

Live Stock

THE ANIMAL BODY AS A MACHINE (Extracts from Farmers' Bulletin No. 346)

Mechanically the body of an animal is a very wonderful machine, but what is of peculiar interest in this connection is that the body is what the engineer calls a prime motor—that is, like the steam or gasoline engine, it moves itself and may supply power to move other machines. In fact, there is in some respects a very close likeness between the animal body and what are known as internal-combustion motors, i. e., those engines in which power is developed by burning liquid or gaseous fuel (gasoline, alcohol, producer gas, etc.) in the cylinder of the engine itself. Such an engine requires two things for its operation: (1) Sufficient repair material to keep its working parts in running order, and (2) a supply of fuel in proportion to the work to be done. Just these same two things are what the animal requires—repair material and fuel.

In one respect, however, the animal body differs from the artificial machine—it can not be stopped and started again at will. As long as the animal lives the vital machinery is in operation, although less actively at some times than at others. The animal might be compared to an automobile whose engine must be kept running at a low speed in order to have the power available when needed. Consequently, the animal requires to be supplied with repair material and with fuel as long as it lives and not merely when it is in active use.

That the feed of the animal is its source of both repair material and fuel is sufficiently obvious. We do not need a physiologist to tell us that when an animal is deprived of food its tissues waste away while its fat is burned up in the effort to keep the bodily machinery in motion. We may proceed at once, therefore, to consider the feed in these two relations.

Demand for Repair Material

The repair material for any machine must be of the same kind of which the machine is made. We have just seen that the machinery of the body is composed of protein, ash and water. These, then, are the materials which must be supplied to keep it in repair.

Water, of course, is or should be abundantly supplied in the drink and scarcely need be considered in a discussion of rations.

Ash—The ash supply has received less attention in the past than its importance deserves. In the ordinary operation of the bodily machinery its ash ingredients are being continually excreted and the food must supply ash sufficient in amount and of the right kinds to make good the loss, while the growing animal needs an additional supply for building up its new tissues. Fortunately, normally constituted rations appear to be rarely deficient in ash. Usually it is only when large amounts of certain by-product feeds are used or when there is a misrelation between grain and coarse fodder that special attention needs to be given to the ash supply.

Protein—The protein supply, on the other hand, calls for careful consideration. Protein is the characteristic ingredient of the animal mechanism, and is broken down and destroyed in its operation at a fairly regular rate. Moreover, since the bodily machinery is running all the time, whether any external work is done or not, this loss is continually going on.

The body differs from a machine in being self-repairing, but it can not manufacture protein for repair purposes out of the carbohydrates and fats of its feed any more than it is possible to make repairs for an automobile out of the gasoline which supplies the power. For its protein the body is absolutely dependent on the protein of the feed. This protein is needed for two purposes:

First—It is required for repair purposes in the strict sense; i. e., for making good the wear and tear of the bodily machinery. The amount needed for this purpose is comparatively small, and is no greater under normal conditions when the animal is doing work than when it is not. Like a good engine, the body makes relatively small demands for repair material and requires chiefly fuel.

Second—Protein, as well as ash, is needed in the growing, pregnant, or milking animal to furnish the material for enlarging the working machinery of the body of the animal itself or of its young. The amount of protein required for this purpose is just so much in addition to that needed for repair purposes simply, and hence the feed of these animals must contain a more liberal supply of this ingredient. This is important, physiologically, to secure proper nutrition of the young and economically, because the growth or milk produced is the principal object of the feeder.

Feed as a Source of Repair Material
For the reasons stated, the ash has generally been omitted from consideration in discussing the feed as a source of repair material.

The value of a feeding stuff as a source of protein to the animal body evidently depends in the first place on the amount



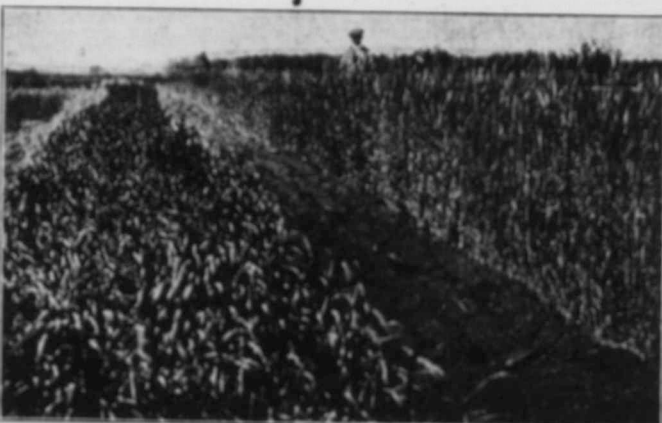
Line of Corn Stalks at Manitoba Agricultural College

of protein which it contains. Cottonseed meal carrying some 43 per cent. of protein, is evidently, other things being equal, a better source of protein than Indian corn, carrying about 10 per cent.

In the second place, however, the protein of the feeding stuff must be capable of being digested by the animal. Of two feeding stuffs containing equal amounts of protein, that one is the more valuable as a source of supply in which the larger proportion of the protein is digestible.

The Demand for Fuel Material

Since the animal machinery is running continually, it requires a continual supply of fuel material, the amount which is necessary depending upon the amount



Field of Spring Rye at Manitoba Agricultural College

of work done. This fuel material consists chiefly of the carbohydrates and fats of the food, although if more protein be fed than is required for repair and construction purposes it, too, may be used as fuel, while the worn-out portions of the protein tissues are also utilized—that is, the bodily engine can burn up its own waste products as fuel. The unnecessary use of protein as fuel material, however, is wasteful, because protein is ordinarily more expensive to buy or to produce on the farm than are carbohydrates and fats.

If the fuel materials supplied in the food are just adequate to the work to be done, they are virtually burned up

as a source of power. If more are supplied than are immediately needed, the body is able to store away the surplus for future use, much as we may fill up the gasoline tank of an engine. To a small extent the body stores up carbohydrates (in the form of glycogen), but most of its surplus fuel it converts into fat. The fat of the body, therefore, is its reserve of fuel. In fattening, the body is accumulating a surplus against future needs which man diverts to his own use as food. If the feed becomes insufficient, this store is drawn upon and the animal gradually becomes lean. Similarly, in growth and in milk production, the animal sets aside a part of the supply of both repair and fuel material in its food for its own growth or for the use of its young, and man appropriates the resulting meat or milk as repair and fuel material for his own body.

Feed as a Source of Fuel Material

We can run an engine with various kinds of fuel. For the steam engine we may use coal or wood or petroleum; for the internal-combustion motor, gas, alcohol, or gasoline may be employed. Similarly we supply the animal body with a great variety of feeding stuffs from which it has to extract its supply of fuel, and

converting it all into heat, by burning the substance, and measuring the heat produced. Various units have been employed in measuring heat, but the one used in this bulletin is the therm.

A therm is the quantity of heat required to raise the temperature of 1,000 kilograms (2,204.6 pounds) of water 1° C. (2.12° Fahr.). A pound of good anthracite coal would produce heat enough to raise the temperature of about 3,583 kilograms of water 1° C. Consequently the chemical energy contained in the coal is 3,583 therms per pound. In precisely the same way the amount of chemical energy contained in many feeding stuffs has been measured. The following are the results of a few such determinations:

Chemical Energy in 100 Pounds

	Energy therms	Total value therms
Timothy hay	175.1	33.56
Clover hay	173.2	34.74
Oat straw	171.0	21.21
Wheat straw	171.4	10.36
Corn meal	170.9	88.81
Oats	180.6	60.27
Wheat bran	175.3	48.23
Linseed meal	190.7	78.92

But the value of a fuel depends also upon how much of the chemical energy which it contains can be used. Hard coal contains plenty of energy, but it would not be of much use to run a gasoline engine. Wheat straw contains fully as much chemical energy as corn meal, but much of that energy cannot be utilized by the animal machine.

Two causes combine to affect the utilization of the chemical energy contained in feeding stuffs.

First, more or less of the feed escapes from the body unburned.

Second, as already pointed out, the animal body has to extract its real fuel material from its feed, separating it from the relatively large proportion of useless material which it excretes. To effect this separation requires work and consumes energy, and this energy, of course, is not available for other purposes. The case is somewhat as if the gasoline engine had to distill its own gasoline and separate it from impurities.

It is not then the total chemical energy contained in a feeding stuff which measures its value as fuel material to the body, but what remains after deducting the losses in the unburned materials of the excreta and the energy expended in extracting the real fuel materials from the feed and transforming them into substances which the body can use or store up. For example, while 100 pounds of corn meal contain, as stated, about 170.9 therms of chemical energy, only about 88.8 therms remain, after all these deductions have been made to represent the actual value of the corn meal as a source of energy to the organism.

THROUGH FINE COUNTRY

That the country through which the new Hudson Bay railway will run possesses agricultural and mineral possibilities that need only railway facilities to open them up was the substance of an interview given at Ottawa on Sept. 19 by Prof. R. W. Brock, director of the geological survey, who has just returned from a trip on which he accompanied Earl Grey through the north country.

"While I had not time to make a thorough examination of any kind," said Prof. Brock, "I noticed one promising looking belt on the Echimaish river, up which we went. It was about 130 miles long. There has of course been no prospecting in this district owing to the difficulties of transportation. The railway, however, will supply a splendid base for this work, and several of the inlets afford great opportunities for it.

As regards agriculture, the country, of course, does not offer such advantages as does the prairie, still there is a lot of land that could be used for farming north of Lake Winnipeg particularly. It would, however, need experimental work to decide this question fully.

"There is any amount of water power available all through the country that is capable of development, the Nelson river itself being one of the biggest in the world in this respect."

"Our route," said Prof. Brock, "lay somewhat south of the location of the road, but I do not think the district offers many difficulties for railway work. There are muskegs, of course, but these are to be found in northern Ontario where the Temiskaming & Northern Ontario operates, and on the Transcontinental, too."