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UNITED STATES GOVERNMENT

Memorandum

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PD-AAQ-836

ACTION MEMO

TO : DS/PO, Mr. Robert Simpson

DATE: February 10, 1978

FROM : DS/AGR, Leon F. Hesser

SUBJECT: Small Project Activity/Special Project Inputs, Improved Rice Threshing, Drying and Milling Systems and/or Equipment

Proposal: This is to request an allocation of $90,000 to Dr. Robin S. Saunders, Cereals Division, Western Regional Research Center (WRRC), USDA, 800 Buchanan Street, Berkeley, California, 94710 for funding of a state-of-the-art review of appropriate village level rice threshing, drying, and milling systems and/or equipment. The project proposal, developed after several months communication with WRRC, is attached as Annex A. The WRRC has had over 25 years of continuous and substantial basic and applied cereals research; has a broadly experienced staff and has evolved numerous and active contacts in industry, academic institutions, professional societies and other U.S. and foreign government units concerned with cereals. WRRC is recognized worldwide as a wheat and rice research center. A more complete description of the Cereals Unit is attached as Annex B.

1. Background: Rice drying, threshing and milling was an area of postharvest loss reduction research presented in the FY 1979 ABS, page 139, and discussed at the DS/AGR Portfolio Review before the Regional Bureaus. Preliminary summary reports of the National Academy of Sciences, in response to the DS/AGR contract for a review of global food losses and appropriate methods of intervention, gives a high priority to research dealing with rice threshing, drying and milling systems. In fact, of all potential research on commodities, rice threshing, drying and milling systems was listed first by the National Academy of Sciences.

Projections of grain production, consumption, and deficits for the LDCs by several responsible agencies e.g., the USDA, the World Bank, FAO, and the International Food Policy Research Institute, suggests LDC grain deficits to average 70 million metric tons per year by 1985. Rice, of course, is the major grain crop in the LDCs with current production being around 200 million metric tons (MMT). per year. Postharvest losses of rice in the threshing, drying, storing and milling systems is generally considered to be the highest of any grain crop. De Padua in the Philippines has reported postharvest losses to be from 10 to 37 percent of the harvested crop.

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Using De Padua's loss estimates, postharvest rice losses would range from 20 to 74 MMT a year with a mean value of 47 MMT per year. This mean value of the quantities of rice postharvest losses translates to a quantity of food to feed 170 million people, with a value (at $200 per ton) of $9.4 billion per year. A mere 2 percent reduction in losses would provide 4 million tons of rice, equivalent to the caloric requirement of 14 million people, and at $200 per ton would save $800 million per year.

The postharvest losses in rice, are in the handling, threshing, drying and milling systems. The losses are not primarily due to insects, mold, birds, rats, or other biological causes. The losses are in the mechanics of the handling systems. Therefore improvements in the mechanical handling systems of threshing, drying, parboiling and milling systems are considered to be the most practical approach to reducing rice postharvest losses.

2. Purpose: The central purpose of this Small Activity is to be a state-of-the-arts review of rice threshing, drying, parboiling and milling equipment and/or systems with the express goal of determining potential new or improved systems which might be more appropriate at the village level in the LDCs. Any actual development of potential new or improved rice postharvest equipment and/or systems is not intended to be covered in this Small Activity but would be covered by possible future contracts.

3. Integration with other AID Funded Activities: AID in the past has provided supplemental funding to IRRI for its Small Scale Mechanization Project. IRRI developed several types of small scale equipment under this project. Much of the IRRI work on development of rice postharvest handling equipment has been cut back or discontinued with IRRI's major emphasis to be the development of agricultural production equipment. The current Small Activity will review in detail the work which has been done and is being done at IRRI. Further, this Small Activity will also consider the work being done by AID in its "Industrial Extension of Small Scale Agricultural Equipment Developed at IRRI" and the "Pakistan Village Level Food Processing Project." One of the objectives of this latter project is to investigate "better utilization of rice bran", which may relate directly to this proposed Small Activity.

4. Implementation: Discussions of the objectives and scope of this project have been underway between DS/AGR and the Cereals Division of WRRC, USDA since early November 1977. The project would move forward very rapidly if implemented by May 1, 1978. Personnel are available at the C[illegible]als Division, WRRC, USDA to begin field trips and anslysis durin[illegible]iod June - August 1978. If the project would be implemented by M[illegible] the scheduled date of completion would be February 28, 1979. [illegible]tive schedule of visits to various contacts is contained in th[illegible]ed proposal.

5. Personnel: The primary reason for negotiations with the WRRC, USDA at Berkeley, California for this Small Activity was because of the generally outstanding quality, experience and expertise of their personnel.

A Curriculum Vitae for the research leader of the Cereals Division, R.S. Saunders, who is to be project leader on this proposed Small Activity is attached as Annex C as well as a Curriculum Vitae for Dr. A.I. Morgan, Jr., Director of WRRC, who earlier showed an interest in this project; A.P. Mossman, a research associate, and T. Wasserman, a rice processing engineer, who will be hired as consultants to assist R.S. Saunders on this project.

6. Budget: The budget is presented in detail on page 10 of the project proposal. One item, item 5, "Equipment, materials and supplies $18,000" may need some explanation. This was included in the budget so that in case the investigations found new, different or unusual small scale postharvest handling equipment they might purchase a unit and ship it back to WRRC for more detailed analysis.

7. Reports: Not less than 100 copies of a final report will be made available to AID. This report will summarize the literature, interviews, and on-site visits in an analysis of appropriate village level rice threshing, drying, parboiling and milling systems with particular emphasis on how the system and/or equipment might be modified to improve performance.

8. Evaluation: DS/AGR, together with contract employees such as KSU and South East Asia Cooperative Postharvest Loss Research and Development Programme personnel, will review and evaluate the report and its recommendations within 60 days of reciept of the final report.

Approved: [signature]

Disapproved: _____

Date: 3/24/78

Enclosures:
Annex A - Proposal
Annex B - Description of Cereals Unit
Annex C - Curriculum Vitae (4)
Annex D - Bibliograph

Clearances:

ASIA/TR/ARD: RNewberg Date: 2/21/78
LA/DR/ARD: [illegible] Date: 2/17/78
NE/TECH/AD: ROlson (AD) Date: 2/16/78
AFR/DR/ARD: HMJones Date: 2/18/78

4

PROPOSAL

Improved Rice Threshing, Drying and Milling

I. Introduction

The world food crisis is affecting both developed and developing countries. During an era when the impact of the "Green Revolution has been demonstrated and when total food production in 1974 was 32% greater than the base period of 1963 (Figure 1) the per capita food production has not been measurably altered. Undernutrition and malnutrition are major health problems in economically developing countries (1,2).

In a 1975 address, Handler, President of the National Academy of Sciences, summarized the worldwide seriousness of the situation (3). He stated "...what is required is the full effort (financial and technical assistance) necessary to bring the affected nations to... maximize the nutritional value of crops in each region."

Rice currently accounts for as much as 75% of the total caloric intake of the 1.9 billion people living in Asia, and up to 33% of the caloric intake of the 0.8 billion people living in Africa and Latin America (4). It is noteworthy that in those regions which are heavily dependent upon rice, protein-calorie malnutrition is prevalent. Particular attention has been drawn to the Indian subcontinent and Southern Asia, including the Phillipines (3). In terms of production, Southeast Asia accounts for over 90% of the world's rice crop (5). Preliminary 1975 production figures for rice in different world regions are listed in Table 1 (4). According to the most recent FAO food outlook report, the prospective world crop for 1977-78 is 350 MMT.

Table 1

1975 rice production by geographic region* (million metric tons)

Asia	Africa	South America	Central America
318	7	12	2

*World total: 350 MMT

Excluding rice production in the developed countries (including the People's Republic of China), rice production in the LDC's can be calculated to be about 200 MMT, 88% of which is in Asia.

It has been estimated that during the next decade, worldwide rice production must increase by about 30% just to maintain current (though inadequate) levels of consumption (6). The major thrusts for rice scientists in the

next decade must be to "develop improved rices and associated technology ...to help produce more food from limited land" (6).

In the National Research Council's "World Food and Nutrition Study" (1977), from more than 100 priority areas prepared by 12 interdisciplinary study teams, post-harvest losses were ranked as one of the foremost lines of research identified as needed to contribute to alleviating malnutrition in the world. The same study recommended that the United States should be a leader in "introducing more productive technologies throughout the food system...(such) improved technology can reduce food losses...". In order to meet food-deficits, two needs usually predominate the headlines: increasing food supplies and limiting population growth. However, a third need is emerging into prime importance: drastically reducing food losses caused in field, processing and storage, through diseases, waste, erosion, pests, spoilage, improper processing, and improper storage. These losses have been estimated to claim up to one-half of the world's food supply (7). Experts estimate that between 30 and 40% of crops harvested in the LDCs never get to consumers, and they predict that the quickest way to reduce these losses is to control post-harvest losses occurring between the field and consumer; they have called for a comprehensive adoption of existing technology as a solution.

According to FAO (8) rice post-harvest losses are among the highest of LDC crops. IRRI (9) estimated rice post-harvest losses to be from 10 - 37% of total production. Their actual estimates are listed in Table 2.

Table 2

Estimates of Rice Post-harvest Losses

Step	Losses
Harvesting	1-3
Handling	2-7
Threshing	2-6
Drying	1-5
Storing	2-6
Milling	2-10
	10-37

Assuming the 1975 LDC rice production figure estimate of 200 MMT, post-harvest losses range from 20-74 MMT. The mean value of 47 MMT, in terms of caloric requirements of 2500 cals/day/capita, translates into food capable of sustaining 170 million people. At prices of $200/ton, the monetary value of the losses would range from $4 billion to $14.8 billion per year. At the current rate of production, a mere 2% reduction in losses would provide 4 million tons of rice, equivalent to the caloric requirement of 14 million people, and at $200 per ton, would save about $800 million per year.

Since most of the rice losses are a result of mechanical losses during harvesting, handling, milling, etc., rather than losses due to biological causes such as insects and rodents, the most direct approach to reducing losses would be to improve the village-scale processing technology.

In the past decade, IRRI, with partial funding by AID, has developed several small scale equipment prototypes, though with an emphasis on production rather than processing. Some of these, such as a weeder, tiller, seeder, dryer and hot sand rice parboiler have enjoyed limited success However, this particular IRRI project has been discontinued by AID. It is apparent that commercial equipment manufacturers are not filling the need in developing small scale rice equipment to combat post-harvest losses due to incorrect or inadequate processing techniques. The United Nations Development Program apparently also recognizes this anomaly. They have recently (1977) contracted a project into appraising rice processing and byproducts utilization in Bangladesh, where one of the objectives will include an analysis of village-scale processing equipment.[1]

II. Project Overview

It is proposed in this project to analyze the specific potential for developing new or improved rice threshing, drying and milling equipment to be utilized in reducing rice post-harvest losses caused by (currently) inadequate processing technologies in LDCs. Close familiarity with other efforts in this direction (10-14) will be emphasized to ensure coordination and avoid duplication. A team of food processing scientists, including one scientist with many years experience in these particular phases of rice processing both within the United States and in LDCs, will conduct on-site surveys of equipment and processes currently in use in LDCs. These same scientists will also visit commercial rice equipment manufacturers in Japan, India and elsewhere, wherever it is deemed likely that such input can be effectively incorporated into recommending technological innovations to meet the project objectives. As a result of the surveys, recommendations for potential improvements in equipment and systems designs will be geared to specific prototype developments. To aid in thoroughness of evaluations, any equipment discovered in the LDCs or in the commercial manufacturers' inventory which is considered to exhibit exceptional promise for reducing post-harvest processing losses will be purchased and shipped to the Western Regional Research Center.

It is envisioned that any equipment research and development activities, such as design modification, would be covered in a subsequent contract either at the Western Regional Research Center or elsewhere.

1/ E. C. Beagle, UNDP Consultant, personal communication.

III. Plan of Work

The subject areas to be investigated will include but not necessarily be limited to the following:

A. Drying

1. Sun drying (no additional fuels for heat)

   (a) Panicles plus straw

   (b) Threshed rice

2. Shade drying (no additional fuel for heat)

   (a) Panicles plus straw

   (b) Threshed rice

3. Mechanical drying (including utilization of rice husks and straw)

   (a) Flat bed dryers

   (b) Oscillating screens

   (c) Deep bed dryers

   (d) Continuous flow dryers or batch columnar dryers

B. Threshing

1. Hand threshing

2. Hand-operated mechanical threshers

3. Powered mechanical threshers

4. During combining

5. With flails

C. Removal of chaff

1. Mechanical blowers

D. Parboiling

1. Steam generators

2. Hot sand-bed types

3. Utilization of rice husks and straw in heat generation

4. Effects on milling yields and nutritive quality

E. Milling

1. Hand pounding

2. Without hull removal in huller

3. After hull removal

   (a) Abrasive cones or cylinders

   (b) Rubbing grains against each other in Engelberg or other mills

4. Hull removal

   (a) Under Runner Disc Husker

   (b) Rubber roller husker

5. Husk separators

   (a) Aspiration

   (b) Compartment separator

   (c) Separating table

6. Removal of brokens, seeds, etc.

   (a) Sieving

   (b) Indented cylinders

   (c) Indented discs

   (d) Magnets

   (e) Stoners

This activity proposes that equipment and methods presently available for improving village level rice threshing, drying, parboiling, and milling be determined and critically examined from the standpoints of adoptability by potential users, for their ability to reduce post-harvest losses, and for potential improved design.

A range of equipment is needed for different situations: the small farmer operating alone, cooperating groups at the village level, small entrepreneurs who buy paddy from the farmers and process the products, and custom operators who perform such tasks as threshing, drying, and milling for a fee. Shortages or absence of fuel and power at the level to which this project is primarily addressed has always been a problem in LDCs, but present fuel costs require that proposed equipment use as little fuel and power as possible. Energy from the sun, water power, local fuels and byproducts such as rice hulls and straw should be important considerations in the search for new methods and equipment. Rice hulls are being used more and more for fuel, and furnace design is improving. Another consideration is the desirability for choosing equipment designs that can be adapted for manufacture locally or in the country where used. Primary information sources for equipment will be publications and visits to multinational and national institutions and universities, equipment manufacturers, and experts in the field of rice equipment mechanization. These sources are outlined in section IV, Itinerary.

Experts in the field of mechanization will be participants in such meetings as the Meeting of Experts on the Mechanization of Rice Production and Processing, Paramaribo, Surinam (1971) and contributors to Annual Reports of World Research and Development on Post-Harvest Utilization of Rice, Valencia, Spain (1975). Other sources of information will develop as the activity proceeds.

Although equipment that has achieved successful application will be stressed, other potentially useful but unadopted developments will be examined to determine whether changes, extension programs, or use in different locations might increase their adoption.

IV. Itinerary (Assuming project initiation May 1, 1978)

May - Set up contacts and visit schedules.

June-August 1978 period - Wasserman and Mossman
(2 trips: 3 weeks duration each)

Country	Contacts	Interest
Japan	Satake Engineering Co. Ltd, Tokyo. Mr. Yoshiharu Satake, Managing Director Mr. Hisashi Ishida, Manager Overseas	Manufacturers of rice milling and drying equipment.
	New Food Processing Techniques Association, Tokyo Prof. J. Bakurai, Director	Interested in husk utilization.
	National Food Research Institute Dr. Watanabe, Director	Interested in post-harvest losses, increased food availability, etc.
	CeCoCo, Osaka	Manufacturers of rice milling and drying equipment
Philippines	International Rice Research Institute, Manila. Dr. Nyle C. Brady Dr. Amir U. Khan	International rice organization. All phases of rice equipment R&D
	University of the Philippines, Los Banos. Mr. Dante de Padua	R&D rice milling, drying, etc.
Malaysia	The East Asiatic Co. Ltd., Kuala Lumpur. Mr. Hans Malinowski	Rice milling and drying machinery
Indonesia	Central Research Institute for Agriculture, Bogor	R&D rice processing
India	Ministry of Food and Agriculture, New Delhi Mr. M. Kuppuswamy, Chief Engineer	R&D rice harvesting drying & milling
	Indian Institute of Technology, Rice Process Engineering Center, Kharagpur Dr. T. P. Ojha	R&D rice processing

Country	Contacts	Interest
India	Modern Machineries Corp., Calcutta Mr. S. Aggarwar	Rice milling machinery.
	Central Food Technological Research Institute, Mysore Dr. HSR Desikachar	Rice drying and processing R&D.
Sri Lanka	International Rice Research Institute/ Ford Foundation, Colombo Mr. James E. Wimberly	All phases of rice situation, particularly drying and storage.
	Paddy Marketing Board, Colombo Mr. N. Ederinsingh	All phases of rice situation.
Thailand	Technological Research Institute Applied Scientific Research Corporation of Thailand, Bangkok	Research organization, including ric

October-November 1978 period - Wasserman and/or Mossman or Saunders
(1 trip: 2 weeks duration)

Colombia	Federation of rice growers & Instituto de Investigaciones Tecnologicas, Bogota Dr. T. Salazar de Buckle	Rice industry, R&D, rice
	Centro Internacional de Agricultura Tropical, Cali	R&D, rice
Brazil	Instituto Rio Grandense de Arroz, Porto Alegre	R&D, rice

October-November 1978 period - Wasserman and/or Mossman or Saunders
(1 trip: 3 weeks duration)

Egypt	The Ford Foundation, Cairo Dr. G. W. McLean	General Agricultural development.
	The Egyptian General Organization for Rice Mills, Cairo. Mr. A. Ezzat Said	National organization, rice processing.
Liberia	West Africa Rice Development Association	General rice R&D
Italy	Riseria Gariboldi, Milan Mr. F. Gariboldi	World expert on all phases of rice processing.
	FAO, Rome Mr. M. Manni	Rice processing expert, Agricultural Services Division

Country	Contacts	Interest
United Kingdom	Ron Hawkey Partners and International Business Consultants, London Mr. R. Hawkey	Consultant/Contractor for building village-scale rice processing equipment in Indonesia
	Lewis C. Grant, Scotland Mr. R. M. Storie	Manufacturers of rice milling machinery and grain driers.
Austria	Light Industries Section UNIDO Mr. Andras Miklovicz Mr. E. D. Manning	Improved rice processing equipment.
United States	Hawaiian Agronomics, Honolulu or Guadalcanal Mr. W. G. Golden	Rice processing consultant, formerly in Asia

January-February 1979 period - Final reports.

Scheduled completion - February 28, 1979.

Final Report

The report will summarize literature, interviews, and on-site visits in those phases listed in the Plan of Work; viz. drying, threshing, parboiling, and milling of rice at the village-scale level in developing countries. The report will include photographs, equipment design drawings where possible, and a critical appraisal of effective equipment used in these phases of rice processing. The equipment will be analyzed from the standpoints of efficiency and ease of operation, and on its potential impact in reducing rice post-harvest losses in different locations in developing countries. Efforts will be made to recommend the best equipment for the particular rice processing phases and locations, and how this equipment could be modified to improve its performance.

Not less than 100 copies of the report will be made available to AID, and subject to AID approval, will be distributed by this Center to parties contacted during this project.

V. Budget

Total Amount Requested	$90,000
Dept. and Agency Overhead (@ 14%)	12,600
	77,400
WRRC Location Support (@ 25%)	19,350
Net:	58,050

Salaries and Wages:

1. Project Leader R. M. Saunders (GS-15) (@ 2 months)	6,250
2. Associate A. P. Mossman (GS-9) (@ 3 months)	4,900
Total salaries	11,150
Personal benefits (@ 9.5%)	1,050
Total salaries and staff benefits	12,200
3. Consultants Hire T. Wasserman, retired annuitant, WRRC, for 4 months, as rice processing engineer (at GS-15 rate)	11,150
Hire E. Beagle, Consultant, FAO, for one month, as rice processing and equipment expert	2,800
	13,950
4. Travel and per diem	18,000
5. Equipment, materials and supplies	13,900
Net total costs:	58,050

VI. Background Information

The Western Regional Research Center is a large, mainly self-contained, U.S. Government agricultural science laboratory located near San Francisco. The research program at WRRC is national in scope, but concentrates on those commodities that are particularly important in western U.S. agriculture. Programs are conducted on wheat, rice, dry beans, fruits, vegetables, field crops, forages, poultry products and wool. Broad program objectives are: 1) to combat hunger and minimize the hardships of poverty by improving the nutritional quality of foods and lowering their cost, 2) to enhance the health and well-being of consumers by assuring the availability of safe, wholesome and high quality foods, 3) to promote the utilization of farm commodities by increasing marketing efficiency and expanding exports, 4) to assist in the development of rural America by promoting agricultural industry and new jobs, and 5) to improve the quality of life by controlling the pollution of the air, soil and water from agricultural activities.

WRRC employs over 150 professional scientists in the physical, chemical, food science, food engineering, microbiological, nutritional, toxicological, and economic disciplines. Administrative services are handled largely on location and substantial science support is provided in the form of technical assistants, secretarial services, various trade services (electrical, plumbing, carpenter, machine shop, etc.), instrumentation, analytical services, library, taste panel, biometrical services, computer, central stock of chemicals and supplies, and art and photographic services.

As the result of over 25 years of continuous and substantial basic and applied cereals research, a broadly experienced staff has evolved with numerous and active contacts in the industry, industry associations, academic institutes, professional societies, and other U.S. and foreign government units concerned with cereals. WRRC is recognized world-wide as a wheat and rice research center.

WRRC maintains a working relationship with the University of California at Berkeley and Davis, wherein some WRRC staff are Adjunct Professors and UC students may carry out research programs for advanced degrees at WRRC.

The general expertise of the Cereals Research Unit is summarized in the following:

(1) Excellent familiarity with these transformation steps: drying, storage, milling, incorporation into foods of cereal grains and fractions derived therefrom.

(2) Improved utilization of grains, decreased post-harvest losses.

(3) Nutritional and organoleptic appraisal of foods and ingredients.

(4) Transformation of grains into nutritionally rich fractions such as protein concentrates.

(5) Feedback to breeders regarding quality of end-use food products.

(6) Development and appraisal of grain products, domestic and export.

(7) Experience in nutrition intervention programs, domestic and international.

(8) Experience in vitamin and mineral enrichment, and effects of processing on nutritive value in general.

(9) Familiarity with grain byproducts in animal production.

(10) Wide range of vital contacts in government, university, and industry on an international scale, relevant to cereal grains and oilseeds.

At the present time the Cereals Research Unit at WRRC has a PASA Agreement with AID entitled "Improving the Nutritive Value of Wheat Foods." This three-year project has resulted in five members of the Unit making project assessments in several developing countries in Asia, Africa and Latin America. This work, though concentrated upon wheat, has provided a solid background on working within LDCs from practical (including village-scale), cultural and political viewpoints. The envisioned Project Leader in this proposal is the Project Manager for in-depth project implementation of the Wheat-PASA in Costa Rica. During assessments in Sri Lanka and Egypt on the wheat project, limited surveys of the rice industries were carried out also.

From 1974 to 1977, the envisioned Project Leader in this proposal was Principal Investigator in a three-year cooperative study with the Instituto de Agroquimica y Tecnologia de Alimentos, Valencia, Spain. This study, entitled "Fractionation and Processing of Rice Bran and Germ for Food Uses", was funded by the Cooperative Science Program under the U.S. - Spain Friendship Treaty. Basically, the study was an attempt to demonstrate the utility of rice bran as a food, particularly in LDCs.

VII. References

1. War on Hunger Vol VIII (12):7 (1974). Department of State, Agency for International Development.

2. Harper, A. E., and Hegsted, D. M. Improvement of Protein Nutriture. National Academy of Sciences, Washington, D.C. 1974.

3. Handler, P. Does it matter how many of us there will be? Food Technology, August 1975. p.46

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8. FAO: Analysis of an FAO Survey of Postharvest Crop Losses in Developing Countries. AGPP:MISC/27 FAO Rome, March 1977.

9. IRRI. Research Highlights for 1976.

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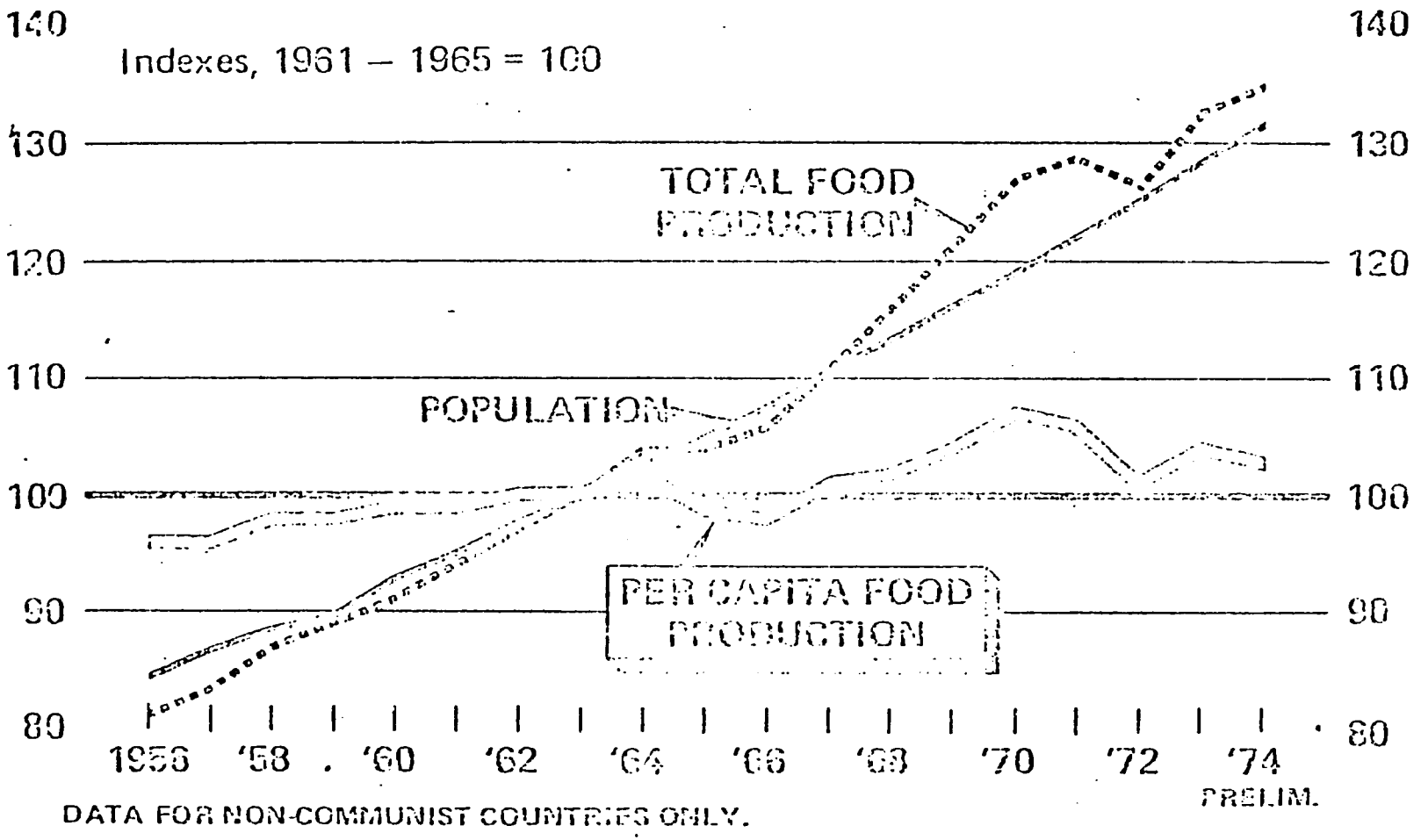
13. Araullo, E.V., de Padua, D.B., and Graham, M. Rice Postharvest Technology. IRDC, 1976

14. FAO. Meeting of experts on the mechanization of rice production and processing. Surinam, 1971. Rome, 1972.

FOOD VS. PEOPLE—THE WIDENING GAP



DATA FOR NON-COMMUNIST COUNTRIES ONLY.

Total food production in the developing countries has increased over the years, but population growth has canceled out the gains.

Cereals Research Unit
Western Regional Research Center
Albany, California 94710

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(7) Experience in nutrition intervention programs, domestic and international.

(8) Experience in vitamin and mineral enrichment, and effects of processing on nutritive value in general.

(9) Familiarity with grain byproducts in animal production.

(10) Wide range of vital contacts in government, university, and industry on an international scale, relevant to cereal grains and oilseeds.

Five members of the Cereals Research Unit are currently engaged in an AID-PASA Agreement, Improving the Nutritive Value of Wheat Foods. This has involved these scientists visiting and working with LDC's (Asia, Africa, and Latin America--commercial and village levels) during the past twelve months.

The Cereals Research Unit recently concluded a successful project with the Instituto de Agroquimica y Tecnologia de Alimentos, Valencia, Spain, funded by the Cooperative Science Program of the U.S.-Spain Friendship Agreement. This two-year project was entitled Fractionation and Processing of Rice Bran and Germ for Food Uses.

Curriculum Vitae

Name: Robert M. Saunders

U.S. Citizenship 1968

Education: (a) University of Birmingham, England, 1957-60
Major Subject: Chemistry
Subsidiary Subjects: Physics, Mathematics, German, French
1st Class Honors B.Sc. in Chemistry, 1960

(b) University of Newcastle, England
Ph.D. in Carbohydrate Chemistry, 1963

(c) University of California, Berkeley, California
USA Department Biochemistry Postdoctoral Fellow, 1963-65

Employment: (a) Philadelphia General Hospital, Philadelphia, Penn., USA
Senior Research Biochemist, 1965-66.

(b) United States Department of Agriculture, Western Regional Research Center, Berkeley, Calif., USA
Research Chemist, 1966-present.

At present time, Research Leader of Cereal Products Research Unit. Interests lie in chemistry, biochemistry and nutrition of carbohydrates, lipids and proteins, particularly in cereal grain by-products, e.g., wheat, rice, triticale, and forages.

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Publications

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List of Patents

Arthur I. Morgan, Jr.

1. Heat Treatment of Sugar Beet Juice
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   Morgan and Randall. U.S. 2,934,441, April 26, 1960

3. Continuous Process of Dehydrating Fruit and Vegetable Juices
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4. Dehydration of Fruit and Vegetable Juices
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5. Process of Dehydrating Fruit and Vegetable Juices
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6. Dehydration of Coffee
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7. Process of Dehydrating Foams
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9. Process of Removing Residual Moisture from Dehydrated Products
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Curriculum Vitae

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At present, member, Cereals Research Unit, studying the processing of wheat and rice.

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