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RESEARCH AND DEVELOPMENT OF A SMALL-SCALE, LOW-COST RICE BRAN STABILIZING UNIT

Report of an *ad-hoc* Expert Group Meeting

Vienna, 6-10 December 1976

Prepared by

The International Centre for Industrial Studies

id.77-664

Explanatory notes

The following abbreviations are used in this report:

ASRCT	Applied Soientifio and Researoh Corporation of Thailand
FFA	Free fatty acid
psi	Pounds per square inoh

CONTENTS

Chapter — Page

INTRODUCTION 4

I. PARAMETERS OF A SMALL-SCALE, LOW-COST RICE BRAN STABILIZING UNIT 6

II. TECHNOLOGY OF RICE BRAN STABILIZATION 9

III. IDENTIFICATION OF RESEARCH AND DEVELOPMENT ACTIVITIES 13

IV. ECONOMIC AND SOCIAL ASPECTS 17

Annexes

I. LIST OF PARTICIPANTS 19

II. PAPERS PRESENTED TO THE MEETING 20

Figures

I. Concept of a dry-air small-scale industrial low-cost bran stabilizing unit making use of IRRI-designed components as developed for a paddy batch drier...................... 10

II. Comparative diagram of dry-heat and moist-heat process.... 12

INTRODUCTION

The Second General Conference of UNIDO, held at Lima, Peru, in March 1975, in adopting the Lima Declaration and Plan of Action[1/], called upon UNIDO to assist the developing countries in the research, development and application of innovative technologies, and in the establishment of small-scale rural-oriented agro-industries. Also stressed in the Lima Declaration is the need for co-operation between developed and developing countries and among the developing countries themselves in the transfer of industrial technology.

In order that it might better discharge these new tasks, UNIDO was restructured to include an International Centre for Industrial Studies and, within it, a Development and Transfer of Technology Section. A project given priority by the Section was to undertake research and development on a small-scale low-cost rice bran stabilization unit (ID/B/173 and A/C.5/31/11, para. 103, item 3.4, project No. DTT-8/76). This decision was taken in view of the need for more economic and efficient utilization of rice bran in the developing countries. The proposed project would have an impact on the development and application of technology in rural areas where the rice mills are located.

To define the scope of the project, an Expert Group Meeting was convened at the headquarters of the Economic and Social Commission for Asia and the Pacific (ESCAP) at Bangkok, in May 1976. The Meeting reviewed the importance and usefulness of the project and recommended that a research project be subcontracted to the Applied Scientific and Research Corporation of Thailand (ASRCT). Accordingly, ASRCT was entrusted with developing the technical parameters, and with defining an appropriate design for a small-capacity, low-cost rice bran stabilization unit for attachment to existing small-scale rice mills. On completion of this study, UNIDO convened the present ad-hoc Expert Group Meeting on the Research and Development of a Small-Scale, Low-Cost Rice Bran Stabilizing Unit, with the main objectives of identifying alternative processes and designs and of promoting the co-operation of institutes in developing countries in the further development of the project. The Meeting

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1/ Endorsed by the United Nations General Assembly at its seventh special session (resolution 3362 (S-VII)).

was held at UNIDO headquarters in Vienna from 6 to 10 December 1976. The list of participants is given in annex I. The titles of the papers presented to the Meeting appear in annex II. W.H. Tanaka, Acting Head of the Development and Transfer of Technology Section, was elected Chairman of the Meeting; H.G.R. Reddy, UNIDO Regional Industrial Adviser, ESCAP/UNIDO Division of Industry, was elected Rapporteur; and H. Koening, UNIDO, acted as special technical adviser to the Meeting.

In his opening statement, Mr. Tanaka drew attention to the importance of the project and briefly sketched in the background. The world output of paddy was 300 million tons, which was equivalent to a rice production of 200 million tons. This would correspond to the availability of 12 million tons of rice bran with a potential of nearly 2 million tons of rice bran oil. It was known that rice bran was at present being used to a limited extent in the extraction of oil and that a large quantity of it was not being put to the most economical and profitable use. The main issue was the poor quality of the bran, which deteriorated rapidly immediately after being separated from the grain in the milling process. The technology of rice bran stabilization was known, but the question was to adapt the technology to a low-capacity industrial scale unit to be attached to rice mills in rural areas, and to make it available at a cost that the average rice miller could afford. It was emphasized that the focus of the Meeting should be the development of a new design for a rice bran stabilizing unit; this should be simple in design and operation while low in energy consumption. The long-term objective was to make rice bran a valuable industrial raw material by stabilization, not only for the extraction of oil but also as one of the ingredients in the feed industry.

I. PARAMETERS OF A SMALL-SCALE, LOW-COST RICE BRAN STABILIZING UNIT

The Expert Group had before it a discussion paper, the ASRCT report "Draft study on the definition of the most suitable rice bran stabilizing technology, its verification and the specification of its technical parameters" (ID/WG.240/2). It was agreed that a discussion of the fundamentals of rice bran stabilization should precede consideration of alternative processes and designs. It was decided that the conclusions of the report would be taken up during the general discussion on the fundamentals and processes of rice bran stabilization. To make the discussion effective, an attempt would be made to reach agreement on the parameters of the project. In the discussion that followed, in view of the importance of stabilizing rice bran at the source of its production, it was decided that the location of the unit should necessarily be at the rice mills.

The Expert Group considered existing rice-milling techniques and concluded that only about 15 per cent of commercial mills would be suitable for the attachment of the rice bran stabilizing unit. It was known that a large percentage of the rice mills did not have proper pre-processing equipment, particularly the dehusking machinery which resulted in the mixture of bran, husk and broken rice. The Group therefore decided that the stabilizing unit would be applied, on a selective basis, mainly in conjunction with rice mills of an average milling capacity of one ton of paddy/hour.

As a large number of rice-milling units had no equipment for the separation of husk and bran and since a substantially large quantity of bran of acceptable quality would become available provided certain pre-processing equipment were attached, the Expert Group agreed that the installation of proper husk separators and the adoption of multipass milling techniques would augment the availability of rice bran suitable for stabilization, as would also the introduction of simple bran sifters.

The concept of rice bran varied from country to country, as a result of the different milling practices employed; what was referred to as bran also contained husk and broken rice to a varying extent. It was decided, therefore, to define rice bran as the product composed of the outer and inner layers of rice grain and the germ, with the exclusion of the husk particles and brokens, and therefore containing a high percentage of fat and protein.

There was considerable discussion on the physical and chemical properties of bran available in the rice mills. These properties could vary according to temperature, atmospheric humidity and storage conditions. The Expert Group therefore decided that the bran would have the following characteristics: initial free fatty acid (FFA) of not more than 4 per cent and a moisture content of 12 to 13 per cent.

The Expert Group decided that as research and development on stabilizing conditions varied widely, it was necessary to define certain limits within which the stabilization could be carried out. Therefore, it was agreed that, depending on the process:

(a) The temperature of the bran should be around 100°C;

(b) The duration of stabilization should be short;

(c) The residual moisture content should be optimum;

(d) The FFA content of stabilized bran should not exceed 10 per cent;

(e) The stabilized bran should have a keeping quality of at least four weeks for oil extraction and eight weeks for use as a feed ingredient.

It was well known that bran was used as a feed-stuff for livestock and as an ingredient in the production of compound animal feed-stuffs (balanced rations). The quality of the protein in the bran was an important factor from the point of view of nutrition and therefore the conditions adopted for stabilization should not disturb the nutritional value of the bran. The Expert Group agreed that there should be a minimum of denaturation of protein to be measured by the availability of essential amino acids in the bran to be used as a high-quality feed ingredient.

The Expert Group also considered the effect of heat treatment on the bran, which resulted in the formation of oxidation products or rancidity. It took into account the colour of the oil, which is likely to be fixed under certain conditions of heat treatment. The Group agreed that the effect of hydrolysis of triglycerides and the formation of oxidation products or rancidity should be kept at a minimum in the application of heat. Colour fixation in the oil should be avoided.

The Expert Group noted that, while considerable work had been carried out on the technology of rice bran stabilization, little or no attention had been paid to what might be referred to as post-stabilization technology. Its importance was recognized since once the bran had been stabilized, its keeping quality should be prolonged so that it would be a useful industrial raw material, both for oil extraction and the feed industry. The Group agreed that the post-stabilization technology should include:

(a) Prevention of regeneration of the lipase activity, of insect infestation, of the growth of micro-organisms and of rodent attack;

(b) Packaging conditions;

(c) Storage and transport conditions.

There was considerable discussion on the need to motivate the rice millers to take up the stabilization of rice bran, which necessarily involved additional capital and operational costs. It was also suggested that, unless sufficient incentives were available or the stabilization unit could be proved economical, it might be difficult to have it adopted on a commercial scale. The Group agreed that the incentives to the millers, and the cost benefits of the stabilization of bran should be examined.

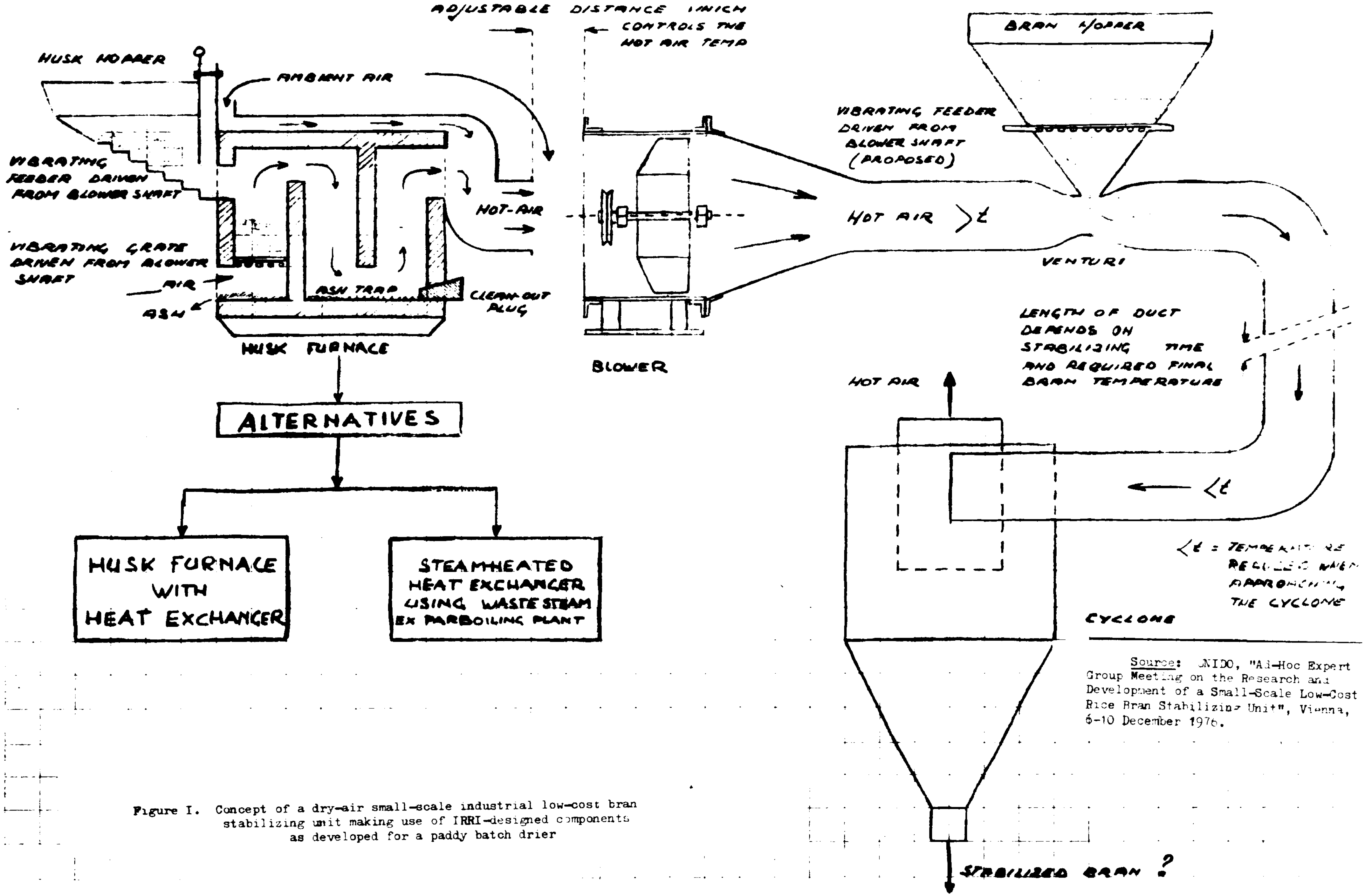
II. TECHNOLOGY OF RICE BRAN STABILIZATION

When the Expert Group had established the parameters of the project as a whole, it discussed the processes and designs so far known for the stabilization of rice bran. In the light of the information available and the research and development work that had been carried out, the Group thought that the stabilization of rice bran could be broadly divided into two processes: dry heat and moist heat. In developing a low-cost, low-energy stabilizing unit, the use of rice husks as a source of energy was of particular interest. It was decided, therefore, that the generation of heat or energy through the use of rice husks should be examined separately from the technology of stabilization.

Considerable discussions took place on the comparative merits of the dry- and moist-heat processes. In support of the dry-heat process, the Expert Group considered a theoretical concept of a dry-air, small-scale, low-cost rice bran stabilizing plant (see figure I).

It was generally thought that the capital cost of dry-heat equipment might be less than that of a moist-heat process. According to available information on the dry-heat process, the reduction of moisture was from 12 to 6 per cent. It had the disadvantages of denaturation of the protein owing to direct contact with the hot air and of agglomeration of the bran in a fluidized-bed system. In weighing the dry-heat process further, doubts were expressed as to the control of the hot-air temperature, the extent of cooling of the treated bran and the possibility of ash being mixed in the bran itself. In support of the process, it was mentioned that instead of blowing the hot air directly, the possibility could be explored of introducing a heat exchanger.

With regard to the moist-heat treatment, it was claimed, on the basis of the research and development work carried out, that it destroyed not only the lipolytic enzyme-lipase but also the oxidative enzyme-oxidase, both of which were responsible for the deterioration of the quality of the rice bran. In the process that had been tried, it was argued that the disadvantage of agglomeration (aggregaters) of bran had been overcome. The keeping quality of the stabilized bran was reported to be at 6 per cent FFA for a period of 90 days with reference to the protein quality of the bran. It was noted that this process had not been tried sufficiently under the humid tropical conditions prevailing in the developing countries where rice bran is produced. In the discussion of this process, reference was made to the possibility of adding water instead of steam at the initial stages.



Source: UNIDO, "Ad-Hoc Expert Group Meeting on the Research and Development of a Small-Scale Low-Cost Rice Bran Stabilizing Unit", Vienna, 6-10 December 1976.

Figure I. Concept of a dry-air small-scale industrial low-cost bran stabilizing unit making use of IRRI-designed components as developed for a paddy batch drier

In view of the competing claims regarding the advantages of both processes, a comparative diagram was drawn (figure II) from which it may be seen that in the moist-heat process there is the additional step of steaming the rice bran. Except for this, the drying process in both methods would amount to a removal of about 4.5 per cent of the moisture. The dry-heat process results in 95.6 kg of bran with 8 per cent moisture content, whereas the moist-heat process results in 100 kg of bran with 12 per cent moisture content. The latter, therefore, is of greater commercial acceptability.

In the ensuing discussion, particular reference was made to the possible disadvantages of moisture content in the moist-heat process, such as (a) the growth of micro-organisms, (b) hydrolysis of triglycerides, (c) rancidity and (d) agglomeration. It was explained that the moist-heat treatment did not produce these adverse effects and, in the view of the Group, such deterioration occurred only when the moisture content was higher than 12 per cent.

It was also mentioned that a large number of rice mills in the organized sector were already equipped with steam boilers, and the steam was readily available. In addition, the use of rice husk, which at present is considered to be a waste material, would economize on the cost of fuel for raising the steam. The requirement of steam in the moist-heat treatment was said to be about 10 per cent of the bran weight, which was considered an insignificant amount. Contrary to these advantages, the dry-heat process still suffered from a number of drawbacks, such as the risk of the regeneration of the lipase activity with the increase of moisture content and the more serious problem of agglomeration of the bran in the fluidized-bed treatment. The process developed by the Central Food Technology Research Institute was also briefly considered; it involved the dry-heat process, and the Group came to the general conclusion that because of the design of the equipment and the use of electricity as a fuel it might not be a suitable process to be considered within the parameters decided upon for the project.

Dry heat	100 kg rice bran (RB) 12 per cent moisture content (MC)	Moist heat

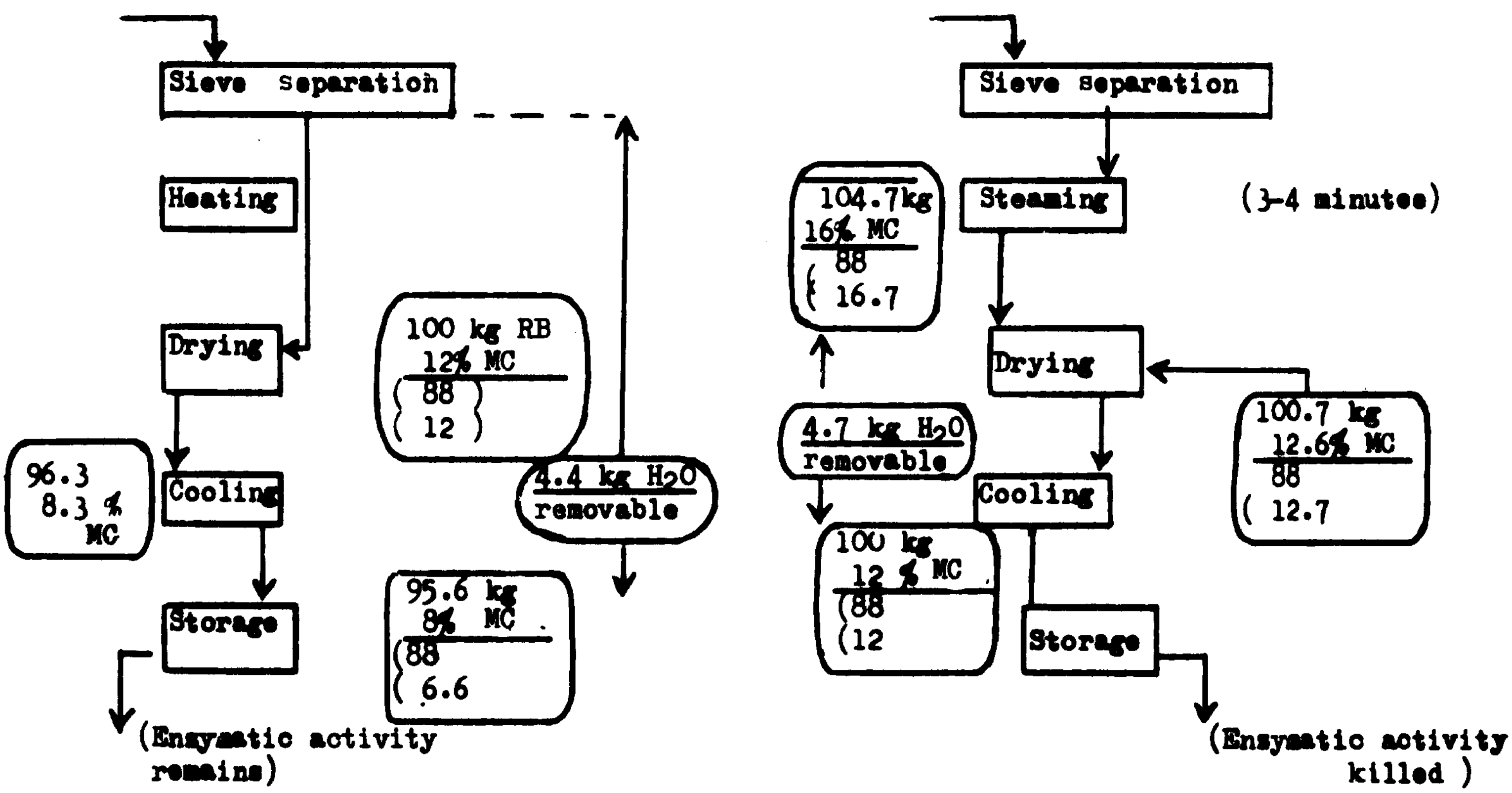


Figure II. Comparative diagram of dry-heat and moist-heat process

III. IDENTIFICATION OF RESEARCH AND DEVELOPMENT ACTIVITIES

The Expert Group was not in a position to identify specific designs for a small-scale, low-cost rice bran stabilizing unit within the parameters defined and according to the technology discussed in the previous section. The Group felt that before a decision could be taken, further extensive work would have to be carried out on the analysis and evaluation of the competing processes, and on designs that might already be available or that needed to be developed. The Group therefore decided to divide itself into three working groups covering: husk furnace and/or heat exchange; rice-bran heat processing; and packaging, storage and transportation of heat-processed rice bran. The conclusions and recommendations of the groups are as follows:

Husk furnace and/or heat exchange

Heat efficiency

Assumed effective heat production: 1 kg husk = 2,000 kcal (Eff. = 66 per cent) (12 to 14 per cent moisture content)

Furnace efficiency: 90 per cent after providing for 10 per cent radiation loss

Consequently, the furnace is to produce 1,800 kcal/1 kg husks

Parameters for construction

Fuel

Variable control of husk feeding (stoking) from husk hopper to combustion area

Continuous discharge of ash

Provision to arrest the fly-ash from flue gas

Air

Adjustable primary air inlet

Adjustable secondary air inlet

Forced draught (direct or indirect)

Heat exchanger (if required for flue gas)

Flue gas through-flow area should be accessible for cleaning

Heated-air through-flow area should be accessible for cleaning

Exchanger should not cause excessive restrictions to flow of flue gases or heated air

Optimum efficiency in heat transfer should be in balance with construction costs and heat requirement

Construction should permit economic and easy replacement of worn-out parts

(if required for steam)

Exchanger should be designed for low-pressure wet steam: maximum 1 kg/cm^2 or 14.5 psi

Steam through-flow area should be accessible for cleaning

Heated-air through-flow area should be accessible for cleaning

Exchanger should not cause excessive restrictions to flow of steam or heated air

Optimum efficiency in heat transfer should be in balance with construction costs and heat requirements

Construction should permit economic and easy replacement of worn-out parts

Provisions for condensate removal should be included

Specifications

Capacities of furnace and heat exchangers, the velocity of heated air, the temperatures of flue gas and heated air should be compatible with stabilizer design and requirements.

Rice-bran heat processing

Stabilization methods

Heat stabilization is generally accepted as a method for the stabilization of bran. It can be divided into two processes, depending on the means of heating:

(a) Dry-heat stabilizers are heated with either direct or indirect contact heating to achieve an efficient heating effect. The dryers may be heated by hot air or flue gas resulting from husk burning and can be divided into rotary dryers, conveyors, or fluidized beds;

(b) Wet-heat stabilizers are divided into autoclaves, conveyors, stack cookers. They depend on moisturization of the bran to be stabilized, followed by a drying process.

General requirements of stabilizer

Low-cost with an efficient stabilization

Suitable for attachment to small rice mills in rural areas

Easily operated with less attendance

Easily maintained

Design and function of stabilizer

The stabilizer is designed for 100 kg/h and should fulfil the following conditions:

Temperature of the bran should be around 100°C

Shorter residence time of the bran, i.e. 3 to 5 minutes

Efficiency in heat transfer

FFA per cent of the stabilized bran does not exceed 10 per cent on an average

4-8 weeks storage depending on environmental conditions

High-quality oil and protein constituents

Packaging, storage and transportation of heat-processed rice bran

The conclusions of this working group were as follows:

(a) "Stabilization" should be taken to mean the process commencing with heat treatment of the bran after milling, and terminating with its use as an animal feed or as a raw material in further processing. However, it was generally understood to mean the heat processing only, and attention was drawn to a possible problem of terminology in this connexion;

(b) There was an urgent need for studies of the physical properties of rice bran basic to packaging, storage and transportation;

(c) There was also an urgent need for detailed studies of biochemical microbiological changes in heat-treated bran stored under normal commercial conditions, particularly in the humid tropics. An objective of such work should be the establishment of criteria for safe storage and the development of procedures for monitoring changes;

(d) Considering the hazards and costs associated with storage and transportation of bran in reusable gunny bags, it was recommended that a study should be made of alternatives, including simple forms of bulk storage and transport;

(e) The importance of "good housekeeping practices" in storehouses for bran at rice mills and of further processing units was emphasized;

(f) Control of infestation by rodents and insects was an integral part of the bran stabilizing process and, in particular, facilities should be available for disinfestation when required;

(g) There was a need to promote research and development work on post-stabilizing technology. In this connexion, the development of a standard laboratory stabilizing unit would be helpful.

The question of pelletizing the stabilized bran was considered in the operation of continuous solvent extraction plants. It was known that the batch system did not require pelletization of the bran, whereas in the case of the continuous plants this was a prerequisite. Opinion varied as to the suitability of pelletizing the stabilized bran. However, the Expert Group desired that this question should also be examined under the post-stabilization technology.

The conclusions reached by the three working groups could form the basis for the continuation of the project on the rice bran stabilization programme.

IV. ECONOMIC AND SOCIAL ASPECTS

The main consideration should be the availability of incentives for the rice millers to justify the additional capital and operational costs involved in the installation of stabilizing units. One view was that the solvent extraction plants that were interested in securing raw material of a superior quality might be interested in investing in units for attachment to rice mills. Since the extraction plants were economically more powerful, they could perhaps undertake this activity once the stabilizing units had been successfully developed. However, a reservation was expressed about the problems that might arise in the dual control and management of the units. In support of investment in the stabilizing units, it was mentioned, on the other hand, that it could create additional employment opportunities in the ancillary branch activities in rural areas, and also that the higher cost of the raw material would be sufficiently offset by the sale of rice bran oil for the domestic or export markets and of defatted bran of a higher protein content and better keeping quality.

It was also suggested that a conscientious effort be made to create markets for the stabilized bran. To this end, feasibility studies had to be carried out, especially on market demand or demand analyses with particular reference to the rate of return and the benefits that would accrue by the installation of stabilizing units.

The Expert Group placed considerable emphasis on the choice of equipment or, in other words, the adaptation of a technology appropriate to the conditions prevailing in the rural areas. This was broadly interpreted as generating employment and keeping capital costs low.

The traditional use of rice bran in rural areas, such as for livestock feed-stuff, could not be changed unless alternative low-cost feed-stuffs were made available to the farmers. Another point to be considered was the problem of middlemen in the purchase of the raw rice bran from the millers.

The extraction of oil from rice bran had been a well-established practice for the production of both edible and industrial-grade oils in some countries such as Burma, India, Japan and Thailand, whereas in such vegetable-oil exporting countries as Indonesia, Malaysia, the Philippines and Sri Lanka it had not yet been found feasible or profitable to extract oil from rice bran. Government policies and incentives would also affect, to some extent, the increased use of rice for industrial purposes.

In order to examine the numerous economic and social problems confronting the profitable utilization of rice bran as an industrial raw material, the Expert Group agreed that a project be initiated that would encompass the issues discussed.

The Group recognized that the stabilization of rice bran was the first essential step towards its fuller utilization as an industrial raw material, both for the extraction of oil and for the feed industry. Much remained to be done through research, development and extension to promote its most economic and profitable utilization. To this end, the Group recommended that a manual be published containing comprehensive information on the science and technology involved as well as on the potential of commercial utilization of rice bran.

Annex I

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Annex II

PAPERS PRESENTED TO THE MEETING

ID/WG.240/2 — Draft study on the definition of the most suitable rice bran stabilizing technology, its verification and the specification of its technical parameters
by the Applied Scientific Research Corporation of Thailand (ASRCT)

ID/WG.240/3 — Rice bran stabilization
by H.G.R. Reddy, UNIDO Regional Industrial Adviser, ESCAP/UNIDO Division of Industry, Housing and Technology, Economic and Social Commission for Asia and the Pacific (ESCAP), Bangkok, Thailand

ID/WG.240/4 — General outlook on heat stabilization of rice bran
by M.H. El-Mallah, Research Professor, National Research Centre, Cairo, Egypt

ID/WG.240/5 — Rice bran stabilization
by D. Adair, Head, Industrial Development Department, Tropical Products Institute (TPI), Berkshire, UK

ID/WG.240/6 — Socio-economic aspects of rice bran stabilization in rice producing countries
by M.H. El-Mallah, Research Professor, National Research Centre, Cairo, Egypt

ID/WG.240/7 — Stabilization of rice bran
by S. Barber, Deputy Director, Instituto de Agroquímica y Tecnología de Alimentos (IATA), Valencia, Spain

ID/WG.240/8 — General outlook on industrial dryers
by M.H. El-Mallah, Research Professor, National Research Centre, Cairo, Egypt

ID/WG.240/9 — Engineering aspects of a simple low-cost rice bran stabilizer
by P.S. Barton, Agricultural Engineer, International Rice Research Institute (IRRI), Bangkok, Thailand

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche

G-322

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