GRAIN DRYING SYSTEMS: R AND D PRIORITIES

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ABSTRACT

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NOV 19 1987
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Grain drying is part of a chain of processing operations to prepare the product from the farm for the consumers. It is critical in preserving grain quality. Sun-drying is a practice and has its applications and will persist where there is a market for low grade rice. To maximize benefits in the grain business by producing good quality milled grain, free of toxins, the controlled handling and drying of the grain is a pre-requisite. In the context of the rice industry in the ASEAN, the difficulties and possible options of providing drying capacity are discussed.

AFHB CONSULTATION WORKSHOP, 24-27 NOVEMBER 1987, HYATT CENTRAL PLAZA HOTEL

BANGKOK, THAILAND

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There are many kinds of people involved in the development and promotion of grain drying technology. These are design engineers, manufacturing and sales engineers, grain businessmen, plant operators, researchers, financing institution officers and government do-gooders. Each group has a different perspective and consultations such as this are extremly important if we are to make best use of resources made available and we thank the AFHB for this.

There has been a lot of tinkering by the engineers, pronouncements by the economists, misconceptions by the grain businessmen, inappropriate dryers sold in the region and financial resources expended from donor agencies. In all candor, there has been a lot of good intentions, a lot of learning, but still very little progress in providing actual grain drying capability to have an impact in preserving grain quality during the wet harvest season.

What are the problems, where are the bottlenecks? Part of the difficulty is that some researchers get so enamoured with their tinkering and forget what we are trying to achieve. Rice is a staple food product, that we remember. It is also a major source of income for the greater masses of people in the region. The post harvest system is a delivery system of bringing the food grown in the farms to the consumers. In the commerce of people, it is a marketing operation. Grain drying is a method of preservation and is only part of a bigger chain of operation. There has been no discovered nor invented substitute for grain drying. It simply has to be done, but it has to be done efficiently as part of the marketing operation. It is a critical part of a processing operation where if there was no drying capacity, there are serious consequences. Grain deterioration occurs, unwarranted losses are incurred, quality is impaired, prices drop and benefits lost and the gains in the other components are nullified.

The textbooks and the literature can provide information on the bio-physical properties of grain and the engineering parameters for grain dryer design and the economists will make their assumptions anyway to show how good investment dryers are. What seems to be missing is a guide for the formulation of a drying strategy as a guide for research and development and for investment. My task therefore this morning, I thought, is to try to stimulate discussion to provide a framework for drying strategy.

DRYING STATEGY - WHAT IS IT?

A drying strategy is a recognition of all the biological, physical, environmental, social, economic and financial requirements needed to promote drying technology as a means of preserving grain quality and to engineer a system that will meet this requirement. It is not the promotion of a particular drying concept or technology, but a review of the options and selecting the most appropriate system. The requirements vary for different farming and marketing situations and there is not going to be one system that will fit all.

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A DRYING STRATEGY - WHERE IS IT NEEDED?

Grain deterioration and consequently losses occur in small rice farming areas where double cropping is practiced and harvesting occurs during the rainy season when sun drying is not reliable. This has also been a problem where labour for harvesting is not available and mechanical harvesting is used and compatible handling and drying systems have not been properly engineered. The same problem is also encountered where monocropping is practiced, where sun drying is feasible but field transport and storage is lacking. In large estate mechanized farming, the complementary post harvest facilities are commercially available and grain drying is not a problem. Thus temperate country systems can be adopted to tropical conditions and their successful adoption is one of our problems because of the lack of understanding of some of the basics.

CONDITIONS FOR GRAIN DRYER APPLICATION (IN THE REGION)

Farm Drying

Rice and maize farming in the ASEAN is as we all know, ~~are~~ done by millions of farmers in farm lots from 1/3 to a few hectares. Except in Malaysia and Brunei, harvest - reaping is done manually and threshing is by beating, treading or small threshers. Assuming a generous 5 tons yield per hectare and a marketable surplus of 70% or 3.5 tons from a hectare, a one hectare farmer cannot afford a mechanical dryer. Ever a 5 hectare farmer who can harvest the 5 hectares in a day or spread out the harvesting in 5 days or even 10 days still cannot make economic use of a dryer. He just doesn't have the economy of scale or in other words the volume to justify investment in a dryer. The marketing system has adapated to the situation. There are traders, millers and even government procurement centres where the farmer can sell his wet grain. The farm price is discounted for the wet dirty grain, but this is still not enough negative justification for an investment in artificial grain dryers for farmer use. The development and promotion of farm dryers may not therefore be a feasible approach. Providing price incentives for farmers to invest and use grain dryers, is at most a political exhortation. In a free and segmented market, the market force governing traders and millers is to buy low from farmers and to sell high to retailers.

Sun Drying

The optimum time for harvesting grain to minimize field losses due to shattering, is at a certain stage of maturity of the crop where the grain moisture is till high. Unless the grain is dried within 24 hours, the biological activity results in significant dry matter loss, discolouration, infection and growth of fungi and the development of toxins. The preservation of the harvested grain, by drying is an ancient practice and this is by sun drying. During periods of inclement weather, air drying under a shelter is resorted to. Dry air and heat are already recognized as needed for successful drying. The same principles of physics have not changed, but the environmental conditions during the harvest season has changed. A strategy therefore has to accommodate the fact that farmers, traders and millers will sun dry whenever feasible and artificial drying is merely a fall back system. Therefore, a combination of sun drying and artificial drying transition period will take

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place before the benefits of a full capacity drying plant is recognized. The system design therefore should be modular, that will allow for adding on drying capacity as the need is recognized. The drying plants that are now in place are so fixed and rigid that additional drying capacity has resulted in difficult double handling.

PRODUCT REQUIREMENTS

Paddy, maize, groundnuts and other agricultural commodities have different product characteristics. Their tolerance to drying temperatures differ, their rates of drying differ, quality parameters differ, their homogeneous or non-homogeniety differ, their resistance to air flow differ, their equilibrium moisutre contents differ and so therefore the universal multipurpose/multicrop dryer is a much more difficult design challenge.

Some researchers contend that the rate of drying affects milling head rice recovery. Our own research experience indicates that under the tropical humid climates where it is needed to increase the sensible heat of the drying air to reduce its relative humidity, the drying air temperature and the resulting grain temperature as a consequence of heat transfer is more critical to the milling head rice recovery. Higher drying air temperatures means lower relative humidity with the same absolute humidity, a higher temperature differential between air and grain and so a faster rate of heat transfer from air to grain resulting in a higher vapour pressure differential and higher rates of drying. The same accelerated rate of drying can be effected by depressing the absolute humidity of the drying air without damaging the grain. Ergo, the critical temperature is first reached before the critical drying rate is reached. If you cannot follow the heat and mass transfer process, stick to entomology. The drying strategy therefore should recognize that drying capacity cannot be increased by using elevated drying air temperatures without sacrificing milling head rice recovery.

Much of the moisture in high moisture grain is surface moisture and the rate of removal is much higher than when the rate of drying is controlled by diffusion. It is also now known that if the grain moisture can be dropped to 18% wb, the grain metabolism is slowed down enough to allow for transient storage. Design strategy for handling and drying should take advantage of this condition. The concept therefore of a two or even three stage drying should be explored.

Grain is hygroscopic and paddy has been shown to fissure when it reabsorbs moisture either by rewetting or by absorption from a humid environment. The temperate climate practice of blowing ambient air during the final stages of drying, is a dangerous practice to copy in humid environments. The psychrometric conditions are such that instead of removing 1 or 2% moisture, the reverse will occur resulting in fissuring of the grain. Design and operational practice should bear this in mind.

DRYING LOAD REQUIREMENTS

This is a little bit difficult to explain. With land preparation equipment or threshing equipment, each piece of equipment would have a specific field capacity and to accomplish the task, enough time has to be spent in the field. If additional capacity is needed to cope with the requirements, additional units can be fielded. In comparison, the process of drying wet products is under heavy time pressure, especially for the high moisture harvest. Once the crop is reaped, the field stack has to be threshed and the threshed grain has to be dried. There is a lot of exothermal heat generated that cannot escape in a field stack or a mass of wet grain. As we know, it is a combination of the heat and the fungi that causes the bio-chemical change that it manifested by the yellow kernels and the general darkening of the grain. The heat has to be dissipated and the moisture dropped to stablize the grain.

A drying plant that has an undercapacity will cause a backlog of undried grain that increases from day to day during the harvest season. A drying plant that has an overcapacity is a non-economic investment. If one considers that a drying plant is only used 3 months each harvest season, an overcapacity that is idle the rest of the year is hard to justify.

An integrated plant that has linkages with farm production and the retail markets is a rather straight-forward situation to design a drying plant for. The usual procedure is to size a drying plant to handle receivals designed to provide a buffer storage to keep the milling plants in operation year round to meet its marketing requirements. The difficult situations are for:-

1) Processing plants that have an open paddy procurement plan. The volume of grain coming in is unsteady

2) Processing plants that insist on sun-drying wherever they can and use their dryers as a rainy day facility;

3) Government complexes where receivals vary from year to year depending on current policy;

No study has been made to determine the parameters of dryer sizing for the different applications and the consequences of under or over-rated capacities.

PAYING FOR THE DRYING COST

The drying facility and its ancillary equipment for conveying, cleaning, working storage, controls, cost a lot of money. The fuel for moving air and for heating it are a continuous opeational costs which is now estimated to be about 30% of the processing cost. Purchasing wet grain and trading it off as dry grain does not pay. The price differential between wet and dry grain cannot cover the cost of drying. The paddy has to be converted to good quality milled rice to realize the value added.

Mechanical or artificial drying does not increase milling recovery by itself. Commercial mills with present varieties produce about 65% milled rice, 70% of which is head rice. (Head rice based on paddy weight (0.65 x 0.70 = 46%). Any improper handling of paddy during the predrying and drying process can drastically reduce the head rice and possibly the total milling yield if the

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fine brokens are lost to the bran. The major determinants of total milling yields in a commercial process is the cleanliness of the grain and the significant presence of immature kernels. In other words, anything that is included in the paddy weight that cannot be converted to milled rice affects the milling recovery. There is no mystery here.

The pay-off is:-

1) If premium prices are paid for whole grains, the more whole grains produced or the less broken grains produced the more benefits derived. Here is where controlled handling and drying counts the most. Processing plants that supply markets that demand and pay for good quality (graded rice) cannot afford not to operate a grain dryer.

2) The second application that can pay-off is if a plant has unutilized milling capacity. Investment in a grain dryer will allow it to purchase paddy during the rainy season. This will increase its over-all plant throughput and possibly justify investment in a grain drying system.

<u>IN SUMMARY - A GRAIN DRYING STRATEGY SHOULD CONSIDER THE FOLLOWING:-</u>

1) Farm drying as an extension of the operations of processing plants. It is to their interest and they stand to benefit from it and should bear the cost if farm drying were to be practiced.

2) The other approach would be for processing plants to establish a network of purchasing stations equipped with pre-dryers and provide the necessary field transport in addition to the regular lorries that haul off the semi-dried grain to the finishing plants.

3) Design processing plants to receive wet grain, pre-dry it and store it until it can be finally dried for long term storage.

4. Undertake economic studies to determine the influence of non-investment in grain dryers.

5) Undertake studies for establishing procedures for sizing drying plants that combine sun-drying.

6) Design modular drying plants that provides the flexibility to accommodate varying volumes of incoming wet grain.

7) Undertake adaptive trials and tests for drying system utilization.

8) Produce more drying extension information material for millers.

9) Stop re-inventing dryers.

10) Stop drying rates and drying equation studies. They are non problems.

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TECHNOLOGICAL OPTIONS

FARM DRYING 0.05 - 0.10 TPH	MILLERS/COOPS/GOVERNMENT STORES
Solar Huts free convection dryers pit dryer conduction heated dryers passive systems	Batch Type (static or recirculating) CFD with receiving and tempering bins in-store drying systems Multi-stage Drying, 1st stage at farm or procurement centres 2nd stage at the milling/storage plant