Lecture no. 31
Slurry Handling Machinery.

Crushers:

A considerable quantity of plant nutrients is lost from the digested slurry when it is dried. The digested slurry, after drying forms large and hard clumps and if the size of particle is more than 5.5mm, it is not mixed with soil particles and the plant will be unable to absorb the nutrients present in the slurry. Ali et.al (1987) and Nag et.al (1988) have reported development and testing of different types of crushers for the size reduction of dry slurry into particles having size less than 5.5 mm. The basic size reduction machine consists of three main components: (a) crushing unit, (b) power transmission unit and, (c) feeding and supporting unit.

The crushing unit consists of a beater and concave. The beater is provided with abrasive surface with either rasp bars or hammers to reduce the size of dried slurry clumps. It rotates at very high rpm inside the concave. The concave is made of M.S. sheet and flat in such a way that it becomes a perforated plate. The beater is powered by a 3 phase, 5hp, 1440 rpm induction motor through V belt and pulley arrangement. The materials are fed to the crushing unit with a hopper made of 0.3 cum capacity. The machine is supported on a M.S. frame.

Four different types of crushers have been developed which include circular drum type crusher with rasp bars, octagonal drum type crusher with rasp bars, drum type crusher with sharp edged rigid hammer and hammer mill type crusher. Fig.1 shows the crusher while Fig.2 gives details of hammer mill type crusher. Tables 12.7 and 12.8 give the results of performance evaluation of all these types of crushers at various speeds ranging between 360 to 2880 rpm. The performance evaluation of above crushers showed that a drum type crusher with rasp bars or octagonal drum type crushers with rasp bars can be used for reducing the size of dried slurry with optimum speed of 1440 to 1800 rpm while the speed recommended for hammer mill type crushers is 700-1400 rpm.

Slurry handling machine

A slurry handling machine has been developed at PAU, Ludhiana. The technical details of this machine are given in Figures 12.3 and 12.4. Based on the sieving concept, the machine has been designed to separate the effluent slurry of biogas digesters into solids and liquid fractions. An assembly of two sieves with different hole sizes (top sieve 2000 micron, lower sieve 500 micron) utilizes slider crank motion with

the help of a crank shaft and a set of hangers. A propeller pump is used to provide uniform flow rate at a particular head. The percentage of dry matter in influent slurry, solid and liquid fractions, separated with two sieve assembly at different flow rates are given in Table 12.9 Separation efficiency was found to be maximum at the flow rate of 54-1/m.

The digested slurry is fed through the channel, flowing over a layer of green or dry leaves and filtered in the bed. The water from the slurry filters down which can be reused for preparing another fresh dung slurry. The semi-solid slurry can be transported easily as it was in the consistency of fresh dung and used for top dressing of crops like sugarcane and potato.

Biodigested slurry is also being used for fish culture, which acts as a supplementary feed. On an average, 15-25 litre of wet slurry can be applied per day in a 1200 sq. pond. Slurry mixed with oil cake or rice-bran in the 2:1 ratio increases the fish production remarkably. In general organic manures about 10 t / ha, in the form of FYM or compost or biodigested slurry is recommended to be applied once in three years to maintain the organic content of soil, besides providing nitrogen, phosphorous and potassium in the form of organic fertilizers to the crop.

Enrichment of biogas plant slurry

The nutrient values of biodigested slurry can be increased considerably by means of enrichment, thereby reducing the quantum of slurry required for application to get the desired level of nutrient. Otherwise, we need to apply large amounts of dried slurry to obtain higher crop yields. An effective method of treating such manure is to enrich them with fertilizer nitrogen and with phosphate fertilizers to obtain concentrated organic-mineral fertilizer which could be applied in comparatively smaller quantity.

a. **Enrichment by impregnation**

The enrichment can be done by taking 11 kg of urea and 31 kg of super phosphate and dissolving them in about 15 litres of water. This solution is adsorbed in 48 kg of dry low grade manure and mixed thoroughly and spread out in the shade to dry. The enriched manure would then contain 5 percent P2 O5 in addition to the original contents. Such impregnated manures have been found to give high response in field experiments.

b. **Enrichment by pelletization**

Enrichment of biodigested slurry is also done by pelletization with

rock phosphate and coir-pith. A pelletizer has been developed for densification of biodigested slurry into granules or pellets .The pelletizer consists of two major components, viz. pellets extruder and gyratory shaker.

The biodigested slurry is enriched with 50 g of rock phosphate and 100 g of powdered coir waste per kg of slurry, with addition of 70 - 75 percent moisture. Enriched biodigested slurry of optimum consistency is fed into the hopper of the pellet extruder and the feed material is extruded by helical screw through spout and made into thick noodles. The noodles are cut into small equal pieces and made into spherical pellets in a gyratory shaker. Addition of enriched pellets about 2 tonnes per hectare to many crops like ragi, sorghum, maize has been 'found to increase the yield.

Biogas slurry handling equipment

The current technology for production of biogas from anaerobic digester requires feed input (organic matter) at 90 percent water content. The out coming slurry from the biogas plant poses a great problem fro suitable disposal, especially from large capacity plants. Keeping in view of this problem of handling bulk quantity of slurry from large sized plants, it becomes necessary to develop suitable equipment to handle the slurry and convert it suitable for field application.

a. **Slurry solid - liquid separator**

The slurry solid - liquid separator equipment consists of a set of two long rectangular sieves mounted at 16 cm apart. The sieves are arranged one over the other. The upper sieve has holes of larger diameter than the lower sieve. The sieve assembly is suspended with the help of hangers arranged in the main frame. The sieve assembly is powered by an electric motor through a crank arrangement.

During the operation, the liquid slurry is fed on the upper sieve. The water along with the dissolved contents passes through the sieves, while the large and small solid particles are retained in the upper and lower sieves respectively. The water collected from the lower sieve is recycled for mixing the raw dung before being fed into the biogas plant which will result in increased biogas production. The separated liquid is rich in nutrients and can also be used for irrigation directly.

b. **Organic slurry injector**

Normally the biogas slurry is left open to dry before used as farm yard manure. It is a time consuming process and moreover, a large

quantity of organic content of the slurry gets evaporated while exposed to sunlight. Further, the possibility of run off is also a problem due to the liquid nature of the slurry. It may be noted that for better utilization of slurry, it is important to apply it in its original condition and place it at the proper soil depth and at a desired rate. It will help the slurry to come in direct contact with the foot zone of the plant so that the organic content present in the slurry is better utilized. Moreover, the shallow placement of organic waste favour aeration and biological stabilization, since the materials are closer to the atmosphere. In order to inject a specified volume of slurry and to cover it, an injector must perform the main functions of opening of soil and covering of deposited slurry.

The equipment designed for the above purpose consists of a main frame, storage tank for slurry and injector tool. A three point linkage is also provided to the main frame. The storage tank has a trapezoidal cross section to facilitate easy flow of slurry. A control valve is also provided to the outlet of the slurry tank to regulate the flow. The biogas slurry injector cuts the soil, place the digested slurry at proper depth in the soil and cover the slurry with soil.

c. **Dried slurry crusher**

It is a fact that slurry or dung applied in dried form to the field directly, does not easily mix up with the soil, if the size of the particles are more than 5.5 cm. The reason being, the dried slurry clumps become spongy in nature and do not dissolve in water and remain as such even after a long time. Further, the particles with less than 1.5 mm size drift in the air to cause problem of air pollution.

The dried slurry crusher consists of a crushing unit, power transmission system, hopper and the supporting frame. The crushing unit has a circular drum beater and a concave having a clearance of 27 mm. The material reduced in size by the beater is passed through the openings in the concave. The drum and beater assembly is also available with various designs viz., octagonal drum with rasp bars, drum with sharp edged rigid hammer and hammer mill type beater. Experiments conducted with all the above types revealed that for most satisfactory operation, the drum with rasp bars could be use for reducing the size of dried slurry.