An unconventional large quality grain growing unit on the east coast of Jutland in Denmark

by FLEMMING JUNCKER

OVERGAARD was bought by the present owner in 1938. It consisted of 3,000 acres of which 1,200 were arable with 1,000 acres of salty marshes, partly dyked.

Practically no cash was paid, mortgages being taken over for 98 per cent of the price. A few hundred acres of adjoining marshes have since been bought, and 2,300 acres were dyked in from the sea during 1962-65. This area of sea-bottom is gradually being transformed into normal land by draining with plastic tubes, assisted by surfacing for maximum run off by deep-ploughing from 18in. on heavier soils to 26in. on lighter soils in order to reach deeper layers of salt or to bury the originally wave-sedimented top layer of the old sea-bottom to avoid a too heavy tendency to wind erosion.

A heavy fertilisation with phosphoric acid has been necessary, as well as with nitrogen, in order to build up humus and thus create a reduction-oxidation balance without which heavy iron deficiency occurs on sandy soils, where shells cause a too high pH transforming all available iron to ferri-compounds. On the heavier silts a high salt content is only slowly leached, until then hindering oxidation of excess ferrosulphide toxicity. The plastic pipe drainage has been well mechanised and therefore cheaply made, but on the heavy soils the drainage effect progresses slowly, and supplementation during the early years with surface drainage is of greatest importance.

The heavier soil is therefore ploughed in the autumn in narrow beds of 32ft. with the openness of the final furrows well controlled, even if handwork is necessary. The lighter soils, which are not ploughed earlier than just before planting in order to reduce wind erosion, are surface drained by small ditches with 64ft. distance made in the stubble by a Finnish ditching machine working to 15-18in. depth pulled by a 110 hp tractor in low gear, working the ditch twice, thus spreading the fill to both sides.

These combined measures have given excellent water control, which cannot during the first six to eight years be obtained satisfactorily through closed pipe drainage, and has greatly helped aeration of the top layers of the soil which would otherwise be completely waterlogged during the winter. After eight to ten years the reclaimed sea-bottom seems to be gradually normalising.

Before the end of this period the original cost of dyking and tile draining (£65 per acre) will at least have doubled through compound interest and cost of excess fertilisations, corrections of ditches and supplemental road building.

A third of the reclaimed land and some of the old land can be watered cheaply through a system of canals connected with good wells from which water is pumped in June and July, distributed through the drainage system and thus efficiently watering the most drought susceptible areas. Even the heavier flat soil consumes an astonishing amount of water under droughty conditions, when well fed through canals and tiles.

In the past Overgaard laid main emphasis on cattle, grazed during summer on the larger part of the area lying under unfertilised grass, often inundated by the sea during winter. In 1908 the larger part was dyked in, but only small areas came under cultivation, till I bought the place in February 1938 and put as much as possible under the plough the following spring. The cattle herd was expanded and comprised a thousand head around 1955, 200 cows being milked, 200 bull calves being bought annually and 300 2½-year-old bullocks being sold every May-June.

After systematic breast measuring of all male cattle monthly it was found that the biannual change between grazing and stable foddering was uneconomical, and all calves were kept indoors the first summer with the result that the bullocks weighed 10-11 cwt. at 1½ years of age and never were grazed, but mainly fed all year on maize silage, of which close to 5,000 tons could be stored in large circular cheap silos with a feeding chute in the centre.

During the war, when the protein shortage was great on the continent, we tried pressing sugar beet, fermenting the juice with Torula utilis, mixing the yeast milk (8 per cent) with the remaining pulp and feeding the mixture to the dairy cows. They milked well, and the fertility was high. It also worked well with sows, but during the hot season it gave trouble to keep the continuous fermentation vessel free from too much contamination with other micro-organisms.

We found it easier the following year to take all skimmed milk back from the dairy, feed it to the cows in place of water and thus reuse our short protein several times, bringing the butterfat to the dairy.

The study of fermentation processes in cow feeding concentrated attention on the cow's own excellent fermentation vat, the rumen, and in the years 1948-52 after the war we started feeding ammonium carbonate and urea to the cows for protein supplementation of the poorer roughage. It worked moderately well, but had undoubtedly an appetite reducing effect and the system was abandoned through the application of cheap nitrogen, anhydrous ammonia (AA), direct to the soil in larger amounts with the result that all crops, maize for silage as well as harvested grain (spring wheat), increased their protein contents by more than 25 per cent compared to earlier fertilisation methods based on moderate use of the much more expensive nitrate of lime. The use of this was not only limited by price, but also by a greater lodging tendency than experienced following the larger application of anhydrous ammonia.

The direct use in the soil of ammonia was clearly to be preferred, compared with the complications of incorporating ammonia in the cattle feed, whether by fermentation in front of the cow or inside it.

Alkaline digestion of straw according to the Beckman principle with the use of AA instead of caustic soda showed some advantage in increased digestibility of the straw. However, the more complicated procedure and other minor faults made the process uninteresting, as it was found that protein problems in cattle feeding were easily solved by the intensive field use of AA.

Having used AA on a large scale since 1953 we called a meeting at Overgaard in 1958 with the purpose of forming an Ammonia club promoting cheap imports into Denmark of AA and spreading the knowledge of its advantages.

The famous Swedish pedologist, Sante Mattsson, who has given the best existing explanation of the humus formation, wrote in a letter in 1955: "In the soil ammonia is the natural fertiliser—to add nitrate to the soil is to deprive it of the microbiological and chemical functions belonging to ammonia."

The club developed into a company, Danish Nitrogen Import, which in 1963 together with W. R. Grace and Co. of the USA built an atmospheric pressure ammonia storage plant near Fredericia with a good deep water quay. AA was imported in large tankers from Trinidad, and while Denmark in 1958 used around 100,000 tons of nitrogen annually with 98 per cent in the form of nitrate of lime, the total nitrogen consumption in 1970 was 270,000 tons of which more than 40 per cent was AA and only around 15 per cent was nitrate of lime. Two-thirds of the Danish nitrogen consumption was imported as AA at only one-fifth of the previous price per kg. N of imported nitrate, while the remainder also was cheaper than before due to the competition created by the cheap AA. Danish farmers exclusively using AA as their nitrogen fertiliser and applying it with own equipment now have their nitrogen in the soil at less than 30 per cent of what it cost 12 years ago.

Having nitrogen that cheap it is natural to apply greater quantities per acre. At Overgaard one gradually has increased the AA rate per acre to 250 to 300 units of N for spring wheat after introduction of the short and stiff strawed Mexican dwarf wheats selected by Dr. Borlang for maximum fertility conditions and day length neutrality. By making possible, without lodging, an application of up to 300 units of N per acre some Mexican wheats of high quality and nitrogen response have given milling wheats of high value with protein contents of around 20 per cent of the dry matter and with wet gluten values of around 60.

Danish mills have paid high prices for these wheats, and a ship load was sold to Norway in late 1968 comparing well with and paid as the best imported Manitoba wheat. Some Mexican wheats (Inia) are very early compared to the European ones. Others are very resistant to shattering and sprouting as well as to fungal diseases (Tobari). Many new varieties are tested each year. During the last two seasons Overgaard has exported 2,000 tons of seed wheat to Iran via Ladoga-Volga.

In many fields at Overgaard wheat has been grown continuously for many years. On lighter soils susceptible to drought some damage can be registered in dry years as well from take-all as from nematodes—the drought hindering sufficient reproduction to replace damaged roots, but both diseases have here had a typically secondary character.

Good work has therefore been done at Overgaard to reduce the effect of drought in a climate with only 18in. average precipitation of which often only 3in. are registered in the growing season. By deep ploughing, at 18-26in. depth, the area available for root activity has been increased and by systematical ploughing in of all straw where possible the total humus content has increased considerably and added to the water retention ability of the soil. Professor Sante Mattsson's theoretical work on humus formation has been the leading principle, providing the soil with the maximum of organic residue and activating this with around 20 per cent ammonia nitrogen for the purpose of forcing an ammoniacal oxidation of the organic matter resulting in the formation of around 40 per cent durable humus with around 5 per cent nitrogen content placed as nitrogen bridges connecting rings and chains of hydroxylated hydrocarbons. This is nature's natural polymer of acidoid nature covering the mineral particles, reversibly absorbing the plant nutrients and, by forming a network of agglomerates, increasing the water storing ability of the soil.

Ninety per cent of Overgaard's area is flat enough for controlling the ground water level through canals

and drainage pipes and through periods of extreme drought in July 1969 and June 1970 it has been possible to feed major areas with well water in quantities corresponding to 4in. of monthly precipitation, more than 70 per cent of the estimated evaporation. On flat sandy soil this effect can be enhanced by use of the afore-mentioned Finnish ditcher by creating parallel surface ditches just after spring planting. When they are fed from adjoining canals during the droughty periods it seems possible, even on undrained flat areas of coarse sand, to control a reasonably good ground water level without recourse to manpower demanding an overhead irrigation system or to a more dangerous surface irrigation system as used in the dry hot climates. This would be too risky in our northern climate where we may have rainbursts of 4-5in. in one day followed by cold periods with even more rain. The surface network of small ditches intended for ground water control may even assist as surface drainage possibility under very moist conditions.

The deep ploughing technique, which as a drought reducing measure is supplemented with the above described ground water control, has been carried out with large tractors of 100 to 180 hp., since the later fifties and is based on the use of 18in. to 36in. wide tyres and generally single crop ploughs specially constructed in Denmark for our purposes.

We could not in the fifties buy sufficiently large tractors with wide enough tyres and low enough weights for our ends and we therefore built ourselves in 1958 and 1959 two tandem tractors (the first in Europe) by combining two 75 hp. Volvo tractors, relieving them of their front wheels and combining them with the maximum of relative movability. We thus constructed a four-wheel tractor with equal wheel-size (18in. by 26in.) and midsteering exactly as the most modern tractor types but with the drawback of requiring a specially able driver capable of working while synchronising the two motors.

A third tandem was built later. This was based on 70 hp. Fiats. They have all rendered good services till now and we are not sure we will not still get the cheapest and lightest 260 hp. tractor by combining again two conventional 130 hp. machines.

In the mid-sixties we imported two American Swamp Buggies from Franklin Va with 190 hp. motors and four 36in. wide wheels. They have rendered good services but spare part trouble has been a considerable drawback.

A principal difficulty has naturally been the adaptation of the drawn equipment to match the gradually increasing tractor-power.

In some years 100 per cent of the area has been sown exclusively to spring wheat, as this seems the most profitable and the easiest grown crop.

Six 12ft. combines, preferably Claas, have been able to harvest an average of 700 acres each during a season of five weeks. As the sowing season often may stretch over four to six weeks, and there may be two weeks difference in maturities, this works well. Drying capacity is very high, so that temperatures above 115 degrees can be avoided and actual drying time stretched over four hours.

All grain should be brought down to 13-13.5 per cent moisture before 18 hours after harvest and delivered cooled to the storage bins in order to have 100 per cent protection against any damage.

As the major part of all fodder grain in difficult harvest years may be infected with storage fungi producing mycotoxins dangerous to livestock, any grain sold or used for fodder should be treated like this and tested for high germination. In coming years we may expect that there will need to be a premium on fodder grain with more than 90 per cent germination (at least latent). A drying or conservation method reducing germination might also reduce the possibilities of ensuring the quality by a quick test (latent germination).

At Overgaard an annual production of 2 million broilers has clearly shown the importance of producing not only seed and milling grain of highest possible quality and storability, but also that the same qualifications are highly important in production of monogastric animals.

GRAIN IN JUTLAND

DISCUSSION SUMMARY

During the question time after the paper was given, Mr. Juncker dealt with the following points:—

1. Anhydrous ammonia was applied on his light land at the time of ploughing; it was applied through a pipe which deposited the material at the bottom of the furrow. At seeding time the control was so arranged that all coulters were at 4in. spacing, every third coulter being used for the injection of anhydrous ammonia, whereas other coulters carried the seed.

2. The equipment used was cheap for the farmer to provide, although the cost of using hired equipment and a contractor would be 60-80 per cent. more. It was desirable to use two 3-ton tanks on the farm so that one might be filled as soon as it was empty.

3. The cost of anhydrous ammonia in his region of Denmark was .53 shillings per kilo at store, but with the cost of transport to the field and injection, a further .11 shillings should be added.

4. Of the Mexican dwarf wheats which he had tried, Mr Juncker thought that Tobari was probably the most satisfactory, being 100 per cent. resistant to shattering and also very resistant to sprouting, but the yield was in fact about 7 per cent. under that of Kolibri.

5. It was explained to a questioner from the Netherlands that it was not unreasonable to expect one combine harvester to deal with 700 acres of grain in a season, due to the spread of harvest over a five or six week period which the selection of crop varieties allowed. The rainfall in Denmark was less than that normally experienced in Holland.

6. Twelve men were employed on the 4,000 acre farm, and spent a good deal of their time between busy seasons making improvements to the property, mainly in improvements to the dykes.

7. Mr. Juncker said that it was unlikely that his present suppliers of AA would extend their facilities to other parts of Europe, because in dealing with him they had made serious administrative errors and they were concentrating their efforts on other more remunerative activities outside the field of chemicals.

8. On the subject of his irrigation system, Mr. Juncker explained that apart from the fact that his men disliked the conventional overhead irrigation system, he had found his own system of regulating the level of ground water to be more satisfactory.