Exploratory Report on PD-AAS-786
Dairy Industries in Somalia

REPORT

of the

FARM MACHINERY CONSULTANT

PROJECT NO. 698-0135(PDS)

CONTRACT NO. AID/FAC-C-1475

NOVEMBER 1978

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File: Livestock Gen Doc.

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# I. INTRODUCTION

This report is the result of a contract between Kenneth E. Felton and USAID to provide short-term technical assistance to the Ministry of Livestock to resolve some immediate technical problems confronting on-going Government of Somalia (GOS) programs and to develop a reservoir of broad technical information to support USAID PIDs and GOS requests for A.I.D. funding that are expected to be developed over the next three or four years.

The areas to be included were the following:

1. Conduct a survey of dairy farms and plant equipment to determine appropriateness and/or adequacy relative to current and planned needs.
2. Design an inventory system and make a quantitive list of spare parts, fuel and lubricants necessary to keep equipment operational.
3. Determine cattle feed requirements and identify feed sources - locally produced (field crops, pasture) and import. Design an inventory system to maintain an adequate supply of feed ingredients.
4. Work jointly with the poultry production specialist, design a feed-mixing facility that is able to produce high-quality dairy and poultry feed concentrates. Also design a feed quality control activity and requisite laboratory.

5. Identify manpower requirements of the dairy farm, dairy plant and feed plant, and develop a training program for managerial, operational and maintenance personnel.

Upon arrival in Somalia it was determined that the areas of work had been altered to some degree. Especially the assessment of dairy farm equipment had been expanded to encompass farm machinery.

In the process of gathering necessary data relating to crops, acreage, production (both plant and dairy animal), farm machinery on farms, etc., to make sound observations, analysis and eventually recommendations, it has been concluded that one of the major problems facing persons trying to plan for the future is the serious lack of agricultural statistics. Without proper inputs to the decision-making process it is impossible to have a sound program.

To gain as much knowledge and insight into the situation involved there were many, many discussions and visits to facilities. The people involved were cooperative and willing. They seemed most sincere in trying to give the necessary information to assist in decision-making. Unfortunately there were contradictions and uncertainties. Good agriculture statistics would have alleviated these contradictions and uncertainties.

## II. MOGADISCIO DAIRY PLANT

### A. SITUATION

The Mogadiscio Dairy Plant was visited 31 October 1978 and discussions were held with the General Director of the Plant, Ahmed Abucar Mohamud, who has been General Director for 4 months, however has been at the plant for two years.

The plant, of U.S.S.R. design, is very old and in a wornout condition. It was placed in operation in 1965 and has operated one shift per day for the past thirteen years. It has a maximum capacity of 10,000 liters per 8-hour shift. From 70 to 80 percent of the milk received is from private dairy cow owners, the rest is from government and municipal dairy farms. Most of the private herds are 2 to 3 head per herd and are located inside the city limits of Mogadiscio. However, milk is received from as far away as 70 km. There is only one milk transfer station, at Afgoi. Milk is received twice per day, at 7 A.M. and 6 to 9 P.M.

All of the milk is sold as fluid milk. Should they receive enough milk to go to two shifts, they have capability to make milk products. Milk is received at from 4.2 to 6 percent butterfat and is standardized at 2.8 percent. The butterfat from the milk standardization operation is used in reconstitution of skim milk powder to fluid milk. Milk is pasteurized using a flash-type pasteurizer that heats the milk to 78° C for 10 seconds.

The purchase price paid to the dairyman is So.Sh. 1.10 to 1.20. The processing plant pays So.Sh. 1.40 at the plant and sells it for 2.00 shillings per liter. There is some problem with water adulteration of the milk by the haulers.

It has been estimated that there are 30 to 40,000 dairy cows within the city of Mogadiscio and that two-thirds are being milked. Some of these cows are reported to produce 10 to 12 liters per day. Cows are fed 10 to 13 kilos per day of roughage, most of which is brought in daily from the areas of Afgoi and Jowhar. Also the cows receive 2 kilos of ground maize bran and 1 kilo of sesame cake. The dairy cattle outside the city limits are nomadic and the cow population varies from few to many depending on the availability of pasture grasses.

Much of the milk produced in Somalia is used by the family for food and for raising calves or is sold to their neighbor. Selling to neighbors would be more prevalent in cities such as Mogadiscio.

## B. FUTURE PLANS

There are plans to increase the size of the plant to 80,000 liters per day. These plans have been in the planning stage for four years and are at the present undergoing modifications to bring them up-to-date prior to construction. The plans call for all new equipment within the plant and additional building construction to accommodate the necessary additional equipment. There is ample amount of vacant land around the plant for necessary additions and modifications.

To provide milk for the increased capacity the number of milk collection stations will be tripled - from three to nine. There will be three collection stations within the municipal limits of Mogadiscio and the other six stations will be outside of Mogadiscio.

## III. FARM MACHINERY

Due to the lack of agricultural statistics it is difficult to get a clear picture of the present farm machinery in use in SOmalia. The large fruit plantations do own their farm machinery but numbers and types are not available. There are a few joint ventures that also own their farm machinery. There are a few other large private farms that own farm machinery. The government farms have their own farm machinery. Due to the lack of replacement the government farms visited have very little usable farm machinery. Most of it is old and obsolete. Some of the government farms are planning to buy new farm machinery in the future.

The cooperatives, small farmers and to some degree the government farms rely on ONAT for tractors, farm machinery and operators to prepare the soil, plant and harvest the crop.

In addition to tractors and equipment being rented by ONAT to the farmers there is custom work being done by farmers who own their own equipment. There is also evidence of loaning equipment between farmers.

Dairy farm equipment for milking cows has a very minimal requirement since all milking is performed by hand. The requirements consist of a bucket for each milker. The nomadic people use a bucket made from wood, bark and leather and to sanitaize the utensil a method of applying fire or heat from a burning stick is used. This leaves a burnt wood taste that is picked up in the milk.

## A. FARM MACHINERY AND AGRICULTURAL SERVICES ORGANIZATION (ONAT)

### 1. Situation

The Farm Machinery and Agricultural Services Organization (ONAT) is a government organ within the Ministry of Agriculture. It has two divisions: the Services Division is concerned with selling to the agricultural communities all supplies concerned with agriculture production such as hoes, shovels, back-carried sprayers, fertilizers, seed and other agricultural supplies and chemicals. The other division, the Tractor Division, has the responsibility for renting tractors, farm machinery and equipment to the agricultural community, be it government or private. An operator is furnished with each tractor.

ONAT has a history dating back to 1958 although its function has changed over the 20-year period. Initially tractors were supplied to the private farmers and he paid rent for them after harvest. At this time it was a Branch of the Development Bank. In 1964 it became an independent organization in the Ministry of Agriculture with its objective being to make tractors, farm machinery and equipment available to the farmers. This included both private and government farms. In 1975 ONAT started to sell, in addition to rent. On September 1, 1978, ONAT stopped the sales of tractors, farm machinery, equipment and parts and is strictly in the rental business as far as the Tractor Division is concerned. The sale of tractors, farm machinery, equipment and spare parts was transferred to another government organization (X-Fiat).

The basis of rent is on hours-of-use plus a charge one-way for distance from the ONAT outstation, of which there are 17, to the farm. The rent paid by the private farm, either individual or cooperative, is 33 1/3 percent lower than that paid by a government farm. Rent is paid in advance by the private sector and by invoice by the government sector.

In the instance where the distance from ONAT to the farm is excessive, trucks are available for hauling equipment. Since all districts do not have outstations, adjacent districts have the responsibility for providing services.

All tractors, farm machinery and equipment were initially received with a supply of manufacturer's recommended spare parts. Over the years the supply has been depleted for the much-used parts and for this reason much of the equipment is no longer in working condition. This is especially true for the equipment received from the U.S.S.R. For Italian equipment, the delivery time on parts is 10 to 15 days by air and for British, delivery time is approximately 45 days. Parts for U.S.S.R. equipment require at least six months for delivery and in most instances they are never delivered.

Modifications have been made to some of the equipment by a staff of mechanics that is considered to be very good, however, the staff is small in number. Each of the 17 ONAT outstations is equipped with a mechanic shop and is staffed. In an effort to keep as much of the U.S.S.R. equipment in operation as possible, "cannibalization" is practiced. However,

this is rarely necessary on equipment from the free world contries because spare parts are available.

ONAT has equipment from the United Kingdom (Massey Ferguson and International Harvestor), Italy (Fiat), Germany (Deusch) as well as U.S.S.R. Equipment from each of these manufacturers is confined primarily to one region so that spare parts and interchange of equipment can be concentrated.

A visit was made to the ONAT outstation at Afgoi and Jowhar which were considered to be typical although among the larger outstations. At this station most of the equipment is of U.S.S.R. origin and it appeared that 90 percent or more of it was inoperative and no likelihood that it would ever be operative. This is apparently typical of all U.S.S.R. equipment in Somalia. This means that without a massive program of tractor, farm machinery and equipment replacement in the immediate future, ONAT's capability will be tremendously reduced. In fact at the present time the users of ONAT equipment in many instances are placed on a waiting list. This is unsatisfactory because when a crop must be planted, cared for, or harvested, a delay will produce an undesirable effect on the production.

Most of the farms in the dry farming area, especially those enterprises in grain production, are small in size (5 ha. or less) and the farming is done in the traditional method which means animal traction and a lot of hand work. In these areas ONAT has put on demonstrations in land preparation,

crop care and crop harvesting. These are reported to show an increase in yield. As a result of these demonstrations, there has been an increased interest and demand for ONAT to rent equipment to these farms. This, of course, has increased the need for additional equipment.

ONAT's 20-years' experience in renting equipment has made them well aware of the need for an adequate supply of spare parts. There is reported to be an inventory system in each outstation as well as an overall control system in the main office in Mogadiscio. A concerted effort appears to be made to keep an adequate inventory of spare parts on hand.

2. Problem

The major problem that ONAT has is the short supply of good equipment for land leveling and other irrigation and preparation equipment, and farm machinery.

Another problem with the ONAT system is that the distance between outstations is such that the farmer pays a lot of money for travel time. If a farm only has a couple of hours work and is an hour's travel time from the outstation, one-third of the bill is for travel time.

3. Solution

The following list shows the numbers of available equipment and the ONAT suggested need over the next three years. With a lack of present and projected crop acreages and number and size of farms, it is impossible to substantiate or refute the projected need. The fact that the available equipment represents a small (approximately 10 percent) percentage

of the initial purchase of equipment, which was primarily of U.S.S.R. origin and is now worn out or otherwise unavialble because of lack of repair parts, points to the fact that new equipment is needed.

| Item | Available (1976) | Required (3 yr. period) |
|---|---|---|
| 1. Bulldozers: 100-120 hp | 60 | 200 |
| 2. Scrapers, Motor: 100-120 hp | 26 | 150 |
| 3. Tractors, crawler: 100-120 hp | 18 | 100 |
| 4. Tractors, crawler: 70-80 hp | 10 | 60 |
| 5. Tractors, crawler: 40-60 hp | 10 | 40 |
| 6. Tractors, wheeled (2 diff.): 80-90 hp | 7 | 120 |
| 7. Tractors, wheeled (2 diff.): 60-70 hp | 12 | 80 |
| 8. Grader, Motor: 100-120 hp | 4 | 20 |
| 9. Excavator, 0.5 to 1 Cu M.: 120-150 hp | - | 4 |
| 10. Excavator with bulldozer, 1 Cu M: 80-100 hp | - | 2 |
| 11. Loader, Cap. 1 Cu. M: 100-120 hp | - | 2 |
| 12. Combine Harvester-Rice-Sorghum | - | 4 |
| 13. Thresher for Maize | - | 10 |
| 14. Thresher for Sorghum | - | 8 |
| 15. Plough (Mono Vomeio) | 10 | 20 |

| Item (Continued) | Available (1976) | Required (3 yr. period) |
|---|---|---|
| 16. Plough (Bi Vomeio) | 12 | 60 |
| 17. Plough (Tri Vomeio) Large | 40 | 80 |
| 18. Plough (Tri Vomeio) Small | 15 | 100 |
| 19. Disc Plough (3 disc) portable, hydraulic | 27 | 200 |
| 20. Disc Plough (4 disc) portable, hydraulic | 10 | 50 |
| 21. Disc Harrow (32 disc) pull type | 50 | 50 |
| 22. Disc Harrow (20 disc) pull type | 60 | 500 |
| 23. Disc Harrow (16 disc) portable | - | 50 |
| 24. Disc Harrow (16 disc) pull type | 40 | 50 |
| 25. Furrow, 5 points, pull type | - | 50 |
| 26. Seed drills, Maize, rice, sorghum | - | 10 |
| 27. Ditchers, large | 6 | 10 |
| 28. Ditchers, small | 12 | 6 |
| 29. Cultivators, small | 0 | 10 |
| 30. Arginatore | 15 | 50 |
| 31. Agricultural Trailers | 5 | 60 |
| | 451 | 1,758 |

The total estimated cost of the needed equipment is So. Sh. 205,642,000.

There are two ready solutions to problem two. One would be for ONAT to establish substations that would reduce the travel distances. This has a couple of disadvantages: (1) It would probably require more equipment, (2) It is likely that equipment would sit idle more of the time. As

the luxury of more equipment occurs this may be a desirable solution. The second possible solution would be for ONAT to have an agent or representatives in the field to schedule equipment to farms in a certain area. The agent would line up several days' work in an area for equipment before the equipment would be scheduled to the area. This function could be the responsibility of the Extension Service.

## B. 21ST OCTOBER DAIRY FARM

### 1. Situation

Farm equipment or machinery to prepare the land, plant, care for and harvest the crops at the 21st October Dairy Farm is in very poor condition. The farm was established in the mid-60's and a supply of the necessary machinery was supplied. However, provision was not made to maintain a supply of or a means of obtaining spare parts. Most of the machinery is inoperative for this reason and the fact is it is old and worn out. At the present time there are seven small tractors - in the 35 hp range which are used primarily for transport. There is one Fiat DC7 crawler tractor but no medium size tractorswhich are needed. There are two plows - one a three-bottom moldboard and the other a three-disc plow. For the present operation this number of plows will meet the need. However, for the soil type on the farm the disc plow does a more satisfactory job. There is one old disc harrow, however three new disc harrows are to be received. This should take care of the disc-harrow needs.

The land preparation consists of plowing and discing. Then the land stands until the weeds are seven or eight centimeters high; then the land is disced again and the crop is planted.

There are a couple of old grain drills on the farm. However, as in other cases they are inoperative because of the lack of spare parts. Fertilizer use is virtually nonexistent. However, the farm does use a small amount of urea. Because the equipment for spreading manure is inoperative, due to the lack of spare parts and age of equipment, manure from the feed lots has been stacked for the past two years. Therefore, the fertilizer value of this product has not been realized.

The crop care equipment consists of one tractor-mounted sprayer and a number of "back pack" sprayers. The weed control is accomplished by laborers with hoes.

There are a total of 1,200 hectares (ha.) of land on this farm. By the 1979 cropping season it is planned that 271 ha. will be under irrigation--growing maize, sudan grass and sorghum. This will be an increase from 138, almost double, in 1978. There are 184 ha. that are being grazed. The potential irrigated land on this farm is 745 ha., which has already been cleared.

2. Problem

There is not enough farming equipment on this farm to do the proper job and it is too large to rely on rented equipment except for land leveling and irrigation canal work.

3. Solution

The following list of equipment should be supplied to this farm:

| | | |
|---|---|---|
| 1. | Tractors, 100 hp | 2 @ 96,000 So. Sh. |
| 2. | Grain drill | 2 @ 24,000 |
| 3. | Hay balers | 1 @ 24,000 |
| 4. | Mowing machines | 2 @ 12,000 |
| 5. | Hay rake, side delivery | 1 @ 18,000 |
| 6. | Field chopper | 1 @ 30,000 |
| 7. | Fertilizer spreader | 1 @ 24,000 |
| 8. | Cultivator | 1 @ 15,000 |

9. Spare parts - 10 percent of the total cost.

C. WARMAHAN DAIRY FARM

1. Situation

The dairy farm at Warmahan consists of 3,700 ha. total, of which 360 ha. were planted to forage producing crops in 1978. In 1979 there will be an additional 180 ha. under cultivation. There are approximately 200 additional hectares that have been cleared. To date this land has not been irrigated, however, some 600 hectares of this land are being planned for eventual irrigation. This dairy farm has been planned since 1976 but is just starting to be developed. Additional information pertaining to the Warmahan Dairy Farm is in the report by John Halpin.

2. Problem

To properly cultivate a farm of this size requires the ownership of the necessary farm machinery. This farm is virtually without machinery.

It has been relying on rented and borrowed machinery which is unsatisfactory. For the land clearing, leveling and other related work in preparing the land for irrigation the farm can rent machines and operators from ONAT.

3. Solution

The solution to the lack of farming machinery is to purchase the following:

| | | |
|---|---|---|
| 1. | Tractors, 65 to 75 hp | 5 @ 85,000 So. Sh. |
| 2. | Disc plows | 3 @ 20,000 |
| 3. | Disc harrows | 2 @ 25,000 |
| 4. | Field sprayers | 3 @ 25,000 |
| 5. | Pickup baler | 2 @ 24,000 |
| 6. | Mowing machine | 4 @ 12,000 |
| 7. | Side delivery rake | 2 @ 18,000 |
| 8. | Grain drill | 2 @ 24,000 |
| 9. | Thresher | 2 @160,000 |
| 10. | Trailer (wagons) | 6 @ 45,000 |
| 11. | Field chopper | 1 @ 30,000 |
| 12. | Fertilizer spreader | 2 @ 24,000 |
| 13. | Cultivator | 2 @ 15,000 |
| 14. | Workshop | 1 @120,000 |
| 15. | Spare parts - 10 percent of the total cost. | |

D. SUMMARY

Because of the shortage of agricultural statistics it is impossible in a short period of time to grasp the true scope of the farm machinery situation and its future. It is complex in that there are many different government, private and foreign financed projects that have their own agricultural machinery and equipment. There needs to be a bringing together of all information from all sources related to farm machinery and equipment availability and need. This can best be done by an in-depth study by a multi-discipline team. It would require a study of two to four month duration by a team consisting of, but not limited to economics, agricultural engineering, agronomy and management specialists.

They would need to contact every feasible organization that might be remotely concerned with farm machinery and equipment, also, every organization concerned with crops that would have a need for the use of agricultural machinery and equipment.

This study should not have an influence on that which is planned over the next year. It should, however, be a long-range planning tool that would chart the course for the future as related to the farm machinery and equipment needs and the direction that plans should follow to meet the needs.

# IV. FEED (DAIRY)

## A. SITUATION

Generally, although the dairy animals appear to be in rather good condition, the nutritional level of the feed they receive, especially during the dry periods, is low. It is not of the type that allows a high milk production. The situation might best be presented by outlining the feeding program at the 21st October Dairy Farm as gleaned from discussions with the farm manager, Dr. K. K. George of the A. I. Center, et al.

The approximately 200 cows that are being milked are maintained separately from the rest of the herd. After milking in the morning they are herded approximately 6 km where they are allowed to graze until around 12 o'clock noon. The pasture condition varies from very poor in the dry period to good in the rainy season. Also the pasture may be natural grasses or it may be sudan grass, early in its growth or following cutting. During the period the cows are in the pasture, either dry maize stalks, green chop of sudan grass, sorghum or maize, or hay is delivered and placed on the ground in the cow compound and two kilos of bran are placed in the feed trough when available. The bran comes from the spaghetti plant via the Ministry of Livestock, Forestry and Range (MLFR) feed mill and is available to the dairy farm about two-thirds of the time. When it is not available there is no substitute. The manager noted that there is a noticeable drop in milk production when bran is not available and that it is very difficult to bring production back once it has dropped off.

There are two concrete, horizontal silos in which silage has been made in the past. However, at the present the field chopper is inoperative and the likelihood of its being repaired seems remote. This, of course, means that the animals will not be receiving green chop when it becomes available.

At the 21st October Dairy Farm there is a total of 1,200 hectares (ha) of land. At present 138 ha are irrigated on which two crops per year are grown. It is anticipated that next year 271 ha will be under irrigation. Of the 138 ha. 60 ha. are in sorghum production. There are 20 ha. of maize production and 58 ha. of sudan grass. Next year of the 271 ha. of irrigated land, 50 ha. will be in maize and 221 will be in sorghum. There are 184 ha. being grazed. There is a potential of 745 ha. of irrigated land at this location.

There is a source of high protein sesame cake available, however, the price is So. Sh. 1.65 per kilogram and the price of milk does not justify its purchase at this price according to the farm manager.

If the genetic potential for milk production is present in a cow, probably the major limiting factor is nutrition. Therefore, as cows are bred for milk production more consideration must be given to feeding. One way to improve feed and assure that a supply is always available is to cut and store quality hay and/or silage during periods of good grass and other fodder-producing plant production.

At the present, most animals either forage the year around or hay is cut on a daily basis. Daily the 30,000 to 40,000 cows in Mogadiscio are fed grass that comes in from the area of Afgoi, Jowhar or other areas, on small donkey carts and flatbed trucks. This is true for the Municipal Dairy Farm in Mogadiscio. For additional information on dairy feeds see the report by John Halpin.

B. PROBLEM

One of the problems is to have enough high quality forage so that the recommended level of forage feeding can be maintained the year around.

C. SOLUTION

The potential of the present dairy animals in Somalia is such that they should have about 12 kilos of silage equivalent per day and the producing animals should have two kilos of concentrate. If the silage was stored in a horizontal silo, filled during each rainy season and fed out during the dry season, a storage capacity of 150 tons/100 animals for 120 days would be required. To fulfill this need at the 21st October Dairy Farm, where there are 827 animals, would require storage for 1,200 metric tons of silage and at Warmahan a requirement of 1,500 tons would be required for 1,000 head. This would require 30 and 37.5 ha. respectively, of sudan grass producing 40 tons per hectare twice per year.

To protect against extended periods of drought, a full year of silage should be kept in reserve. To do this, an additional storage capacity of 3,600 tons and 4,500 tons would be required at 21st October Dairy

Farm and the Dairy Farm at Warmahan, respectively. As the dairy farmer becomes more stable and uses improved pastures and grasses he should be encouraged to store silage or make hay to guard against these periods of short supply of feed.

To reduce silage spoilage, horizontal silos should be constructed so that 15.0 cm of silage are removed daily across the exposed face of the silage Assuming that the silage is stacked 3.0 meters high, a silo for 100 cows should be 5.8 meters wide and 18.0 meters long. The important thing about horizontal silo dimensions is that they are such that enough silage is removed daily to prevent spoilage. If more cows are to be fed from the silo its width can be increased proportionately to the increased number of animals. If it is planned to feed more days the length should be increased proportionately.

If silage storage is to be provided for a year's drought period, several silos should be constructed and they should be fed out on a rotational basis.

# V. FEED MILL

## A. SITUATION

There is a large number of dairy cows, fattening stock and poultry that requiresdaily feeding of feed concentrates to maintain a high level of production. The actual numbers are not available. The amount of agricultural products and by-products for feed concentrate has not been ascertained. Nor is there available reliable information on plans for production over the next three to five years.

The feed mill operated by the Ministry of Livestock, Forestry and Range has a one-shift capacity of 24 tons. To do this they have a one-half ton vertical mixer with a single-shift capacity of 8 tons and a one-ton vertical mixer with a single-shift capacity of 16 tons. At the present time only the one-half ton mixer is being used. Thus the mill is producing 8 tons of feed per day.

In addition to the two mixers they have three hammer mills (some with cyclones), of various sizes, rotary screen (inoperative), a pellet mill with pellet cooler, a "V" mixer for premix, and the necessary conveying, bagging and weighing equipment. There are two storage buildings and two bulk tanks equipped with an elevator leg and conveying equipment.

Although the mill produces only 8 tons of feed per day, the demand is estimated to be 25 tons per day. The reason given for producing only 8 tons is the shortage of wheat bran which is a by-product of the spaghetti

factory. They have feed grain in their warehouse which could be used in an alternate ration so that their capacity could be increased. They periodically receive food items, that are no longer fit for human consumption, that can be incorporated in the ration. These include powdered milk, flour and rice.

The feed analysis laboratory is almost complete but it does lack some of the necessary supplies to function properly. See the report by Charles Davis for additional information.

B. PROBLEM

There are two schools of thought on milling. One is that there should be a series of small grinder-mixer mills located throughout the country. The other is the mills should be at a central location where there is better control over the operation. This system would include storage facilities where grains in storage would be maintained under proper environmental conditions. This would also require a more organized distribution system. This would include fumigation, aeration, protection from rodents and insects, and potection from the elements. Also, the finished products would be stored in properly constructed and maintained facilities. Another important factor is the question of maintenance. A larger facility can better justify expenditures for a maintenance program which would include shop facilities, mechanics and a store of spare parts. These items are no less important in a small mill but they are less likely to be available.

The above are all positive on the side of centrally located feed mills. However, for an operation of this size to properly function it has to operate on a given schedule and for this reason there has to be a stable source of inputs. Many of these inputs are local products. In fact they could all be local inputs. On the other hand, some could be imports. The use of feed grains makes central feed mills a much more stable undertaking.

## C. SOLUTION

In order for a sound decision to be made on the direction the feed mill industry should follow, a thorough study should be conducted. The study team should be multi-discipline consisting of, but not limited to, agricultural economics, agronomy, livestock and agricultural engineering. The economist should study, in addition to the economics of various operations, the business organization required. The agronomist would determine the potential and acreages of the various local crops and evaluate their adequacy for supplying the mill or mills with local grains and/or imported grains. The livestock specialist would be familiar with the nutritional requirements of poultry, dairy cattle and livestock, and the various additives that should go into the feed. He would determine the rations that would be manufactured in the mill. The agricultural engineer would plan the layout of the mill which would include storage before processing as well as after processing and the processing, but not a final design. With this type of a study a sound decision could be made on the direction the feed mill industry should follow.

In the meantime the present mill should operate at least at its maximum one-shift capacity. The necessary supplies for the analysis laboratory should be obtained so that regular feed analysis can be made on the mills' products.

## VI. INVENTORY SYSTEM

A system of inventory control to assist in maintaining a supply of equipment, spare parts, feed, feedstuffs, etc., can be very simple or very complicated. However, it is better to have a system that meets the needs and at the same time is not so complicated as to make it a burden. A system utilizing an inventory control card, similar to the one in Figure 1, would be satisfactory.

Figure 1: Inventory Control Card

| Item Number _____<br>Location _____<br>Source Number _____<br>Normal Stock Level _____<br>Reorder Level _____<br>Unit _____ | | Description (including Parts Number | |
|---|---|---|---|
| Date | Stock on Hand | Issued | Balance |
| | | | |

The Item Number would be a numerical listing of the items to be included in the inventory. There would also be a cross index, or list of items by part number. The Item list would include a description of the item, location, source number, reorder number, normal stock level and unit. Location would tell a person where to find the item; it might include a building

identification, a bay identification and shelf identification. This is the same information that would be on the Inventory Control Card. The Source Number refers to a number in a list of sources where the item can be obtained. The Reorder Level indicates that when the stock gets down to some predetermined level it should be ordered, and Normal Stock Level indicates to what level to bring the stock up to and the Unit indicates in what units (each, kilogram, tons, etc.) the item is inventoried.

The Inventory Control Cards should be kept in a file box by the person responsible for the stock of items. This would allow him to know the status of any item at all times.

## VII. RECOMMENDATIONS

The following is a list of recommendations as covered in the body of this report:

1. There should be established a program for the collection, tabulation and distribution of agricultural statistics.
2. There should be an in-depth study of the farm machinery and equipment availability and needs. This study should plot the future of the farm machinery and equipment program(s).
3. The 1979 farm machinery and equipment requirement of ONAT should be purchased. Subsequent purchases would be subject to the findings of the study group recommended in No. 2.
4. ONAT should establish a network of substations or they should establish scheduling agents to reduce the rent paid for travel time by the equipment users.
5. Farm machinery and equipment should be purchased for the 21st October Dairy Farm and the Dairy Farm at Warmahan.
6. Roughage storage facilities should be provided on dairy farms so that proper feeding could continue during drought periods.
7. A system of inventory control should be initiated to assist in maintaining an adequate supply of stock items.
8. There should be an in-depth study of the feed milling capability and potential to assist in plotting the future of the industry.

APPENDIX

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Appendix D - Drawbar Horsepower for Tillage Tools . . . . . 35

APPENDIX A

Machinery Performance Data***

| Machine | Typical Energy, Power or Draft Requirement | Speed of Performance Rate | Typical % Field Efficiency |
|---|---|---|---|
| Tillage | | | |
| Moldboard or Disk Plow, light soils | 3-6 lbs. per square inch (of tilled cross-section) | 3.5-6 mph | 70-90 |
| medium soils | 5-9 lbs. per square inch | 3.5-6 mph | 70-90 |
| heavy soils | 8-14 lbs. per square inch | 3.5-6 mph | 70-90 |
| Chisel Plow | 200-800 lbs. per foot | 4-6.5 mph | 70-90 |
| Subsoiler, Sandy Loam | 70-110 lbs. per in. depth | 3.5 mph | 70-90 |
| Medium or Clay Loam | 100-160 lbs. per in. depth | ----- | ----- |
| Powered Rotary Tiller, 3-4 in. increment of cut | 5-10 PTO hp per foot | 1-5 mph | 70-90 |
| Harrow | | | |
| Tandem Disk | 100-280 lbs. per foot | 3-6 mph | 70-90 |
| Offset or Heavy Tandem Disk (22-24 in. blades) | 250-400 lbs. per foot | 3-6 mph | 70-90 |
| Spring Tooth | 75-310 lbs per foot | 3-6 mph | 70-90 |
| Spike Tooth | 20-60 lbs. per foot | 3-6 mph | 70-90 |
| Roller or Packer (Cultipacker) | 20-150 lbs. per foot | 4.5-7.5 mph | 70-90 |
| Rotary Hoe | 30-100 lbs. per foot | 5-10 mph | 70-85 |
| Rod Weeder | 60-120 lbs. per foot | 4-6 mph | 70-90 |
| Field Cultivator, average soils | 15-40 lbs. per foot per in. depth | 3-8 mph | 70-90 |
| heavy clay soils | 30-55 lbs. per foot per in. depth | 3-8 mph | 70-90 |
| Row Crop Cultivator | | | |
| Shallow | 40-80 lbs. per foot | 2.5-5 mph | 70-90 |
| Deep | 20-40 lbs. per foot per in. depth | 1.5-3 mph | 70-90 |
| Bed Sled or Shaper | 15 hp per row | 2-4 mph | 70-90 |
| Unpowered Rotary Cultivator | ----- | 3-7 mph | 70-90 |
| Fertilizer and Chemicals | | | |
| Fertilizer Spreader, Pull-Type | ----- | 3-5 mph | 60-75 |
| Anhydrous Ammonia Applicator | 420 lbs. per knife | 3-5 mph | 60-75 |
| Sprayer | ----- | 3-5 mph | 50-80 |

Machinery Performance Data***--Continued

| Machine | Typical Energy, Power or Draft Requirement | Speed of Performance Rate | Typical % Field Efficiency |
|---|---|---|---|
| Planting | | | |
| Corn or Soybeans Drilling Seed Only | 100-180 lbs. per row | 3-6 mph | 50-85 |
| Corn or Soybeans Drilling All Attach. | 250-450 lbs. per row | 3-6 mph | 50-85 |
| Grain Drill | 30-100 lbs. per foot | 2.5-6 mph | 65-85 |
| Harvesting | | | |
| Mower Only | 1 DB hp per ft., 0.5 PTO hp. per ft. | 5-7 mph | 75-85 |
| Mower-Conditioner, Cutterbar-Type | 1-15 DB hp per ft. 2-2.5 PTO hp per ft. | 4-6 mph | 60-85 |
| Mower-Conditioner, Flail-Type | 10-17 PTO hp per ft. | 4-6 mph | 60-85 |
| Self-Propelled Mower-Conditioner-Windrower | 2-2.4 DB hp per ft., 2-2.5 PTO hp per ft. | 3-6 mph | 55-85 |
| Conditioner Only | 2 PTO hp per ft. | 5-7 mph | 75-85 |
| Rake | ----- | 4-5 mph | 70-85 |
| Baler | 1.5-2.5 PTO hp-hr per ton | 3-10 tons/hr. | 60-85 |
| Hay Cuber | 15-20 hp-hr per ton | 3-5 tons/hr. | 60-85 |
| Loose Hay Sweep | ----- | 7-24 tons/hr. | ----- |
| Bale Loader-Stacker, Loading Only | ----- | 9-15 tons/hr. | ----- |
| Flail-Type Forage Harvester, Green Forage** | 1.1-2.5 PTO hp-hr per ton | 5-10 tons/hr. | 50-75 |
| Forage Harvester, Flywheel or Cylinder Knife | | | |
| Green Forage | 1-2.5 PTO hp-hr per ton | Performance rate is generally a direct function of the PTO horsepower available from the power source. Usual travel speeds are 1-1/2 to 4 mph. | |
| Wilted Forage | 1.5-5 PTO hp-hr per ton | | |
| Dry Hay or Straw | 2-5 PTO hp-hr per ton | | |
| Corn Silage | 1-2.5 PTO hp-hr per ton | | |
| Recutter Attachment | 0-100 percent increase in above figures | | |
| Combine | | | |
| Small Grain | 1 PTO hp per in. cylinder width | 2-4 mph | 65-80 |
| Corn | ----- | 2-4 mph | 65-80 |

Machinery Performance Data***--Continued

| Machine | Typical Energy, Power or Draft Requirement | Speed of Performance Rate | Typical % Field Efficiency |
|---|---|---|---|
| Corn Picker | | | |
| 1 row, trailed | 8-10 hp | 2-4 mph | 60-80 |
| 2 row, trailed | 12-20 hp | 2-4 mph | 60-80 |
| 2 row, mounted | 12-18 hp | 2-4 mph | 60-80 |
| Beet Topper | 5-8 hp per row | 2-3 mph | 60-80 |
| Beet Harvester | 30-45 hp per row | 3-5 mph | 60-80 |
| Rotary Mower, Horiz. Blade | | | |
| Open Field | 3-8 hp per ft. cut | 3-8 mph | 75-85 |
| Row Crop | 9-18 hp per ft. cut | 3-6 mph | 75-85 |
| Forage Blower | | | |
| Wilted Forage | 1-2 hp-hr per ton | 20-30 tons/hr. | ----- |
| Corn or Grass Silage | 1-1.5 hp-hr. per ton | 20-50 tons/hr. | ----- |

*For trailed harvesting equipment, add power required to overcome rolling resistance to the listed soil or crop power requirements.

**Energy requirements per ton are lowest with high feed rates, low cutterhead speeds, and long cuts.

***Source: "Agricultural Machinery Management Data," ASAE D230.2 *Agricultural Engineers Yearbook*, American Society of Agricultural Engineers, pp. 319-321, 1973.

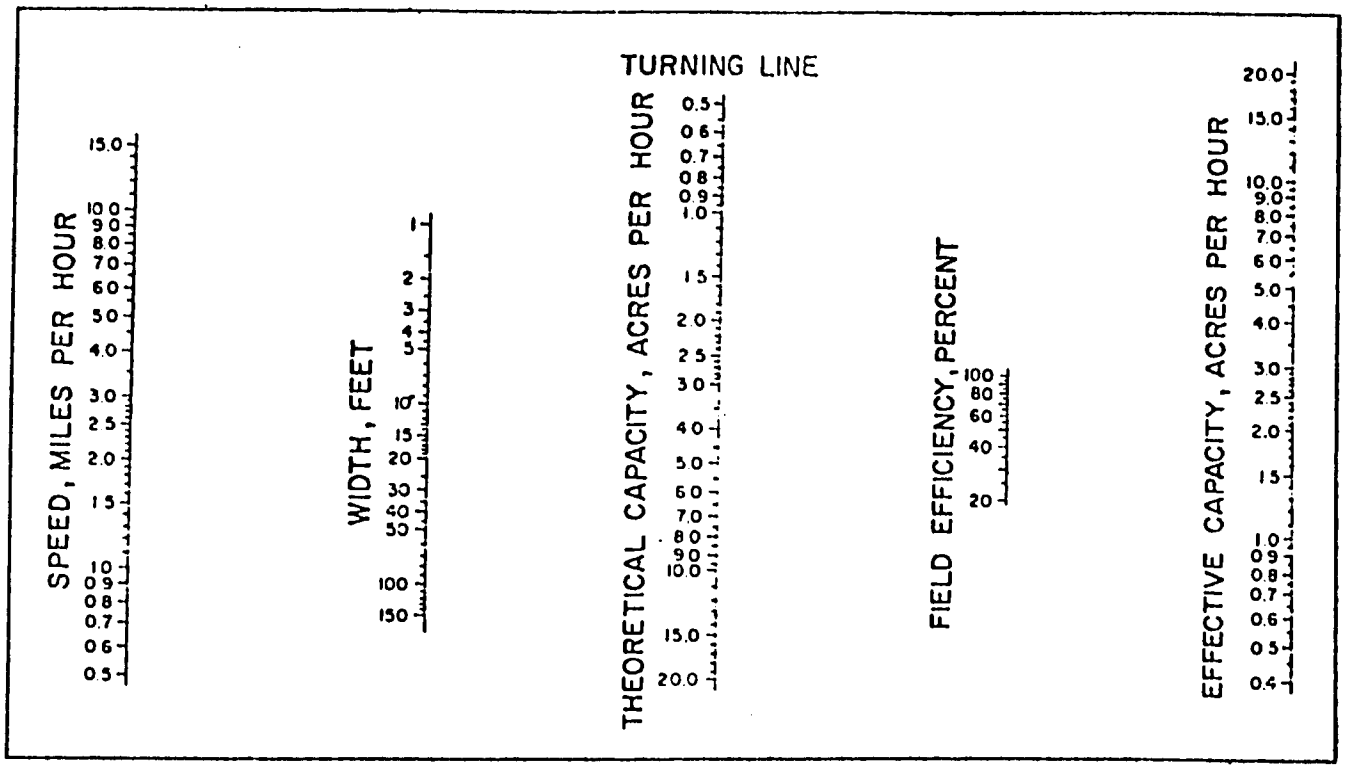
# APPENDIX B

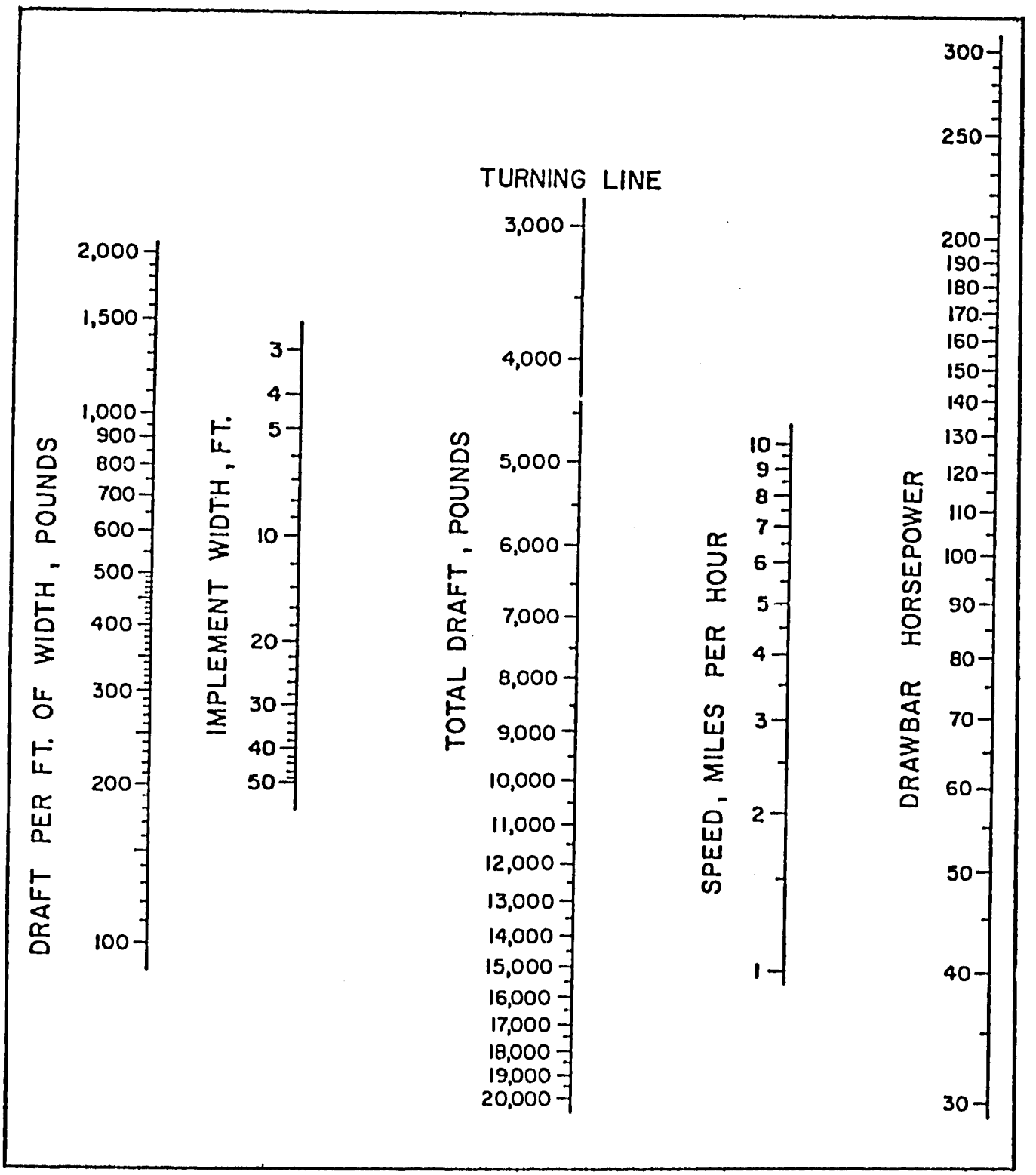
## SOIL RESISTANCE

| Operation | Pounds of Draft/ Foot of Width | Typical Speed, mph | Drawbar Horsepower per Foot of Width |
|---|---|---|---|
| **PLOWING (8 INCHES DEEP)** | | | |
| Gumbo | 1250 | 4.0 | 13.3 |
| Clay | 1050 | 4.0 | 11.2 |
| Loam | 950 | 4.5 | 11.4 |
| Sandy Loam | 700 | 5.0 | 9.3 |
| Sand | 350 | 5.0 | 4.7 |
| **CHISEL PLOWING (8 INCHES DEEP)** | | | |
| Hard, Dry | 800 | 4.0 | 8.5 |
| Medium Clay Loam, Good Moisture | 500 | 5.0 | 6.7 |
| Sand, Sandy Loam | 200 | 6.0 | 3.2 |
| **FIELD CULTIVATOR** | | | |
| Heavy Clay Soils or Dry and Hard Conditions | 650 | 4.0 | 6.9 |
| Clay Loam | 450 | 5.0 | 6.0 |
| Sandy Loam | 300 | 5.0 | 4.0 |
| Sand | 150 | 6.0 | 2.4 |
| **TANDEM DISK HARROW** | | | |
| Heavy Draft | 300 | 4.0 | 3.2 |
| Medium Draft | 200 | 5.0 | 2.7 |
| Light Draft | 100 | 6.0 | 1.6 |
| **OFFSET OR HEAVY TANDEM DISK** | | | |
| Heavy Draft | 400 | 4.0 | 4.3 |
| Medium Draft | 325 | 5.0 | 4.3 |
| Light Draft | 250 | 6.0 | 4.0 |
| **ONE-WAY DISK** | | | |
| Heavy Draft | 400 | 4.0 | 4.3 |
| Medium Draft | 300 | 5.0 | 4.0 |
| Light Draft | 200 | 6.0 | 3.2 |

# APPENDIX C

## MACHINE CAPACITY NOMOGRAPH



APPENDIX D

# DRAWBAR HORSEPOWER FOR TILLAGE TOOLS