metabolised by different species of animals.

The causes of loss always are three:—

(1). Part of the food is not digested.

(2). During digestion and during metabolism part of the food is transformed into materials which cannot be utilised by the animal and which are excreted.

(3). All foods, to a different degree, stimulate vital processes. This stimulation is not observed by the eye, but nevertheless it results in the dissipation of energy in the same way as does muscular movement.

These three points require a little elaboration to make clear just why each constitutes a loss to the animal.

Process of Digestion

The term "digestibility" is used in animal nutrition in a special sense to mean the percentage of feed which is extracted during its passage through the alimentary tract. It should be realised that the ingestion of a food does not mean that is is then all utilised by the animal. While food is in the alimentary tract it is merely conveniently placed for action by digestive processes. Only the part which is digested and absorbed is utilised by the animal. The undigested portion is passed on and eliminated in the faeces, and is a total loss so far as metabolism is concerned. The undigested residue can readily be measured by collecting the faeces under suitably controlled conditions.

The practice in the determination of digestibility is to feed the same weight of food daily over a long period and to collect the faeces for this period. The difference between the food intake and the faecal outgo is considered as the digested portion. The digestible portion can be expressed as a percentage of the total food intake. It is apparent, also, that by chemical analyses of food and of faeces the percentage digestibility of any of the food constituents, such as proteins, carbohydrates, fats, etc., can be measured.

Digestibility

It was stated earlier that digestibility varies for different foodstuffs and for the same foodstuff fed to different species of animal. A sheep, for example, can digest 55 per cent. of the total dry-matter of hay, but can digest nearly 90 per cent. of the total dry-matter of maize. A fowl can digest only about 30 per cent. of clover, but digests about 80 per cent. of wheat. A sheep will digest more than 40 per cent. of wheat chaff, whereas a pig will digest only approximately 20 per cent. of this same substance.

A knowledge of digestibility of a foodstuff is obviously of first importance in assessing its nutritive properties. Attempts have been made to use the percentage digestibility or, as variously expressed, the **DIGESTIBLE NUTRIENTS** or the **GROSS DIGESTIBLE ENERGY** as a measure of nutritive property of foods. Such a procedure neglects the two remaining causes of loss which were indicated earlier.

During digestion, especially by cattle, a gas known as methane is formed as an inevitable consequence of the processes of fermentation. Methane contains energy which was present in the original food, but which cannot be utilised by the animal. The loss of methane, therefore, is a direct loss from the food. When some foods are fed to cattle and sheep this loss reaches or exceeds 10 per cent. of the total food energy, although it is usually 8 per cent. or less. In horses the loss is usually less than 2 per cent., and in pigs less than 1 per cent.

In addition to the loss due to gas formation, further loss occurs due to the fact that there are excreted in the urine certain substances which are incompletely oxidised. The loss by way of the urine is frequently in the region of 5 per cent. of the total food energy. The **GROSS DIGESTIBLE ENERGY**, therefore, does not represent the nutritive value of a food, because the losses which have just been described must be subtracted before the nutrients available to the animal can be computed.

Metabolisable Energy

The nutrient value of a food after subtraction of the undigested matter and the losses due to gas formation and excretion in the urine is defined as **METABOLISABLE ENERGY** of the food. This metabolisable energy is the fraction which is finally left for the use of the animal.

But not yet all the metabolisable energy is available to the animal for production purposes or for the provision of maintenance requirements, because the third cause of loss has yet to be allowed for. This loss is due to the stimulating effect of the food on the body cells. Energy is used by this stimulation, and must be debited to the food which causes the stimulation. The energy used up is converted to heat, and is eliminated from the body in this form. The fraction of the energy lost by this heat formation is a direct loss to the body for production, although the heat can be employed in maintaining the body temperature. Losses of from 17 per cent. to nearly 40 per cent. of the total energy of the foodstuff may occur as a result of this stimulation.

Net Energy

What is left to the animal after the three losses have been deducted is the proportion of the food available for maintenance or for production purposes. It is defined as the **NET ENERGY** of the food. For ruminants the net energy of roughages may vary from 5 per cent. of the total energy for wheat straw to 24 per cent. for clover hay; for concentrates it may vary from 30 per cent. for wheat bran to 50 per cent. for molasses.

The net energy of a food can be measured only by actual experiment on animals. The methods employed are highly technical, and a description of these is beyond the scope of this article. It will suffice to say that in the measurement all the losses which occur during metabolism of a foodstuff and which were described earlier are properly allowed for. The net energy, then, is the net value of the foodstuff to the animal.

The unit for stating net energy is the therm, and the practice is to give the number of therms of net energy per 100lb. of foodstuff. Thus, for ruminants the net energy of wheat straw is 7 therms per 100lb. and of hay is 40 therms per 100lb.

Starch Equivalent

The therm has not yet been adopted universally as a means of expressing net energy, mainly because of the difficulty sometimes experienced in applying an abstract conception like a therm to the rationing of stock. An older measure of net energy will, therefore, often be encountered. This measure is the **STARCH EQUIVALENT.**

The starch equivalent is the number of pounds of starch which yield the same net energy to the animal as do 100lb. of the food.

The reason for selecting starch as the standard of reference was that it was a familiar substance, and therefore easily visualised. The net energy of pure starch for cattle was found by