OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

19896

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.529/1(SPEC.)
29 October 1992

ORIGINAL: ENGLISH

Regional Preparatory Meeting
on Animal Feed and
Related Industries in Africa

Bamako, Mali, 15-17 December 1992

PROCESS AND EQUIPMENT FOR SMALL-SCALE ANIMAL FEEDS MANUFACTURE USING LOCAL RAW MATERIALS AND BY-PRODUCTS

Background paper*

Prepared by

Andras Miklovicz
UNIDO Consultant

* The views expressed in this document are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. Mention of firm names and commercial products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO). This document has not been edited.

V.92-58055

CONTENTS

ANNEX

PREFACE

The System of Consultations operates under the guidance of the Industrial Development Board of UNIDO. Based on this guidance and the approval by the Board, activities have been initiated towards organization in the 1992/93 biennium of a consultation on the animal feeds industry.

UNIDO is therefore preparing the Consultation on animal feeds which could promote through international co-operation the establishment of new industries which are particularly suited to the developing countries. This could include, inter alia,

- the use of local agricultural raw materials, stimulating demand or including new cultures and therefore rural development;

- integration with agricultural production and with livestock producers, which would help to increase the supply of meat, eggs and other related products;

- training of experts on use of equipment and machinery.

I. UTILIZATION OF ANIMAL FEEDS

1. As a result of the rapid expansion of demand for livestock products and the cost and limited availability of land in many countries, developed countries have moved from traditional extensive breeding on grassland to intensive breeding through industrially-produced compound feeds.

2. Until the mid-seventies the developed countries had been the main promoters for the development of the animal feeds industry.

3. As per capita consumption of meat and meat products reached near saturation level, demand and production tended to level off. As a contrast, demand for these commodities has increased in developing countries.

4. It has been estimated that world consumption of animal feeds in the mid-eighties was over 3500 million tons of barley equivalent. About one-third was consumed in the form of concentrated feeds mainly cereals, milling by-products and oil meals. The remainder was consumed as roots and tubers, roughage - primarily grass and forage, agro-industrial by-products and other non-conventional feeds.

5. The feeding of concentrates has been increasing at a faster rate than the roughages, illustrating changes in the composition of the livestock and in feeding methods. Over the last few years, the number of ruminant animals increased at a far slower rate than those of the monogastric ones. Monogastrics are increasingly dependent on concentrates and the increase of their numbers together with the more intensive feeding of some ruminants (dairy cows and beef cattle) has had a major impact on the pattern of feed use.

6. Although roughages are a small proportion of the total feed resources used as animal feed, they are about three-quarters of the total animal feed available resources. Most of this feed is obtained from crop residues and pastures that are grazed by the ruminants.

7. In most developing countries, however, priority had to be given to the production of food crops and only in recent years in a few countries has emphasis been placed on increasing livestock production through the development of roughage resources.

8. World utilization of concentrate feeds has risen rapidly over the past two decades - roughly 4.5 per cent/year. Developed countries used the main part of the world's concentrate feeds. The rapid expansion and intensification of livestock production (poultry, etc.) resulted in an increase of feed requirements in developing countries. Only in Africa has the use of concentrate feeds remained relatively low.

9. Utilization of a wide variety of concentrate feeds has been promoted by the growth of compound feed manufacturing. World manufacture of compound feeds was estimated at 392 million tons in 1986 of which 89% was produced in developed countries and only 11% in developing ones. Compound feeds manufacture is basically a local activity; this fact is reflected in the international trade estimated at about 1-2% of world production.

10. In contrast, the international trade of ingredients for compound feeds, estimated at 169 million tons in 1985, is very active and developing countries' share is about 30% of the total in volume and 24% in value.

11. In developing countries compound feed production has increased at an average rate of about 13% per year, albeit from a very small base. The farm mixing of feed is widespread in Brazil and Mexico, and is rapidly expanding in China and parts of the Near East, where Egypt and Turkey are large producers.

12. An important factor in compound-feed production is that it enables a greater variety of ingredients to be used for livestock feeds. This is especially important in developing countries where some crops and many by-products are neglected or under-utilized.

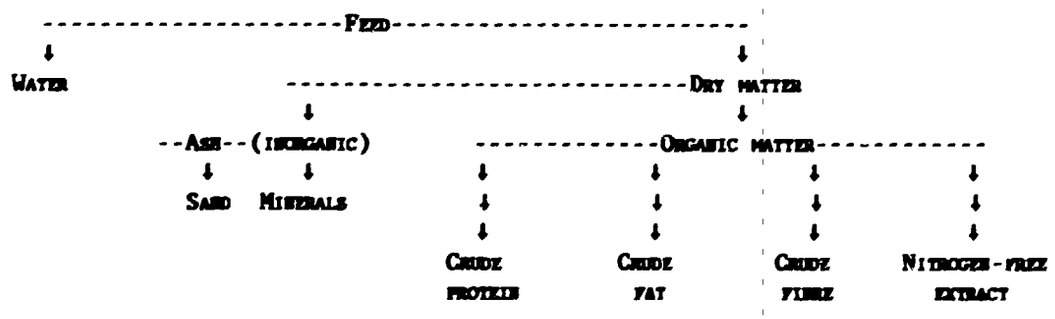
13. Due to the above-mentioned factors, it is necessary that measures be proposed by which developing countries could adapt to these circumstances, establishing competitive compound feed industries, in the following directions:

- Use of existing knowledge on characteristics and properties of tropical and semi-tropical plants to be used as local raw material inputs for compound feed processing;
- Use of oil cakes from wide varieties;
- Use of equipment and machinery allowing local small-scale production;
- Dissemination of available technologies and know-how through local or regional industrial development research centres.

II. COMPOSITION OF ANIMAL FEEDS

14. The composition of feeds has been arrived at by a scheme of analysis known as the Weende method, named after an experimental station in Germany where it was developed over 130 years ago.

15. A feed is divided into six fractions: water, crude fat (ether extract), crude fibre, crude protein, ash and nitrogen-free extract.



16. Below is the composition, both natural and chemical, of some typical feedstuff:*

Feedstuff	Water	Protein	Fat	Ash	Crude fibre	Nitrogen-free extract
Natural composition						
Lucerne hay	10.8	16.5	2.4	7.5	25.5	37.3
Wheat straw	9.9	3.0	2.0	11.0	35.1	38.9
Barley grains	10.3	10.8	1.8	5.5	4.7	66.9
Wheat bran	11.9	14.3	4.6	4.6	10.3	54.3
Soya meal	10.8	44.5	0.6	5.6	4.5	34.0
Soya bean	9.1	47.9	17.4	4.9	5.3	25.4
Fish meal	9.0	62.0	2.5	23.8	-	-

Chemical composition

Carbohydrates constitute the greatest proportion of animal feeds. They are the most importa: components of plants. Under this heading are sugar, starch, pectin, hemicellulose, lignin.

Lipids are mainly fats and oils.

Proteins are amino acids, amides, peptides, nucleic acids, purines.

Minerals. To minerals belong calcium, phosphorus, sodium, potassium, magnesium, iron, copper, cobalt, manganese, iodine and many other so-called micro minerals.

Vitamins are not feedstuffs in the ordinary sense, but they function catalytically. They are required in relatively small amounts for the normal function of animals. The important vitamins for animals are: A, D, E, K, B_1, B_2, B_3, B_6, B_{12}, C.

* A.A. Bondi: Animal Nutrition, Pub. Wiley & Sons, 1987.

III. CLASSIFICATION OF ANIMAL FEEDS

17. The main feedstuffs are roughages and concentrate feeds.

18. **Roughage** is mainly used for ruminants. It has a high crude fibre content - between 25 and 30% in dry matter. It is comprised of plants which are fed green as pasture or harvested and given indoors, and products obtained from green crops by conservation, such as hay, dried grass, silage, etc.

19. **Concentrates** are the main feeds for monogastric animals. The term "concentrate" is used for feeds low in crude fibre and moisture.

20. Concentrates used mainly for energy and low in protein are cereal grains, pulses, oil seeds, milling by-products which are high in starch, and further fats, molasses, etc.

21. Protein concentrates are important elements for rapidly growing animals. The most important protein concentrates are oil cakes and meals, fish meal, dairy by-products, animal by-products, etc.

22. To improve the productivity, feed additives, such as minerals, vitamins, antibiotics, enzymes, aromatics, non-protein nitrogen, etc., are added to animal feeds.

IV. UTILIZATION OF LOCALLY-AVAILABLE RAW MATERIALS AND BY-PRODUCTS

23. Grains and their by-products are the most important sources of carbohydrates and energy used for feeding. In addition to supplying carbohydrates and proteins, they also include vitamins and minerals.

24. The most widely-used grain for feeding is maize, especially for pigs and poultry. However, maize needs an adequate supplementation with protein and/or essential amino acids.

25. Sorghum contains a good source of energy in the form of starch but should also be supplemented with proteins and/or essential amino acids.

26. Barley has a good feeding value.

27. Wheat is low in fibre and high in energy. The crude protein content varies between 13-15 per cent.

28. Oats contain a relatively high protein content (11-14 per cent), however they are not widely fed to pigs and poultry due to the fact that one-third of the grain is hull.

29. Rye is a cereal not very commonly used.

30. Developing countries are importing cereals that can be consumed by both humans as well as animals. This is a special concern for all in developing countries. Therefore utilization of local feed resources to substitute imports is a necessity for both economic and social reasons.

31. One of the potential sources for substitution is the utilization of roots and tubers.

32. Roots and tubers are efficient converters of solar energy and their yields are good under proper conditions. Root crop yield per unit area is higher than the biomass of cereal crops. Cassava and sweet potatoes are the most widely used species. They are rich in carbohydrates, low in protein (excepting potatoes), fats, vitamins and minerals. The protein requirements could be supplied by adding soybean meal, fish meal and/or synthetic lysine.

33. The utilization of roots and tubers, mainly cassava, is subject to price of cereals versus cassava and requires serious economic consideration and analysis. The price of protein supplements is an influencing factor.

34. Among locally-produced raw materials and their by-products, sugar-cane by-products play an important role in the animal feed industry.

35. By-products of the sugar industry originate from harvesting: tops, leaves and straw, and those obtained from processing: bagasse, molasses and filter mud.

36. Harvest residues can be used directly as forage in sugar-cane producing regions. In addition to by-products, sugar-cane juice may also be used.

37. Molasses is the main by-product of the sugar industry and has been used as animal feed for a long time.

38. The yearly production of molasses (both beet and cane) is in the region of 40 million tons. The export trade for this commodity has reached the 6 million ton level.

39. Excluding Brazil, some 70% of the molasses available world-wide is utilized as an ingredient in animal feeds. In this respect, 6.5 gallons of molasses are equivalent in carbohydrate value to 1 bushel of corn (i.e. approx. 35 kg of molasses = 25 kg of corn). The yield of molasses is about 3% per ton of cane, its specific gravity about 1.43.

40. The value of molasses as animal feed is well known. The utilization in Europe in 1990 was some 4 million tons and in the USA about 1.6 million tons.

41. The most important element of cane molasses as animal feed is its high content of carbohydrates, mainly sugar. The great advantage of molasses is its palatability, which induces animals to eat roughage of poor quality. It improves pelletization and can serve as a transfer for urea and phosphoric acid in liquid feeds.

42. The nutritive value of cane molasses in comparison with oats and maize can be seen in Table 1.

Table 1

COMPARATIVE NUTRITIONAL VALUE OF CANE MOLASSES, OATS AND MAIZE			
ITEMS %	**CANE MOLASSES**	**OATS**	**MAIZE**
Carbohydrates	58.0	58.6	69.2
Water	20.0	10.0	15.0
Crude protein	3.5	11.6	8.7
Fibre	-	12.0	2.0
Mineral matter	10.5	4.3	1.2
Calcium (Ca)	0.8	0.09	0.02
Phosphorus (P)	0.10	0.33	0.27
Total dry matter	80.0	90.0	85.0
Total digestible nutrients (TDN)	57.0	68.5	80.0
Digestible protein	1.2	9.0	6.7
VITAMINS (mg/kg)			
Carotene	-	0.1	2.6
Thiamine	0.8	5.6	3.4
Riboflavin	3.0	1.0	1.0
Niacin	28.0	12.6	19.6
Pantothenic acid	35.0	12.0	4.8

43. Mixtures of molasses and a fibrous carrier - generally bagasse pith - have been used widely as animal feed by every cane-sugar producing country.

44. About 75% by weight of molasses was mixed with about 25% of dried bagasse pith with the addition of urea, soya meal or groundnut cake.

45. A lot of research work has been carried out in this field, the results of which have been published by FAO - with case studies in Zimbabwe, Colombia, Mauritius, the Philippines and many other countries.

46. Fruits and fruit by-products could be used as cereal substitutes in many developing countries. Among these is the banana.

47. About 10-15 per cent of the production is rejected for human consumption and could be used as animal feed. The amount of rejected quantity is approximately 10-15 million tons per year.

48. Another by-product source is the cannery industry. By-products account for about 40 per cent and 45-60 per cent (citrus) of the weight of fruit coming into the factory. The by-products could be used fresh, without treatment or storage, which could be done either by drying or by silage making. The energy value of these products is similar to cereals; however the level of crude protein is generally low.

49. There should be economic considerations related to the transport of products (bulkiness) and distances.

50. In addition to the above-mentioned by-products as substitutes and components of animal feed, many others could be used in the animal feed industry.

51. There are also utilizable by-products from the beer industry, using the obtainable yeast as a protein-rich supplement. Similarly, the by-products from the fermentation alcohol industry can also be used.

52. The vegetable oils and fats processing industry is very important from the point of view of animal feed production. Oil cakes and meals have been widely used for a long time as protein resources. Lecithin could be used as a substitute in some cases. Oil residues - not fit for human consumption - could be added to animal feeds.

53. Meat, poultry and dairy industries are valuable resources for by-products which are used extensively in the animal feed industries. These include the processing of bones, blood, feathers, low quality meats, and whey.

V. MANUFACTURING OF ANIMAL FEEDS, TECHNOLOGICAL OPERATIONS

54. The technological process, including small-scale operations, for production of animal feeds consists of step-by-step actions.

(a) Components calculation, and their continuous development;
(b) Storage of components and raw materials;
(c) Preparation for mixing, moving of materials, weighing;
(d) Milling, grinding, mixing;
(e) Adding of molasses, fats, vitamins, additives, etc;
(f) Granulating, pelleting;
(g) Special thermo-processes;
(h) Storage of ready-made products, transport;
(i) Quality control.

(a) Components calculation

The basis for up-to-date animal feed production is the careful preparation of components calculation, taking into account the requirements of the animals, their energy and nutritional needs, based on wide research and experimental work - in comparison with the traditional methods. The task of manufacturing is to prepare the most suitable compound feeds - according to the needs, such as feeds for milking cows, beef cattle, poultry feed, etc.

Due to the rapidly changing prices of the various components, economic considerations play an important role in the case of components calculation development. Many countries apply computer-based monitoring of price factors and composition.

(b) Storage of components and raw materials

The difference between industrial and agricultural production systems is that the latter is seasonal and the harvest therefore has to be kept for continuous production for a longer period. This is a costly operation, due to the need for proper storage facilities, quality protection and the place requirement. The real processing time in the case of many animal feeds is 20-40 minutes from milling to feeding, bagging or storing in a bin. The storage of raw materials or other components lasts weeks or months.

This is again an operation where economic factors, cost of storage, and continuous supply for manufacturing, should be very carefully considered.

(c) Preparation for mixing, moving of materials, weighing

Materials for animal feeds must be prepared properly. This involves cleaning from impurities (stones, sand, etc.), pre-storage, transporting the various components to the mixers, grinders, bagging and so on. The applied transport equipment can be mechanically-operated conveyor belts, pneumatic transporters, vertical lifts, scrapers, augers, etc.

The exact control of weights of various components is the basis for proper processing. The weighing in small-scale operations is mainly by batch-type equipment; the dosage can be undertaken by hand or semi-automatically.

(d) Milling, grinding

This operation is the most widely used and is applied in animal feed production, mainly to change the physical structure of the grains, and increase their surface for easier digestion in animals. Some animals (cattle, pigs) do not masticate properly and therefore proper milling is essential.

Other components such as oil cakes and minerals also need grinding.

To illustrate the importance of milling, the following table shows in various stages the digestibility of barley.

Table 2

BARLEY	Digestibility, per cent			
	Organic matters	Crude protein	Crude fat	Crude fibre
Grain	67.1	60.3	36.7	11.8
Semi-fine milling	80.6	80.6	54.6	13.3
Fine milling	84.6	84.4	75.5	30.0

Usually the level of grinding is given by indicating the maximal measures of particles, for example in the case of poultry feed:

96% of the feed max. 1.4 m/m
max. 4% between 1.4 and 1.8 m/m.

The most generally used equipment is the hammermill, the operation of which is relatively simple. The measure of particles is regulated by different sieves and screens.

For ruminants, flake-making rolls are used which are now also obtainable for smaller scale operations. The result of this process is that the grains are transformed into thin flakes - more easily digestible for cattle.

In the case of need for flour-like materials, various types of mills can be used, in horizontally or vertically-operated forms.

A basic operation in the animal feed production is the mixing of the components. The requirement is a homogeneous distribution of components, including small parts (20 - 100 g) of feed. To assist the proper distribution of small amount components, the mixing can be made stepwise - by preparing a so-called pre-mix containing the micro elements and adding this to the main part of the feed for second-step mixing. The mixers operate mechanically, or, for special purposes, fluidization is applied. The mixers are horizontal, slanted or vertical.

(e) Adding of molasses, fats, vitamins, additives, etc.

Molasses is used as a binding material, containing carbohydrates which also improves the taste of the feed. By adding fats, the energy value of feeds is increased. Another advantage is the reduction of dust.

In areas where the temperature is not high, the bins and pipelines should be insulated or kept in heated conditions.

(f) Granulating, pelleting

During the operation, small rolls are pressed by a rotating press and the extruded material is cut to the required size. The feed is conditioned by steam to make the pressing easier.

The pressing procedure not only creates physical, but also chemical changes. This is not always advantageous and therefore cooling should be applied in some cases. This operation is not, however, typical in small-scale operations.

(g) Special thermo-processes

There are two main groups of process namely the hydro-thermic and the dry-thermic process.

In the hydro-thermic process, various flakes are produced from oat, maize, barley. (Steam rolling).

In the case of puffing, cereals are handled by high pressure steam, increasing their volume by explosion.

The thermic handling of soya meal is called toasting which is achieved by applying temperatures of 115-120° C for 15-40 minutes.

Other processes for use in small-scale operations

Treatment of straw

The nutritional value of straw depends on the fibre content. The digestibility of crude fibre can be improved significantly by applying various treatment, such as **treatment with alkaline; treatment with ammonia; biological treatment; high pressure steam treatment.**

Conservation of feeds by drying

For many years drying was the only way of conservation; the cost of labour was low and time was available. Solar energy - especially in the southern countries - was applied. In the last two decades the main technological change has been the introduction of hot-air drying. To avoid a decrease of carbohydrates, the drying process should be started as soon as possible after harvesting.

Conservation by fermentation

There are two processes, at low temperature and at higher temperature.

In the case of low temperature fermentation, the temperature within the silo should remain below 35-40° C.

The higher temperature is above 40° C. This however involves a rather significant waste of valuable components, and therefore, with the exception of a few special cases, the low temperature fermentation is usually applied.

In the case of low temperature fermentation, the lactic acid producing micro-organism ferment at 10° C; however, the optimum is about 30° C.

The temperature of fermentation can be regulated by the compression of raw materials. Smaller particles are more able to be compressed.

VI. EQUIPMENT USED IN MANUFACTURING ANIMAL FEEDS FOR SMALL-SCALE OPERATIONS

55. It should be borne in mind that this paper is the first to be prepared for the consultation meeting. The information related to the equipment therefore has been obtained from a limited number of countries and companies. The listed equipment represents only part of the complete profile of companies. Catalogues should be requested direct.

56. There are, therefore, a large number of other companies dealing with the same area of activity and these will be mentioned in other papers prepared for the meeting. As far as prices are concerned, these are of an indicative nature and are approximate. Final prices are established by a binding contract between buyers and sellers.

57. Before listing the different equipment the advantages to having ones own feed processing system should be mentioned. This enables one to:

- use ones own raw materials, thereby having the chance to select the best quality for a given purpose;
- buy the additives in bulk at a lower price;
- produce special composition of compound feeds;
- have complete control over the production;
- keep costs lower than buying commercial feed on the market;
- sell feed to other farmers;
- use fresh feedstuffs.

58. The following is a list of a few companies and a description of the equipment most used:

DENMARK

A/S Maskinfabrikken SKIOLD, Saeby
Kjelgaardsvej, P.O.B. 143
DK-9300 Saeby
Telefax: 98 46 7930

Hammermills. with capacities of 300 to 2000 kg/hour. Capable of milling all cereals and fitted with a large selection of accessories.

Up to 1000 kg feed consumption/day the model is DM-2 with 5.5-7.5 kW motor. Number of hammers 16. RPM 2900. weight with motor 155-160 kg.

Screens 0.7 to 7.0 mm.

Approx. price DKr 9.000-10.000 plus accessories.

Vertical feed mixers with mixing capacities of 300 to 1000 kg. Motor 1.5-4.0 kW.

Mixing time is short. Approx. price, depending on capacity DKr 12.000 to 22.000.

Steel plate mill. applicable for maize, millet, wheat, sorghum, rice, groundnut, cassava, etc.

Diameter of steel plates/grinding stones 300 mm.

Power requirements: electric motor 5.5 h.p.
petrol engine: 5.0 h.p.
diesel engine: 8-11 h.p.

Output: dry material 200-350 kg/hour;
wet material 150-200 kg/hour.

Straw mill with a capacity of 50-80 bales, each 12 kg/hour, with a motor requirement of 7.5 kW. Approx. cutting length 5 mm.
Price DKr 14.000 incl motor.

Complete feed mill with a capacity of 500 kg/hour including auger, pre-bin, mill, mixer, filter, motor, control panel and spare parts.

Price ex-works approx. DKr 42.000.
Same with a capacity of 2-4 tons/hour, approx. price DKr 82.000.

Strawmix plant, batch system for all types of straw/stalks pressed into bales or loose, with possibility to add by-products such as molasses, citrus pulp, and other waste products.

Capacity 250-300 kg/hour, with a 7.5 kW straw mill and a 5.5 kW mixer. Approx. price ex-works DKr 60.000. (See Figure No. 1).

Maskinfabrikken Cormall a/s
Tor.holm 3
DK-6400 Sonderborg
Telefax: 74 48 6120

Complete diet cattle feedstuff plant

Capacity 500 kg/hour, based on max. 50% straw/stalks.

The system includes a horizontal mixer, straw mill, cyclone, piping, molasses pump, storage tank, weighing scale, control box.

The horizontal mixer has a 4 kW motor, the straw mill 11 kW motor. Molasses pump energy requirement 3.0 kW motor.

Approx. price ex-works DKr 155.000. (See Figure No. 2).

Mobile feedstuff milling and mixing unit

Feed components: straw (cereals, maize, rice), cereal residues, molasses, minerals, vitamins.

Capacity 750 kg/hour ready feedstuff.

Power supply: Diesel generating set 220/380 V, 50 H_z.

The system comprises a trailer for tractor transport, two axles, baleshredder, hammermill, piping, cyclone, filter, charge mixer, pump for molasses, diesel generating set 45.6 kW, control box, spare parts for 2 years' operation.

Approx. price ex-works DKr 1,172.000 (Trailer cost DKr 525.000). (See Figure No. 3).

President Mollerimaskiner Poul Diness A/S
Springstrup P.O.B. 20
DK-4300 Holbaek
Telefax: 45 53 44 1821

Diagonal force-mixer "TD"

Cubic content of the mixer 500 to 1000 kg. Motor 3-4 kW, auger RPM 140.

Mixing time 15-20 min, discharge time 4-6 min.

Grinding-mixing plant 4 K

Capacity 500 kg ready mix, with hammermill and mixer, spare parts for 2 years.

Hammermill capacity up to 300 kg/hour, motor 5.5 h.p.

Feed mixer contents 500 kg, motor 2 h.p. - 1400 RPM. (See Figure No. 4).

The company supplies hammermills, feed mixers, mixing units, pre-cleaners.

THE NETHERLANDS

A complete range of machines for farming and feed production is manufactured by the following agricultural machinery firms. Because 70% of the total output is exported, foreign market research provides the foundation for modifying the machines to meet specific local requirements on overseas market.

There are well over 100 companies which manufacture agricultural machinery. Information on these companies and their recent profiles, prices, etc., can be obtained from the following sources:

I.M.A.G. Institute for Agricultural Engineering
6700 AA Wageningen
Telefax: (31) 83 70 25 670
Telephone: (31) 83 70 76 300

AGRIMACH DATABANK
6700 Wageningen
Telephone: (31) 83 70 76 450

Ministry of Agriculture and Fisheries
Foreign Marketing and Economic Co-operation Service
P.O.B. 20 401
2500 EK Den Haag
Telefax: (31) 70 347 74 59
Telephone: (31) 70 379 24 89

UNITED KINGDOM

Lister Taylor Ltd.
Grayingham Road, Blyborough
Gainsborough, Lincolnshire, DND 214 EX
Telefax: 04 2773 8065
Telephone: 042 773 8063

Feeding, bedding equipment, mixer wagons, silage feeders, straw milling.

Hi Spec Engineering Ltd.
Station Road, Bagenalstrow, Co Carlow
Telefax: 010 353 503 21980
Telephone: 010 353 503 21929

Electronic weigher, hydraulic elevator discharge feeder, pulping system.

Single rotor system.

Master Farm
33 London Road, Marks Tey
Colchester, Essex CO6 ID2
Telefax: 0787 72813
Telephone: 0206 211515

Turbo driers
Incorporation feed systems cattle, pigs
Effluent disposal
Rotating feeder bar
Grain thrower.

Victoria Industries (UK) Ltd.
Sideley, Kegsworth, Derly, Derlyshire DE 72FJ
Telefax: 0509 674017
Telephone: 0509 672571

Silos, drying fans, suction/blowers.

John Rutherford & Sons Ltd.
Home Place, Coldstream, Betwickshire
Scotland TD 124 DS
Telefax: 0890 3151
Telephone: 0890 2366

Calf feeders.

FRANCE

Syndicat Général des Constructeurs de Tracteurs et Machines Agricoles (SGCTMA)
(French Farm Equipment Manufacturers Association)
19, rue Jacques Bingen, F-75017 Paris
Telephone: (1) 47 66 02 20

Represents over 200 manufacturers.

HUNGARY

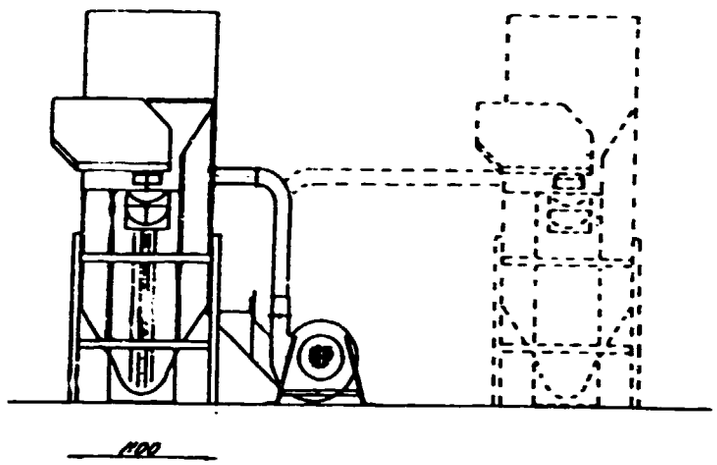
There are many small- and medium-scale manufacturers. Information can be obtained from the

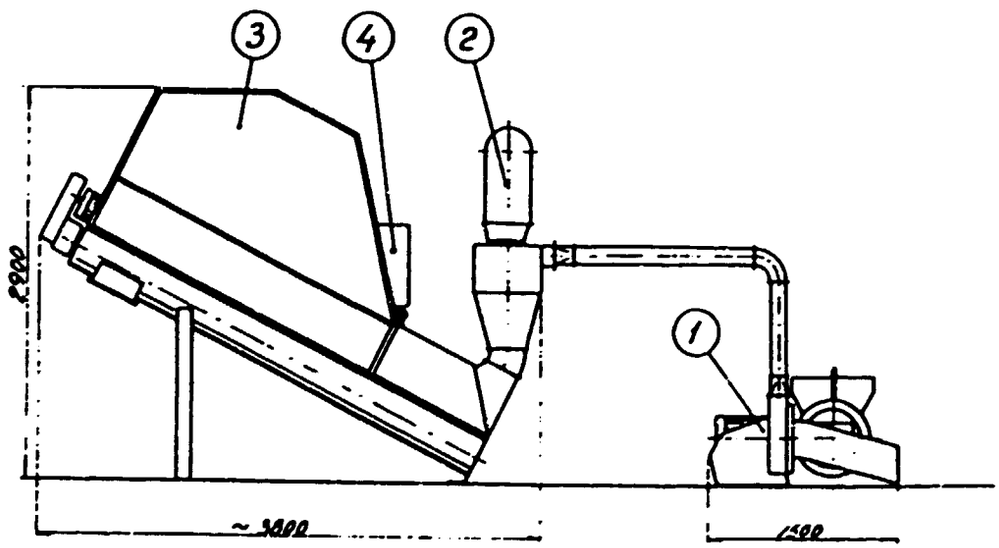
Agricultural Technical Institute
Gödöllö
Tessedik Samuel ut

Technical University Budapest
1111 Gellert ter 4, Budapest
Telephone: (361) 166-5011 Ext. 12-39
Telefax: 185 3493

59. I would like to express my thanks to the representatives of Denmark and The Netherlands for their kind assistance during my official mission to their countries to gather information related to the study in question.

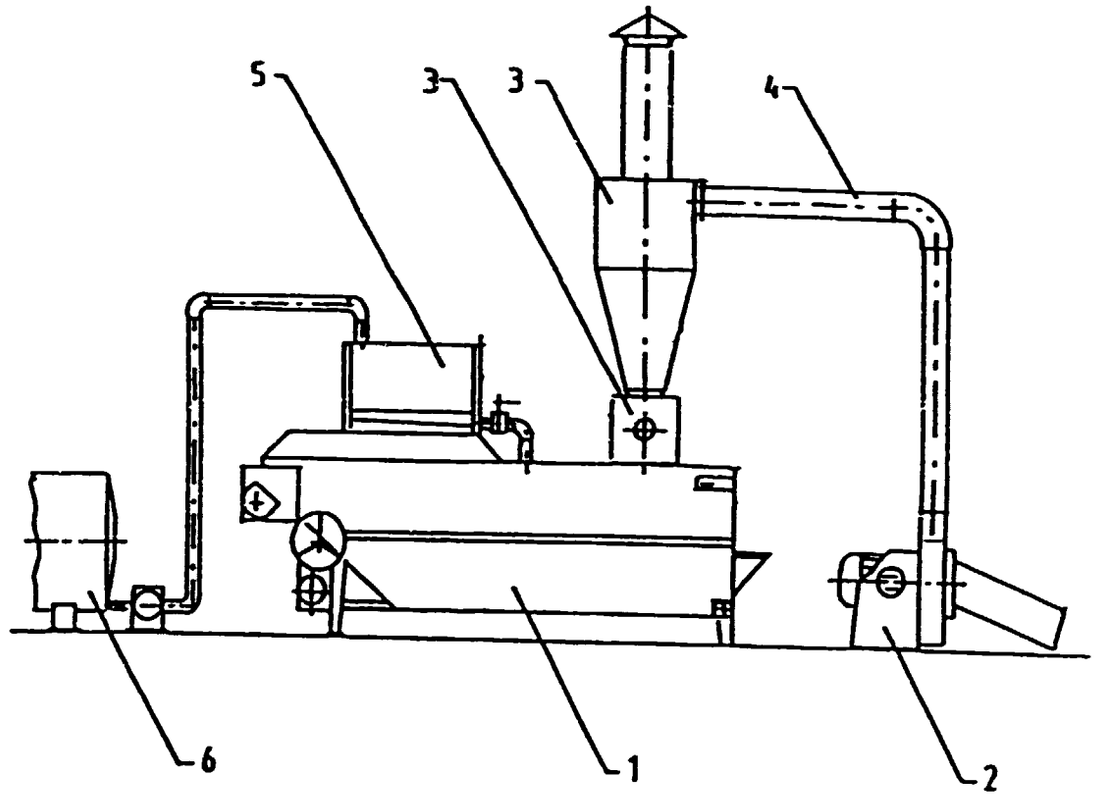
FIGURE 1: STRAWMIX PLANT

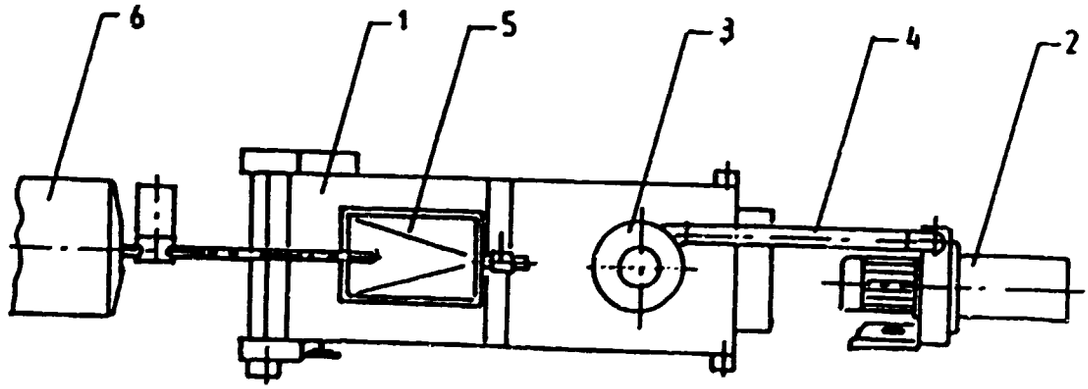




1. Combi mill BM
2. Straw cyclone
3. Straw mixer
4. Bins

FIGURE 2: COMPLETE DIET CATTLE FEEDSTUFF PLANT





1. KB 6 Horizontal mixer
2. HDH-40 Strawmill
3. Cyclone with dust brake
4. Piping
5. Molasses pump FF
6. Tank for molasses

FIGURE 3: CORMALL MOBILE FEEDMILL FOR PRODUCTION OF COMPLETE DIET RATIONS FOR CATTLE BASED ON AGRICULTURAL RESIDUES AND BY-PRODUCTS

CAPACITY: 750 KG/HOUR

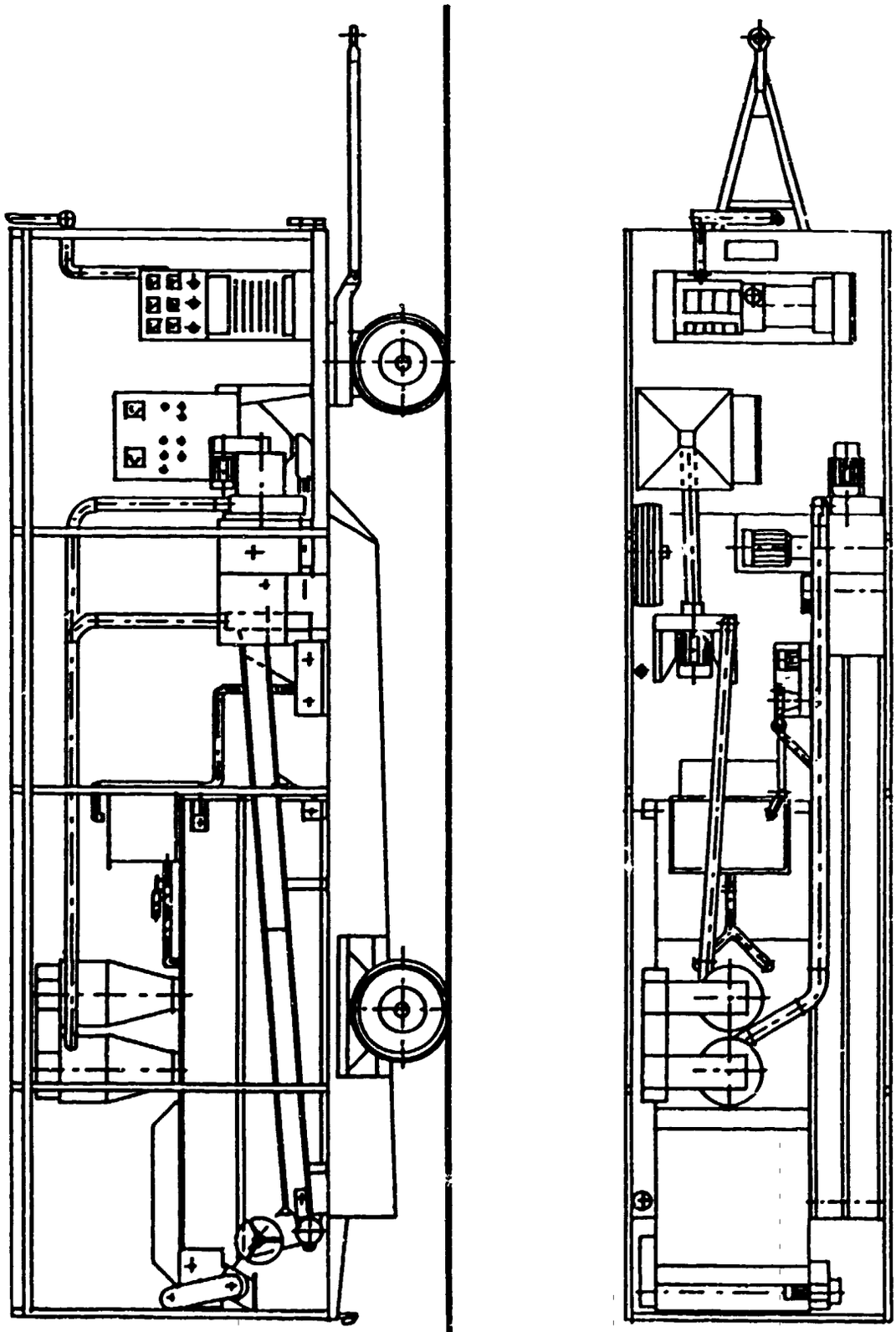


FIGURE 4: GRINDING AND MIXING UNIT