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Interregional Seminar on the
Industrial Processing of Rice

SUMMARY

RICE-BRAN WAX RECOVERY AND UTILIZATION 1/

by

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I. INTRODUCTION

1. As a by-product of rice processing, rice-bran amounting to 5 - 13 per cent the weight of the unmilled rice, is produced. The nutritive protein content (10 to 18 per cent) of the rice-bran has a high potential for food use if it could be concentrated or extracted and recovered economically.

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2. Rice-bran conta ns about 5 to 29 per cent (or on average 15 per cent) of lipids. The most useful and exploited field of by-product utilization in the rice processing industry relates to that of oil production from the bran.

3. The crude rice-bran oil contains a considerable amount of wax. The characteristics and physical properties of purified wax are similar to those of carnauba wax.

4. This paper discusses some of the problems of rice-bran wax recovery and utilisation.

II. QUALITY DEFINITION OF RICE-BRAN WAX

5. An international standard for rice-bran wax has not yet been established. According to the prescriptions of FDA, rice-bran wax is the refined wax from rice-bran meeting the following specifications: m.p. 75 - 80°C, max. free fatty acids content 10 per cent, max. iodine number 20, saponification number 75-120. Based on the data published in literature and on the results of my own investigations the proposed quality prescriptions for rice-bran wax may be summarised in the following: colour yellowish-white, iodine number 4-20, acid number 5-20, saponification value 80-120, non-saponifiable matter 52 - 58 per cent, m.p. 78-82.

III. WAX CONTENT OF RICE-BRAN OIL BY COMPARISON WITH WAX CONTENT OF COMMON OIL-BEARING SEEDS

6. The wax content of crude rice-bran oil will be dependent upon the solvent temperature conditions, source and the age of the bran and many other factors.. Summarising, we can state that the crude rice-bran oil, depending on production conditions, contains 2 - 5 per cent of wax.

7. The wax content of crude oil from common oil-bearing seeds is generally much lower than that of rice-bran oil. Here I also want to emphasize, that the wax content of crude oil will be dependent upon the conditions of production. Sunflower wax, soyabean wax, sesame seed wax, sorghum grain wax etc. are also known, but they have no importance from a commercial point of view.

IV. USES OF RICE-BRAN WAX

8. The purified rice-bran wax has similar properties to those of carnauba wax. This means that the potential field of use of the rice-bran wax is very wide. As a potential substitute for carnauba wax, rice-bran wax may also be a "melting point booster" for other waxes. It may be employed in different polishing emulsions, as a constituent of shoe creams and as an ingredient or coating for candy, chewing gum and fruits.

V. CHEMICAL AND PHARMACEUTICAL PRODUCTS WHICH CAN BE RECOVERED ON A COMMERCIAL SCALE FROM RICE-BRAN WAX AND THEIR USES.

9. One of the pharmaceutically interesting components of the rice-bran oil is oryzanol consisting of ferulic acid ester of triterpene alcohol. This compound is efficacious for climacteric troubles, unbalanced autonomic nerve and for acceleration of growth. One of the ways of isolating oryzanol is the treatment of the dark oil obtainable from soap stock in the alkali refining of the rice-bran oil.

10. Inositol, a product of decomposition of phytin, is produced from defatted bran. The process of recovery has been developed by several Japanese companies.

11. Oryzanol and inositol were also isolated from Hungarian rice-bran and rice-bran oil, but only on a laboratory scale.

VI. THE MARKETABILITY OF RICE-BRAN WAX

12. To estimate the marketability of a new product is very difficult. The world production of the vegetable waxes is estimated at approximately 20,000 tons per year. About half of this quantity is carnauba wax. The production of other plant waxes is relatively smaller. The most important consumer, the USA, imports practically all the hard vegetable waxes. The countries of Western Europe also import relatively high quantities of plant waxes. The prices vary from US$ 1,100 to US$ 1,800 per metric ton of wax. Prospectively the marketing of 3,000 - 5,000 tons rice wax seems to be possible.

VII. TECHNICAL PROCESSES USED FOR THE RECOVERY OF RICE-BRAN OIL AND RICE-BRAN WAX; EQUIPMENT AND ECONOMICS

13. The simplest method of rice-bran wax recovery is the separation of crude rice-bran oil tank settlings with filtration or centrifuging. In recent years separation of wax is being done more and more by using solvents. One of the possible methods is the dissolving of crude oil in hexane and cooling of this solution to 0°C. A practically complete dewaxing is obtainable by this method.

14. By the use of the methods described in the preceding paragraph the amount of produced wax is only 1 - 1.5 per cent, because no attempt is made by common extraction to extract the maximum quantity of wax. For rice-bran wax production a higher extraction temperature is needed.

15. A modern, economical, large industrial scale rice-bran wax production can be achieved by use of the filtration extraction process first proposed by Pominski et al.

16. The two possible processes are the following: (a) extraction with cold hexane at about 5°C to remove oil, followed by a hot hexane extraction to remove wax, both operations being conducted on a single apparatus. Wax is recovered by cooling of hot wax miscella; and (b) single hot hexane extraction in a continuous filtration extraction apparatus. After hot water washing and separating the hot miscella is cooled and the precipitated wax separated by centrifuging. The first method of cold-hot extraction is preferable.

17. The material balance of the cold-hot extraction process for the simultaneous recovery of wax and oil, and also the estimated additional equipment and costs are discussed in this chapter. Some problems of the establishing of plants for the recovery of the rice-bran oil and rice-bran wax are described, and also the possible effects of the new high-yielding varieties of rice on the rice-bran oil and rice-bran wax processing industry are discussed.

VIII. "SEM" MILLING OF RICE AND RICE-BRAN WAX RECOVERY

18. The extractive milling of rice also provides a possibility for rice-bran wax recovery. In the common X-M process a hot crude oil is obtained containing about 1 to 1.5 per cent of wax. This crude oil can be chilled, stored and the precipitated wax can be separated by c ntrifuging.

19. Laboratory scale experiments indicate that increased quantities of wax may be obtained if, after centrifugal separation, the bran is mixed with hot hexane.

IX. POTENTIAL FUTURE DEVELOPMENTS IN THE RICE-BRAN WAX PROCESSING INDUSTRY, AND POSSIBLE IMPEDIMENTS

20. A general modernisation and growth of rice production and rice processing will create new, more favourable conditions for the development of rice-bran oil production and also rice-bran wax recovery. Since wax production on an industrial scale is not possible without rice-bran oil extraction, the development of the wax processing is determined by technical advances in rice oil production.

21. The scarcity of domestic sources of oils and fats and traditional dependence on imports is an incentive for development. On the other side the economic factors operating in oil exporting countries with inexpensive traditional sources of oil are likely to determine the development of rice-bran oil production for as long as its costs of production are higher.

22. Prospectively a production of rice-bran wax in an amount of 2,000 - 4,000 tons per year seems to be possible.

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RICE-BRAN WAX RECOVERY AND UTILIZATION 1/

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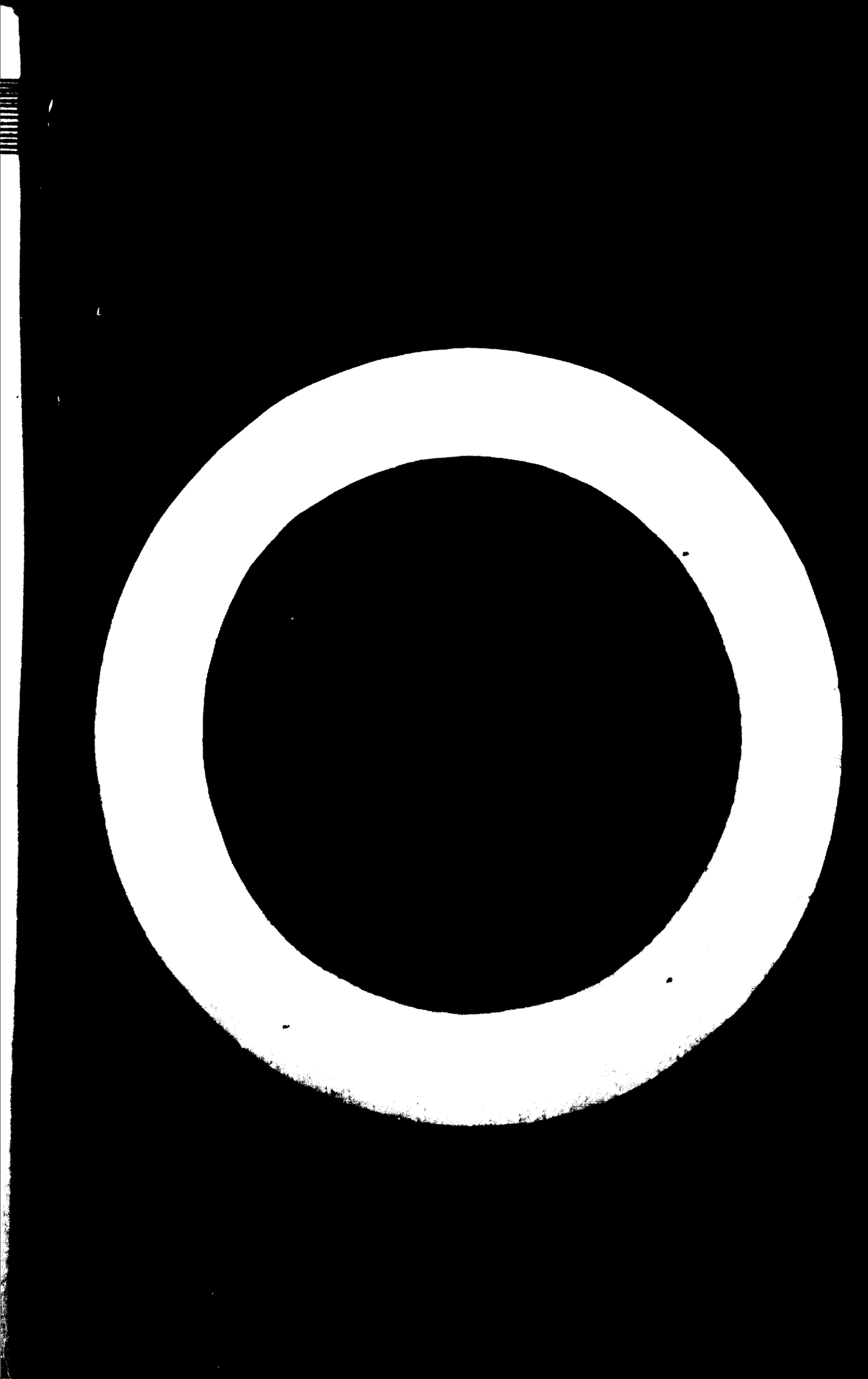


CONTENTS

Introduction

1. Though cereal consumption has decreased in the industrially developed countries in the past decades, in Asia and especially in South East Asia the rice is the basis of the daily diet of the population. The present rice production in developing countries of South East Asia is not sufficient to cover the ever-growing needs of population at an optimal level.

2. The solving of the nutritional problems is only possible by increasing the food production. The greatest prospects for improving supplies of food lie in increasing the yields from rice and other cereals, crops which already dominate world protein production. It is estimated that about one tenth of this yield is lost by poor harvesting conditions, drying, collection and conveying. Therefore preventing the losses which take place between harvesting, processing and marketing is also very important.

3. Great possibilities are offered by the use of some byproducts of rice processing. As byproduct of milling, rice-bran amounting to 5-13% the weight of the unmilled rice is produced. The nutritive protein content (ten to eighteen percent) of the rice bran has a high potential for food use in many areas of the world if it could be concentrated or extracted and recovered economically. Extracted bran meal, fresh or stabilised whole bran and milk-like emulsions from the bran or aqueous concentrates

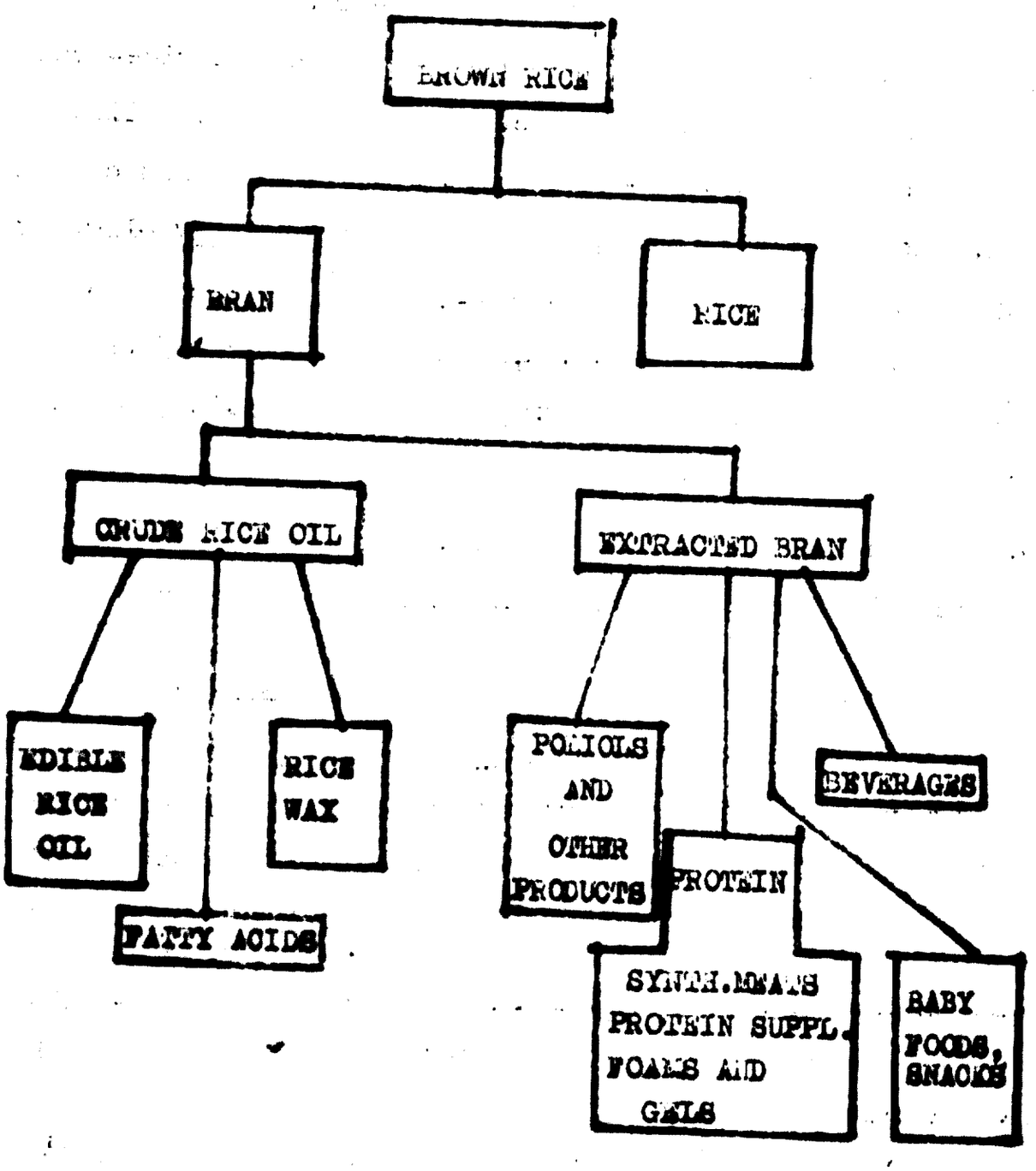
from it can be used as dietary supplements of vitamins and proteins. The germ meal is an excellent source of proteins of high biological value.

4. Rice bran contains about 5-23% (or on average 15%) of lipids. The most useful and exploited field of by-product utilisation in the rice processing industry relates to that of edible oil production from the bran. The crude rice oil contains a considerable quantity of wax.

5. The isolated wax is similar to carnauba wax. The potential rice bran applications are summarised in Scheme No 1. (Page 3).

6. The purpose of this paper is to explain some problems of rice-bran wax recovery and utilisation.

POTENTIAL RICE BRAN APPLICATIONS



SCHEME N° 1.

Quality Definition of Rice-Bran Wax.

7. An international standard for rice-bran wax is not yet published. According to prescriptions of FDA rice-bran wax is the refined wax from rice bran meeting the following specifications: m.p. 75-80 C°, max. free fatty acids content: 10%, max iodine number 20, saponification number 75-120. It may be used under the Federal Food, Drug and Cosmetic Act at a max. level of 50 p.p.m. as a coating for candy and fresh fruits and vegetables and 2,5% as a plasticising material in chewing gums.

8. Venkateswara and his co-workers give the following characteristics of rice bran wax (See Table 1. below)

Table 1.

Characteristics of Rice-Bran Wax

Description	Color	Iodine number	Non saponifiable matter %	Total Ash %	M.p. C°
1. Purified Wax	Brown	10,0	58,1	0,3	81
2. Wax bleached with H_2O_2 (0,5 part)	Buff	4,3	55,6	nil	81
3. Wax bleached with Cr_2O_3 (0,5 part)	Yellowish White	4,7	53,3	nil	80,5
4. Wax bleached with Cr_2O_3 (1 part)	White	2,5	49,3	nil	81

9. Tsuchiya and Mamura found the following values for crude rice-bran wax: acid value 2,31, saponification number

147,8, iodine number 70. The wax contained oleic, linoleic, linolenic, palmitic, stearic and behenic acids.

10. Raghunata Rao and Khrisna Murthy separated the crude brown rice wax into a low- and high - melting wax having the following characteristics M.p. 35-55 and 80-83 C°, iodine value 67 and 20, saponification value 115 and 109 resp.

11. Janssen and Feuge (J.Am.Oil Chem.Soc. 30. 9-14.1953.) obtained a hard wax fraction from tank settlings of rice-bran oil. Characteristics of the wax; iodine number 11,1--17,6, free fatty acids 2,1-7,3% and m.p. 75,3-79,9.

12. Japanese authors gave the following data m.p. 80-82, acid number 17, saponification number 90 and iodine number 4. Hydrogenated wax had a higher m.p. 83-93 C°.

13. Wax recovered from Hungarian rice-bran showed the following characteristics: m.p. 73-77 C°, acid number 21, iodine number 18, saponification value 109, non saponifiable matter 55,9%.

14. Based on these data the proposed quality prescriptions for rice-bran wax may be summarized in Table 2. (Page 6).

15. It can be stated that characteristics and physical properties of purified rice-bran wax are similare to those of carnauba wax. Though the crude and unprocessed rice-bran wax could not compete with carnauba wax in lustre

Table 2.

Proposed Quality Prescriptions for Rice-Bran Wax

Name of Product	Color	Iodine number	Acid number	Saponification value	Non saponifiable matter %	M.p. C°
Crude Rice Wax	Brown	10-50	10-35	80-130	52-60	40-70
Purified and Bleached Rice W.	Yellowish White	4-20	5-20	80-120	52-58	78-82
Refined, Hydrogenated Rice Wax	White	2-4	6-10	90-100	50-54	84-93
Carnauba Wax	Yellow	7-14	4-8	80-95	52-56	82-85

giving properties, oil absorption capacity was quite statisfactory and it gave a nice homogeneous product when used with other waxes. This shows the comparative merits of rice bran wax with other waxes.

Wax Content of Rice-Bran Oil by Comparison with Wax Content of Common Oil Bearing Seeds.

16. The wax content of crude rice-bran oil is dependent on many factors: (variety of rice, technique of milling process, method of oil extraction, quality of solvent, extraction temperature etc.)

17. Typical composition of undewaxed and dewaxed rice oils is given in Table 3. (Lawrence and Gary, Food Technology Chicago. 22. 1250. 1960.)

Table 3.

Typical composition of undewaxed and dewaxed rice oils.

Characteristics	Undewaxed:	Dewaxed:
Insoluble impurities %	1,0	0,15
Acetone Insoluble %	3,0	1,0
Free Fatty Acids %	4,0	2,0
Iodine Value	100-105	100-105
Saponification Value	180-190	180-190
Unsaponifiable Matter %	4,0	2,2

From data of Table 3. the wax content of crude rice-bran oil is about 2-3%.

18. Cousins found that most of the crude rice-bran oils presently produced in USA contain only 1-2% wax because no attempt is made to extract it with the oil. Rice bran contains in average about 15% of lipids of which 3 to 9% is wax. The oil-wax relationship will be dependent upon the solvent temperature conditions, source and the age of the bran and other factors. On the bran basis this is equivalent to 0,4-1,5%

wax. But only a part of this is a hard wax fraction having a melting point of 75-82 C°. The yield of hard rice wax from the bran is really about 0,25%.

19. Venkateswara and his co-workers have opinion that from an estimated quantity of 10000 tons of rice bran oil produced annually in India about 500 tons of hard wax type settlings may be anticipitated.

20. Giovanni and Martinengni (Italia) isolated with an solvent dewaxing method (1:1 solution in commercial hexane and cooling at about 0 C°.) 2,5% hard rice wax from the crude rice-bran oil.

21. Japanese authors estimate the wax content of crude rice-bran oil from 2,5 to 3,5%. The Hungarian crude rice oils produced at pilot plant conditions have a wax content from 3 to 5%.

22. Summarising we can state, that the crude rice-bran oils depending on production conditions contain 2-5% of wax.

23. The wax content of crude oil of other common oil bearing seeds is generally much lower that those of rice-bran oil. Here I want also/to emphasize, that the wax content of crude oil will be dependent upon contitions of oil production and many other factors. For example the average sunflower oil also has a given wax content.

24. The oil tank settlings formed by cooling of sunflower oil under 15 C° consists of 96% oil and 4% wax.

25. The isolated pure wax has acid value 0,3, saponification value 33,5, iodine number 8, melting point 75-76 C°. The

... quantity of wax is very small about 0,1% of crude oil. The wax esters in tank settling originate from sunflower seed hulls. The wax content of sunflower hulls is relatively high 1-3% (Popov and Ivanov: Fette, Seifen, Anstrichmittel 70. 235. 1968).

26. The sawa-millet bran oil also contains a small amount of wax (about 0,5%). The characteristics of wax are the following: melting point 71-75 C°, acid number 21,8, saponification value 85,6, iodine number 5,5. The wax contains ceril alcohol, cerotic acid and ω-hydroxydocosanoic acids.

27. The crude oils of other oil bearing seeds as soya, corn, sesame, peanut etc. contain also a small quantity of waxes. The waxes were isolated from oil tank-settlings. In most cases the amount of waxes is smaller than 0,1%. Corn wax from Zea mays L. is composed of hentriacontane, myricyl tetracosanate and myricyl isooctanoate.

28. Soybean wax, sesame seed wax, sorghum grain wax are also known, but they have no importance from commercial point of view.

Uses of the Rice-Bran Wax.

29. The purified rice-bran wax has similar properties to those of the carnauba wax. That means that the potential field of use of the rice wax is very wide. As potential substitute of Carnauba wax rice-bran wax may be also a "melting point booster" for other waxes. It can be used as a hardener in leather dressing, for candles, and in the manufacture. It may be also employed as a constituent of shoe creams, in photographic films, in chalk, in matches, and in different polishing emulsions.

30. In the USA rice wax is FDA approved as an ingredient or coating for candy, chewing gum and fruits.

31. As mentioned above the crude and unprocessed rice bran wax has a quite satisfactory oil absorption capacity, and it gave a nice homogeneous product when used with other waxes. This shows the good compatibility of rice bran wax with other waxes and enlarge the possibilities of its use.

Chemical and Pharmaceutical Products which can be Recovered on a Commercial Scale from Rice-Bran Wax and their Uses

32. One of the pharmaceutically interesting components of the rice-bran oil is oryzanol consisting of ferulic acid ester of triterpene alcohol. This compound is efficacious for climacteric troubles unbalanced autonomic nerve and for acceleration of growth. One way of the isolation of oryzanol is the treatment of dark oil obtainable from soapstock in the alkali refining of rice bran oil (Japanese Pat. No. 1441/1960). The residue of distillation of dark oil is extracted with methanol. The insoluble portion contains oryzanol and wax esters. This residue is treated with cold acetone to separate into acetone insoluble wax and acetone soluble oryzanol.

33. Inositol a product of decomposition of phytin is obtained from extracted bran. The manufacture was been developed by several Japanese companies. Production is estimated to 100 tons per year.

34. Oryzanol and inositol was isolated also from Hungarian rice-brans resp. rice-bran oils, but only on a laboratory scale.

The Marketability of Rice-Bran-Wax.

35. As a preliminary I emphasize, that to estimate the marketability of a new product is very difficult. Starting from the potential possibilities of use of rice bran wax and production data of plant waxes I can write the following.

36. The world production of vegetable waxes is estimated about 20000 tons/per year. About half of this quantity is carnauba wax. The production of other vegetable waxes (for example candellila, ouricuri, sugar-cane, yoyoba etc.) is relatively smaller. The most important consumer the U.S.A. import practically all the hard vegetable waxes it uses in polishes, carbon paper, food wraps, and vegetable and fruit coating. For the past ten years the imports have amounted to over 20000 pounds per year, approximately 3/4 of which was carnauba wax. The countries of Western Europe also imports relatively high quantity of plant waxes.

37. The price varies from 1100 to 1800 $ per metric ton of wax.

38. Calculating with a potential rice-bran wax production of 5000 tons per year and an average price of 1200 $ per ton the total value of production is about 5-6 million $ per year.

Technical process used for the recovery of rice-bran oil and rice-bran wax, quality of the end products.

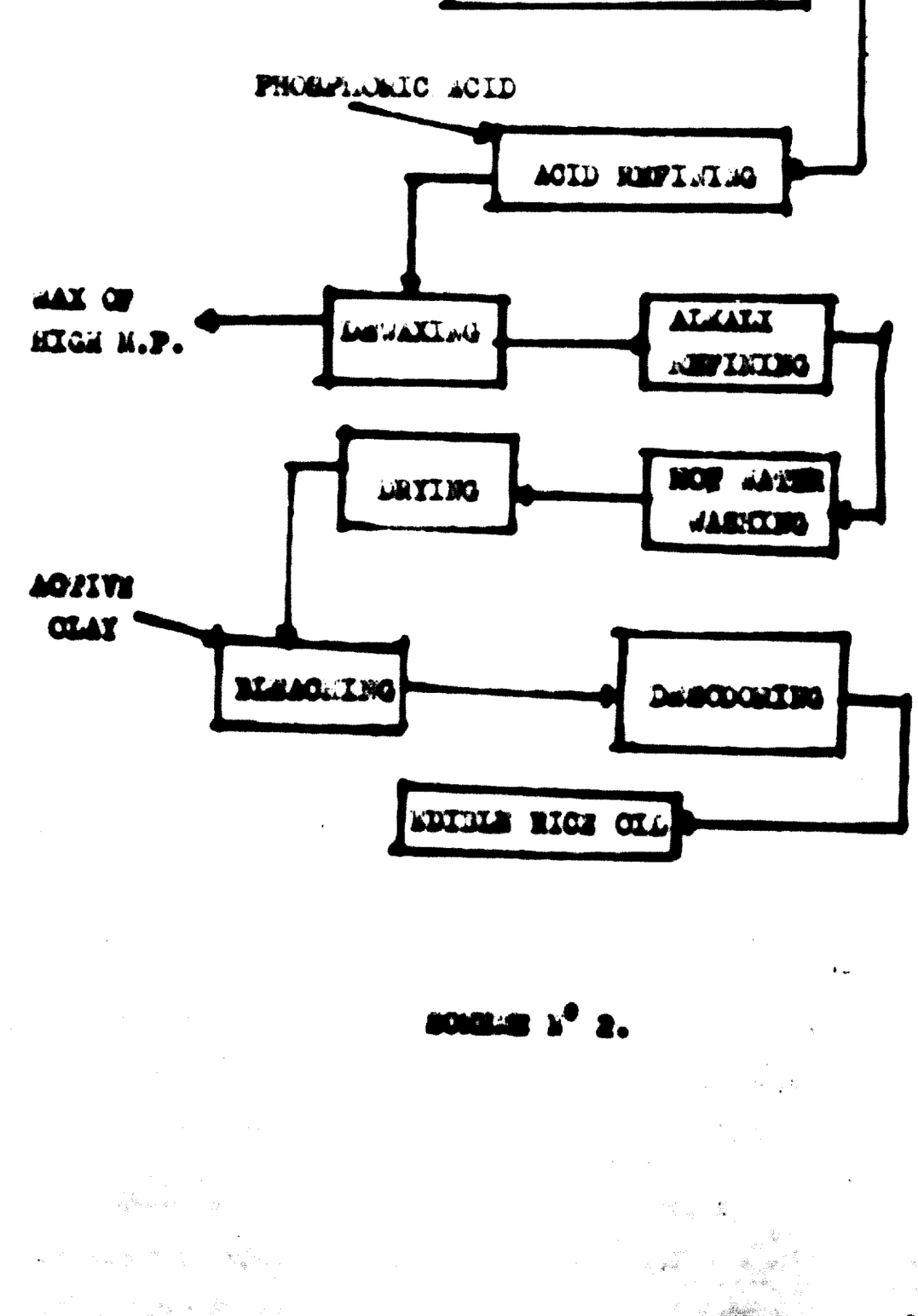
39. The problem of rice-bran wax recovery are closely connected with the rice-bran oil production. Therefore the rice oil and rice wax production must be simultaneously investigated.

40. The simplest method of rice bran recovery is the separation of crude rice-bran oil tank settling with filtration or centrifuging. The sediments are formed by allowing crude rice oil to stand at a temperature lower than 20 C°. The obtained so called rice-bran wax oil is treated with acetone or isopropanole at room temperature. The glycerid and fatty acids are dissolved, wax and some impurities (gums) remain undissolved. The wax is dissolved with hot isopropanol (or acetone) and a gummy residue remains undissolved.

41. More pure wax is produced when preliminary a removal of moisture and foreign matters and a degumming with phosphoric acid is made (see Scheme N° 2.). The composition of "gums" collected immediately after steam stripping from crude rice-oil sludge and a more fatty material, which settles down on longer storage is the following: moisture and volatile matter 45,0 and 1,0%; sand, meal particles 3,5 and 2,2% oil 43,5 and 79,0%, crude wax 2,2 and 17,5% resp.

42. In the last years separation of wax is being done more and more by using solvents. One of the possible methods is

REFINING OF EDIBLE RICE-BRAN OIL



SCHEME N° 2.

the dissolving of rice-bran oil in hexane (1:1) and cooling of solution at about 0 C°. A complete dewaxing is obtainable. Similar results give the dissolving of rice oil in a mixture of acetylenetrichloride and methanol and cooling at 0 C°.

43. With the use of in the preceding described simple methods the amount of produced rice-bran wax is about 1-1,5% (crude oil basis), because no attempt is made to extract it with the oil. The solubility of the rice-bran wax in the hexane, the best commercial solvent for extraction, at low temperature is relatively small. Therefore from point of view of rice-bran wax production a higher extraction temperature is optimal.

44. The effect of temperature on the hexane extraction of acetone insoluble lipids from rice bran is demonstrated in Table 4.

Table 4.

Effect of temperature on the hexane extraction of acetone insolutle lipids from rice bran

(Hungarian rice-bran from factory Karcag)

Temperature C°	Extracted aceton insoluble lipids %
5	28
15	49
25	68
40	85
60	90
70	93

45. In upto date large scale plants a continuous solvent

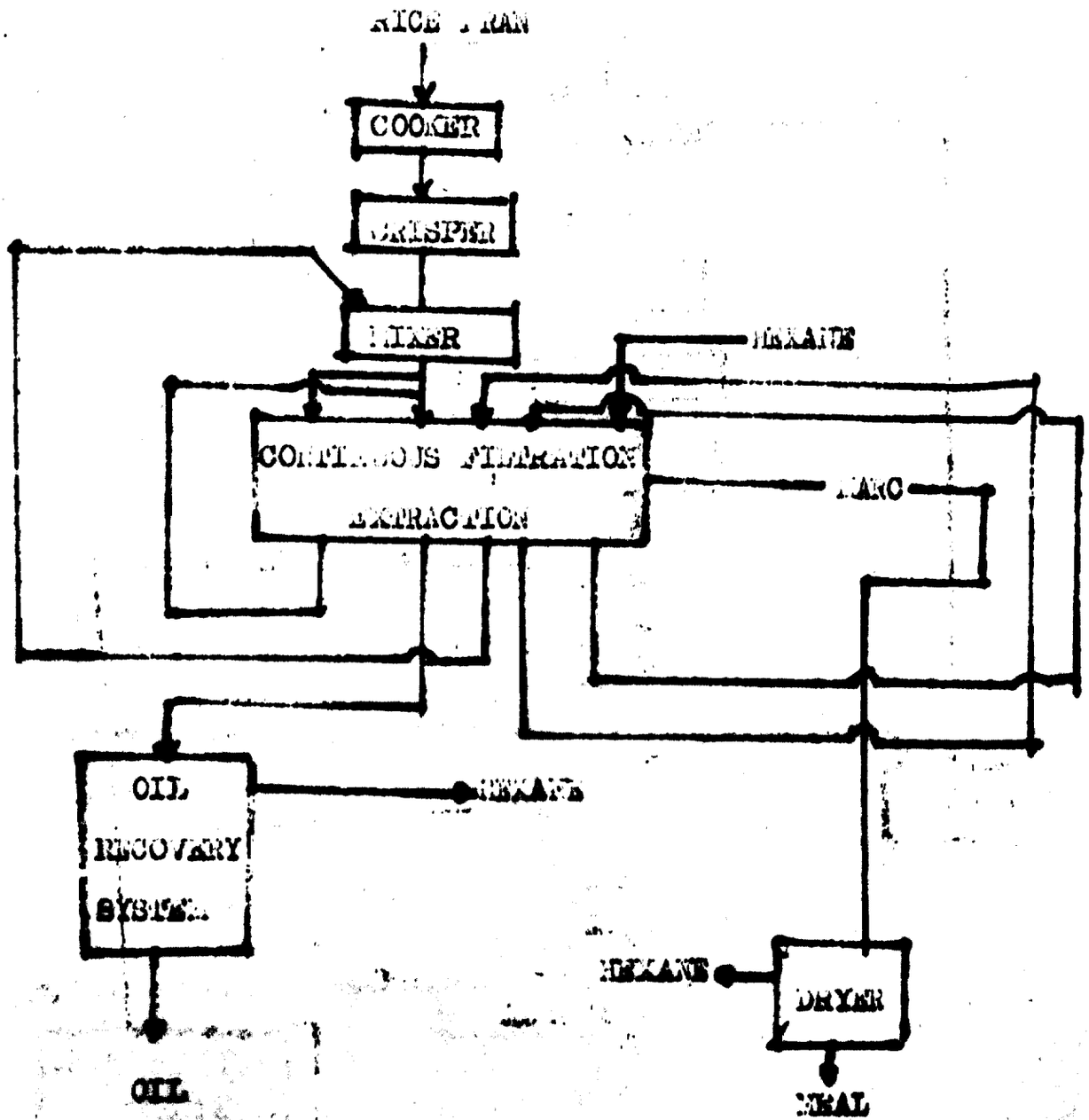
extraction process is used.

46. From known continuous extraction processes an filtration-extraction process seems to be optimal. The flow sheet of filtration-extraction of oil from rice bran is shown in the Scheme N° 3.

47. When a maximal wax production is the purpose a hot extraction is needed. The two possible processes are the following: a) Extraction with cold hexane at about 5 C° to remove oil, followed by a hot hexane extraction to remove wax, both operations being conducted on a single continuous horizontal filter. Wax is recovered by cooling the hot wax miscella to 5 C°, separating the precipitated wax by centrifugation, and desolventizing the solvent wet wax by evaporation and stripping. b) Single hot hexane extraction in a continuous horizontal filter. After hot water washing and separating the hot miscella is cooled and precipitated wax separated by centrifugation. A multiple cold solvent washes would be necessary to purify the wax. The desolventizing of wax is made by evaporation and stripping. The flow sheet of both processes-proposed first by Pominsky etal. - is shown in Scheme 4 and 5.

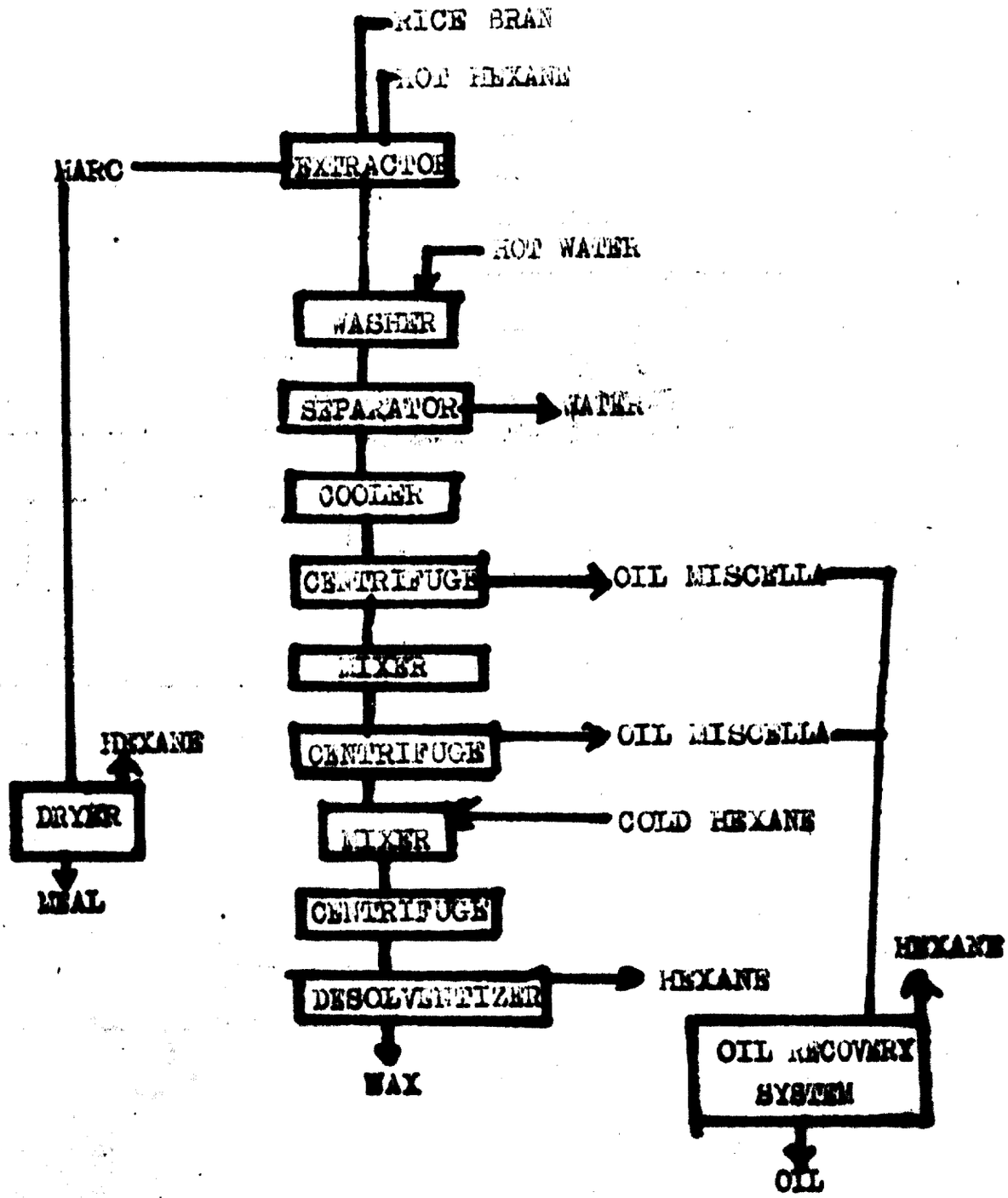
The first method (cold-hot extraction) is preferable. In this method the data indicate that if rice bran is cooked both hot and cold solvent extractions can be performed in a single extractor of the filtration extraction type. This method has

FILTRATION - EXTRACTION OF OIL FROM RICE BRAN



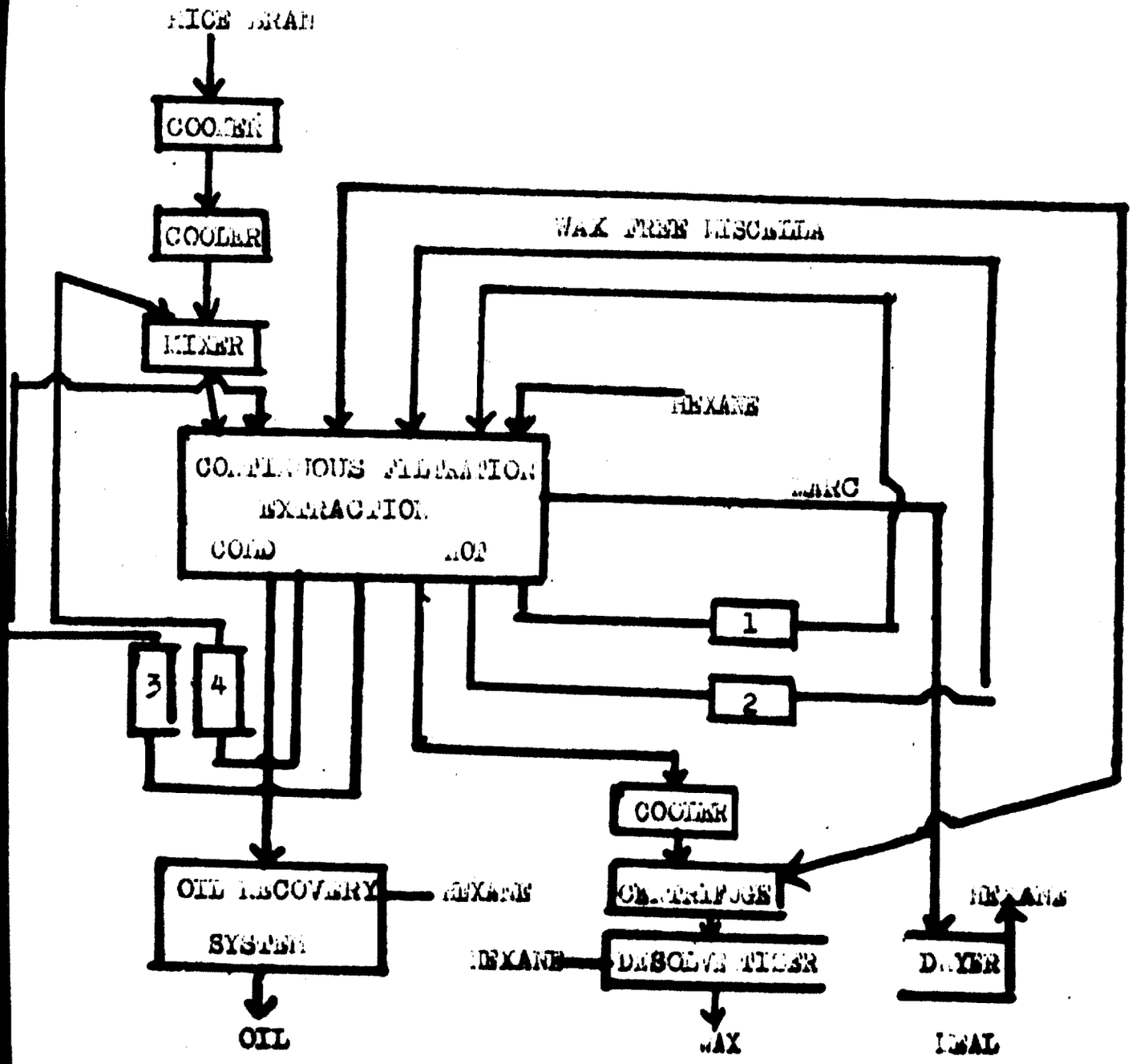
SCHEME N° 3

PROPOSED FLOW DIAGRAM FOR SIMULTANEOUS PRODUCTION OF RICE WAX AND OIL BY SINGLE HOT EXTRACTION



SCHEME N° 4

PROPOSED FLOW DIAGRAM OF FILTRATION - EXTRACTION PROCESS FOR SIMULTANEOUS PRODUCTION OF RICE WAX AND OIL



1, 2, 3, 4 - HEAT EXCHANGERS

SCALE NO 5

the advantage that no water or solvent washing is necessary to produce purified wax, and probably only one centrifuge is necessary. In the second method the multiple number of cold solvent washes necessitate the use of a number of centrifuges.

49. The material balance of the cold-hot extraction process for simultaneous recovery of wax and oil is shown in Table 5.

Table 5.

Material balance of the cold-hot extraction process for simultaneous recovery of wax and oil

(100 tons of rice bran)

Investigated material	Continuous process (Pominski etal) kg	Discontinuous process (Hungarian rice bran pilot plant) kg
Rice bran	100000	100000
Oil in bran	14570	12500
Wax in bran	353	340
Final meal	80952	82480
Wax recovered	250	255
Oil extracted	14192	12030

50. The production of rice-bran oil and rice-bran wax are closely connected together. Therefore the investigation of costs of rice wax processing is very difficult. Taking into consideration only additional equipment required in comparison with single oil extraction without rice wax recovery the estimated equipment and costs are summarized in Table 6.

Table 6.

Estimated additional equipment and costs

(100 tons per day rice-bran)

(Based on data of Pominski et al.)

Equipment	Costs $
Refrigerating units (40 tons)	20000
Heat exchangers (5)	2500
Crystallizer for cooling wax miscella	5000
Centrifuge	15000
Pump for centrifugal liquid discharge	3000
Evaporator and accessories, desolventizing equipment	3000
Stripper, desolventizing equipment	1000
Insulation of filter and slurryer	2000
Instrumentation of centrifuges and desolventization equipments	1000
Pumps (3) and tanks (3) for extra washing of filters	1700
Meal coolers	10000
Cold room, labor, installation	20000
Other expenses (piping, utility) contingencies, engineering expe ser	40000
Total additional costs	124200

51. Calculating with fixed additional costs of 22000 $ 8 year write-off and insurance and tax rates and with additional processing costs of 120 $ per day with a 1200 $ per ton price of rice wax, the approximate net profit of 23000 $ for

plant operation of 250 days is probable.

52. The production of high quality waxes needs a bleaching of wax. The most efficient bleaching process is using Cr_2O_3 dissolved in sulfuric acid.

53. The quantity of Cr_2O_3 is 1 part per 1 part of crude rice wax. The use of H_2O_2 (29%) is also possible.

54. The costs of bleaching are approximately 0,10 $ per kg of wax.

Problems of the Establishing of Plants for the Recovery of Rice-Bran Oil and Rice-Bran Wax.

55. Generally the optimal location and size of a new plant is dependent of many different factors (raw material sources, possibilities and costs of transportation, resources of labor force etc.) In the last decades, a constant development towards most rational middle and large plants has been going on in processing of different cereals. The always increasing needs as well as the unavoidable striving for higher living standard require also in rice processing a development towards rational methods.

56. High requirements on quality and losses yield of rice can also be obtained only by using the latest experiences in grain storage and processing by economic middle and large plants /with an output of 100-600 t per day fitted with a technology meeting all demands. In such a mill, calculated an overage quantity of 10%, 10 to 60 tons of rice bran is produced. If we take a bran-oil plant which is integrated with the rice milling plant and utilizing the above mentioned quantity of rice-bran per day for a 250-day year the estimated profit would be about 15-20%.

57. By simultaneous rice-bran wax recovery (with an cold-hot hexane extraction) an additional profit of about 2-3% would be obtained. The economic benefits gained by establishing a plant for the recovery of rice-bran oil and rice-bran wax as an integrated part of an existing rice mill are the following: 1. Facilities already located such as steam, water and electrical services should be commonly used for both

plants, 2. The transport of rice-bran, and the difficulties to collect it for oil extraction are eliminated.

58. If the capacity of rice mill is smaller than 100-600 ton per day the economical advantages of an integrated system are also smaller.

59. In this case the plant for rice-bran oil and rice-bran wax recovery may be established as completely separate unit collecting the rice-bran raw material from many different small rice-mills.

60. Under special circumstances other savings are also possible. For example utilization of rice-bran in plant producing other vegetable oils. In Hungary also the rice-bran is transported to plant for vegetable (sunflower, soya) oils, and in this plant is produced the refined rice bran oil. A separated crude rice oil production and rice-oil refining is also possible.

The Effects of the New High-Yielding Varieties of Rice on the Rice-Bran Oil and Rice-Bran Wax Processing Industry.

61. In all rice producing countries great efforts were made to introduce new high-yielding strains of paddy . Major objectives of the breeding progrem are to provide new rices with higher yield lodging resistance, early maturity , increased protein content good seedling vigor ,resistance to blanking , resistance to the rice water weevill, excellent milling and cooking quality and cooking characteristics etc.The lipid content and wax content of paddy is not be found in achieved purposes.

62. Unfortunately I have no data about lipid and wax acetone insoluble lipid content of new high-yielding rice varieties such as IR-8 and others.Investigation of lipids of 2 Hungarian and 7 Soviet rice varieties showed that the differences in wax content between different rice varieties grown under the same conditions are not very important.

63. The effect of the new high-yielding varieties of rice on the rice bran oil and rice bran wax processing industry is indirect.The higher yields , the more concentrated rice production give better conditions for modernisation of rice milling and preprocessing technique and make possible to collect large quantities of bran of good quality for extraction of oil on an industrial scale.

"[illegible]" Milling of Rice and Rice-bran Wax Recovery.

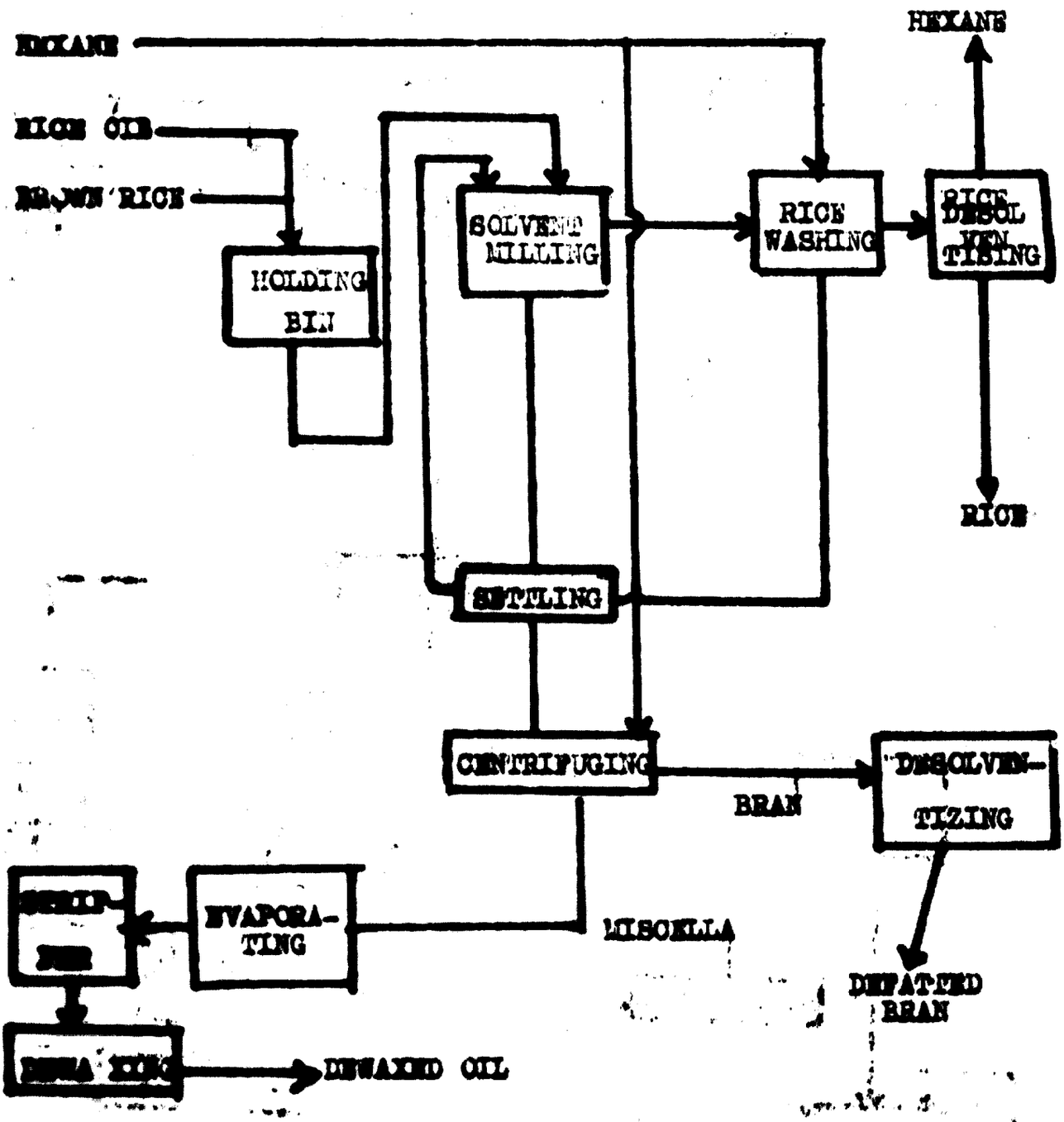
64. Extractive milling of rice in the presence of an organic solvent opened a new chapter in the rice milling history. The new process (L-M process) give a higher yield of rice with less kernel breakage . During milling the fatty components of the bran are extracted and high quality by-products defatted rice-bran and crude rice oil are obtained.

65. The L-M process give also a possibility for rice-bran wax recovery.In the normal L-M process (see Scheme 6.) a hot crude oil is obtained containing about 1,5% of wax. This crude oil is chilled and stored for 2 days.The long residence time is to allow crystal formation and growth.The precipitated wax is seperated in a classical continuous vegetable oil refining type centrifuge.

66. Increased quantity of wax may be obtained (based on laboratory scale experiments) if after centrifugal separation ,the bran is mixed with hot hexane. The slurry of hot hexane ,extracted bran and miscella is centrifuged.The miscella is cooled for precipitating of wax. The flowsheet of modified process is shown in Scheme 7.

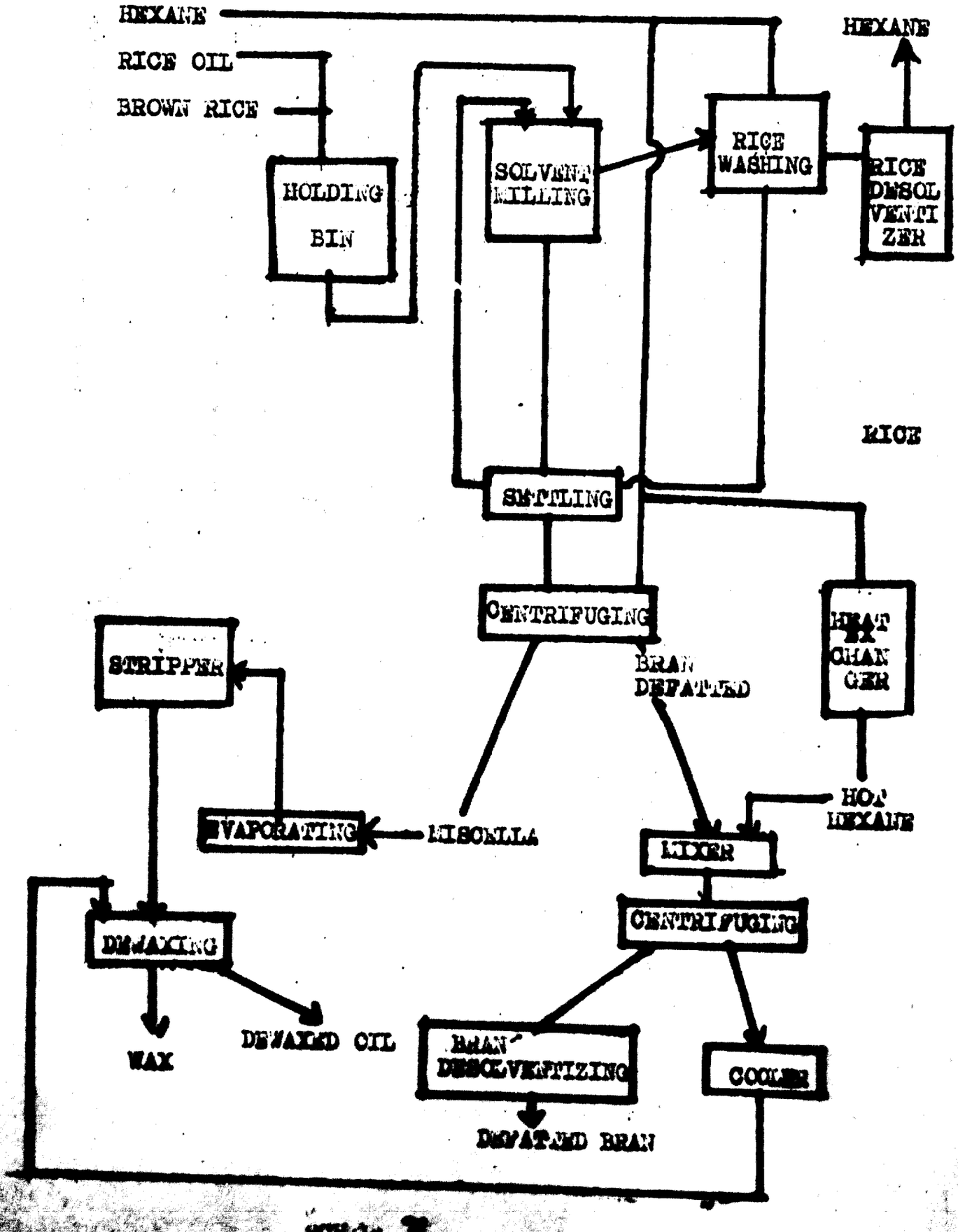
67. The eventual purifying and bleaching of wax may be made by previously described method.

RICE MILLING PROCESS FLOWSHEET



SCHEME N° 6.

WAX RECOVERY WITH SEM PROCESS



How to Encourage the Use of Modern Methods of Recovering Rice-Bran Wax and Rice-Bran Oil in Developing Countries

68. The problem of the use of the modern methods for rice oil production and rice-bran wax recovery is closely connected with needs of general modernisation of rice production and rice processing.

69. The two possible ways of help are :First a constant information about.new results of the rice-bran wax processing , marketability of rice wax and rice oil, economic advantages of rice oil production and rice-bran wax recovery. Secondly an financial support of development of the rice oil producing industry and factories.

Potential Future Developments in the Rice-Bran Wax Processing Industry, and Possible Impediments.

70. A general modernization and growth of rice production and rice processing will creat new, more favourable conditions for development of rice-bran oil production and also rice-bran wax recovery. Since wax production in an industrial amount is not possible without rice - bran oil extraction the development of the wax processing is determined with technical advances in rice oil production.

71. The scarcity of domestic sources of oils and fats and traditional dependence on imports is an incentive for development, if the problem of collecting of bran of good quality is solved. On the other side the economic factors operating in oil exporting countries with an inexpensive traditional sources of oil are likely to determine the development of rice bran oil production for as long as its cost of production is higher.

72. Prospectively a production of rice -bran wax in an amount of 2000-4000 tons per year seems to be possible.

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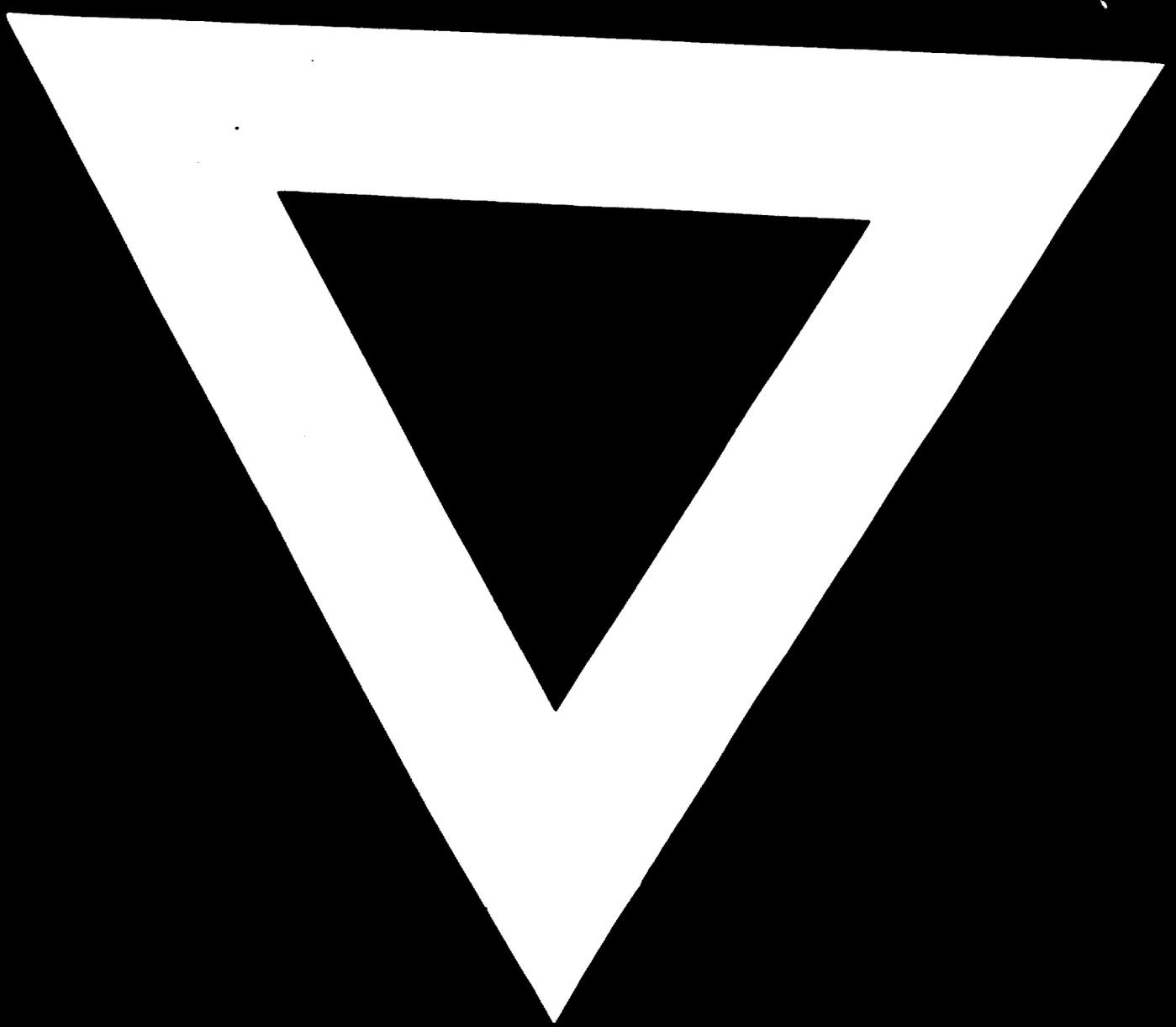

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