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Cattle and other ruminant animals, traditionally luxury food, may help meet world protein shortage

by Christopher Weathersbee

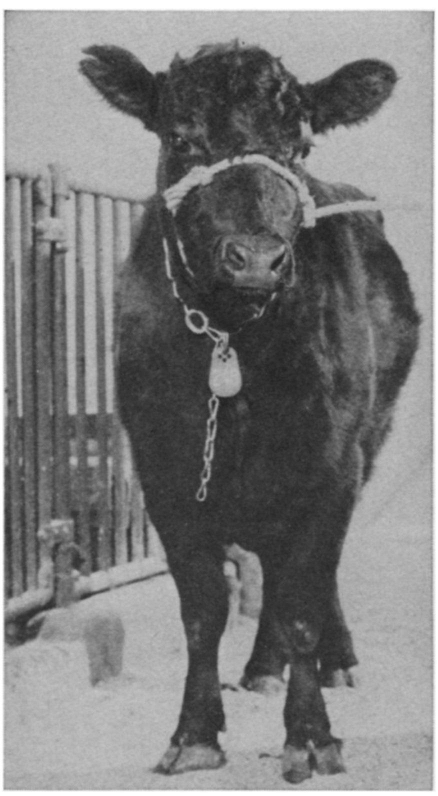
The bulk of the world's population could use more protein. Multitudes are sick or dying from protein lack. In war-strangled Biafra, hundreds die each day from kwashiorkor, a protein deficiency disease, even though Biafran markets are well supplied with casava and other starchy energy foods.

Radical proposals have been advanced as solutions for the protein crisis predicted as the result of exploding population.

Fish might be farmed like cattle, for instance. Palatable steak substitutes might be made from yeasts or soybeans. Seaweeds might be grown and harvested, as might tiny plankton. Man might learn to synthesize amino acids, subunits of proteins, cheaply enough and in enough quantity to provide dietary supplements that would make natural protein unnecessary.

Notably absent from such discussions is mention of livestock. Steaks, mutton, poultry and bacon are tacitly assumed to be the luxury accorded to the over-developed and overfed nations. Livestock is said to be the least efficient way of producing protein from land.

Angus cow, fed no protein, . . .



So far, however, none of the other proposals has even begun to threaten livestock as the world's protein source.

In fact, many agricultural scientists look at the raising of food animals as the only realistic chance to provide at least a short-run solution and buy time for the farther-out schemes to mature. They are pushing research that could bring up the protein-producing efficiency of the animals.

The best bet for new ways to get protein out of animals appears to be the suborder *Ruminantia.* This group includes cattle and sheep, as well as deer, giraffe, okapi, goats and the numerous antelopes.

Ruminants have provided the bulk of man's meat throughout history. The reason is that other kinds of livestock, such as poultry and swine, eat cereal grains, root crops and other food in direct competition with man. It is borrowing from Peter to pay Paul (though poultry and swine, when they can use man's waste, have an important role).

Cows and sheep, on the other hand, live on grass, which humans can't digest, and make from it highly useful and digestible meat, milk and fat. This is their value in the current crisis.

Animals cannot build proteins from anything less than amino acids, the fragments of other proteins in the diet. Only plants and microorganisms can synthesize the stuff of life from scratch. Non-ruminants, therefore, can never put on protein weight faster than protein is supplied in the diet.

But ruminants can. They are able to do the apparently impossible, synthesize protein from the non-proteins in grass. Grass is mostly cellulose and water. It contains a small amount of protein, but not nearly enough to account for a cow's protein weight gain.

It has even been found, in experiments at the U.S. Department of Agricultur 's research center at Beltsville, Md., that cattle can grow to maturity (hundreds of pounds of juicy protein) on a diet of indigestible ground wood (cellulose), ammonia, vitamins and minerals.

At the moment, this diet has to be supplemented with starch and other more digestible carbohydrates than cellulose. There is, however, not a scrap of protein in the experimental diet. The ammonia is supplied as urea, uric acid, urea phosphate or biuret.

Each ruminant—whether cow or giraffe—has four stomachs. The first two constitute a great bag called the rumen. The grazing cow swallows grass almost unchewed, along with a lot of saliva. This salad is stored in the rumen.

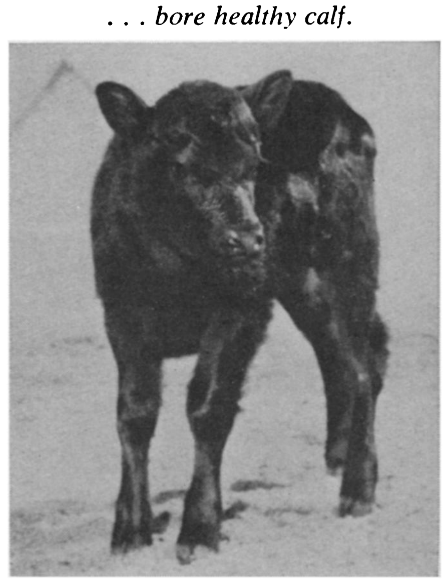
Later the cow retires to chew the cud. Portions of the ruminal contents are regurgitated, thoroughly chewed and mixed with more saliva, and returned to the rumen. This goes on until most of the swallowed grass is pulped.

The rumen is the protein factory: It provides the shelter and the grass-soup, the food for a large colony of bacteria from the biological activity of which the cow gets the bulk of her protein.

The bacteria produce the enzyme cellulase, and thus are able to break down cellulose and obtain its chemical energy, much the way animals can digest simpler carbohydrates and obtain energy. They then use the energy to combine the fragments of the cellulose with the ammonia to make amino acids. These are used to build proteins for bacterial growth and reproduction.

After fermentation the fluid passes into the true stomach, an organ compa-

. . . bore healthy calf.



Zebra, kudu, wildebeest and other antelopes, instead of cows, may prove the most efficient African farm animals.

rable to the single stomach of other mammals. There and in the intestine the cow digests and absorbs bacterial protein, grass protein, carbohydrates, fatty acids, vitamins and minerals.

Theoretically, ruminants could live on pure cellulose, vitamins and minerals, and some source of the nitrogen essential to amino acids.

This is important, because at the moment cellulose is one of the more abundant and wasted natural products. Paper, mountains of which are discarded daily, is almost pure cellulose. Straw, cornshucks and similar plant remnants may constitute 60 percent of the weight of plant material produced, yet these are often discarded.

In practice there are several difficulties that only now are beginning to yield to researchers. What is required is a nitrogen source that the bacteria can utilize, that is cheap, and that is nontoxic to the cow. Then cellulose material must be obtained that the cow can be induced to eat. And essential trace compounds found in or resulting from the digestion of natural diet have to be identified and replaced in the artificial diet. Some headway is being made but much is still to be done.

A major problem encountered has been one of reaction rates. Cellulose, especially cellulose derived from wood which may be complexed with lignin, breaks down slowly in the rumen, providing only a slow stream of energy. The bacterial enzyme urease, on the other hand, degrades urea very fast into carbon dioxide and ammonia.

Unless there is an ample supply of chemical energy to allow this ammonia to be used up, toxic levels of ammonia develop. Efforts now are directed at getting the urea to dissolve more slowly in the rumen, thereby keeping pace with cellulose energy production. Other work is being done to try to speed up cellulose degradation, by predigesting it.

In tests at Beltsville, Angus cattle have been fed one such artificial diet. The growth rate was only 70 percent that of cattle fed a diet containing protein, but adult size was the same. A urea-fed bull was mated with a urea-fed cow and a healthy calf resulted.

Dr. P. A. Putnam, acting chief of the beef cattle research branch of the animal husbandry research division, says many practical problems connected with the artificial diet still must be solved before cows can start living on waste paper. The main value of the feeding experiment is to demonstrate that a beef animal can successfully go through its life cycle with no protein in its diet.

So areas which now have no hope of raising meat animals because of poor forage quality or because of unsuitability of vegetation, might be able to contemplate thriving herds. Lacks in the natural diet could be made up with a supplement of urea and waste cellulose.

The ultimate extension of the idea would be the rearing of cattle which never leave a corral—much the way chickens are intensively bred in cages. Wastepaper might be pumped into one end of a factory and beef packed out at the other.

The trouble with that picture is that it will always be more economical to let the animals graze what range there is than to collect their food for them.

One difficulty at least might halt the vision of a world overrun by plump steers. That is the difficulty of harvesting the full yield of cellulose from a piece of land. There would be no problem if the land were under a uniform crop to be harvested anyway for its grain yield, and the cellulose—60 percent of the plant material—fed to cattle.

But vast areas of poor range are found in the underdeveloped (and protein short) areas of the world. These ranges might support coarse grass, scrubby bushes, a few trees and assorted other flora. Cattle could graze and browse but little of it. Yet such variety would take a tremendous amount of labor to gather and process; it might not be worth it.

An alternative—to remove the native flora and try to plant corps, or at least more acceptable forage—has often proven to be a failure because of poor soil and climate. The vegetation which has adapted to the environment is often the only kind which can stand it.

A daring way out of this dilemma has been suggested by some animal husbandmen: Native animal species could be farmed and harvested.

Advocates of this scheme have parts of Africa in mind. In many areas there, ranges are bad and climates inhospitable to domestic cattle. The bulk of African mammals, however, are ruminants, and additionally are adapted to the vegetation and climate. Giraffes browse the tops of trees, and from there to the ground almost every slot in the ecology has its specially adapted animal.

The lid is kept on these herbivorous animals by predation and disease. It is proposed that disease be controlled and man substituted as the predator to harvest the protein. Total protein per acre is expected to be much higher from indigenous species than from exotic cattle or protein crops on poor soil.

The Russians have gone so far as to husband a herd of tame eland, at 2,000 or 3,000 pounds the world's largest antelope and an efficient grazer, in a study of its meat producing potential. The King Ranch in Texas is reportedly investigating the eland also.

In New Zealand, commercial deer farming is almost a reality. Several experimental farms have been started, and Government approval of large-scale ventures is expected soon. The deer, presently classified as noxious animals, could graze in country where sheep or cattle would starve to death.