When a pig been hand-fed according to method? Observation would have been that we never would have a record gaining pig.” Of course
APPETITE OF SWINE

APPETITE OF SWINE

APPETITE OF SWINE

APPETITE OF SWINE

evaporation, Dietrich* was able to produce pigs that weighed when
251 days old, or really eight months and seven days, 308
pounds. These were the heaviest for this age of any pigs he
produced in all those years. Particularly enough, these "free-
choice" fed pigs we are discussing, so chose their own ration
that they weighed eight pounds more in three days less time
with the best lot (II); the other two groups likewise were
slightly heavier for their age than the Dietrich-fed pigs above
mentioned. Then too, it is well to note that these pigs fed by
Dietrich at the Illinois Experiment Station received milk during
a considerable part of the feeding, which advantage was not
enjoyed by the "appetite" fed pigs. These comparative figures
are simply given to show that these pigs which were given a
fair opportunity to eat a variety of feeds according to their
own free-choice developed to exceptionally good weights in a very
reasonable minimum of time.

Evidently the free-choice system whereby pigs have access to
suitable feeds enables and encourages maximum development;
in other words actually permits the inherited specifications to be
fulfilled to all intents and purposes. Good breeding, and good
feeding, and good environment are the three great requisites
necessary in maintaining the maximum development possible. No.
one of all of these conditions should be omitted nor neglected;
they should all receive the greatest consideration in order to en-
courage an animal to grow and thrive to the fullest advantage.

A free-choice fed pig (see Plate XLV), a female, made a won-
derful record in so far as weights for age are concerned in one
of the free-choice fed groups, namely, group II, which received
these feeds ad libitum: shelled corn, meat meal, linseed oil meal,
whole oats, limestone, charcoal, common salt and water. This
female swine weighed 405 pounds when 247 days of age; an
average pig this old usually weighs from 200 to 250, a very good
one, 300, and the exceptional one, 350 pounds. A normal growth
in weight is about 250 to 275 pounds in this time, this being
very satisfactory indeed. What would have happened had this
pig been hand-fed according to the ordinary "hit-and-miss"
method? Observation would teach us that the chances would
have been that we never would have known that "here is a
record gaining pig." Of course, it is entirely possible that if

*Communication from W. J. Carmichael, Illinois Experiment Station,
December 10, 1914; also verbal communication with H. S. Grindle, same
Station. November, 1914.
milk had been added to this ration in addition to the feeds allowed, this pig would have made even a greater showing than it did. At any rate, there is the suggestion that this pig did remarkably well under this free-choice scheme of feeding and the indications are that the gains were greater than they would have been had ordinary methods been practiced. Inasmuch as this is the biggest pig for the age that has ever been fed in Experiment Station work, to our knowledge, this suggestion seems all the more real and true.

The palatability of the specific feeds is not at all constant, but much depends upon the stage of development of the pig and on his environment; the pig seems to adjust himself automatically, perhaps unconsciously, to the conditions at hand. If he is growing he eats a larger proportion of protein, or better say, a mixture heavier in amino-acids, than after he attains his growth, when he is simply maintaining himself. That feed, therefore, which is palatable to swine when they are small, young, and immature may be relatively distasteful when they are large, old, and quite mature. It would seem that that feed is the most palatable which most nearly satisfies the appetite, this ultimately meaning the satisfaction of the specific cells in need.

The feeding standards which have been proposed for growing and fattening swine are still in a somewhat crude form. Attention is given primarily to the apparently digestible protein, carbohydrates, and fats; ratio of crude nutrients (that is, the number of pounds of carbohydrates or its equivalent present with every pound of protein); dry matter; and sometimes water. The Wolff-Lehmann standard, which has been the foremost one considered by animal husbandmen, was first proposed by Wolff, a German scientist. This standard has been supplemented by the work of C. Lehmann of the Berlin Agricultural High School, Germany. This standard, based on the crude nutrients required per thousand pounds of live weight, is shown in Plates XI, XII, XIII, and XIV. The Illinois or Dietrich standard was proposed by Dietrich of the Illinois Experiment Station. The Dietrich standard calls for a definite amount of protein, carbohydrate, and fat daily for the specific feeds, but it pays little attention to the crude nutrients although these are figured from the requirements which are then added. The diet gives the water requirements for this time. These standards are discussed in full.

In converting the Wolff-Lehmann or Dietrich standard to the Con- sumed Daily to a Thousand Pounds of Live Weight standard, the figures from the crude protein, crude carbohydrate, and crude fat are equalized, and therefore the fats are added to the carbohydrate equivalent. All figures presented below are figures from the crude protein, crude carbohydrate, and crude fat.

Inasmuch as there is considerable variation in the composition of feeds, this depending upon the animals used, and also the way in which they are fed, it is deemed advisable that the concentrates of this chart are:

1. The close similarity of composition curves determined from three different combinations of concentrates presented on Plates XLI and XLII.

2. The similarity of composition curves determined from four different combinations of concentrates presented on Plates XLIII and XLIV. The Illinois or Dietrich standard was proposed by Dietrich of the Illinois Experiment Station. The Dietrich standard calls for a definite amount of protein, carbohydrate, and fat daily for the specific feeds, but it pays little attention to the crude nutrients although these are figured from the requirements which are then added. The diet gives the water requirements for this time. These standards are discussed in full.

The consumption curves determined from three different combinations of concentrates presented on Plates XLI and XLII.


**Dietrich, William: Swine, 1910. The Revised Standard was given to the author by Dietrich in May, 1914, which standard is figured on the crude nutrient basis in Plates XI, XII, XIII, and XIV.
rich standard calls for a definite amount of digestible protein, carbohydrate, and fat daily for a hundred pounds of live weight; it pays little attention to the ratio of digestible or crude nutrients although these are figured and presented in Plate XLIV from the requirements which Dietrich suggests. Dietrich in addition gives the water requirement, but this is not considered at this time. These standards provide an interesting theme for discussion.

In converting the Wolff-Lehmann standard and the Illinois or Dietrich standard to the crude nutrient basis we have assumed for the particular grain feeds used a digestibility of 80 per cent for the protein (which really means we added one-fourth or 25 per cent to the digestible figures given to get those presented on Plates XLI and XLII); 91 per cent for the carbohydrates (this calls for an addition of practically one-tenth or 10 per cent to the digestible figures given); and 70 per cent for the ether extract or fat (this calling for an addition of three-sevenths or approximately 42.86 per cent). We have likewise based the figures for the carbohydrate equivalent, assuming that one pound of crude fat is equal to 2.2 pounds of crude carbohydrate; therefore the fats are simply multiplied by 2.2 and this is added to the carbohydrate figure—this giving the crude carbohydrate equivalent. All figures are reduced to the Amounts Consumed Daily to a Thousand Pounds Live Weight.

Inasmuch as there is considerable variance in the digestibility of feeds, this depending upon the preparation of the feed, animals used, and also the ways in which the feeds are mixed together, it is deemed advisable to base the present paper upon crude nutrients rather than upon digestible ones; inasmuch as concentrated grains or their by-products were used entirely for the organic portion of the ration without any roughages whatsoever, the use of the crude nutrients is all the more justified.

The crude protein consumed daily to a thousand pounds live weight is given in curve form in Plate XLIII. The striking features of this chart are:

1. The close similarity and coincidence of the feed consumption curves determined by the free-choice fed pigs fed upon three different combinations of feed.
The somewhat natural tendency of the free-choice curves to gradually change without any general tendency towards abrupt differences. (This omits consideration of the ten day periodic variations.)

3. A "period of readjustment" is noticeable in the first 30 days, as it takes the pigs a few weeks to adjust themselves to the new conditions of eating—new feeds, new quarters, new environment, and other not hitherto experienced factors.

4. The fairly close agreement between the Dietrich or Illinois standard and the "appetite" curves.

5. The contrasted character of the Wolff-Lehmann curves and the "appetite ones." The type of curve is different in these two instances.

Peculiarly enough, the pigs ate somewhat as the Dietrich Illinois standard would allow, but without the specific rises and falls.

While the breaks in the curves are noticeable, especially on the 135th day of age, the 145th and the 155th, yet these are probably due indirectly to technique, climatic and other immediate factors. After the pigs reached the age of 160 days, however, it is quite noticeable that the curves are more uniform. This is explained somewhat by an improvement in the method of "weighing back" the uneaten feed. At this time a constant hour was set aside for this procedure at the end of every ten day period; whereas formerly the feeds were "weighed back" sometime during the forenoon, considered as from 7 A. M. to 12 M. At any rate, the general natural tendency of the "free choice" "appetite" curves is well brought out; the data from a large number of trials would smooth out the appetite curves.

After the 245th day of age the Dietrich standard has not been formulated, hence it is incomplete from that point on.

The Wolff-Lehmann standard calls for a lesser amount of protein than does the "appetite" in most of the growing period, or until the pigs reach the age of practically 190 days, at which time the requirement is in excess of the appetite. Of course, it is entirely probable that if the protein allowance is based on the Wolff-Lehmann standard early in the period the pigs will tend to compensate for this deficiency later. We note this to a considerable extent in practice: pigs that have been starved for amino-acid mixtures during the early part of their life, do, when later given a free opportunity to eat an abundance of amino-
The tendency of the free-choice curves indicates a general tendency towards the consideration of the ten day period is noticeable in the first thirty days to adjust themselves to new feeds, new quarters, new environmental factors.

The curves of the Wolff-Lehmann curves vary somewhat as the Dietrich Illinois curves. The Dietrich Illinois curves are more uniform, without the specific rises and without the specific declines that are noticeable, especially on the 140th and 155th days, yet these are climatic and other intermediate conditions.

The crude carbohydrate equivalent consumed daily to a thousand pounds live weight is given in Plate XLIII. The striking features of this chart are:

1. The marked similarity and coincidence of the curves of the three free-choice system or appetite fed lots.
2. The period of readjustment in the first thirty days of feeding.
3. Fairly close agreement of the Dietrich Illinois standard with the appetite curve when the pigs increase in age from 80 to 160 days; after which time, however, this standard calls for carbohydrate nutrients in excess of those actually eaten.
4. The gradual natural decline in carbohydrate equivalent consumption from the 160th day of age until the pigs are practically a year old. This decline is most marked after the pigs are a little more than five months of age, thus indicating that early in life the consumptive ability kept pace with the increase in weight. After the first five months of life, however, the capacity (as indicated by the amount eaten) did not enlarge proportionately as rapidly as the weight increased.
5. The relatively low requirement of the Wolff-Lehmann standard until the pig reaches seven months of age as contrasted with the appetite curve (or even the Dietrich standard requirement). The high comparative Wolff-Lehmann requirement after seven months is much greater than the appetite, fully satisfied from the beginning, demands.
more naturally run are those of the "appetite" fed pigs, providing these lines are smoothed out on a "general average basis".

Dietrich found that his standard was more satisfactory than the Wolff-Lehmann one. If that is true then it would seem that the "appetite"-fed pigs are certainly nearly right, and there is a question whether or not they would not excel Illinois standard fed pigs.

Investigations are now in progress at the Iowa Agricultural Experiment Station in which the Illinois standard, the Wolff-Lehmann standard, and the freedom of choice or appetite system are being compared.

The ratio of crude nutrients (pounds of carbohydrate equivalent eaten with every pound of protein) has been worked out for the two discussed standards—the Dietrich and the Wolff-Lehmann, as well as for the free-choice system fed pigs. The close similarity of the ratios until the pig reaches about 190 days of age is quite strikingly evident. At this time, however, (187 days) the Dietrich ratio curve mounts to an almost inconceivable height, and then on reaching its maximum on the 210th day comes quickly down again to the apparently normal. This marked widening of the Dietrich ratio at this time is primarily due to the very rapid decrease in protein inaugurated on the 187th day. This decline continues until the 213th day when a level is reached. On the same day that this low level point of protein allowance is reached (213th day) the ratio begins to narrow, as is evident from Plate XLIII. This is true subsequently. At this time it was gradually narrowed to about 55.5 pounds live weight on the 213th day. (This is due to the 275th day, which is disc.

Note, however, that the Wolff-Lehmann standard; the Dietrich and the Wolff-Lehmann; and the freedom of choice or appetite system are being compared.

The Wolff-Lehmann standard approximates the "appetite" curve very closely up to the 175th day or thereabouts but from that time on it calls for a narrower ration (which is more expensive, generally, though not always, from the animal husbandman's standpoint, than the ratio chosen according to the appetite). Practical men for the most part assuredly wish that the "appetite" curve as compared to the Wolff-Lehmann requirement be more nearly correct, because the former is more economical, ordinarily, likewise easier to accomplish.

The Wolff-Lehmann standard and the "appetite" scheme more closely agree than the crude protein and the crude carbohydrate equivalent, consumption daily to a thousand pounds live weight. The disagreements, however, are clearly evident.

Taking everything into consideration, the ratio of crude nutrients in the two standards and the "appetite" scheme more closely agree than the crude protein and the crude carbohydrate equivalent, consumption daily to a thousand pounds live weight. The disagreements, however, are clearly evident.

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The gradual tendency of animals to widen their ration as the period progresses is self evident. It has not been demonstrated heretofore to our knowledge that animals allowed free expression as regards satisfaction of appetite would widen their ration as these have done, only to narrow it again in the later stages of fattening. This is evidently what happens with growing pigs and the reason is probably not far to seek. From the 80th up to the 255th day of age the "appetite" fed pigs did gradually widen the ratio from about 1.4 to 1.77, after which time it was gradually narrowed until it reached a ratio of 1.64 on the 345th day. (This is disregarding the drop in Lot III on the 275th day, which is discussed in a footnote.)

One would think that with a narrower ration the pigs would, of course, want more protein per unit live weight, but reference to Plate XLII shows this not to be the case because the protein actually decreases gradually. Reference to the carbohydrate equivalent, Plate XLIII, likewise demonstrates that the carbohydrates per thousand pounds live weight eaten are gradually lessening at this time although comparatively at a more rapid rate than the protein.

Now, what is the reason for this narrowing of the ration, after the maximum "wideness" had been approached? Reference to Plate XLII shows that there is a gradual lessening in the amount of total grain feed eaten after the 193d day, at which time a maximum of a little over 9.7 pounds was reached until on the 350th day the amount of grain feed eaten had decreased to about 5.5 pounds, a decrease in consumption of more than 45 per cent. The total protein consumption likewise, has gradually declined after the 193d day although this decline has been somewhat slow from the 300th to the 355th day. The carbohydrate equivalent has lessened markedly after the 193d day, and this decrease continues to the finish of the experiment, the
decrease from the 300th to the 355th day being plain. To eat the certain minimum amount of protein, which may be assumed as absolutely necessary and to be as shown in Plate XLIII, the pigs must narrow the ration toward the finish (after the 255th day) in order to get protein sufficient. The quality of the ration must be changed so as to have more protein in a hundred pounds of feed, inasmuch as less units of feed are being eaten because of an evident lack of consumptive ability.

Just what would lessen the capacity of the animals after the 193d day is not definitely known but this may be attributed to:

1. A lack of alimentary volume due to the greatly increased stores of internal fat.

2. An actual lessening in the demands for feed nutrients because the most rapid period of growth has been passed. The milch cow when giving a large quantity of milk daily will eat more feed than if not lactating; the same is true of the sow suckling pigs. The working man eats more heartily, naturally, than the sedentary one; the growing child eats to the limit oftentimes compared to the mature and aged. It is thus seen that the pig which is rapidly growing has great demands upon its digestive apparatus to eat and digest feed to furnish the necessary nutrients for assimilation. The greater the outlet for the assimilable nutrients the greater, ordinarily, the consumptive ability of the animal in question.

One dominant reason for the sometimes ineffective results secured in feeding according to ordinary standards is the difficulty of knowing the resultant of the many, specific units, as many as a hundred, which in all probability are comprised in an ordinary feeding-stuff such as maize grain, or meat meal, or oats, or oil-extracted flax grain residue. The suitability of different individual feeds for the animals in question has been determined largely from a careful observation of results secured in practical Animal Husbandry. This general knowledge of practical feeding-stuffs and their effects is of great advantage in supplementing the best feeding standards. At best the "best" standard available today is but a crude approximation of actual requirements. When the appetite is given full control of what shall be eaten it is surprising to note how the pigs naturally select the specific feeds which swine herdsmen have long since approved as of the best, and what is equally surprising the pigs show marked avoidance of those feeds usually considered as ill-adapted to swine.
Undoubtedly the kind of feeding stuff offered to growing and fattening swine determines to a considerable extent the relative quantity of the different feed constituents,—proteins, carbohydrates, fats, minerals, water, and so on,—which is consumed. On a milk diet for instance, in which buttermilk is allowed at free will in conjunction with such feeds as Indian corn, 60 per cent protein meat meal, wheat middlings and rock salt, the amount of protein eaten tends to be quite high as compared to a similar ration without the milk,—but it is yet to be demonstrated that a lesser milk allowance (limited) under such circumstances would be an improvement judged from the physiologic viewpoint; it is entirely likely that economic considerations would preclude the possibility of allowing such large quantities of milk, yet that, too, depends upon the relative value of the different feeds in question. When buttermilk can be had for nothing and the other feeds are charged at normal corn belt (1915) rates, then the maximum consumption of the milk would likely be attended with greatest economic profit regardless of the physiologic aspects, unless they be unhappily and extraordinarily unfavorable to the milk addition, which development, however, is not probable. The point to this paragraph is this: The source of the different constituents,—proteins, carbohydrates, fats, and so on affects quite materially the best physiologic standards to be formulated. In other words, to be specific, it is quite probable that a different standard would need to be used in order to secure the greatest physiological returns if buttermilk and Indian corn are used as a general source of these constituents than if meat meal and Indian corn be depended upon. This theme, however, awaits much more investigation before it is possible to make positive statements, statements that can be backed up with the evidence.

In the formulation of human dietaries much effort has been expended in determining what different people actually eat under varying conditions of life. In the production of swine feeding standards, however, this feature has been, to our knowledge, almost wholly neglected. The pig has not been given an

41 See Stabler, A. L., Pig Feeding Experiments, 1911, Maryland Agr. Exp. Sta. Bul. 190, pp. 108-112. Stabler self-fed five young growing pigs for 77 days, giving them corn meal, wheat bran, linseed meal, and meat meal in separate troughs, but the results are presented without significant comment. In part he says,—"It is worth noting how regular these pigs were in their habits of feeding", and "the pigs ate much more of the corn meal than of all the other feeds combined", and, "these pigs made very satisfactory gains for feed consumed." The experiment was discontinued on the eve of "possible striking developments."
opportunity to "tell" what he would take in order to grow to advantage. If an investigator wished to improve the methods of swine feeding the usual and customary procedure has been to use the most approved standard as a basis and compare the new schemes with it. The method of deductive reasoning employed in the study of the human dietary stands in marked contrast to that used in the research done on swine standards. The pig has been kept in the background; whereas he might have occupied the foreground advantageously.

A few closing words concerning appetite, and the factors affecting nutritional needs may not be amiss. Appetite is the resultant of thousands upon thousands of generations of biological selection. Certain physiological specifications are inherited, and then unconsciously they are fulfilled in so far as the environment allows. The various demands, changing from day to day, affect the bill of materials necessary. Every slight act or movement plays a specific part in creating the nutritional demands. In addition certain external factors must be reckoned with, such as extremes of temperature, humidity, atmospheric pressure, and other conditions.

Factors which we control and factors over which we have no control are operative in this business of living our lives through the years of development; both must be reckoned with, and faced squarely from the nutritive standpoint.

SUMMARY.

1. There is much difference of opinion as to whether or not the appetite may indicate reliably the nutritional needs.
2. The futility of ideally balancing the diet or ration through arbitrary dietaries or standards, based on known physiological and chemical facts, is evident from a survey of the "field of possible unknowns." At best the attempt will result in what may be considered Rough Estimates.
3. The appetite of the pig appears to be a very good guide as to bodily needs; hitherto the apparent reliability of the appetite has not been duly appreciated.
4. Growing pigs fed sodium chloride (common salt) ad libitum made more rapid growth (increase in weight) with less requirement of feed per unit increase than when no salt was allowed, or when it was mixed in variable quantities with a basal ration of corn grain and linseed oil meal (whole flax grain minus most of the oil).
5. The ordinary feeding for Illinois, and the Wolff-Lee, approximate the appetite, but this divergence is quite natural. There are so many "unknowns" involved, the feeds to be used, and the method.
6. The palatability of feed which are relished early in growth of the animals are mature.
7. The appetite of pigs varies during development; many internal as well as desire for nutrients.
8. Pigs fed according to the ordinary feeding, when given suitable ration, times weighing 300 pounds at times weighed 405 pounds in 24 hours. Evidently this "growthy" period is the result of an "opportunity, as regards the appetite," intake, using this as a guide. In the study of human standards, the appetite of the animal is given the "pigs’ appetite" intake, using this as a new comparison, therefore, we have been accented to the "pigs' appetite.

9. Heretofore in studying standards the appetite of the pig has been placed on existing standards, Is it not time to face this fact, and to make the maximum development?
10. The "appetite" studies of the appetite, research along nutritional lines.

APPETITE.
5. The ordinary feeding standards for swine—the Dietrich or Illinois, and the Wolff-Lehmann, in some respects closely approximate the appetite, but in many, they diverge widely. This divergence is quite naturally expected, inasmuch as there are so many "unknowns" involved as regards the animals to be fed, the feeds to be used, and the environment to be experienced.

6. The palatability of feeds is relative; the specific feeds which are relished early in growth may not be relished later when the animals are mature.

7. The appetite of pigs varies according to growth or development; many internal as well as external factors affect the desire for nutrients.

8. Pigs fed according to the "Free-Choice System of Swine Feeding," when given suitable feeds, grow very rapidly, oftentimes weighing 300 pounds at eight months of age; one pig so fed weighed 405 pounds in 247 days, a remarkably good record. Evidently this "growthy" pig was provided a most excellent opportunity, as regards the "bill of materials" supplied, to make the maximum development.

9. Heretofore in studying and formulating swine feeding standards the appetite of the pig has been largely ignored, dependence being placed on existing "man-made" standards. Each new comparison, therefore, was made with the various existing standards. Is it not time to face about and study normal "appetite" intake, using this as a rational basis for further investigation. In the study of human dietaries this has been diligently done, hence it is the more surprising that but little attention has been accorded the "pigs' appetite."

10. The "appetite" studies open a most promising field of research along nutritional lines.

APPETITE OF SWINE
The food consumed daily in the "Free-Choice System of Swine Feeding," when pigs have free access to corn, meat meal, linseed meal, and oats; the progressive live weight is also plotted.

https://scholarworks.uni.edu/pias/vol22/iss1/57
The crude protein consumed daily to a thousand pounds live weight in the "Free-Choice System of Swine Feeding," compared to the requirements of the Dietrich or Illinois, and the Wolf-Lehmann standards.
The crude carbohydrate equivalent consumed daily to a thousand pounds live weight, compared to the requirements of the 'Free-Choice System of Swine Feeding,' the Diehr-Ilinois, and Volff-Lehmann standards.

The crude carbohydrate equivalent consumed daily to a thousand pounds live weight.
Evvard: Is the Appetite of Swine a Reliable Indication of Physiological N

Published by UNI ScholarWorks: nutrients consumed in the "Free-Choice System of Swine Feeding," compared to the Dietrich or Illinois and Wolff-Lehmann standards.
A Free-Choice Fed Pig.
This female swine seemingly developed to somewhere near its inheritance, due indirectly to the system of feeding.