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AGRICULTURAL MECHANIZATION IN ASIA

VOL. VII, NO. 3, SUMMER 1976

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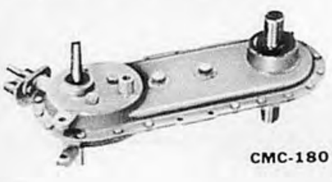
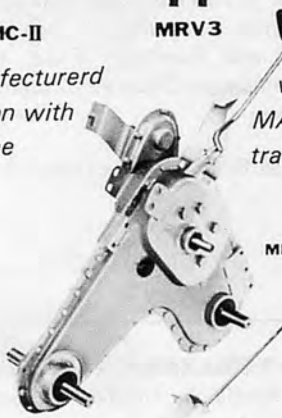


CMC-180



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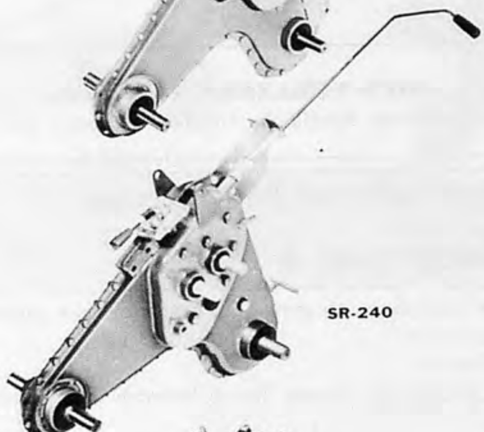

SR-240

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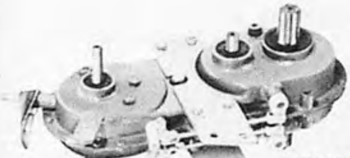

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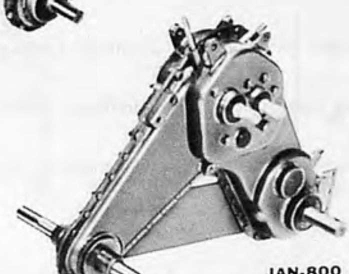

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Model		MC-80	MCF-130K	CMC-180	DMC-180	DMC-II	SKD-18	SKD-II	SKD-III	HMD-250	PM-350	UK-13	MH-750	MT-40
Applications(PS)		1·8～2·5	2·0～3·5	3·0～4·5	3·0～4·5	3·0～4·5	3·0～4·5	4·5～6·0	4·5～6·0	5·0～7·0	6·0～8·0	3·0～4·5	3·0～4·5	3·0～4·5
Shifiting Stages		F1	F1, R1	F2, R1	F2, R1	F3, R1	F2, R1	F2, R1	F3, R1	F4, R2	F6, R2	F2, R1	F1, R2	F1, R2
Sidecluch		—	—	—	—	○	○	○	○	○	○	○	○	○ with Lock
Gear Ratios		F_1=1:21·71	F_1=1:18·16	F_1=1:25·41	F_1=1:25·41	F_1=1:41·31	F_1=1:21·21	F_1=1:31·06	F_1=1:66·07	F_1=1:70·03	F_1=1:53·97	F_1=1:32·13	F_1=1:25·54	F_1=1:37·62
			R_1=1:27·24	F_2=1:15·38	F_2=1:15·38	F_2=1:19·40	F_2=1:10·28	F_2=1:11·34	F_2=1:18·96	F_2=1:38·73	F_2=1:37·41	F_2=1:16·92	R_2=1:29·37	R_1=1:32·83
				R_1=1:35·58	R_1=1:35·58	F_3=1: 9·35	R_1=1:21·33	F_1=1:44·52	F_3=1:11·43	F_3=1:15·81	F_3=1:18·50	R_1=1:32·77	R_1=1:20·22	R_2=1:10·69
						R_1=1:49·91			R_1=1:81·09	F_4=1: 8·74	F_4=1:19·42			
										R_1 1:105·04	F_5=1:13·47			
										R_2 1:23·71	F_6=1: 6·66			
										:	R_1=1:66·67			
											R_2=1:24·0			
Dimensions	A	170	170	170	170	202	192	192	224	234	243·5	192	192	192
	B	434	434	434	435·5	532	492	492	545	578·5	603 3	467	467	467
	C	289·5	289·5	289·5	289·5	344·7	336·75	336·75	336·75	319·7	402·5	409·9	287	287
	D	15	15	15	15	16	16	17	19	19	19	16	16	16
	E	31	31	31	31	31	31	31	31	34·5	34·5	31	31	31

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VOL. VII, NO. 3, SUMMER 1976

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This is the 12th issue from the first issue, Spring 1971.

Preface

Confrontations of acute opinions between the developed and developing countries are remarkably noticeable recently at international conferences. The oil crisis has divided the developing countries further into two categories; one involves countries which have benefited by influx of oil dollars, and the other those afflicted from the inflation caused by the developed countries resulting tremendous deficit in their balance of trade.

The difference in opinions between the developed and developing nations is getting more complicated reflecting the wide spectrum of standpoints among the developing nations. The world's population, however, has steadily been increasing behind the chaotic situation in the political scene of the world.

Our hope as people involved in mechanization of agriculture is to establish a food production and distribution system which enables all of the people in the world to fully obtain food of high quality at low cost. The practical improvement has been hampered in increasing cases not by purely essential or technological difficulties but by the involvement of political problems, which is not at all peculiar only to the development of agriculture.

Mechanization of agriculture in the developing countries is an urgent problem which is not likely resolved without cooperation from the developed countries. We, who are involved in the agricultural machinery, are facing against various kinds of difficult problems, especially engineers from technological aspects. Those efforts dedicated by so many of us must never be wasted in the political confusion. We must present pertinent assertions to win support from the people at large, and endeavor to develop reformalation of world's agriculture. I fully realize the necessity of active communications for this purpose among the engineers not only in the technological aspect but also in the variety of related fields.

Chief Editor
Yoshisuke Kishida

CONTENTS

AGRICULTURAL MECHANIZATION IN ASIA

Vol. VII, No. 3, Summer, 1976

Agricultural Implements and Hand Tools Industry Survey in Thailand

by
Wilburt Feinberg
UNIDO Industrial Design Advisor
Industrial Service Institute,
Chiang Mai, Thailand

Why, Where, When, How and Whom

Objectives: To fulfill project document request for a survey of Agricultural Implements and Hand Tools Industries of the Northern Region.

1. To investigate implements in use, being produced and sold for local conditions of farming.
2. To survey production techniques and manufacturing processes.
3. To offer ISI assistance, (present and future) as to facilities, such as design, management and development for improved sales, production, and "field-use".
4. To contact enterpreneurs dealing in farming implements and impress upon them the need for locally produced equipment to deal with local problems.
5. To spread ISI name and make contacts for other work not necessary dealing with implements (if time permits).
6. To collect all information about implements for future plans and development.
7. To get response and reaction to a tentative forthcoming seminar on "Development of Agriculture Implements", to be organized by ISI, Chiang Mai, in colaboration with other interested institutes.

Duration: 10 days (5 January-14 January 1976)

Provinces and Area Covered: Chiang Rai, Phare, Uttradit, Pitsanuloke, Nakornsawan, Takli, Sukhothai, Lampang, Lampoon, Chiang Mai

Kilometres Travelled: 2300

Survey Team:

—Wilburt Feinberg UN-DP/UNIDO Industrial Design Adviser
—Pairoje Phongsupasamit Agri. Design Eng. ISI
—Vim Roonggrout (Joined Survey 12 January 1976) Extension & Training Section, ISI
—Thongdee Morkmungmuang UNDP/Driver

Provincial/Industrial Officers who assisted Survey Team

Chiang Rai: Kamtorn Dilokkomol
Uttradit: Komchark Nilapan
Pitsanuloke: Krasae Busapakes
Kakornsawan: Paichit Boonyanukrau

Establishments Visited (Total): 36

Schedule:

5 January:	Chiang Mai/Chiang Rai
6 January:	Chiang Rai/Phare
7 January:	Phare/Uttradit
8 January:	Uttradit/Sukhothai/Pitsanuloke
9 January:	Pitsanuloke
10 January:	Pitsanuloke
11 January:	Pitsanuloke/Kamphaengphet/Nakornsawan
12 January:	Nakornsawan
13 January:	Nakornsawan/Takli/Nakornsawan
14 January:	Nakornsawan/Chiang Mai
26 January:	Chiang Mai/Lampang/Lampoon/Chiang Mai

Survey Team

Originally it was decided that two international staff members and two Thai counterparts conduct this survery, (two representatives from Workshop, two from Industrial Design Section) and Mr. Vim of Extension and Training Section was asked to participate (due to illness Mr. Vim only joined the survey in the final days). It was thought that since the workshop was to carry out (and contribute to) any assistance or new developments being considered by ISI, their participation was extremely necessary. Unfortunately the workshop chose not to participate.

General Impressions :

Basically there is a wide gap in conditions employed for farming in Thailand, both mechanical and psychological. Different ideas, techniques and primitive ways, vary from north to central plan and even from province to province. Partically due to varied soil conditions and crops, many unique conditions dictate unique circumstances. But, in our limited observation we feel that there is also the lack of proper methods being employed and proper technological investigation being made to produce larger and more viable cropping.

The general over-all impression of our survey is encouraging. The team was suprised at the number of relatively new established firms primarily concerned with advanced methods of soil conditioning. Most of the firms visited produced an acceptable product, evident by the sales and competition from other local producers and import models. Naturally we could not ascertain the extent of "years of service" since most firms have only started with major production (Re : power tiller, four wheel tractor), but for the most part, the product "looked good". We experienced the actual use of the implements and interviewed the various end users. Most spoke very highly of their "iron-buffalo" and would not go back to using the "old methods".

Author's Comment

What I have tried to do, during this survey and the contents of this report is to bring forward and shed some information we possibly have uncovered. The report is by no means statistical, but does contain some statistics, it is by no means totally complete as to do a more comprehensive report would entail much more budget and time that has been allotted to this survey. For those who are interested in further details, I quote a list of current reports, papers, etc. that deal with the subject in Appendix I.

I have used these report as partial conclusions to some of my thoughts and have included those comments freely, (with credits) in this paper.

Implements

Power tiller

By far the most impressive work being carried out in all the provinces was the assembly and fabrication of the Power Tiller. A rather simple machine mounted with external stationary engines, Ranging in horsepower of 5-15 Hp. As varied as the producers, so was the deviation from one accepted standard. Most of the work being done was repetition to a design made 10 to 15 years ago by The Engineering Division of the Department of Agriculture, Government of Thailand. The original plans were lost to the current producer and his only reference was to those tillers already being produced by another competitor, (who also did not use the original plans). This "step-down" production would naturally lead to a possible inferior product, with little, if any improvement. The fact that the farmer purchased the tiller, was enough conpensation and approval for the producer to 'stick-to-his-product". Another early method of "design" was the modification of imported models of tillers.

Experience gained by the local users, (in the early stages of production) enabled the producers to introduce changes according to the farmers suggestions, their own knowledge and equipment. The locally produced power tillers and implements cost 30 to 50 percent less than the imported models.

(1) Specific information about power tillers

a. Weight :

Varied between 220 kilograms to 300 kilograms including engine. Engine weight was approximately 50 to 70 kilograms, depending on size and manufacture. Gasoline as well as diesel fuel was used, with 5-10 Hp. being chosen, (according to conditions) and prefered by the farmer.

b. Engine Selection :

—Preference of engine is the Japanese variety, with selection being in this order : Yanmar, Kubota, Honda, Mitsubishi, Iseki,

—There was also a selection of US Manufacture and those were in order : Briggs & Stratton, Clinton, Tecumsum,

—Majority of farmers selected 7 Hp.

—The Japanese variety has added features that are not available on the U.S.A. models, those being :

1. Oil Bath filter
2. Compactness, no exterior protrusions
3. Specifically designed for tiller use
4. Electric generating plant

5. Head light
6. Consumer appeal, streamlining

c. Engine Costs and Financial Terms :

Costs varied between ฿ 3,500—6,000, depending on horse-power size. Prices are comparable between the U.S.A. product and the Japanese. Spare parts are plentiful and maintenance is a simple process for one who understands and knows what he is doing. The farmer most often pays for his engine and equipment by cash. How this is done, we could not find out during our survey, but in general questioning of the dealers, agents and manufacturers, it was told to us that the farmers paid cash at the time of purchase.

d. Mass Production :

The quantity of production is interesting in that with less than four years in manufacture (figures only of establishments visited) the estimated current production and sales in the provinces we surveyed, was approximately 5,000 per month during the peak season (4 months), (Nakornsawan sold approximately 1,000 per month × 4 months).

e. Projected future sales :

If one can project future sales of power tillers, it is evident that according to population figures of the provinces visited and certain information obtained, the below calculation is valid :

1. Total population of 10 provinces (Appendix II) = 6,552,593
2. 80% farmers (estimated) = 5,242,074
3. *No of persons per household Rural = 967,172 hh.

When we consider that current sales in the Northern Region approximate : 5,000 per month × 4 seasonal months = 20,000 per year, and with the normal growth rate in Thailand of 2.8 percent, the next 5 year period could see a potential market of approximately 1,000,000 household users.

Projected potential households in 1981, Northern 10 Provinces (Fig :)

1974 Population		Actual Farmers Estimate		*Number Farmers Estimate
6,552,593	×	80%	=	5,242,074

Per Rural Household		Actual Households		Annual Growth
+5.42	=	+967,172	×	2.8%

Annual Actual Growth	Added to Existing Households	Total Rural Household in 1981
=27,080×5 yrs	=135,404	
	+967,172	
		=1,102,576

* Percentage Figure

1970 Population and Housing Census, Northern Region, National Statistical Office.

f. Improvement on product

The potential for mass improvement is difficult. The present status of the current power tillers hold a very high place with the end-user and his limited knowledge of mechanical equipment does not encourage the producer to "improve his design or quality. The three most complaints we encountered with the power tiller was:

1. Weight
2. Width of the handles span
3. Turning circle too wide

All three complaints could be solved by an effort to re-design those in question. It has been discussed in ISI, to enter into a project at reaching a solution to the above mentioned problems, and possibly to make other improvements not mentioned by the agents but observed during this survey. ISI feels reluctant to enter such a program due to lack of funds, manpower and knowhow. In the case of problem (c), this has partially been solved by the introduction of individual wheel clutches. Another major problem discovered was the quality of casting being used (from Bangkok). There is a possibility of improvement with ISI assistance.

g. Equipment in Workshops

Most Workshops had the same set of equipment. Depending on the size and number employed, the amount of equipment varied. The maintenance and shop layout--organisation was according to the owners' habits; some were clean, some were unbelieveable.

g-1. General Equipment

1. Lathe Machine
2. Electric or Acetylene welder
3. Sawing machine
4. Drilling machine
5. Air compressor (limited)

Larger firms in addition had

1. Pressing Machine
2. Steel Roller
3. Sprocket wheel cutter

g-2. Material in Workshops

1. Mild steel
2. Iron castings (mostly from Bangkok)
3. Ball bearings
4. Sprockets, gears (Mostly from Bangkok)
5. Chains for sprockets (Bangkok)
6. Other specialized parts from specific producers

g-3. Labour

Mostly trained in the establishment, with little or no formal technical training. The elders training the younger workers. Age varied from 14 years to 65. If the apprenticeship served, linked-up with some advanced techniques, there could possibly be an internal development of ideas and improvements. Unfortunately in most cases, there is little if any, encouragement for the worker to improve the product of his technique.

Four Wheel Tractor (local production)

Surprisingly the amount of four wheel tractors seen were starting to make an impact on the market. Sales were much more than expected, and the farmer acceptance was positive. Various models were seen and more or less, were of similar design. Fabrication for the most part was done in Bangkok and shipped to the agent/dealer to be sold in the provinces. The engines (10-15Hp. Japanese models) were selected by the individual farmer at time of purchase. Costs varied from ฿ 36,000—฿ 38,000. The designs seen could use some improvement and one major discouraging observation is the lack of safety considerations built into the machine. Exposed drive belts, chains and moving parts were everywhere, and especially those places that were interfering with the operators safe use of the tractor. Implements were available e.g. (disc plow, harrow, etc.). The four wheel tractor has not been in use in the North, for any period of determining time, therefore additional information was limited. My observations were that there is a definite market possibility and with some basic improvements a sound product will envolve.

*In the area of small-scale industry, the farm machinery industry is a very promising one. The hypothesis is that the local manufacturing firms of tractors in Thailand employ labour intensive techniques which are in accordance with the endowment of the Thai economy. The cheaper price and high quality of the local tractor make it possible to substitute them for imported tractors and also to expand the use of farm machinery.

* Marketing of and Demand for the Domestically Produced small farm tractors in Thailand, Ungthip Chinapant

Other Implements

(1) Animal Drawn Plow

Other implements were observed during this survey and the predominate animal drawn plow was obvious. Production in the Nakornsawan area (distributed through out the Northern provinces) was approximately 10,000 per year for this single item. There seems to be a trend by the farmer that if they can afford the price of a two wheel power tiller they would buy one instead of continuing with the animal drawn plow. But the question still to be answered how will most of those farmers find 6,000-8,000 Baht to improve his yield?

(2) Water pumps

Both imported and locally produced with little complaints about function and price. It was generally accepted that what was available on the market sufficed the demands.

(3) Disc plows

Practically every workshop could produce disc plows. According to their equipment, the various size requirements could be met. The disc's were only available from Bangkok (local and imported) since the heat treatment (hardening) technique was only available there. All other work was done by the local workshop.

(4) Corn Shellers

The only province workshop producing corn shellers was Nakornsawan (2). These manufacturers shipped all over the Northern Region.

(5) Sorghum Threshers and Corn Threshers

Again produced in Nakornsawan and distributed in the Northern Region. (Approximately 400 per year)

(6) Rice Threshers

Various models and sizes observed, most models seen were produced in Thailand.

Case Study

Anusarn Co. Ltd.

Anusarn Co. Ltd. is located in Chiang Mai. The business of the Company (on the agricultural machinery side) is to sell and service Honda Walking tractors, produce IRRI Designed power tillers, small rice mills, and water pumps. The Honda tillers works well in the soils and cropping systems employed by Chiang Mai farmers, but they are expensive and the machines are too complicated.

The IRRI power tiller operates almost the same as the Honda tiller except for plowing dry soils for upland crops. The IRRI moldboard plow seems unacceptable for they dry soil conditions. Even though the traction was increased by attaching wheel weights, excessive wheel slippage frequently occurred when using this plow. The problem of the plow was solved by attaching a Takakita plow (Japanese made) to the IRRI machine. The same plow is also used with the Honda tiller. A new attachment developed by Anusarn Co. is a furror maker, a development done prior to the IRRI Design Model.

To make the IRRI machine operate more smoothly while plowing and rotating in dry soil, an improvement was made by lowering the engine mount frame 1 ½ inches from its original location. After modification, the tiller is easier to operate and runs more efficient.

The director of the company, Mr. Ruang Nimmanhaeminda, is a graduate of Yale University, U.S.A., Industrial Engineer. He first made contact with the Thai-IRRI Engineering group through Industrial Service Institute, Chiang Mai. He agreed to strictly follow IRRI specifications in the fabrication of the tiller after studying its performance under various field conditions in Chiang Mai. Two units were made as first manufacturing prototypes.

The plan for production and organization for the mass production of tillers is being considered and should shortly be arranged. Tools and dies for making machine parts are being prepared. One engineer from the company was sent to IRRI for training with the Agricultural Engineering Department. Expectations are that at least 100 units will be fabricated within the next few months.

The problems of the Anusarn Company are the cost of materials and general production organization. Specifically the sprockets designed designed for the tiller are not available in the market and when the nearest equivalent size sprockets were used, problems with tension on the chains occurred. That is, one chain was too tight and other too loose. This problem has encouraged revisions of the two machines that have been made and some small design changes on the power train drive system were introduced. When full production is introduced these problems should be solved by producing the proper size sprockets.

The cost of the tiller produced by the company is relatively high compared to the local design tiller being made by workshops throughout the Northern Region as well as other places in Thailand. Hopefully, the cost will be reduced when Anusarn moves into larger production.

Hand Tools

Some words must be said about "Hand tools". Although the current production is as primative as it was 50-100 years ago, there is a definite and growing market for same. The methods of production are as basic as "The Village Blacksmiths" and general acceptance leads one to belive that we should leave "well enough along". Unfortunately the farmer or end-user is not aware of better methods of heat treatment of the steel implement he purchases. The steel originating from car/truck flat springs is available and of an acceptable quality for simple tools, but once the blacksmith works it, it losses its quality. The rehardening and temperring is of such a primative nature, it is any wonder that "an edge" can be achieved at all. To introduce a large-scale development "project" for hand tools is without any basis at this time, since the manufacturer is content with his sales and product. Thus, resistance to change. What has been indicated is a desire to export quality tools and this then (if competition can be met) may be the "foot-in-the door" towards developing a better product. But, I must caution those who see a vast improvement eminent in the near future, as the few, but large manufactures we visited are steeped in the very old tradition and show signs of staying there.

Conclusions Recommendations and Comments

There is no doubt that the current production of Agricultural Implements will continue. There is also no doubt that the acceptance of improved ways and means of farming will eventually be present in Thailand, and to those goals, and attempt has been introduced. How can the future intuoduction of assistance in the field of research and design development meet the manufacturer and positively help him is the basic question? It is not important to make semi-annually visits to various producers, look over their shoulder and then disappear to write a report about the accomplishments, or lack of them, that the manufacturer has or has not incorporated in his equipment. It should be the task of ISI, Chiang Mai, to co-ordinate research and development activities with precise feed-back from all institutions, government agencies, bilateral assistance and all other's concerned with the improvement of Agricultural Implements The information, designs, plans derived from these investigations should then be field-tested for farmer acceptance, durability, function, cost reduction, distribution patterns and ease of maintenace and manufacture. The information should not only benefit a few individuals, but should be widely exposed and distributed (after positive rsults from extended testing) with on-the-spot assistance for those who are interested in improved models. Not two hour visits but "in-depth" assistance, until the manufacture can accomplish the standard that has been set by the-institute.

The question is, can ISI offer the above program? The opportunity is present, the farmers are in need and the manufacturing has started. It is of most importance that some concrete assistance be given. The price of imported equipment is at least double the cost of similar models of local production and any government policy to encourage farm machinery business would encourage the Thai manufacture towards a sound contribution to the Thai economy.

An attempt has been made to co-ordinate information and "get-together" various institutions in Chiang Mai (NADC, Chiang Mai University, Ford Foundation Multiple Cropping Program, ISI) towards a better effort and productivity. At present the group is still in the meeting stage and it is hoped that it will move into the practical stage in the near future.

APPENDIX I

1. Article: Summary report on Agricultural Mechanization and Development in Indigenous Farm Machinery Production in Thailand. By Chake Chakkaphak, Agricultural Engineer, Dept. of Agricultural, Bangkok
   AMA, Agricultural Mechanization in Asia, Vol. VI, No. 2 Autumn 1975 Farm Machinery Industrial Research Corp.
2. Final Report: A study of manufacture of Farm and Artisan Hano Tools in Thailand, UNIDO Contract No. 71/85 Project No. SIS 71/1162/Thai—26 1973
3. Manual on: The Employment of Draught Animals in Agriculture, Centre D'Etudes Et D'Experimentation Du Machinisme Agricole Tropical and FAO 1972
4. A Thesis: Demand for and marketing of domestically produced small farm tractors in Thailand
   Ungthip Chinapant, Thammasat University, Faculty of Economics, June 1974
5. A Thesis: Economics of Small Tractor production in Thailand
   Chirmsak Pinthong, Thammasat University, Faculty of Economics, June 1974
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APPENDIX II

Population

Provinces	Year	Total	Male	%	Female	%
1. Lampang	1974	639,248	326,781	51.11	312,467	48.89
2. Chiang Rai	1974	1,273,079	638,326	50.14	634,753	49.86
3. Phare	1974	473,239	208,825	44.12	204,414	55.88
4. Uttradit	1974	385,014	193,454	50.24	191,560	49.76
5. Pitsanuloke	1973	626,233	312,057	49.84	314,176	50.16
6. Nakornsawan	1974	958,890	486,090	50.69	472,800	49.31
7. Kamphaengphet	1973	337,451	171,188	50.73	166,263	49.27
8. Sukhothai	1974	488,182	243,434	49.86	244,744	50.14
9. Lampoon	1972	312,021	155,096	49.70	156,965	50.30
10. Chiang Mai	1974	1,086,203	547,130	50.37	539,073	49.63
Total		6,552,593				

(a) Estimate 80% farmers =5,242,074
(b) No.* of persons per Rural household= 5.42

* 1970 National Stalistical Office, Office of The Prime Minister, Thailand

APPENDIX III

Implements among tractor owners studied in Thailand

Owners knowing of:	100%
Disc plows	100
Mould board plows	15
Disc harrows	58
Spike tooth harrows	10
Rotary tillers	32
Small grain drills	5
Cornplanters Check with fertilizer	8
Rotary hoes or weeders	5
Cultivators	3
Corn pickers	3
Combines	3
Winnowers	1
Cotton pickers	1
Rice threshers	2
Mowers	2
Rakes	2
Balers	3
Spraying equipment (tractor mounted)	1
Corn Shellers	31
Trailers	43
Crop Stalk Shredders or Slashers	4

Source: Coordinated Industry Study of the Royal Thai Government

An Analisis of the Options for Farm Mechanization (Appropriate Technology)

by
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The introduction of high-yielding seeds and fertilizer has markedly raised agricultural production, but many farmers in the LDCs are experiencing a power and equipment constraint as they attempt to maximize their production with the HYV technology.

Unfortunately, there is wide divergence of opinion about whether this constraint can be removed best by redeployment of the labor force, by better utilization of available animal power or by investment in tractors and equipment. Because of the limited research on most aspects of this technology, farm mechanization policy tends to be ill-defined and development programs have not included machinery components. One of the most serious factors causing apprehension about mechanization is an anticipated adverse impact on the surplus labor force of most LDCs. This paper briefly reviews the current state of the art and describes the options open for development assistance.

Introduction

Farm mechanization is an independent variable in the production function but a factor closely related to farm size. The selection of machinery as a farm management decision is based upon the micro-economic analysis of the farm enterprise by the individual farm manager. Macro-economic analysis of the trend of development in several LDCs has pointed out that the collective impact of the individual farm management decisions has had adverse social impact. In order to optimize benefits as predicted by both micro and macro analysis, it will be necessary to construct a more differentiated description of the spectrum of farm enterprises and undertake a more comprehensive, composite analysis of technology.

Of the farm inputs, the interdependence of farm size and the economic performance of various machines makes the analysis of power and equipment input levels one of the most complex exercises of development planning. The general knowledge about LDC farms describes these operations as typically small size and of very limited resources and potential. This generalization masks the differentiation of the several critically significant descriptive factors that combine to define the total farm picture of the country. For purposes of illustration, the case of India is selected; farms of 5-10 acres are adequately served by a pair of bullocks; farms of 10-50 acres are presumed to be best served by small tractors of 5-15 Hp; while farms of less than 5 acres do not justify individual ownership of any power unit. These groupings have essentially equal importance as potential food producers and on that basis none can afford to be neglected, although attention is commonly focused on the less than 5-acre size group because of the large portion of the population included in this category. **The table** that follows illustrates the perspective necessary for evaluating these divergent forces impinging upon a policy or strategy formulation.

Table 1. All-India farm power spectrum

Farm Size	Appropriate Power Source	Farms		Area
		Number	Portion	
(acres)		(thousands)	(percent)	(percent)
0- 5	Hired	31,076	62.3	19.0
5-10	Bullocks	9,646	19.3	20.3
10-25	Small Tractors	6,843	13.7	30.8
25-50	Small Tractors	1,795	3.6	17.9
50+	Large Tractors	514	1.0	11.8

The Energy Question

Before dealing with the several mechanical technologies that are options for development, the item of petroleum prices merits special attention. The 1973-74 increase in petroleum prices, as might be expected, caused many LDCs and development analysts to re-appraise farm machinery policy; particularly to think more highly of human and animal energy sources rather than tractor power. However, at the same time, rising food prices, and also rising demand for food, has placed heavier demand on increasing agricultural production. In fact, the rising price of food has proven to be more than adequate to cover the higher cost of petroleum needed for cultivation power and fertilizer. Nonetheless, the trend of petroleum prices has raised the Foreign Exchange costs for many LDCs and foreign exchange is a scarce resource for most of these countries. In the final analysis, the LDC countries are well served neither by decreasing fuel imports nor by arbitrarily maintaining a particular level of imports. The changed international food and fuel economy makes the improvement of farm mechanization policy both more complex and more important, but the change of petroleum prices itself should not simply and proportionately alter the choice of the best technology option.

Intermediate Technology Options

In the development literature of the last year or so one finds the terms "appropriate" or "intermediate" technology appearing with increasing frequency. The terms are applied particularly to raising the questions about the type of farm mechanization that should be introduced in the LDCs; what kind, how much, what are the adverse implications, what are the costs and benefits, etc., etc.??

Only a few analysts of development continue to support the attitudes of the early 1950s; that is, rigorous support of either "pro-mechanization" or "anti-mechanization" points of view. The majority of people, while tending toward an anti-mechanization point of view, are not so adamant as to advocate no mechanization or tools of any kind. Likewise, the pro-mechanization advocates recognize a significant number of features which restrict the choices of intervention to improve the developing agricultural enterprise of the LDCs. In fact, the attitude of today's analyst cannot be described as "for" or "against" mechanical technology but a serious inquiry as to how technology can be identified and introduced with maximum benefit and minimum detriment.

Farm production has been raised significantly by the seed and fertilizer innovations, particularly where farmers have the power and other facilities to improve water management. As a result of higher productivity many farmers have been able to generate capital, raise their standards of living and, in some instances, invest in their farming operations in order to further improve production potential. As farmers advance to more complex technology they commonly experience power and equipment constraints. Obviously, most farms in LDCs have not reached the stage of "mechanization"; however, the numbers of farmers who are approaching power limitations is large enough to stimulate interest in farm machinery research and development.

There are four categories of equipment that have been identified within that broad class of "intermediate" or "appropriate" technology. In the following discussion these categories are identified by the power source of each, although each category represents a complete range of tools and may require significant differences in farm operation and management practice. There categories are: improved hand tools, improved animal-drawn implements, small tractors sized according to the power and management demands of individual farms, and 35 Hp tractors sized to achieve maximum economy within physical limitations of maneuverability. As mentioned below, improved hand tools have not proven to have high potential. Improved bullock-drawn implements are expected to be a low-cost route for raising operational capacity of the existing draft animal population. The advocates of small tractors are supported by the experience of Japan in applying technology to the small size of farms as found predominantly in the LDCs. The support for 35 Hp tractors is based upon the estimated low power cost. Each of the technologies has encountered serious problems in application to LDC agriculture. Problems of distribution of raw materials and extension of designs have seriously hampered the bullock implement industry. Also, cost and performance of improved, animal-drawn equipment have remained considerably below the expecta-

Table 2. Relation between agriculture productivity labor force, and tractor population in selected developing countries.

Country	Agr. workers per 100 ha. (Arable)	Agr. output per ha. (Arable)	Tractors per 1000 ha.	
			Large	Small
	(1)	(1)	(2)	(2)
Japan	250.0	961	1.55	232.82
UAR	166.7	643	4.28	NA
Taiwan	166.7	477	0.56	NA
Philippines	83.3	139	0.66	NA
Pakistan	83.3	133	0.15	NA
India	83.3	91	0.21	NA
Israel	44.4	557	19.24	NA
Mexico	24.4	110	1.96	NA

Ag. Inputs Div. USAID, New Delhi   Source: USDA No. 27-ERS

tions of the farmers. Small tractors have attracted relatively little research and development investment by either public research institutions or private manufacturers and investors in the LDCs. The 35 Hp tractor has gained some popularity and has become somewhat established on the larger farms. However, a system of joint-use has not yet been evolved that would make the 35 Hp tractor "appropriate" for small farms in spite of considerable effort in this regard. The identity of appropriate technology requires a much more intensive study than has been undertaken thus far. Each of these categories will be dealt with in somewhat more depth in the sections below.

More Intensive Labor Use in LDC Agriculture

LDC agriculture is characterized as being both heavily dependent on human labor inputs and relatively unproductive. Some have hastily concluded that low agricultural productivity is a consequence of heavy use of human labor. This argument is an unsound judgement. Japan has probably the most labor using agriculture in the world, and at the same time also uses the most tractor power per acre in achieving one of the highest land productivities in the world. The data illustrated in **Table 2** displays the interrelationship of productivity and both labor and power inputs. This data suggests that increases in labor and tractors by amounts considerably greater than can be expected in the LDCs could be absorbed in increasing production.

The available hand tools in the LDCs have the benefit of centuries of trial and error development. Innovation has been limited often by the materials available, the skills of the blacksmith and the capabilities of the production tools at the disposal of the blacksmith. Efforts to introduce improved shovels, for example, have encountered such problems as the fact that LDC peoples do not wear a heavy shoe which is necessary to force the shovel into hard ground. Also alloy steels are not available, consequently a strong shovel becomes a heavy shovel. As another case, efforts to introduce the scythe or cradle as an improvement over the hand sickle most commonly used in crop harvesting have been unsuccessful due to the excessive shattering of grain, problems with weak straw and more seriously the fact that laborers who were at best only minimally nourished, short of stature, and working in a very hot climate, could not in fact handle the heavy workload of a cradle.

Many of the engineering problems of improved hand tools are at least theoretically solvable but the tools will not become popular because of the economic environment.

At today's LDC fuel prices, one Hp-hour of work output in tillage will cost on the order of 10 cents from a tractor, but it takes a man a 10-hour day to do one Hp-hour of work. Labor wages are low in the LDCs but not that low. Unfortunately, at current food prices a man cannot buy food energy for a one Hp-hour day of work at daily wages equivalent to the current 12-25 cents range common in the LDCs. In the LDCs laborers with the common, simple tools have such low productivity that the unit costs of output become uneconomical for the enterprise that hires them irrespective of the matter of social cost. The case for irrigation is a simple illustration of this principle. (**Table 3**), and similar data can be shown for threshing, road building and several other tasks. The crucial factor is that even low-cost tools and cheap wages can still produce unsatisfactory unit costs when productivity is as low as that common for manual work in the LDCs.

The limited potential of manual labor technology is also illustrated by the benefits that have been realized from two improved tools that one finds extensively used in LDCs; the rubber-tired hand cart and the

Table 3. Performance data, low-lift irrigation pumps

Power Source	Discharge			Command area (ACRES)	Investment per acre (RS.)	Water** cost (RS/10 A. in)
	Lift (FT.)	Rate (GPM)	Investment (RS.)			
Manual	5	38.4	360/-	2.5	145/-	120/-
Bullock	15	50.8	3000/-	3.3	910/-	118/-
	25	230.00	10500/-	15	700/-	45/-
Engine	40	200.00	10500/-	10	1050/-	60/-

Includes well
** Includes cost of man & animal power
Ag. Inputs Div. USAID, New Delhi, Sept. 1969

bicycle rickshaw. The rubber-tired hand cart has proven to be popular because it enables a small one or two-man crew to move a four-man load from one place to another. The cart can be fabricated at essentially the same cost as the traditional designs because the rubber tires, wheels and axles are discarded auto parts. Junk parts are adequate structurally and the available supply has been adequate for rather extensive conversion or modernization of the hand cart equipment. Rickshaws cannot be produced from junk or discarded hardware, but the bicycle industry is established in the LDCs and the manufacture of rickshaw parts requires little of special technology. Neither the rickshaw or the carting trade are self-employment as there are many contractors who let out the rickshaws or carts for a daily rent to any laborer who can make a modest security deposit. Some laborers manage to save something from their earnings toward purchase of a rickshaw or cart. However, most carters or rickshaw men look for other employment and do not serlously consider this type of work suitable for a permanent job. Carting and hauling a rickshaw are strenuous work, not well paying even in the best of times, and most laborers find their health and nutrition inadequate to the rigors of this kind of work. The most sought after employment by this class of worker is a job loading trucks at a factory because of the prospects of steady employment with some medical, housing and/or other fringe benefits even though the work might be only nominally less difficult and more regimented.

It may be further instructive to review the failures in attempting to introduce labor intensive cultivation. In nearly every country of Asia one can find discarded and rusting Japanese hand weeders lying in back of the shops or offices of the Extension headquarters and field workers. These were produced by the thousands in the 50s and 60s during the promotion of the Japanese methods of rice cultivation. The theory was that rice yields could be increased significantly by reducing weed competition. Use of the hand weeder was promoted as a labor intensive innovation. Use of the hand weeder required changing from a random planting pattern to transplanting in rows. Weeding was expected to be done by the farmer as needed to kill weeds and would require nearly continuous work through the first half of the growing season. The problem was that very few demonstration plots were managed well enough, that is achieved adequate weed reduction, to raise yields appreciably. The potential benefits of weed control are perhaps only 10-50% of the crop and generally average closer to 10% than 50%. Unfortunately, if the weeder is not properly used it damages more of the crop than it benefits negating the value. Also, the small blacksmith is generally not able to acquire the sheet metal and flat-iron needed to fabricate a light-weight, efficient machine. Further, in many LDCs weeding is considered women's work and not the regular job of a permanent laborer. While each of these problems is solvable individually, the combination has been a formidable obstacle with the result that hand weeders have been abandoned and classified as "junk". It has probably been a wise decision by extension workers to devote their time and energy to promotion of the HYVs, fertilizer and better irrigation management rather than continued promotion of hand weeders with the relatively low potential benefit inherent in this technology.

Of course, the chapter of hand weeders should not be permanently closed as weed control of heavily fertilized, HYV crops has a greater potential benefit that as an improvement of the practises common five to ten years ago. From the Japanese experience we confirm that weed control does become an essential input with successively higher levels of productivity.

A simple supply-demand balance sheet identifies a couple of critical aspects inherent in excessive dependence on manual labor as a source of power for expanding agricultural production. The LDCs have set targets for increasing agricultural production in the range of 4-6 percent per year. This suggests that power inputs should be raised somewhat more than this, say five to ten percent, as a result of a simple application of the law of diminishing returns, on the supply side we find that agricultural populations are growing at the rate of two to three percent and have an under utilized reserve labor force which could be mobilized. In the present circumstances, manual labor is only a portion of the power input to agriculture For example, the power resource of Indian agriculture is 150 million laborers, 80 million draft animals and 100,000 tractors resulting in a total power supply of approximately 60 million Hp. A five percent annual rate of increase in power for agriculture would require three million Hp per year which would imply a thirty million increase in laborers or an increase of 20% of the labor force Obviously, from this simple illustration, there is an engineering potential to absorb the increase in labor force as well as the underutilized reserve ; however, a brief economic analysis indicates another side to a policy of establishing a heavily dependent labor policy. With the expected 5% rate of growth in agricultural production, it would be necessary to have a 4% rate of increase in commodity prices in order to offset the labor bill of a 20% growth rate in agricultural employment, assuming constant wages and no inflation. For governments who are committed to holding down food prices the idea of commodity prices increasing 4% annually is not an easy choice.

This analysis is just another illustration of the need for LDCs to introduce new production functions for the labor input factor so that agriculture will achieve both a higher output to input ratio and greater labor absorption capacity. New functions are possible as the evidence of several countries shows. Agriculture diversification into such enterprises as horticulture crops, multiple grain crops and livestock have potential and are being seriously considered. Unfortunately, the treatment of these options has often neglected the capital requirements for undertaking such policies, particularly in terms of the magnitude of change that would absorb the labor force at the rates desired. These capital requirements are significant and their neglect is a serious constraint. For example, the irrigation investment to raise cropping intensity from the range of 80-130% to something approaching 200% would probably be at the minimum $100 per acre. One estimate of the extra labor requirements of irrigated agriculture is one additional man-year of labor per five acres where cropping intensity has been raised from 130 to 200 percent or $500 per job. This cost per job might be reduced somewhat by adjustment for the jobs created in the marketing of the extra produce. To give some perspective, using India with 150 million workers and with a target of creating a 5% growth rate of employment, using a level of $250 per new job would require an investment level of $1.875 billion per year. (For perspective, the Indian AID program was maintained at the level of $250 to 300 million annually during the years of greatest assistance.)

Improved, Bullock-Drawn Implements

There are many good designs of improved, bullock-drawn Implements in the LDCs. Some of these implements are well described in the FAO publication Farm Implements for Arid and Tropical Regions (FAO 1960), The Michigan State University report (ALD Contract) Agricultural Mechanization in Equatorial Africa (1969), the Indian Council of Agricultural Research publication Indigenous Agricultural Implements of India (1960), and many other publications. It is not lack of designs that inhibits this type of technology.

Basically, the limitations for extensive use of improved, bullock-drawn implements are the economic and industrial factors in production and servicing of this technology. Simply, a set of improved implements may as much as double the work output of a pair of bullocks. Unfortunately, many improved implements have proven to be poorly designed and poorly manufactured with performance much below optimum and causing the farmer to become extremely cautious about further investment in this kind of equipment. Nonetheless, farmers have purchased a significant number of improved implements and there appears to be some demand in excess of current supply. Unfortunately, the village blacksmith and small-scale industry who seem to have some interest in manufacture of improved agricultural implements have such a weak bargaining position that they cannot obtain a regular supply of the necessary raw material. Alloy steels, particularly, although needed in small quantities, are essential for the fabrication of high performance tools. Unfortunately, the governmental administrative priority or capability has not been effective in directing the limited supply of such materials from the more aggressive large-scale industrial sector. A few craftsmen have attempted to adapt their tool designs for available raw materials, with negative effects on product quality and performance. Some manufacturers do not alter their designs, but produce items only when and if they obtain the necessary material; again detracting from their reputation as dependable suppliers. There are other problems as well; such as, few credit programs for supporting implement sales; little training on either manufacturing, service or use of improved implements; and a proliferation of "officially approved designs" which tends to keep both farmers and interested manufacturers in a state of uncertainty about the best investment decision.

However, perhaps a more fundamental constraint on a policy to depend heavily on animal power is the fact that the power needs of modern agriculture are greater than can be supplied by simply doubling the productivity of the existing draft-animal population. While one might question the validity of the precise relationship between yield output and power input presented in the President's Science Advisory Commission report, this document established for the first time the apparent existence of a positive relationship (**Figure 1**). The implication of this positive coefficient is that under a policy of intensive animal-powered agriculture development, the number of draft animals must increase significantly, (2-4 times). It is hypothesized that we may already have animal populations in several countries that are so large that any further increase in population would have a net negative impact on food

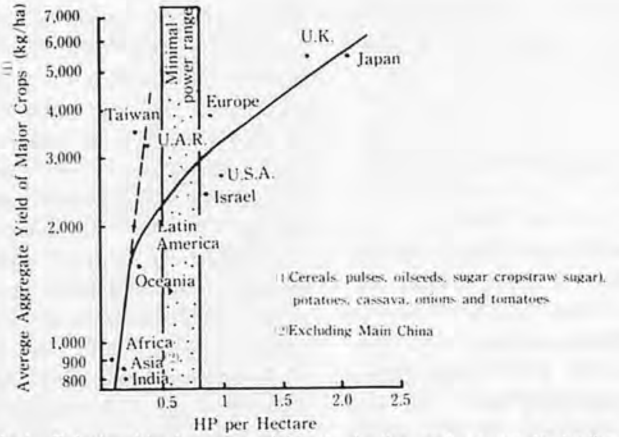

Fig.1. Relationship between yields in kg/ha and power in hp/ha— Major food. crops (Source : World Food Study Report Vol. III p. 180)

production. It must be remembered that to maintain one draft animal in work it takes seven animals - parents and immature stock. Thus, while one can foresee some gains from R & D on improved, animal-drawn implements, the long-term prospects appear markedly inadequate for agricultural development.

This does not imply that the bullock should be abandoned; nor could any country afford to abandon a resource of this size, particularly the LDCs. In fact, under present tenure and cultural practices the 5-10 acre farmer is probably provided adequate and minimum cost power by a pair of draft animals. This group of farmers are a sizable portion of the agricultural enterprise of most LDCs—perhaps 20% of the farmers, and control 30% of the cultivated land area. Thus, bullock power and improved implements have a place, not as an alternative, but as a component of a developing agricultural context.

Small Tractors

Because the farms in the LDCs are approximately the size of farms commonly found in Japan and Europe, there are many who hypothesize that tractors of the type found in Japan and Europe would benefit the LDCs. Field trials of Japanese and European equipment have produced mixed results. Japanese soils are relatively light, which means that structral failures are more frequent when Japanese equipment is used in the heavy textured soils found in many LDCs; and European equipment is too heavy, being built for heavier clay soils and operated by husky men in cool weather. Nonetheless, there is a growing body of information that suggests a productive role for suitable designs of small tractors in LDC agriculture.

The fundamental case for small tractors is that they provide the independent farmer with adequate and readily available power in order that he might manage his cultural operations according to his individual needs. It is recognized that the small tractor is less efficient than a larger machine measured in strict engineering terms, but this disadvantage is outweighed by the higher productivity of timely farm management decisions and operations.

The IRRI Power Tiller, the several small tractors of the Agricultural Machinery Company of Taiwan, the Kabota Iron Buffalo of Thailand, the Krishi Power Tiller of India and other small tractors are all examples of commercial success with this level of technology. The Tractor Evaluation Project of the Allahabad Agricultural Institute provided some detailed, quantitative data on small tractor performance. The data is indeed incomplete, but there is sufficient evidence to justify a role for small tractors in modernizing agriculture. An analysis of the impact of small tractor application on an extensive basis is contained in "The Utilization of Small Tractors in Integrated Agricultural Development: The Tractor Evaluation Project Applied" by Balis (Cornell University, Agricultural Economics Staff Paper 1974).

There are several factors relating to small tractor mechanization that stand out particularly in review of the available experience. First, the 10-50 acre farmer who is best served by a small tractor, is a progressive farmer and is interested in raising the land and labor income from his farming operation. Second, the tractor is not perceived as an alternate to hiring labor but as a means of raising output. In fact, the tractor-owning small farmer has retained his labor force and any "free" time resulting from tractor use has been utilized by the farmer owner-manager to acquire more inputs and new technology. Third, the farmer changes farming operations to raise cropping intensity -- that is to double-crop more land--thus raising farm production and significantly increasing marketings. Fourth, the total impact on society is a modest decline in on-farm employment, but a more than compensating increase in urban, commercial activity associated with greater food marketings and industrial enterprise. This last point is of further significance as the urban enterprises of small tractor production and manufacture of consumer goods is very well suited to dispersed small-scale, labor intensive type of manufacturing highly desired as appropriate industrial technology for intermediate stages of development.

More research is required to establish the dimensional parameters of these observations. Innovation in industrial policy will also be required to develop the manufacturing, distribution and service facilities. At this point, while there may be unknowns about the role of small tractors, there does appear to be adequate justification for considering small tractors as promising power alternatives for the farms of 10-50 acres.

Large Tractors

Tractors of 35 Hp have been proposed by the established farm equipment companies as the best power source for the developing countries. 35Hp tractors are economical, versatile and adequately maneuverable for good performance in small plots. These tractors have been manufactured and sold in considerable numbers throughout the LDCs. However, most of the use of the 35Hp tractors has been on larger farms, 50 acres or more, and the use of these tractors has broadened economic and social differentiation, benefiting the already fortunate with little or no benefit to the small farmer and the landless laboring people. For this reason, tractor mechanization has been perceived as an undesirable social and political phenomena. Nonetheless, the farmers who have purchased the 35 Hp tractors have generally increased production and demand for this size of tractor continues to increase. From an economic point of view this tractor does increase production on the 30% or more of the land held in larger farms, even though this is only 4% or less of all farm enterprises.

Multi-farm use of 35 Hp tractors has had many advocates and trials in order to provide small farmers with low-cost power. The problems of scheduling and management to ensure timely work on an adequate number of small farms has defied all pioneers in this effort. Neither government, private or cooperative efforts have been viable. The prospects and problems are quite well documented in the FAO bulletin Multi-Farm Use of Farm Machinery, the paper "Mechanization of Small Farms in Thailand and Malaysia by Tractor Hire Services" by W. J. Chancellor, and the study by William Jay Parson titled "A Report on Machinery Rental and Well Blasting Activities of the Tudyalur Agricultural Cooperative Services." The critical nature of management decisions is illustrated in the paper "Management—The Key Role in Successful Tractor Hiring Service" by Balis.

Toward a Policy

The diversity in farming operations and the limited range of optimum performance for tractors, or any agricultural power source means that the optimum power for LDC agriculture must be supplied by a combination of power sources. Manpower, animal power and several sizes of tractors must be developed to effectively and economically provide the power needs of modern farming for the diversity of farming enterprises found in the LDCs. A study of "appropriate technology" must have a mix in mind rather than a single concept.

The strategy for farm mechanization is interdependent with industrial policy and the state of agricultural development. Some progress in economic growth is required to generate the capital to be invested in new power sources and matching implements. It is vital that priorities for use of raw materials, fuels, and other resources must be matched with agricultural needs and desired returns, a point that is often only partially addressed today. In fact, the important critical unknowns today seem to be within this broad field of establishing mutually consistent priorities and allocations of resources rather than the identification of concepts of technology.

Small tractors of 5-15 Hp appear to be most promising as a subject for further study in all dimensions. Improved hand-tools and bullock-drawn implements have been designed, but volume production is stalemated by unfavorable industrial development policies. Large tractors have had a startling impact but seem to be causing social and political problems larger than the economic gains and may be saturating the upper farm sizes. Small tractors have not yet received much attention yet they can apparently increase productivity within the current modernization concepts of the LDCs. There is no single problem or technology that is limiting production, therefore a multi-pronged attack will be required to develop the appropriate technology. Inasmuch as each of these kinds of power sources has maximum benefits for a limited farm size range, the basic division of effort and investment in development may best be determined by the proportionate distribution of farm sizes. ■ ■

New Agricultural Techniques

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Progress made on various fronts in the country's agriculture during the last decade is better reviewed by discussing some of the important inputs, which have contributed to increasing agricultural production and improving agricultural techniques.

SEEDS

A good starting point is the Seed. The spread of high yielding varieties from an area of 4 hectares in 1964 to 4 million hectares in 1972, resulting in doubling of wheat production is a record with few prallels in the history of agriculture. Farmers can now buy improved seeds of wheat, maize, jowar, cotton and a wide range of important crops.

The National Seeds Corporation is spreading its net-work wide, both in production and marketing. Tarai seeds Corporation in U.P. has made a good contribution in also covering new crops like soyabeen and sugar-beet. Several States including Maharashtra are organizing Seeds Corporations. Then, there are a number of seed companies in the Private Sector. World Bank has approved a project of over Rs. 120 crores for the growth of the Seed Industry.

Some critical areas are availability of seed processing equipment and ensuring that farmers continuously receive good quality seeds and supporting services. There is a good export potential and India can become a leading exporter of seeds.

FERTILIZERS.

In 1950-51, total quantity of Fertilizers used was less than 1 lakh tonnes of nurtrients. In 1965-66, 8 lakh tonnes were used but now 30 lakh tonnes are in use. Development is all around—in simple and compound fertilizers and in production capacities in the public, co-operative and private sectors. Fertilizer sales are seasonal. A comprehensive credit system must cover all aspects of production and marketing, from the factory to the farm. Handling of fertilizers including transport and warehousing at various stages requires studies in depth.

There is need for training of farmers and farm labour in proper use of chemicals. A suggestion has been made to organize a National Institute for Training in Agro-services. Such an apex institution can train trainers and prepare training material and aids. Training of artisans is required on a mass scale to cover the entire gamut of agro-services, including use of Fertilizers, Pesticides, Seeds and Farm Equipment, irrigation techniques and pre-sowing and post-harvest operations. There is some urgency in implementing this useful idea. It will greatly assist in generating rural employment opportunities and converting rural youth into skilled workers.

Agro-service Centres can play an important role in penetration of the market. 260 such Cenres established in Maharashtra by the Maharashtra Agro Industries Development Corporation have been successfully popularising use of Fertilizers, Pesticides and Seeds.

The bacterial fertilizer industry is in its infancy, but is making rapid progress. Maharashtra is an important base for this new Agro-Industry.

Most soils, however, will need the supply of organic manures and for this purpose plans for producing 350 Million tonnes of rural compost and 7.5 million tonnes of Urban Compost have been launched during the current Plan period. There is also a programme for setting up a 8 lakh gobar gas plants so as to provide fuel and fertilizers.

FARM MECHANIZATION

Rower on our farms is provided by 66 million bullocks, 2 million diesel engiens, 3 million electric motors and 2 lakh tractors. All this adds upto 0.4 HP per hectare against an optimum requirement of 0.8. We have to double our power input. Raising more bullocks will take its own time and create problems of land use. We, therefore, have to take to mechanical means fast.

Pump-sets have established theselves as an essential input- Tractors too have found good dcceptance. In 1966, we had 55,000 tractors, today we have over 2 lakh. The indigenous tractor industry is only in its second decade. In 1961, indigenous production was 880 in 1966 it rese to 8,816. Today, annual production is 30,000. There are gaps in mechanisation for operatons like sowin, inter-culture and harvesting.

There has been a wrong notion that mechanization will displace labour and add to our unemployment problems. In various studies conducted by Punjab and U.P. Agricultural Universities and others, it has been proved that total labour requirements are much higher on mechanized farms. Object of mechanization hare is to ensure accuracy and timeliness of farm operation and reduce drudgery. Mechanization will mean a better operation factor. A seed has to be sown at a given depth and fertilizer placed accurately at a given distance—this is so vital to crop yields. Cropping intensity is higher with mechanization.

Logistics require to be properly organised to accelerate the pace of farm mechanization. They include training of equipment operators, supply of farm Fuels and Lubricants, insurance of the equipment, owner and the operator and farm safety education. Custom services or hiring of farm equipment is becoming popular. This enables small and medium farmers to get the benefit of this technology.

Mechanization has led to an Agri-Industrial development. State Agro-Industries Development Corporations have been established in almost all the States. In addition to routine trading in traditional farm inputs, it is necessary for these Corporations to break new ground through development of agro-industries, establishing model agro-service complexes, processing purplus farm produce, developing logistics and encouraging hiring operations. Contracts for topographical surveys and lift irrigation schemes can be taken on a turn-key basis.

Mechanization does require more attention. About Rs. 1000 crores are invested every year in farm equipment inputs. This is a major industry. Its benefits must be made available to all categories of farmers, in particular the small and medium farmers.

It is good to see the bullock cart getting a mention in the national press and becoming a topic at the Indian Science Congress. It is time we give the farmer a good transport vehicle with better payload, less drudgery on the bullocks, less damage to our highways and metal roads and lessroad accidents. There are 13 million carts hauling 70% of the rural goods traffic. Aggregate investment in the animal drawn transportation system is estimated at about Rs. 3,000 crores. This system transports about 10,000 million tonnes of goods every year.

Similarly, can we give the farmer a better sickle and a sugar-cane harvesting knife with more favourable organics, better output and longer life? Let us reduce his drudgery and fatigue. Let him derive some benefit from new technology.

IRRIGATION

Irrigation ushers in an era of rural prosperity. The irrigated area has been almost doubled from 22 million hectares in 1950 to 44 million hectares by 1974. The Prime Minister's 20-Point programme specifies bringing under irrigation atleast 5 million more hectares and a national programme for use of underground water.

Command Area Development Authorities have been established in various States. Ground water survey and development has been intensified. Lift Irrigation Schemes are being popularised. Some States like Maharashtra have established Irrigation Development Corporations.

End use of water must receive due attention. Water conservation has to be aroused as a national campaign. Our researchers can give us a simple water measuring device so that farm water can be charged on a volume basis instead on an acreage basis. Sprinkler Irrigation has made a good beginning in areas of undulating topography, shortage of water and cash crops. Present annual sales are about Rs. 1, crore. Drip Irrigation requires to be studied under our conditions by our irrigation research stations and water technology centres.

PLANT PROTECTION

Seeds must be treated to ensure better and vigorous germination. Crops must be protected from pests and diseases. During last decade, the Pesticides Industry has made a rapid progress both in the public and private sectors. We have more manufacturers of technical material, formulators and the range of available farm chemicals has been widened. Rodent control measures have given good results. Losses during storage have been brought down. Aerial spraying is made use of as and when the need arises.

With spraying and dusting of farm chemicals, hazards have grown too. Safety has to receive more attention. Can we give the farm labour a simple face mask for his use during spraying and dusting operations? Can we support farm labour with adequate under-writing services to protect his family and health?

EDUCATION

Institutes engaged in research, extension and training have a contribution to make not only in development of technology but also in its transfer to rural masses. A national grid has been established of All India Co-ordinated Research projects sponsored by the Indian Council of Agricultural Research and a net-work of 21 Agricultural Universities and 29 Central Institutes. The emphasis now should be to make our research and teaching programmes more topical, practical and result oriented.

HOLDING SIZE

This review is incomplete without a reference to farm holding size. Recent data released by Krishi Bhavan makes an interesting reading. 145 million hectares under cultivation can be divided in 3 categories of operational holdings totalling 70.5 million in numbers.

85% of holdings are small with 40% area under cultivation. Size of these holdings varies from less than 1 to 4 hectares. The Prime Minister's Economic Programme lays great stress on this weaker section. This vast resource of manpower has to be harnessed, trained and properly utilized. There is more social welfare content in the programme than technical. Their holding size is too small and resources meagre. We must look for new agro-management systems to improve the productivity of the land. under these holdings. Besides tilling his own small parcel of land, it is farmer requires additional means of livelihood.

11% holdings are in size 4 to 10 hectares with 26% area under cultivation. This farming has been intensified. Input availability has been improved. They can use improved implements and techniques and make use of custom hiring services. They require proper servicing from input supply and financing agencies.

34% of the area is cultivated by 4% of operational holdings of more than 10 hectares. They produce marketable surplus of agricultural commodities. Though small in number, they cultivate 50 million hectares. They must take to best available technology and improve productivity. Development of agriculture on smaller holdings should be taken by this group as a pocial responsibility.

Each of these 3 categories of farmers has a role to play. Each requires a different attitude, approach and a business technique both by the Government and by the farmer himself. Agriculture has to prosper as a business and not a charity or on doles. This review, with constraint of time, deals only with some aspects of agriculture. Some fields not covered include disciplines like animal husbandry, poultry, forestry, horticulture—in all of them lot of good work has been done. Lot of progress has been made during the last decade but we have 'many more miles to go'

Bombay,
2nd April, 1976

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Development and Manufacture of a Thresher for Developing Countries of Southeast Asia

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The purpose of this paper is to describe some of the design parameters and manufacturing conditions required for the successful design of a thresher for use in the rice producing areas of Southeast Asia. The thresher described is the 7-hp axial-flow thresher developed by the International Rice Research Institute (IRRI) in the Philippines.

In 1965 the United States Agency for International Development (US AID) signed a contract with IRRI to develop agricultural machines appropriate for rice production in the "developing" countries. The IRRI machines are designed according to the basic premises that:

(1) to secure the advantages of viable agricultural mechanization, the machines must be constructed in-country,

(2) the machines will be produced by labor intensive rather than capital intensive methods.

A number of machines have been developed at IRRI. The small tiller, direct seeder, dryer, power weeder, and axial-flow thresher have received high commercial acceptance. Approximately 25,000 machines of IRRI designs have been built during the past ten years. Most of these machines have been built during the past four years.

Threshing is the removal of grain from the plant by striking, treading or rubbing. Today in various parts of the world threshing is accomplished by treading the grain under the feet of men or the hooves of animals; striking the grain with sticks, flails or a threshing machine pegs or loops; and removing the grain by rubbing between stone or wooden rollers on a threshing floor or between the rasp bar and concave of a combine.

In tropical Southeast Asia where dense populations and underemployment are common, why is a "labor saving" machine such as a thresher required? Residents of the temperate zone are conditioned to growing one crop a year and often view machinery as a means of replacing labor with capital to increase financial profit. However, in the tropics, with water control, rice can be grown throughout the year. Each day land is out of production has a cost in grain not produced. For example, using a non-photosensitive short stem 125-day variety of rice yielding 3000 kg/ha per crop means that an average of 24 kg of paddy (rough rice) per hectare is realized for each day from seeding to harvest. Each day lost due to harvesting or in preparing the land for the next crop can be thought of as losing 24 kg of paddy per hectare.

Compared to other grains, most varieties of rice are easy to thresh. In S. E. Asia the common means of threshing is to beat out the grain on a grating of bamboo slats. The mechanical threshers of S.E. Asia nearly all use the wireloop cylinder. Most are light machines powered by a foot pedal. The foot pedal threshers can be carried to the field. Some wire loop threshers are powered by small internal combustion engines. The Japanese have developed the wire-loop thresher to an extensive degree. Most of these threshers are "hold-in" type threshers where the operator grabs the bundle and holds the panicleend against the wire loops of the rotating drum. The wire loops thresh out the grain which forms a pile below the thresher.

In the past IRRI had developed two power-driven threshers (Ref. 1). Both were "hold-in" machines.

The author served as an agricultural engineer at the International Rice Research Institute in the Philippines from August 1973 to August 1974.

The drum thresher was powered by a 3 kw (4 hp) engine. It provided a capacity of 250 kg of paddy (rough rice) per hour. The table thresher weighed 207 kg and was powered with a 2.2 kw (3 hp) engine and provided an output of 250 kg/hr. These throughputs for paddy should be compared with the traditional methods (Ref. 2):

Hand beating	17-20 kg/hr.
Treading with bullocks	140 kg/hr.
Pedal thresher	40-45 kg/hr.

The drum and the table threshers could thresh paddy but they did not find commercial acceptance for when compared to the manual threshing frame they did not provide the farmer with sufficint return on his investment.

Under the direction of Dr. Amir Khan, Head of Agricultural Engineering at IRRI, the design of an appropriate thresher was undertaken. Design work was carried out by engineers J. Policarpio and Bibiano Ramos. Before discussing the details of the resulting axial-flow thresher, let us first consider the principle design criteria.

Manufacturing Facilities

If a developing country is to realize the benefits of appropriate agricultural mechanization, machines must be manufactured in-country for three primary reasons:

(1) Imported machines are usually designed for temperate zone conditions in the U.S. or Europe or sophisticated farmers as in Japan. By building a machine in-country, the machine is more likely to reflect the needs of the local farmer and agronomic conditions.

(2) Foreign exchange is usually in short supply. Although steel, bearings, etc. may need to be imported, foreign exchange will be conserved.

(3) Seasonable surplus labor can be utilized to produce the machines.

Thus one design parameter was that the thresher must be produced by shops or small manufacturers. Required tooling would consists of a lathe, shaper, welder, saw, hand brake, and hand tools.

If a machine is designed to be fabricated with simple tools, it can be repaired with simple tools.

Type of Thresher

The thresher would be a "throw-in" machine instead of the common "hold-in" or "head" thresher. The "throw-in" thresher simplifies movement of sheaves and straw, and provides the possibility of threshing crops such as soybeans, mung beans, sorghum, maize, wheat and other small grains.

Horsepower would be limited to that available from the 3.7 to 5.2 kw (5 to 7 hp) air cooled engines as used on the IRRI tiller.

Weight and size of the thresher must be kept to a minimum so that the thresher can be towed on paddy bunds. Weight with engine should be less than 500 kg.

Cost would reflect the "intermediate technology" of the machine in that it would be of necessity more expensive than simple head threshers but less costly than "MrCormick" threshers.

The "market" for the thresher as for most of the mechanization developed by IRRI would be for a tropical Asia farm of 2 to 10 hectares. This would include over 60 percent of the rice farms and encompass over 50 percent of the total rice area (Ref. 3).

One crop condition that the thresher must handle well would be wet paddy, for rice is the principle grain grown where the thresher is to be manufactured and used.

When designing a new thresher, the prudent engineer will first determine which of past or current designs best meet his requirements. He will then attempt to improve the design by designing a machine to perform better in certain conditions or to be manufactured at less cost or hopefully to provide both better performance and lower selling price.

Although the rasp bar cylinder has captured the thresher (combine) market in the United States and Europe, the wire loop cylinder is the most common in S.E. Asia. The peg-tooth or spike tooth cylinder is used in limited quantities throughout the world. "MrCormick" type threshers with peg-tooth cylinders are manufactured in the Philippines. The J F thresher with rasp bar cylinder is manufactured by Vicon in India. A number of sophisticated wire loop threshers are manufactured in Japan. A design was required which was intermediate to these machines and the pedal thresher.

The IRRI drum thresher and rotary grain cleaner (Ref. 1) utilized axial-flow in the cleaning section. Furthermore rotary motion usually means fewer mechanisms than if reciprocating motions are used, so an axial-flow design was well worth considering. A brief look at patents reveals that the axial-flow principle has also received attention by North American Manufacturers—for example, International Harvester (U.S. 3,481,342), John Deere (U.S. 3,179,111), Sperry-New Holland (U.S. 3,669,122) and Western Roto-Thesh (ASAE paper 74-1581).

Figure 1 is an exploded view of the axial flow thresher.* Sheaves of grain are thrown into the throat at one end of the cylinder. The interaction of the cylinder pegs with the stationary helical sections in the upper concave, moves the straw axially toward the front of the cylinder. Threshing occurs as the material moves forward. The grain drops

* The IRRI axial-flow thresher is covered by Philippines Patent UM-1379 granted to Amir U. Khan.

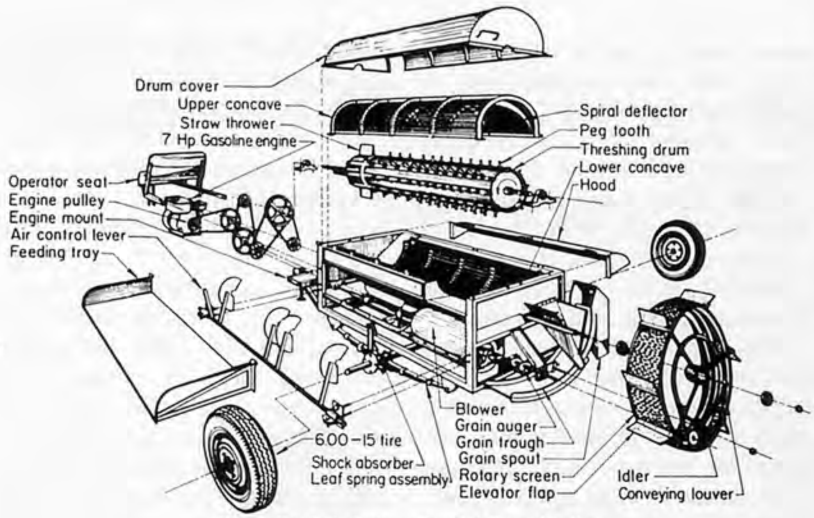

Fig.1. Exploded view of axial-flow thresher.

Fig.2. Forming an auger. Factory in San Pablo, Laquna, P.I.

Fig.3. Transporting thresher by carabao.

through the concave. Four paddles at the front-end of the cylinder eject the straw from the thresher.

The grain and chaff fall through an air blast which blows chaff from the right hand side of the machine. An auger moves the grain rearward to the inner surface of the rotary screen. Clean grain drops through the screen and onto the grain through where flaps of belting sweep the grain into the grain spout, which directs it into containers.

Three men are required to operate the thresher. One to place sheaves on the feed tray, another to feed the sheaves into the feed opening, and the third to collect and bag the grain.

The thresher with engine weighs 480 kg and is 2.3 m. long by 1.8m wide by 1.6 meter high (on wheels). The cylinder speed is 500-530 rpm (940-1,000 m/min.).

The first experimental unit utilized a wire loop cylinder as is common on small rice threshers. However, the wire loops exhibited too short a life to the abrasive paddy. Rasp bars would provide satisfactory life and performance but require a high degree of manufacturing facilities and skill. So rasp bars were ruled out. A peg tooth cylinder was designed using 1.1 cm. dia. steel rods on a 16 mm spacing. The pegs are threaded at one end and are attached to the cylinder by screwing them into nuts welded on the threshing drum interior. Thus a peg exhibiting wear on one side can be rotated 180 degrees to exhibit a new surface. When new pegs are required, the farmer merely threads some steel rods or hacksaws the heads from bolts to form pegs.

In a developing country a particular gage of steel sheet may not be available at a particular time. The thresher is designed and dimensioned so that a wide tolerance in gages and dimensions can be tolerated. Quality control is a problem in many countries. The engineer must design the machine to accommodate tolerance build-ups.

The auger is probably the thresher's most difficult assembly to fabricate, for one cannot pick up the telephone and order auger flighting in most developing countries. The auger is fabricated by cutting a steel disc for each pitch, slitting the disc and then pulling it or hammering it into a single pitch. These pitches are then arc welded to form a helix. **Figure** 2 shows the manufacture of an auger for the axial-flow thresher in a shop in San Pablo, Laguna, Philippines.

Compared to labor, material costs are high in developing countries. Because of this the engineer must use good design and keep scrap at a minimum. One example, the thresher was released to manufacturers in late 1973. Just before the release date it was discovered that only one threshing drum was being obtained from a standard size steel sheet. By reducing the length of the drum and thus the thresher by 6.5 cm, it was possible to obtain 2 drums from a standard sheet.

Designing agricultural machines with intermediate technology for developing countries does not mean resurrecting what was used in the industrial countries fifty years ago, albeit a study of such machines can be useful. It does demand the appropriate utilization of basic engineering principles and current engineering designs and technology.

Typical costs for an axial-flow thresher built in the Philippines are:

Direct Material	US $478
Direct Labor	135
Factory Overhead	179
Manufacturing Cost	$792
Factory Profit	158
Dealer Cost	$950
Marketing and Dealer Profit	170
List price without engine*	$1120
List price with engine	$1240

* Thresher uses the same engine as used on the IRRI sigle-axle tractor.

ADJUSTMENTS by the operator are few in number. Stationary pegs can be added or removed from the lower concave to increase threshing action or to reduce overthreshing. Air blast can be controlled by dampers on the inlets of the fan. Separation of chaff, light grain and heavy grain is controlled by adjusting the angle of the grain collecting board in conjunction with air blast adjustment. Overthreshing of crops such as soybeans can be reduced by reducing engine rpm.

Typical performance (Ref. 4) of the IRRI axial-flow thresher and a "McCormick" type thresher threshing paddy with a grain moisture of 20% (w.b.) and a straw moisture of about 80% (w.b.) is shown in the following table. Each test is an average of three runs.

The Agricultural Engineering Department at IRRI is a design and development organization and not a manufacturing organization. After evaluation of the thresher in a number of S.E. Asian countries, but primarily in the Philippines, the thresher was released to manufacturers. Blueprints were provided free of charge and at times a prototype was loaned to a manufacturer who found it more efficient to copy from the machine than to translate drawings. The axial-flow thresher is currently being manufactured in the Philippines by half a dozen private manufacturers. Limited manufacturing of the threshers is also occurring in countries such as Sri Lanka, Pakistan, Egypt, and Equador.

That the goal of local manufacturers meeting the farmers' requirements is being attained is seen by the improvements created by various manufacturers. The original IRRI machine utilized solid tires. Several Philippine manufacturers are now offering automotive type running gear so that the thresher may be towed behind Jeepneys. Another manufacturer provides a hitch so that the thresher can be pulled by a carabao. **(Fig. 3)**. One manufacturer offers a tailings return by placing wire fingers on the interior of the rotary screen and cutting a hole in the sheet metal at the end of the threshing cylinder. Unthreshed heads and pieces of straw catch on the wire fingers and are carried to about a 12 o'clock position where the tailings fall from the fingers and into a chute which feed them back through the thresher. Another manufacturer offers a reciprocating screen in place of the rotary screen for certain crops.

Of course, there have been some problems. The thresher was developed primarily for rice which is usually threshed with the straw in a very "tough" (high moisture) condition. One manufacturer in Pakistan built five units from the IRRI blueprints, but used them for wheat. The wheat had long straw and was very, very dry. As a result there was considerable straw breakage and a serious overloading of the cleaning section. An aspirator placed on the grain spout in conjunction with the tailings chute mentioned above provided a satisfactory cure to the problem.

I have no doubt that the small manufacturer will continue to find new uses for the thresher and to make improvements to reflect the farmers' needs.

Rice Thresher Test Results (November 1974)

	IRRI Axial-Flow	McCormick Type
Operating speed, rpm-		
Threshing drum 1	520	750
Blower	1000	700
Auger	270	400
Separator	17	200
Horsepower rating, HP	7	65—80
Crop condition:		
Grain M.C., %	20	20
Material length, cm	38	40
Grain-straw ratio	0.53	0.49
Labor requirement	4	8
Men feeding	1	3
Men handling	3	2
Others (tractor operator, collector, checker)	—	3
Test duration, min.	6.25	3
Output, kg/test (total)	97.53	122.50
kg/hr	936.36	2449.4
Labor output, kg/man-hr	234.09	306.18
Capacity, kg/hp-hr	105.19	33.78
Unthreshed loss, kg/test	.195	1.28
〃 〃 percent	0.2	0.98
Separation loss, kg/test	2.6	3.84
〃 〃 percent	2.67	3.14
Blower loss, kg/test	1.5	—
〃 〃 percent	1.54	—
Purity, percent	97.4	99.5

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Study and Discussion on Several Problems for Farm Machinery Education in Iran

by
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Introduction

The author had spent six months from October 1972 to March 1973 in Iran, and engaged to the guidance of Iranian rural vocational education as technical cooperative activity from Japanese Government under the Colombo Plan. Activities in Iran included staying at Gorgan Rural Technical School in North Iran and guiding representative teachers of vocational education in another districts of the inland, and also presenting seminar series on "Farm machinery in Japan" at Gorgan Rural Technical School.

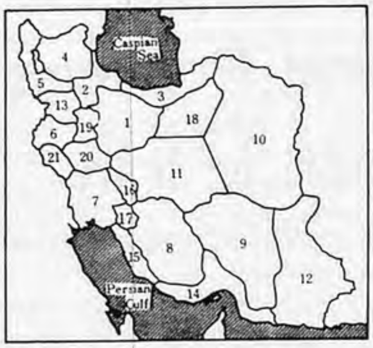
However, after the arrival in Iran, the original program was changed partially by mean of discussing with Ministry of Education in Iran, the Japanese Embassy in Iran and the Branch Office of Oversea Technical Cooperation Agency at Tehran. In cooperation with these three organizations, the author's program was fixed as follows:

(1) To investigate the after condition of technical cooperative activity for farm machinery education by using Japanese farm machines and implements at Rasht Institute of Technology, and Rasht—and Sari-Rural Vocational Schools for about one month. Because, a few years ago Japanese Government presented many Japanese farm machines to the vocational schools as a technical cooperative activity of vocational education.

(2) After that, the author moved to the Gorgan Rural Technical School where he guided students and faculty through the studies of the Farm machinery in Japan by using Japanese farm machines which were brought by the author from Japan. This guidance was carried by both methods of the lecture in class rooms and the practice in fields for about four months (**Fig.1**).

(3) On the last one-month, the

Fig.1. Iranian newspaper "Kayhan" reported the cooperative activity by author (center)



1. Teheran, 2. Gilan, 3. Mazandaran, 4. E. Azerbaijan, 5. W. Azerbaijan 6. Kermanshah, 7. Khuzistan, 8. Fars, 9. Kerman, 10. Khorasan, 11. Isfahan, 12. Baluchistan & Sistan, 13. Kurdistan, 14. Oman sea island & ports, 15. Persian gulf island & ports, 16. Bakhtiari & Chahrmahal, 17. Bovir-Ahmadi & Sardsir Kohgiluye, 18. Semnan, 19. Hamadan, 20. Luristan, 21. Ilam Province.

Fig.2. Administrative division in Iran.

author again returned in Tehran where he conducted co-operative work with the Ministry of Education in Iran. The author was asked counsel of the Iranian vocational education policy and also of the future plan of Iranian vocational education system. These results will be of value for vocational education system. These results will be of value for reference of discussing and making the future plan for Japanese technical cooperative activities.

Above mentioned, his six-months assignment to Iran gave much chances to investigate and to contact with Iranian farm machinery education in relation to the Iranian Rural Vocational Education problem.

During stayed in Iran, the author had met with the ten-years festival of so-called "white Revolution" at Gorgan Rural Technical School and at Tehran Teacher Club. The author felt that one of most important problems on the development for rural vocational education in Iran was rapidly increased Farm machinery education.

National Problems

National land

Iran is a large country with a total area of 1,648,000 square kilometers. It is about four times the size of Japan, and equals the total areas of England, France, Germany, Italy, Belgium, Holland and Denmark.

The Iranian plateau is a triangle set between two depressions···the Caspian Sea to the north and the Persian Gulf to the south. Iran is at 26° −40° the north latitude and at 44° −63°30′ the east longitude. It is bounded on the north by the Soviet Union and the Caspian Sea, on the east by Afghanistan and Pakistan, on the south by the Persian Gulf and the Sea of Oman, and on the west by Iraq and Turkey.

In **Fig. 2**, the administrative division in Iran is shown. This country has twenty-one of administrative division. In **Table 1**, population in Iran by province is shown. As shown in this Table, total population was 25,488,699 in 1973. Increasing rate of population in a year is 2.6%. The ratio of population in urban and rural is 38.9% : 61.1%. Tehran-, E. Azerbaijan- and Khorasan-states have big population. E. Azerbaijan-, Khorasan-, Tehran-, Mazandaran-, Gilan- and Fars-states have big farmer's population. These states are in north Iran area. In urban, population is 3,000,000 in Tehran (capital city), 410,000 in Meshed and 400,000 in Tabriz, respectively. The nomads live Khorasan-, Baluchistan- and Sistan-states in east Iran. There are 46.6% of Agriculture, Mining and Quarrying, 25.9% of Manufacturing and Construction, 27.5% of Business and Services, respectively.

Condition of nature

(1) Geographical condition

Some geographical aspects of various regions of this country is shown in **Table 2**. The triangle of the Iranian plateau is bounded by mountains rising round a central depression, a desert region formed by the bed of a dried-up ocean. The western mountains, of Zagros Rangs, run from nouth-west to south-east, and are over 620 miles in length and 120 in width. The range rises to a height of 5,570 feet and consists of numerous parallel folds, enclosing valleys 30 to 60 miles long and 6 to 12 miles wide. The northern part of the triangle is formed by the mighty Alborz Range, of which the highest peak, Mt. Damavand, rises to over 19,000 feet.

Two great deserts, the Dasht-e

Table 1. Province in Iran

No.	Province	Capital city	Population
1.	Teheran	Teheran	4,951,375
2.	Gilan	Rasht	1,574,128
3.	Mazandaran	Sari	1,843,328
4.	E. Azerbaijan	Tabriz	2,604,593
5.	W. Azerbaijan	Rezaiyeh	1,080,659
6.	Kermanshan	Kermanshah	850,200
7.	Khuzistan	Ahwaz	1,733,043
8.	Fars	Shiraz	1,591,149
9.	Kerman	Kermanr	772,710
10.	Khorasan	Meshed	2,515,063
11.	Isfahan	Isfahan	1,706,759
12.	Baluchistan & Sistan	Zahedan	500,766
13.	Kurdistan	Sanandaj	625,036
No.	Chief gubernorate	Capital town	population
1.	Oman sea island & Ports	Bandar Abbas	366,132
2.	Persian gulf island & ports	Bushire	251,998
3.	Bakhtiari & Chahrmahal	Shahrkord	301,918
4.	Bovir-Ahmadi & Sardsir Kohgiluye	Yesuj	185,244
5.	Semnan	Semnan	206,837
6.	Hamadan	Hamadan	888,663
7.	Luristan	Khorramahad	762,818
8.	Ilam	Abdan	176,290
	Total		25,488,699

Table 2. Some geographical aspects of various regions of Iran

Geographical Region	Entire Country	N.W. Region	Northern Region	Central Deserts	Zagros & Central Mountains	Southern Shores	Eastern Region
Caspian sea level upto:							
300 meters from sea level.	9%	1%	34	1	0	98	1
300 to 1500 met.	55	32	37	94	35	2	55
Above 1500 met.	36	67	39	6	65	0	42
Area sq. klm.	1648000	167255	82811	557239	507792	114745	218158
% Area.	100	10/15	5/03	33/81	30/81	6/69	13/24
Population.	25788680	4894086	3492432	7508753	6273471	1950571	1669367
Population percentage as compared to the entire country.	100	19	13/5	29/1	24/3	7/6	6/5
Population ratio (person/per sq. klm).	15/6	29/3	42/2	13/5	12/4	17	7/7

Lut and the Dasht-e Kavir, occupy a large part of the central plateau and together account for one half of the desert area and one sixth of the total area of Iran. These deserts are the most arid in the world, and while an occasional oasis may be found in the Kavir, the Lut is totally barren, supporting no life whatsoever.

(2) Meteorological condition

Iran is a mountainious country that extends between 25 and 40 degrees north latitude and is, therefore, entirely in the temperate belt of the northern hemisphere. Geographically seen it occupies the major portion of the Iranian plateau. The country is rimmed by ranges of mountains on all sides, circling a central plateau which ranges in altitude from 1,000 to 2,000 mts. above S.L. The two major mountain systems of Iran are the Alborz in the north, an almost continuous range from the Turkisch frontier in the north-west to the Afghan border in the north-east, and the Zagros chains, which extend from the north-west to the south-east of the country. In addition there are north-eastern mountains which, although neither as continuous nor as high as the two major systems cited above, are important from a climatic point of view as they complete the circle of higher elevations that girdle the interior tableland.

Generally speaking, Iran is a country of scant rainfall. The annual amount of precipitation for the country as a whole averages from 300 to 350 mm of rain and snow. The average amount of precipitation range varies from less than 10 mm in the desert interior to more than 2,000 mm in the south-western corners of the Caspian (Rasht in Gilan State). Since rainfall varies greatly from year to year, agriculture is precarious and its economic prosperity depends almost directly on the actual annual precipitation.

Development Plan for the country

In 1946, the government set up a committee called "the Planning Board" to prepare a development plan for the country. This plan has been continued until today.

(1) The fifth development plan (1973-1978)

Studies for the 5th Development plan had been started as early as 1971 so that the Bill for huge 5th Development plan could be ready in time for the submission to the Parliament in 1972. This plan was due to be put into effect in March 1973 and, as usual, will last for five years. What has so far been published about the principle on which it has been based is as under : Heavy industries and important metal mines to remain in the hands of Government : more extensive and deeper services, as regards the qualitative and quantitative effect is concerned, to the people : more incentive to investment in agriculture : more attention to vocational training and expertise of personnel in their own jobs : expansion in all kinds of insurance : study and preparation of plans and charts for complete irrigation network Grade I, II, III, and IV and construction of irrigation network : stablizing earth and preventing land erosion in areas close to the dam watersheds : more attention to matters related to agricultural affairs, establishment of big industrial and farming companies and also setting up of more agricultural joint stock companies : providing fully the electric power needs of industries, agricultural projects, households and commercial projects : more attention to housing and building of residential quarters. Although the work of finalization of the 5th Development plans has not yet finished, yet it had been learnt from well informed sources that 1.3 million new-jobs will be created and by the end of the plan period the active population of Iran will grow up to about 10 million persons. In view of the growing industries : about 300,000 workers will be absorbed in technical fields : total investment for creating every new job will rise from 10,000 to 12,000 (Rials 913,000) in the 5th plan period. It is also believed that for the first time in Iran the number of workers in industries and mines will be larger than those of working in the agricultural fields. By the end of the 5th plan period, (i.e. in 1977'78) the number of workers in mines and industries will be 33.4% of the total population of Iran, in agriculture 31,1% and services 35.5% of the total population. According to these forecasts, total investment in the 5th Development plan, both public and private, will be about 20 billion dollars. In view of this

Table 3. Land distribution in Iran by type

Type of land.	Total.	Lands under annual and permanent crops.	Fallow lands.	Temporary meadows	Thickets.	Forests.	Permanent meadows and pastures.	Arid but cultivable lands	Uncultivable lands	Lands occupied by cities and roads.	Lands under rivers and lakes
%	100.0	4.2	5.7	0.1	0.6	10.9	6.1	20.0	49.7	2.0	0.7

Table 4. Number of tractors imported from various countries

Type of Tractor	Country of Origin	1946 —57	1957 —60
Ferguson	England	700	245
David Brown	England	25	5
Fordson	England	312	—
Nuffield	England	25	—
Massey-Harris	England/Canada	800	—
I.H.C.	England/U.S.A.	400	127
Allis-Chalmers	U.S.A.	176	362
Caterpillar	U.S.A.	27	74
Case	U.S.A.	926	106
John Deere	U.S.A.	57	32
Minnapolis-Moline	U.S.A.	177	247
Oliver	U.S.A.	50	24
Allgaier	Germany	4	—
Fendt	Germany	3	13
Hanomag	Germany	56	531
Deuts	Germany	10	10
Lanz	Germany	320	72
M.A.N.	Germany	187	619
Porsche	Germany	—	5
Bolinders	Sweden	—	92
Fiat	Italy	7	139
Cockahutt	Canada	100	—
Khe-Te-We	UDSSR	10	—
Natod	C.S.R.	35	—
Steyr	Austria	15	168
		4,422	2,873

Table 5. Number and dispersion of tractor, combine, tiller and garden tractor according to province

No.	Province	Tractor	Combine	Tiller and Garden tractor	Observation
1	Mazandaran	600	75	8000	Most of tiller and Garden tractor and all diesel power is 14 ps and min. of them is 7 ps.
2	Gorgan	5785	671	200	
3	Tehran	2449	3	100	
4	Isfahan	2011	—	40	
5	Khosestan	1704	66	20	
6	Shiraz	1355	—	—	
7	Gilan	600	—	6000	
8	Kerman	761	—	70	
9	Kermanshan	952	63	—	
10	Semnan	170	6	—	
11	W-Azarbaydian	2500	70	—	
12	E-Azarbaydjan	2000	130	—	
13	Kordestan and other area	3500	—	—	
	Total	24387	1084	14430	

1) Combine is used for harvest of wheat and barley.
2) All of tiller are Mitsubishi. Iseki, Kubota, Dankoon, Robin, Holder of made in Japan and England and Germany.

huge investment which is unprecedented in the history of Iran, Government will avail itself of all possible sources of investments, including foreign investments. Estimates conducted in early 1972, revealed that Government expected a foreign investment of 2 billion dollars, i.e. 10% of the total cost of the 5th Development plan. Therefore, in this time the 5th Development plan is carrying in this country.

Another hand, the Social Revolution "White Revolution" is carrying as social problems.

Iranian country had ten years memorial celemony from January 21st, 1973 to end of January. At Gorgan Rural Technical School, school building's outside and inside decorated with three color tapes, and celemony party opened about several times. At Tehran city, also street and building town decorated with three color tapes and electric lamp illumination. Also, at teacher club photographic demonstration opened compared people's life about ten years ago and this generation.

Agricultural problemes

Utilization of agricultural land

(1) Outline of land utilization

The total agricultural land is about 22,500,000 ha and this is about 13% of total land. Total land under cultivation including is 11,356,254 ha and this only 50.5% of total agricultural land. The utilization distribution of agricultural land by type is shown in **Table** 3. The cultivated area under irrigation is 41% of cultivated area. Irrigated area is distributed largely to dry area from central Iran to Oman port, and smally distributed in Alborz—and Zagros— Mountains areas.

Mechanization of agriculture

(1) Generals

After the agricultual machinery development Bongah made up, farm machines were introduced rapidly in the farmer. In **Table** 4, the number of tractors imported from various countries during 1946-57 and 1957-60 are shown.

In general, it is very difficult to get the systematical statistic data in Iran. Especially, there were no data in regard to the mechanization problems of agriculture. **Table** 4 was supplied to the author from Professor Hakimi of Pahlavi University at Shiraz.

The mechanization problems of Iranian agriculture are classified into two groups as follows:

(a) Farm mechanization in rice cultivative area of the Caspian Sea of North Iran.
(b) Farm mechanion in another drying area of South-, East- and West-Iran.

In **Table** 5, the number and dispersion of Tractor, Combine, Tiller and Garden tractor by province are shown.

(2) Farm mechanization in rice cultivative area of the Capian Sea of North Iran

In rice cultivative area of

Gilan- and Mazandaran-states, the size of farmer management is small. About 85% of farmers has paddy field less than 3 ha. Therefore, small tractor and other small farm machines are introduced in year by year. Especially, Japanese small tractor was spread to 16,000, and in future it will be increased to 60,000 by planning.

In outside of Tehran, the assembly factory of a Iranian company and Japanese Mitsubishi-Heavy Industrial Company was built up. Small tractor, its attachments and power theresher are being produced.

In general, small tractor, trailer and power thresher are introduced as three-set machine for farmer. About 10,000 of the power thresher were introduced so far and 1,400 per one year are selling. Recently, the introduction of farm pump and sprayer is beginning to be imported.

(3) Farm mechanization in another drying area of South-, East- and West-Iran

Another areas excepted the Caspian Sea district are almost in dryness, and the size of farmer management is large. Therefore, large tractor more than 60 PS and combined harvester are introduced. Total spreading number of large tractor is 24,387 in this country. These are including many kinds of fareign tractors. Especially, the universal tractors made in Rumania (wheel type, 45-65 PS) are recently common.

(4) Production plant of farm machine's industry

(a) Tabriz tractor plant

This factory was made by the help of Rumania, and assembly tractor factory. Large tractors of 40-60 PS are being made about 5,000 in one year.

(b) Arak machin tool plant

This factory was made by the Union of Soviet, and tractor attachments are made.

(c) Tabriz machine tool plant

This factory was made by the help of Czechoslovakia. Elecric motor, pump, diesel engine and machine tools are produced. These yields are 12,000 ton per year.

Education problems

System of education

In the 19th Century an effort was made to introduce a change in the educational system of the country. It was first in the reign of Fatehalishah that a few students from Iran were sent to Europe for higher studies. One of these students, after his return from Europe, laid the foundation of a press industry in Iran. After that, with the efforts of Amir Kabir, a Polytechnic Institute was started in 1747, which included the following sections:- —Infantry Departmental Artillery Department, Cavalry Deparment, Engineering Corps, Medicine, Surgery, Mine Engineering, Pharmacy and Foreign languages (French, Russian and English). Sometime later painting and music sections were also added to the Polytechnic and a total of 16 Iranian teachers and 26 European teachers were employed for the education of 270 students and within 12 terms, about 1,000 candidates passed out of the above sections.

The Ministry of Education came into being first in 1853. First modern school came into existence in 1874 in Tabriz.

(1) There were foreign teachers teaching in this school. In 1881 a Military School came into being in Isfahan and two years later the Military School in Tehran came into existence. First Girls School came into existence in 1896 in the village of Chalbas near Kerman and of course such schools faced opposition from religious leaders. In 1898 the Ministry of Foreign Affairs set up a Political School in Tehran and a shool of Agriculture came into existence a year later. Europeans were also allowed to set up schools in the provinces and following this permission schools where set up at Tabriz, Rezayieh, Julfa, Tehran and Isfahan.

(2) Annual budget for education in those days was Rials 300,000. "The Revolution for Constitution" brought a new life to the system of education in Iran, and not only there was an increase in the quality and number of schools but also Germans, Russians and Americans set up schools in Iran.

The new system of education --- The new system envisages a major change in the structure of education in the country, under which the school cycle, instead of comprising two six-year periods of primary and secondary education, will be divided into three periods consisting of a five-year primary period, a three-year academic guidance period and a four-year secondary period. Until all children of school age are actually attending school, the period of compulsory free education will be temporarily reduced to five years. At the second stage, when all children of school age are enrolled for the five-year period, and when the country can financially afford it, the three-year guidance period will be made compulsory and free so that primary education up to the age of 14, will become universal throughout the country, as it is in many advanced countries of the world. Under the new scheme, the three-year guidance period which has been established as an intermediate period between the five-year primary and four-year secondary periods, is in fact a stage where the talents and capacity to benefit from education in different fields will be identified. The young people will also be guided in selecting job in keeping their talents and the various specialized requirements of the country.

For this reason the curriculum of this period will include technical and vocational courses in addition to the theoretical courses which have until now been taught in the first three years of secondary school so that conditions conductive to the development of pupils' interests in technical and vocational fields will be created and more of them will be directed towards the technical and vocational fields specially required by economic development.

In **Fig.3**, the diagram of new school organization of Iran is shown. Also in **Table 6**, the increase in the number of students in the Third and Fourth Plan period is shown.

Statistic consideration of educational conditions

(1) Generals

In the academic year of 1970-71 the total number of pupils and students enrolled in kindergartens, schools and colleges throughout the country was 4,570,000 of whom 0.4% attended kindergartens, 74.8% were in elementary schools (65.8% in ordinary and 9% in education corps schools run by the 14th, 15th and 16th groups of Education Corpsmen and 2nd, 3rd and 4th groups of Education Corpswomen), 23.1% were in secondary schools and 1.7% attended universities and institutes of higher education.

In 1970, the allocated budget for the Ministry of Education amounted to 15,753,304,000 rials. In addition, the expenditure by private schools, is estimated at Rls. 546 million for elementary schools and about Rls. 869 million secondary schools. Indiviaual contributions, estimated at a sum exceeding Rls. 386 million in either real estate or cash, were also made to the Ministry of Education during that year.

(2) Education corps program

In the academic year of 1970-71 there were over 11,993 education corpsmen of the 14th, 15th and 16th groups and 1,696 education corps-women of the 2nd, 3rd and 4th groups teaching in 10,556 education corps schools comprising 992 regular classes and 12,697 (Multigrade classes). The number of pupils totalled 412,792, nienteen percant of whom were girls. Distribution of pupils in these grades is as follows:

First grade 38%, second grade 21%, third grade 16%, fourth grade 12%, fifth grade 8% and sixth grade 5%. The pupil teacher ratio was 30 to 1. In addition to the school childern 90,828 adults of whom 20% were women, attended classes conducted by Education corpsmen mentioned above.

Furthermore, in the year under survey there were 2,252 education corps (662 men and 1,590 women) in ordinary schools and rural areas. The number of pupils amounted to 84,498 who were studying in 1,284 regular classes and 968 (multigrade classes). In cities, there were also 158 education corpswomen teaching in ordinary schools to 6,884 pupils (1,273 boys and 5,611 girls) in 150 regular classes and 8 (multigrade class). It follws that in the academic year of 1970-71 there

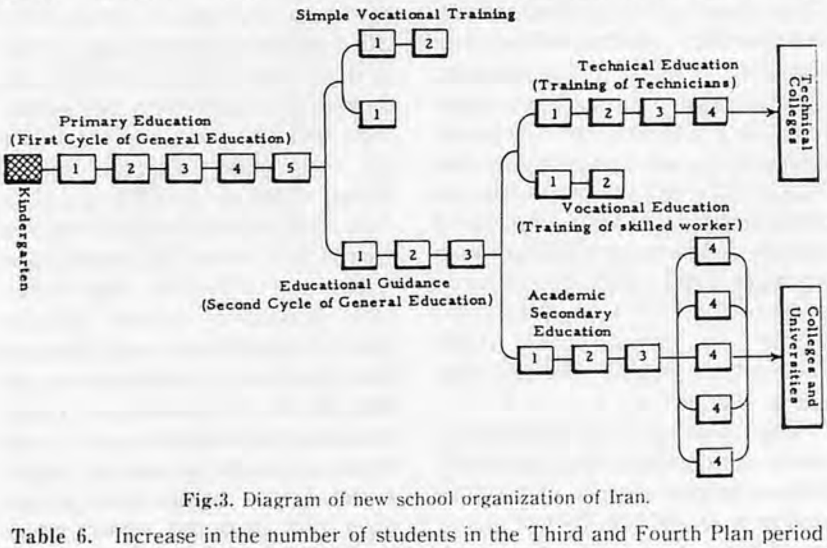


Fig.3. Diagram of new school organization of Iran.

Table 6. Increase in the number of students in the Third and Fourth Plan period (thousands of Students)

	Number at the end of Second Plan 41-42	Number at the end of Third Plan 46-47	Absolute increase	Percentage increase of Third Plan over Second Plan	Number at the end of Fourth Plan	Absolute increase	Percentage increase of Fourth Plan over Third Plan
Kindergarten	13	16	3	23.1	20	4	25
Primary	1,719	2,900	1,181	68.7	3,738	838	29
Secondary	336	658	322	95.9	1,328[1]	670	101
Vocational	9	17	8	88.9	50	33	194
Higher education	24.6	37.5	12.9	52.4	60	22.5	60
	1335	1346	Absolute Increase	Percentage Increase	1351	Absolute Increase	Percentage Increase
Number of literates	1,673	4,673	3,010	179	9,075	4,392	93

(1) This figure comprises 872,000 in guidance courses
376,000 in theoretical secondary courses
80,000 in combined theoretical and vocational secondary courses

1,328,000

(Source: Plan Organization)

were all together 16,099 (12,656 men and 3,443 women) education corps teaching in both ordinary and education corps schools throughout the country.

(3) Vocational education

In the academic year of 1970-71 there were 53 vocational, 90 technical, 22 commercial and banking, 16 secrearial and 8 industrial chemistry schools in operation (under the supervisions of the ministry of Education) with a total number of 30,579 students (24,318 boys and 6,261 girls). Out of this number only 34 were private.

In vocational schools for girls there were some short term courses. In technical schools 3 year courses were established in various fields. Furthermore, 6.261 students were receiving instruction in dress-making, hair-dressing, designing and decoration, child care, cooking etc.

In thechnical and vocational schools for boys 24,318 students were enrolled in the following field. Five % of the total enrollment were in general fields, 24% in metal work, foundry, welding and the like, 17% in electricity, 13% in automechanics, 7% in carpentry, 9% in plumbing, construction, 9% commercial and the remainder were studying in various fields of technical and vocational training.

The number of permanent and contract instructional staff was 1,950 (1,602 male and 348 female) and the number of temporary staff was 86 (49 men and 37 women), some of these were foremen. Some general secondary school teachers were employed on a part-time bases to teach Theoretical studies in these institutes.

The ratio of technical and vocational schools attendance (under the supervision of the Ministry of Education) was 0.7% to the total enrollment at kindergartens, elementary, and secondary schools and universities and 3% of the enrollement at general secondary schools.

Table 7. Students and teaching cadre (full time) of universities and higher educational institutes

Educational Institute	Academic Year 1969-70		Academic Year 1970-71	
	Students	Teaching cadre	Students	Teaching cadre
Tehran University	17,079	716	17,305	764
Tabriz University	4,226	319	5,187	315
Isfahan University	3,594	190	3,654	154
Jondi Shahpur University, Ahwaz	1,250	82	2,099	101
Meshed University	2,995	164	3,075	164
Aryamehr Industrial University, Tehran	1,530	157	1,746	192
National University, Tehran	5,554	184	6,106	220
Pahlavi University, Shiraz	3,116	304	3,483	311
State Higher Educational Institutes	17,529	522	20,226	462
Private Higher Educational Institutes	10,295	135	12,580	216
Total	67,268	2,773	75,461	2,900

Source: The Academic and Scientific Planning Research Centre

Problems of farm machinery education

Faculty of agriculture in University

(1) Generals

When we discuss the problem of vocational, we must know the condition of faculty of agriculture in University.

In **Table 7** and **Table 8**, some samples of University in Iran are shown. That is, in **Table 7** the students and teaching cadre (full time) of Universities and higher education institutes are shown. In **Table 8**, the distribution of students in Universities and Higher Educational Institutes according to their lines of studies. These data were from the Academic and Scientific Planning Research Center at Tehran. As shown in above Tables, there are 8 Universities and 2 Higher Educational Institutes in Iran.

In these Universities, the big Agricultural Machinery Institutes included in Tehran-, Pahlavi-, Tabriz- and Ahwaz-Universities. The author visited and was in contact with the Professors of Farm Machinery in Tehran- and Pahlavi-Universities, and visited Isfahan University and Ary-amer Industrial University.

Table 8. Distribution of students in universities and higher educational institutes according to their lines of studies*

	Academic Year 1968-69	Academic Year 1969-70
Total	59,168	67,268
Social Sciences	14,238	15,991
Humanities	13,426	13,305
Engineering	8,602	11,703
Medical	9,116	9,270
Natural Sciences	7,131	8,963
Agriculture	2,481	2,976
Fine Arts	2,331	2,809
Training Sciences	1,842	2,150

* Fields of study have been extracted from the UNESCO publications

Source: The Academic and Scientific Planning Research Centre

(2) Tehran University. College of Agriculture, Karaji

Tehran University is a biggest University in Iran. Most of the Faculties are in Tehran, but Agricultural Faculty is in Karaji about 52 km distance from Tehran. Author met Dean Professor Dr. Dabochi and he introduced Agricultural Machinery Institute. In this Institute the author met to Assoc. Prof. Tabech, Assoc. Prof. W. Baghestani. They introduced inside of Institute, and showed lecture's text panphlet and curriculum. In **Table 9,** the curriculum in Agricultural Engineering Department is shown.

University Farm is about 8 km off from this Faculty building. Author visited there and met Dr. Saadati. In field, wheat plants are under cultivation, and John Deere- or Ferguson-large tractor and its implements were being arranged.

(3) Pahlavi University, College of Agriculture, Shiraz

Faculties without Medical science are almost in Shiraz. Only Agricultural Faculty is in the village, about 17 km off from Shiraz. The famous ancient place "Persepolis" also is same direction. This University is the second University founded in Iran, followed Tehran University. Teaching methods of this University is American style. Therefore, some American Professors are teaching for students in this Private University. Dean of Agricultural Faculty is Professor Dr. Ghorban. Author investigated the Institute and Laboratory by guiding of Professor Hakimi. The faculty member of institute consists of Professor 1, Assoc. Prof. 3, Lecturer 4 and Assistant 2. The major subject is 'Studies on the control of farm machines noise". Another one is "Studies on the farm mechanization of South Iran".

The biggest Institute in this Faculty is Agricultural Machinery Institute, and Irrigation and Drainage Institute. There are 25 students for one-year class. This Institute gave a deep impression on the modern and new building which was built on sand deserts.

Institute of technology

(1) Generals

This is one of vocational college under 2-year course. At present, there are 4 Institutes of technology in Iran. In **Table 10,** the name and course are shown. The author stayed at Rasht Institute of Technology for about one month in order to help the farm machinery education. This Institute of Technology is included at Rasht Rural vocational school.

(2) Rashe Institute of Technology

This Institute was built in September, 1967. The Institute was in same campus of Rasht Vocational School, therefore same teachers have lectures for both the Vocational School and the Institute of Thchnology.

Lecture in class room and practice in field start from 3:00 p.m. and end at 8:00 p.m., because most of students must have a business in a day time. So, after finishing their business at the outside of campus, they come to class room. The main age of students is 20-24 years old. Some students have wife and family.

In general, Iranian degree is classified as follows: 1) Diploma, 2) Super Diploma, 3) Bachelor of Science (B.S.), 4) Super B.S. and 5) ph.D.

When graduated from Rural Vocational School, student will get "Diploma". When graduated from Institute of Thchnology, student will get "Super Diploma". This school is called a kind of college, research work has not done by any members. When graduated from University, student will get "B.S.".

Rural vocational or technical school

(1) Generals

The auther suppose that the system of Iranian rural Vocational or technical (higher) school is likely to the mixed system of agricultural high school and technical high school in Japan. In October, 1968, Ministry of Education in Iran made up the new project of rural vocational education.

In **Table 11**, the name and courses of Iranian rual vocational and technical schools are shown.

(2) New project of rural vocational education

(a) Purpose

By taking into consideration the rapid economic and social development resulted from the latest years' revolutional decrees, the matter of vocational rural education in Iran has become very important. This Educational System System should consist of many activities and arrangements on the rural level.

The pervading of new technics and the expand of development programmes on rural level have brought with them new requirements for manpower. To secure

Table 9. Curriculum in agricultural engineering department, in Tehran University.

Subject	Credits	Subject	Credits
Mathematics II	2	Electricity II	3
Mathematics III	3	Machine elements	3
Mathematics IV	3	Physics I	3
Mechanic physics I	2	Physics II	3
Mechanic physics II	2	Motor technology	3
Agr. machinery I	3	Repair shop	3
Agr. machinery II	3	Machine drawing	2
Agr. machinery III	3	Pumps	2
Agr. machinery IV	3	Seminar	2
Agr. mechanization	3	Hydraulics I	3
Farm machinery	3	Strength of materials	3
Tractors	3	Topography I	3
Thermodynamics	3	Climatology I	3
Coolers	2		
Internal conbustion engine	3	Total	140
Electricity I	3		

Table 10. Institute of technology

No.	Name	Course
1	Rasht	1. Farm machinery, 2. Soil & water.
2	Tabriz	1. Farm machinery, 2. Soil & water.
3	Rezaia	1. Water & soil.
4	Ahwaz	1. Farm machinery, 2. Water & soil.

this man-power, became a serius problem in the rural areas, particularly in the olden days a part of the rural requirements which has been fulfilled in a way or another, gradually disappeared and the natural replacement which was supposed to be on hand, couldn't serve correctly.

On the other hand, the Governmental funds used in rural regions such as establishment of Agricultural Sharing Coops, performance of Village Development Law, etc. made it very necessary to train technicians, skilled and semi-skilled individuals for various rural trades i.e. mason, fitter, welder, sheet metal worker, tireman, repairer of domestic motor facilities, driver and tractor's repairer, etc. Such individuals who have the tendency of dissolving the technical rural problems will be very helpful in building the economic body of the country.

The wide respective researches made by the Technical and Vocational Training of the Ministry of Education, new educational programmes based on the technical needs of the State rural regions have been prepared. According to the plans taken into mind, it is expected that at the end of 1351 (1972) the expiry date of the Fourth Plan, a number of 30,000 individuals will be trained in one of the requrired trades in the rural regions, or in other word, each year a number of 7,500 technicians, skilled and semi-skilled insividuals will be trained for technical posts on rural level.

For this purpose, the following four educational systems have been taken into mind, and as from the current school-year such systems will be put into action gradually and in co-ordinating manner.

(b) Training of technicians craft 2 in different technical rural trades

Due to the essential renovation in the villages of Iran during the last years, the technical rural problems shouldn't be restricted by agricultural affairs, because both the economic and scial change throughout Iran has caused new technical requirements too. Accordingly, the Technical and Vocational Training Organization of the Ministry of Education has started as from this year special units called Rural Honarestans (Technical School) with new study branches, as shown hereunder, in different regions of the State. The said branches are: a) Mechanic of Agricultural Machineries, b) Mechanic of Water and Soil, c) Animals' Products, d) Food Industries, e) Green Open places and Gradens' Products, f) Rural Development.

Necessary steps have been taken for admission at the above Honarestans for the school year 1969-70. Many candidates throughout the State have interestingly welcomed the above-stated fields of study.

The candidates for admission in these proposed technical schools should have at least a 3rd Grade High School certificate. Endeavours will be made that the candidates will be selected from rural areas. For this reason, in order to encourage the rural students, it has been determined that certain number of scholarships will be awarded each year specially for the excellent rural youths to enable them to continue their study in case they are of poor financial status.

At present there are about 2,000 students in these technical school, and it is hoped that due to the steps taken in respect of developing such schools the number of students at the above study branches will increase to 3,000 or 4,000 at the end of the Fourth Plan.

(c) Training of technicians craft 1

There are three Institutes of Technology in Mechanic of Agricultural Machineries and Mechanics of Water and Soil in existence this school-year at Tabriz, Ahwaz and Rasht. These Institutes purposely train excellent staff to fill up the gap in Agricultural mechanism, Land reforms and Preservation of water and soil. It is expected that during the coming years another study branches will start in accordance with the agricultural requirements and rural areas. At present there are nearly 210 students in the above Institutes. It is hoped that other new branches of study will be estiblished and that the number of students will raise to

Table 11. Vocational and Technical School

No.	Name	Course
1	Rasht	1. Water & soil, 2. Horticulture & gardening, 3. Farm machinery.
2	Sari	1. Water & soil, 2. Animal production.
3	Tabriz	1. Water & soil, 2. Rural development (or construction), 3. Horticulture & gardening, 4. Animal production, 5. Farm machinery.
4	Rezaia	1. Rural construction, 2. Food technology.
5	Ahwaz	1. Water & soil, 2. Farm machinery.
6	Maraghe	1. Horticulture & gardening.
7	Sarab	1. Animal production.
8	Mashhad	1. Food technology, 2. Farm machinery, 3. Rural construction.
9	Esfahan	1. Food technology, 2. Animal production, 3. Horticulture & gardening.
10	Nadjaf-Abab	1. Water & soil, 2. Rural construction, 3. Horticulture.
11	Sharekord	1. Water & soil, 2. Rural construction.
12	Ghalenow	1. Giral & women teacher for rural.
13	Gorgan	1. Rural construction, 2. Farm machinery.
14	Abadeh	1. Farm machinery.
15	Ardebil	1. Farm machinery.
16	Rafzanjan	1. Food technology, 2. Farm machinery.
17	Arsham	1. Rural development, 2. Food technology, 3. Animal production.

600 next year.

(d) Starting short courses at rural vocational school

To get benefit of all facilities and possibilities of the existing Technical schools, also in order to train more rural youths in vocational trades, it has been decided that as from the begining of Aban (23rd Oct.) till the end of Esfand (20th March '70) at least 5 short courses should start at the present boarding Honarestans. The rural youths who gained education in the limits of the Primary school will be entitled to attend these short courses. These youths will be trained in one of the needed trade in their area where they will spend a period between 15 days and 2 months after which they will serve in that trade straight away. According to the computations made, there will be about 2,500 rural youths who will attend such courses in the above Honarestans during this year. In addition, in order to train technical staff fo Governmental Organizations such as Jiroft Development Org. and Women Org. of Iran, steps have been already taken in this regard. On the other hand, new agreements are ready to be concluded to train technical staff for the development of Jiroft and Kahkiloyeh.

(e) Appointment of movable training groups to state rural areas and units

To put into action the teaching programmes for rural areas, as stated in classify 3 hereof, owing to the limited possibilities of the rural Honarestans and other matters in connection with teaching affairs, doesn't seem to be an easy task to make it available in all rural areas. The main object of this teaching system is that to answer the needs of the rural areas by using the Education Corps when graduated from Technical Schools and Institutes of Technology as follows:

a) In the first years a number between 80 and 100 graduates from Technical Schools or Institutes of Technology will be taken account in each training course of Education Corps to serve in various trades at the request of the Technical and Vocational Training Organization up to the date expiry of the training course. These grese graduates will be divided into 20-25 teams of 4 persons each, any one of the teams should be specialized in an technical field.

b) Meanwhile, the abovementioned training teams will be sent and appointed at the following Ostans: East-azarbaijan, West-azarbaijan, Gilan, Khozistan, Khorasan, Esfahan, Mazandarn, Kermanshahan, Fars and Kerman. Such teams will be appointed to perform duties in another Ostans gradually for the next training courses.

c) These teams, after finishing the training courses, introduced by the Technical and Vocational Training Organization to the rural Honarestans of the above Ostans. After receiving necessary training, they will be sent to rural units, as scheduled earlier. The rural Honarestans will supervise and guide the teaching programmes in their areas. Then they will be appointed wherever their services were required by the rural units, villages and centers. This schedule will be examined in the first years at Agricultural Sharing Coops with the collaboration of Rural Coops Syndicate to get benefit of their facilities in the regions where population is good enough.

d) As the period taken into consideration for this training is between 15 days and 2 months for different trades, therefore, it doesn't seem necessary to estabments in the rural areas. The training teams can be locad at the village school, audience Halls, establishments of Agricultural Sharing Coops, Cooperative Org., Rural Education quarters and so forth. It has been decided that prior to the appoitment of the said teams, arrangements for their stay will be made in time.

e) All the inhabitants of the villages, male or female, who feel in need of learning a trade can participate in such courses. Age and standard of education will never be taken into account, except in some special trades.

f) The training teams will be sent to the regions where at least there should be 40 can didates so that the expenditures and the results expected from the Project will compare each other. In addition, the trades to be trained shall entirely be necessary to that region itself. The trainees also will work in their relative trade straight away after completion of the duration. By doing so, they will help a great deal in the development of economy and social affairs in their region.

g) By taking into account the technical, training and financial aspects of this Project, it is expected that there will be at least 4,000 rural individuals who will receive training through the Movable Training Teams.

Pre-vocational trade school

(1) Generals

The pre-vocational trade school means the middle class rural vocational school under rural vocational (higher) school in Iran. Recently, Ministry of Education in Iran made up the new project of Pre-vocational education system.

(2) Project of Pre-vocational education

In Iran's new system of education, the provision has been made for the Ministry of Education to establish special technical schools with one-year and two-year courses for rural youths who, for various reasons, are not able to continue their studies into the guidance cycle. This was done so that these youths would acquire relevant skills during their studies in these centers that, according to need, would make them employable.

Statistics received concerning students in Iranian schools during the last few years, with totals of those completing the fifth and sixth grades of elementary school, and the students in the first year of the guidance cycle and the nation's high schools, show that each year a vast number of youths between the ages of 11 and 17 are not able to continue their studies after completing elementary school with a result that they enter society without any skill or the slightest acquaintance with a specialized trade and the power of their effectiveness goes to waste. With the expansion of elementary education throughout the country their number increases every year so that in the school year 1970-71 of 415,713 students completing the fifth grade in the elementary schools only 259,218 continued on to the 1st grade of the guidance cycle in the school year 1971-72; in order words, more than 154,000 were not successful in going on to the guidance cycle.

Taking into account the implementation in many parts of the country of the Law of Compulsory Education and other revolutionary laws in particular the rapidly increasing extension of the activeties of the Literacy Corps and the quantitative and qualitative expansion of general education which has the effect of spreading up the growth of the number of students in country, it is plain that the number of those who do not countinue their education beyond elementary school in future years will exceed in the above figures at an extraordinary rate. Since from early childhood they have not pursued their father's work and have not become acquainted with any trade and for years have not been employed, it will take a long time before these people are gradually absorbed by the labor markets. After exhaustive examination and lengthy studies made in this connection, provision has also been made in the new edcational system for the Ministry of Education to set up a number or Pre-vocational trade schools each year in various parts of the country according to the circumstances and needs of each locality to follow the first cycle of general education. The charter of the above-mentioned schools was approved by the National High Council of Education of July 2,1972. The plan entitled the Establishment of Pre-Vocational Trade Schools to cost 30,000,000 rials was approved by the Plan Organization in 1972 with intention of setting up these schools and testing the practicability of the scheme.

According to the plan mentioned above, 17 trade schools have been established.

In **Table 12,** the name, province, country and trades of the Prevocational school are shown.

The following measures have been taken for the development of the instructional facilities of the above mentioned schools:

1. Eight technical books have been written at an international standard at the basic-skill level of instruction and 1,000 copies of each have been printed and distributed to the students free of charge.
2. Equipment and tools, expendable materials for use in the workshops and teachers' books have been procured and place at the disposal of each school.
3. The technical staff and instructors necessary for these units have been secured from various sources. First, twenty--three teachers who were employees of the Ministry of Eaucation and who had graduated from trade and vocational schools were sent to the relevant units after a two-month period of orientation and training and complete familiarization with this system of education. For places in which there were no qualified teachers or in order to complement the available technical staffs, Peace Corps Volunteers and members and officers of the Technical Corpe were made use of, so that in the school year 1972-73 there are no shortages observed in this regard.
4. In the school year 1972-73

Table 12. Pre-vocational trade schools

No.	Name	Province	Country	Trades
1	Bisheh Kola	Mazandaran	Amol	Small motors, Electricity.
2	Nuq	Kerman	Rafsanjan	Metalworking, Construction.
3	Jiroft	Kerman	Jiroft	Pump motors, Tractor mechanics.
4	Susangerd	Khuzestan	Daht-e-Mishan	Tractor mechanics, Metalworking.
5	Dezful	Khuzestan	Dezful	Tractor mechanics, Electricity.
6	Azarshahr	East Azarbaijan	Tabriz	Automechanics, Plumbing.
7	Miyaneh	East Azarbaijan	Miyaneh	Tractor mechanics, Metalworking.
8	Khameneh	East Azarbaijan	Tabriz	Metalworking, Small motor mechanics.
9	Bandar Abbas	Coastal Province	Bandar Abbas	Mechanics, Electricity.
10	Purkan	Central	Karaj	Electricity, Metalworking.
11	Takestan	Central	Qazvin	Pump motors, Tractor mechanics.
12	Gabaran	West Azarbaijan	Rezaieh	Metalworking, Tractor mechanics.
13	Farrokhshahr (Qahfarrokh)	Chahar Mahal-e Bakhtiari	Shahr-e-Kord	Automechanics, Metalworking.
14	Borujen	Chahar Mahal-e Bakhtiari	Shahr-e-Kord	Automechanics, Metalworking.
15	Shirvan	Khorasan	Shirvan	Electricity, Plumbing.
16	Bojnurd	Khorasan	Bojnurd	Tractor Mechanics, Metalworking.
17	Behkadeh-e-Ra-ji	Khorasan	Bojnurd	Metalworking.
18	Bijar	Kordestan		
19	Kermansha	Pare-Gasreshrine		
20	Johran	Fars		

approximately 1,200 students are studying in the 17 trade schools and this educational system has been well-received everywhere.

Another vocational training center

(1) Agricultural training center

Under the management of Agricultural Ministry, the vocational education is carried on as same as its level in Rural Vocational School. There are 10 Vocational Training Centers in Iran, these names are as follows: 1. Shiraz, 2. Isfahan, 3. Tabriz, 4. Sahsavar, 5. Mashhad, 6. Kerman, 7. Buroojerd 8. Kermanshan, 9. Bampoor, 10. Mahabad.

(2) CENTO Agricultural machinery and soil conservation training center at Karaji

The center was founded in 1961 to provide facilities within the CENTO region for the training of postgraduate engineers from Iran, Pakistan and Turkey, in the practical aspects of soil conservation, and in the operation and maintenances of farm machinery. Karaji is 40 km west from Tehran, and an altitude of 1,400 meters.

There are two separated courses of study available: 1. Soil conservation, 2. Farm machinery. Both courses are of 10 months duration, commencing in the autumn and terminating mid-summer of following year (October 1st—July 31st).

Governing body: a governing body conisting of representatives of the CENTO regional countries of Iran, Pakistan and Turkey, together with the United Kingdom, meets each year at the center to discuss and formulate policy.

The curriculum is as follows:

1. Soil conservation course; Hydrology, Soil science, Field irrigation, Surveying, Field drainage, Dry farming, Earth moving, Water pumping.
2. Farm machinery course; Farm tractors, Workshop technology, Farm implements and machines, Earth moving, Dry farming, Mechanization management, Water pumping.

(3) Iran technical training center of Karaji

This center is managed by Labour Ministry, and ten years ago built up. This center has 14 sections as follows: Automobile repair, Farm machine repair, Plastic making, Pipe selling in building, Archtecture, Metal dies making, Hand making finishing, Machine finishing, Wooden making, Moulding, Wood moulding, Press, Electric welding, Gas welding.

(4) Short course education

This short course education have done in rural vocational school. There are two kinds, as follows:

1. Farm youth short course education
2. Teacher of middle school short course education

Author investigated this kind education system at Rasht Rural Vocational School and Gorgan Rural Technical School.

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Practical training of Japanese power tiller for teachers and students at Gorgan Rural Technical School.

Practical training of Japan large tractor for teachers and students at Gorgan Rural Technical School.

Short course training of Japanese power tiller for teachers of middle school at Rasht Rural Vacational School.

Practical training of Japanese Binder for teachers and students at Gorgan Rural Technical School.

Practical training of Japanese knapsack mist sprayer for teachers and students at gorgan Rural Technical School.

Agricultural Mechanization in China

by
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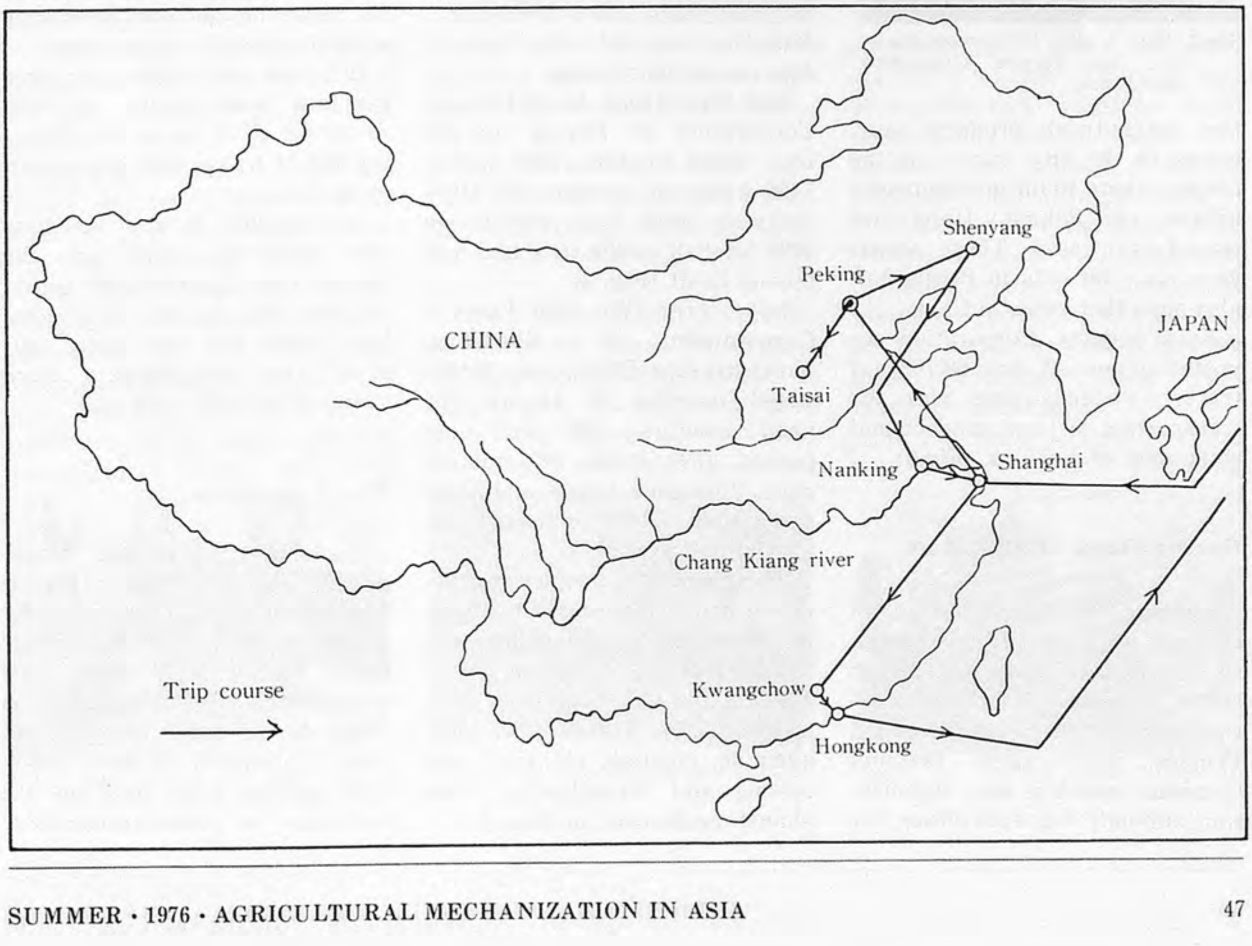
Introduction

Three week trip in China, of Japan-China Agricultural Technique Exchange Mission invited by Agricultural Society of China, was held in Summer 1975. Author, joined as agricultural mechanization specialist, visited Peking, Taisai, Shenyang, Nanking, Shanghai and Kwangchow (Canton).

Government of the Republic China has several slogan "Development based on agriculture and guided by industry", "Agricultural mechanization until 1980", so that the recent development of agricultural mechanization is remarkable in China.

It is a symbol of them that tractors and rice transplanters are painted at wall picture in Peking Hotel (**Fig. 1**).

The first impression of Chinese agricultural mechanization was in Peking that many four wheel tractors, hand tractors and horse drawn trailer mixing with car trucks were operated to transport



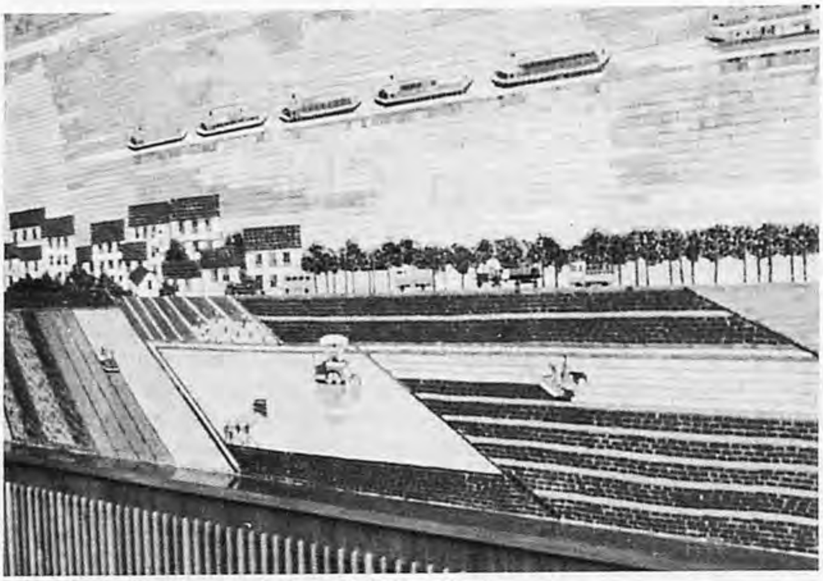


Fig.1. Farm Machinery wall picture in Peking Hotel.

Fig.2. Hand tractor for transporting at Red Star Peoples' Corporation near Peking.

Fig.3. Plowing by hand tractor Peking.

the agricultural products anywhere in the city except at the center, where main governmental offices or Peking Hotel we stayed is located. These scenes were seen not only in Peking but also any other cities in China.

Each peoples' Corporation we visited explained that 60-70% of tractor working time was for transporting of farm product and sometimes of workers. (**Fig.2**)

Recent Status of Agriculture

Statistic of mechanization in China is not officially announced, so we tried to make the recent status of agricultural mechanization clear by introducing several Peoples' Corporation (Renmin Gongshe), which is unit organization not only for agriculture but also for administration.

Red Star (Hong Xing) Peoples' Corporation in Peking has 70 four wheel tractors, 3300 horses, 1200 wells and pumps, and 51000 ton/year total farm product in 8000 ha (half paddy field and half upland field). (**Fig. 3**)

Fifty three (Wu san) Peoples' Corporation in Shenyang, Northern East China, has 42 four wheel tractors, 39 trucks, 160 hand tractors, 290 well and pumps, 1000 hogs, 200 milking cows, 8 ha glass houses and 34000 population (15000 engaged on agriculture) in 3000 ha.

There are 198 Peoples' Corporation and 17 governmental farm in 360000 ha in Shanghai, and 24000 tractors, 8800 rice transplanters and 1250 harvesters were used in 1974. Tillage, threshing, pumping, planting, spraying, processing and transplanting were almost mechanized in Shanghai.

In Nanking they conduct three-crop farming, wheat (or barley or rapeseed)-rice-rice, and their yield are respectively 6000, 7500, 6000 kg/ha at highest, and average 15000 kg/ha/year. The first and second rice transplanting dates are about 10th of April and 8th of August, and harvesting dates of them are respectively 25th of July and 30th of October.

Tilling of both paddy and upland field is 15-16 cm deep with rotary tiller at water submerged field in Spring and Summer, but with plow at dry field in Fall.

Pingzhou Peoples' Corporation in Canton has 28 four wheel tractor and 83 hand tractor at 4500 ha, and tillage is held 70% by tractor and 30% by water buffalos. They said that yield of mechanical tilling field is more than of buffalo tilling field, because of better harrowing and leveling.

Also, most of those Corporation managed a big machine shop for repairing and manufacturing several agricultural machinery.

It seems that cultivating area per four wheel tractor is about 70-110 ha, 15-20 ha per hand tractor and 41 ha per rice transplanter in China.

In Shanghai it was the first rice harvesting period and the second rice transplanting period in July and August. Rice combines were not seen there, but many rice transplanters were operated in paddy field.

Rice Transplanter

Shanghai-I type rice transplanter used most widely (**Fig. 4**) is mounted 3 P.S. engine, 337 kg weight, 14 row, 0.10—0.13 ha per hour and walking type rice transplanter. Seedling used is about 40 cm long. Nursery bed area is one-forth of main paddy field, because more seedlings are necessary for power transplanter

Fig.4. Shanghai I type rice transplanter at Huandu Peoples Corporation near Shanghai.

than for hand transplanting.

Usually rice transplanting is held after twice puddling at water submerged paddy field by rotary tiller.

Production

Most of agricultural machinery used in China is made in China.

Four wheel tractor, named Eastern Red—20, 28, 40, Rich Yield—27, 35, Shanghai—45, Iron ox—45 (number means horse power), and crawler tractor, named Eastern Red—20, 30, 54, 75, and hand tractor, named Kongnong—11,12, Zhongshan—12, are now manufactured in China widely.

Liaoning 518-12 walking type tractor is one of hand tractor, made at Shenyang hand tractor factory in Shenyang.

The factory has 500 machine tool and 1100 worker (in three shift a day) at 10 ha area, and products 8800 hand tractor per year. The hand tractor is not so smart and 580 kg weight (**Fig. 5**), manufactured from 1964, and mounts 15 horse power diesel engine of 150 kg weight made at Shenyang diesel engine factory.

Learn Taisai

There are many slogan "Learn agriculture of Taisai" anywhere in rural China so that we can not speak Chinese agriculture except introducing Taisai.

It takes 7 hours by train and one hour by car from Peking to Taisai, east of Shansi.

Chen Yong Gui was the leader of Taisai, a poor sloping village, and now he is a deputy prime minister of the Republic China.

Taisai has 400 peoples (working population 160) at 56 ha mainly upland field, planting corn 50%, millet 30%, rice 10%, kaoliang 10%, wheat 10%. Sloping valley fields have been changed into the complete terrace fields by boundary of stone arch wall for this twenty years.

They have complete irrigation system including four irrigation reservoir and 25 km waterway, and have each entrance for tractor.

They have 4 four wheel tractor, 2 crawler tractor and 2 hand tractor in Taisai, working mainly for tillage and transporting (**Fig. 6**).

Also, they utilize effectively excrement of animal husbandry, for example, breeding animals at higher part of hill, and have made very fertile soil so called "the spongy soil", and have tried many mechanization using sprinkler or cable transporting system and so on.

These are reason why Taisai is a model as goal of Chinese agriculture.

Zhang Xi Bin, director of the Agricultural Society who tripped with us from beginning to end, told us "it is most important for Chinese Agriculture that we have to learn the Taisai spirit which promoted farm mechanization at a poor sloping village seemed impossible to mechanize".

Agricultural Machinery Exhibition

Many kinds of agricultural machinery were exhibited at agricultural machinery room of Shanghai Agriculture Exhibition Hall.

In front of the room there were small gasoline engines, diesel engines, pumps and sprayers. Turning to left, there were a furrow opener, double-furrow Japanese type plows for hand tractor, a 6-furrow Japanese type plow with fork bourd for three point hitch, rotary tiller with fertilizer and 1.5m wide rotary tiller combined with cultivator.

At back side of the room, there were man power rice transplanter which was a prototype of power rice transplanter exhibited at the next, and rice seedling picker "Huchuan 130—2 type" made for test (**Fig. 7**).

At the next part, there were side delivery reapers originally

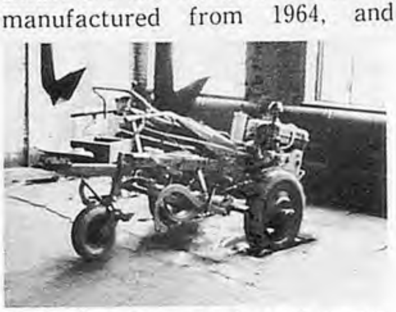


Fig.5. Running test of hand tractor (Liaoning—12) at Shenyang hand tractor factory.

Fig.6. Tractor and trailer for transporting in Taisai.

Fig.7. Rice seedling picker (Huchuan 130—2) at agricultural machinery exhibition room in Shanghai.

Fig.8. Long drum thresher at Huandu Peoples Corporation near Shanghai.

from Japanese type. Also, an attachment type combine "Fengshou-20" (Rich Yield) attached to four wheel tractor "Shanghai-45", self-feeding thresher and rice huller both same to Japanese type, a long drum thresher (**Fig.** 8) and rubber drum type grain thrower and gain mill were followed.

At the center of room, there were four wheel tractor "Fengshou—35, —65", "Shanghai—45" and hand tractor "Gongnong—11" and so on.

Research

Kiangsu agricultural experiment station in Nanking is consist of 8 division; Food, Industry art, Horticulture, Stock farming and Verterinary, Soil and Fertilizer, Protect from insect and pest, Agricultural physics, and Fishery.

The staff of the station are about 600, and they have a system so called three part combination of farmer, research staff and administration official.

Shanghai agricultural experiment station has 200 staff, and farm machinery division has 50 staff engaging to study rice harvester, rice seedling picker (**Fig.** 7) and horticultural machinery.

For Mechanization

"Agriculture based on mechanization" is another big slogan derived from Mao speach.

So they are promoting the irrigation system and the field consolidation, for example, adjusting area of a paddy field into 1-2.7 mu (0.07—0.2 ha), which is fundamentally necessary for agricultural mechanization.

Also they promote the food storage, especially grain storage to prevent famine.

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Whenever you need more informations, pleas write me!

Yours Sincerely
Yoshikuni Kishida
Head of Directors

The Agricultural Mechanization Activities in Turkey

by B.G.Tunaligil
Professor
Ankara Universitesi Ziraat Fakultesi
Ziraat Alet ve Makinalari
Kürsüsü Turkey

Introduction

Many investigations are being carried out in Turkey nowadays. The scope of 80% of them is to find the best way to assist Turkey in development.

The fact should be kept in mind that to change a country from an agricultural to an industrial bases is quite a difficult problem. From the agricultural scientist's point of view one of the keys of progress is correct mechanization of the agriculture. Hence, we have to understand fundamental bases of mechanization and apply them taking into consideration of the country's conditions.

In Turkey, at present, agriculture takes a great place on the steps of going to be an industrial country. In this way to get more crop per unit area, to evaluate the crop obtained, to increase the income of the population employed in farming sector, are essentials of agricultural policy.

Studies on the land reform providing to usage of whole land of the country, solutions to produce more crop, sufficient agricultural input for the farming enterprices are being investigated intensively. Establishing effective cooperatives will lead to have a dynamic production, trade and marketing.

Nevertheless agriculture must be mechanized to be able to function in developing Turkey. That is why mechanization is being studied and applied emphasizing on the matter.

The third five years plan covers quite intensive mechanization activities which are being carried out by ministry of Food and Agriculture, State Planning Organization, Agricultural Faculties, Agricultural Bank, National Productivity Center, Society of Agricultural Engineers, Turkish Scientific and Technical Research Council.

Present Situation of Mechanization in Turkish Agriculture

Criterions Related to Mechanization

While putting forward the present situation of agricultural machinery which are the modern technological inputs, because of their close relation, it is necessary to consider;

1) The land we have, size of farms, distribution patterns of parcels in enterprices.
2) Active population in agriculture.
3) Working time in agriculture, depending on the climate.

These are the most important criteria in a country's mechanization. In addition to these, a country's industrialization position, possibility of getting agricultural machinery from its own production facilities, and income of population which are ocupied in agriculture must also be considered.

1. The Land

According to 1970 Agricultural statistics 39% of the total land is allocated for agriculture. If the horticultural area is excluded the arable becomes 31.9% which is about 24,527 million hectars. Horticultural area is about 3,087 million hectars. Arable land is a 89.2% portion of the total agricultural land. It is seen from these figures that the Turkish agriculture consists of mainly the production of the field crops. 35.8% of the arable land is left as fallow land. This proportionality shows that the Turkish agriculture has an extensive character.

Third five-years plan proposes to decrease the arable area to 23,250 million hectars and to allocate 271,000 ha as meadow, and to decrease the fallow area to 6,500 million ha.

At the present 7% of the agricultural area is irrigated but the research shows that this proportion may be raised to 40%.

According to 1963 figures; 69% of the farms are in the class 1-50 da. If we assume the farms having an area between 50 and 200 da. as small enterprices, then the small enterprices constitute the 96.3% of the total agricultural enterprices. It can be thought that due to inheritance, at the

Table 1. Parcel distribution patterns of the enterprices

Number of parcels	Enterprices 1950	% 1963
1	5.4	9.6
2 — 3	22.7	20.8
4 — 5	23.2	19.9
6 — 9	26.1	24.9
10 or more	22.6	24.8

present the sizes of the enterprices became smaller. The parcel distribution patterns of the enterprices of which the majority are small farms is given **the table 1.**

Distribution patterns of farm size and parcels is impading the advance of intensive farming and limiting the raise of production and also economical mechanization. Land assembling, directing for the medium and large farming enterprices is the basic support of rantable and productive agricultural management. In land reform, eventhough there is a land distribution from the view of possesion; from the view of management some systems providing rantable and productive applications which increase the efficiency the total input are being established by cooperatives.

2. Active population in agriculture

Distribution of active population among sectors is given **the table 2.**

Table 2. Active population among the major sectors

Sector	1955	1960	1965	1970(%)
Agriculture	82	79	75	72
Industry	9	10	12	14
The services	9	11	13	14

It is seen from the above table that a large proportions of our population is employed in agriculture. The population employed in this sector was 82% of the total population, it was only possible to decrease this percentage to 75% in 1965 in a ten years period. It is possible to compare the population employed in agriculture with various other contries from **the table 3.**

Table 3. The percentages of population employed in agriculture in various countries

Country	%
Bulgaria	59
Iran	48
Iraq	50
Syria	50
Turkey	72
Egypt	55
Italy	24

Decreasing the active agricultural population by employing them in industrial sector will be possible if industry and industrial sector reach to a high level. Turkish economy is faced with that matter these recent years. Efforts of creating possibilities for the exceeding agricultural population in industrial sector is precise direction of Turkish economy considering that social economical and some other matters would exist by this replacement.

3. Climate and working time in agriculture

It is a known reality that our country has different climates in a small region. This situation makes it possible to grow different culture plants, and working a considerably long time in agricultural production.

Growing time depends on temperature and it starts +5°C on spring and stops at +5°C on fall. It is a characteristic of Anatolia that spring and as a result the plant animation is late, but it continues very fast and the crops became ripe earlier than, that of cold countries vegetation time should certainly be found out by phenologic observations.

The amount of man, animal and machine as a power source and the amount of cultivated land by them.

In the above we discussed shortly the criterion related to mechanization, the general situation of mechanization is as fallows.

In Turkish agriculture, use of tractor as a power source, starts intensively after 1949. As a matter of fact in 1949 total cultivated land was 13.264 million ha and the number of tractors were about 9,170. In 1950 number tractor increased by 89% and the number of draft animals stayed the same. In 1951 number of tractor reached to 24,000 and 1.8 million ha of 15,272 million ha of land is cultivated by tractors, the remaining land is tilled by 2.5 million draft animals. Both the number of tractors and the tilled area is increased continuously till 1955 and the number of tractors reached to 40,282 and the cultivated land increased from 15.2 million ha to 21 million ha. Only 3 million ha of this cultivated land is tilled by tractor. Here the interesting thing is that between 1951 and 1955 the number of tractors and the cultivated land increased by 68%, but the number of draft animal stayed the same, even the cultivated land per draft animal is increased from 5.3 ha to 7 ha.

It is more interesting that between 1955-1964 the number of tractors increased by 28% and reached to 51,781, but the land tilled by tractor increased only by 18%.

Between 1955-64 the total cultivated land is increased from 21 million ha to 23 million ha that is, the cultivated land is increased by 2,843 million ha.

In this increment of 2,843 million ha. only 862,000 ha that is, 36% is tilled by tractors and in tilling the newly cultivated land the main weight was on the draft animals. As a matter of fact while the number of draft animals was 2,563,878 in 1955 it reached to 2,749,000 that is between 1955-1964 number of tractors is increased by 28% while the number draft animals increased 7%.

Between 1964-1970 cultivated land shows only a 1.9% increase and reached to 24.3% million ha which is the marginal line of cultivated land. In this period the number of tractors show an increase of 104% and reached to 105,865, also the area tilled by tractors show an increase of same percentage and reaches to 7.9 million ha. In this period the number of draft animals is decreased from 2,749,000 to 2,167,555 and the area per draft animal is increased from 7.3 ha (1964) to 7.5 ha (1970) See **tables (4, 5, 6, 7, 8)**.

Third five years plan proposes an increment of 122.8% in agricultural machinery production in the period of 1972-77 that means the number of tractor will increase from 20,000 to 35,000 per year.

An increase from 500 to 750 for combine harvester and from 1,350 to 9,000 for drill is also planned. Until the end of this period 400 tractor will be imported than export of 50 Turkish made tractor will be possible per year. For the other implements manufactory capasity is sufficient enough not to import any.

Following table gives the amount of some machinery available and the target for 1990.

Table 4. The available tractor park of Turkey in 1971

Tractor HP	Amount	%
Smaller than 24	10,843	9.5
24—34	29,878	26.5
34—50	55,398	48.0
Bigger than 50	18,385	16.0

Table 5. Park of horticultural tractors

Years	Number of tractors
1973	2,000
1977	8,640
1990	151,950

Table 7. The amount of some machinery available and projection for 1990

Machinery	Park 1973	Park 1990
Plow	181,920	625,890
Drill	77,320	200,280
Pump	123,600	259,200
Combine harvester	10,380	25,000
Trailer	136,440	625,890
Disc harrow	68,222	219,060
Cultivator	37,900	250,360
Tooth harrow	90,960	312,950
Roller	30,320	62,590
Broadcaster	3,000	309,740
Mower	7,585	62,580
Baler	760	37,550
Potato Harvester	60	6,260
Tractor loader	2,500	62,580

Table 6. Tractor production of Turkey

Tractor BG	1972	%	1973 (programmed)	%
Smaller than 24 HP	—	—	—	—
24—34	1,318	5.4	2,600	6.4
34—50	18,416	82.0	26,300	68.4
50—65	2,200	9.3	8,500	22.0
65—80	700	3.3	1,200	3.2
Bigger than 80	—	—	—	—

Table 8. The tractor park of Turkey for 1990 and the criterions

Area cultivated by tractor (Ha)	Total area(Ha)	%	Necessary* HP/Ha	Used Necessary Total HP
less than 10	7,800,000	42.0	2.10	16,380,000
10.1—20	3,710,000	20.0	1.60	5,936,000
20.1—50	2,432,000	13.0	1.10	2,675,750
50.1—99.9	980,000	5.4	0.95	931,000
100 or more	627,500	3.6	0.95	596,125
Total	15,550,000			26,518,875
Fallow	3,000,000	16.0	1.6	4,800,000
Total	18,550,000	100.0	1.69	31,318,875

Average tractor power : 50 HP
Number of tractor=625,000
* Necessary HP/Ha is taken from "CNEEMA trakteurs et Maschines Agricoles, Tome: 3 Paris 1963" with 20 % of efficiency (adding 20 % more) for the conditions of Turkey.

Table 9. The numerical power distribution of agricultural tractors for 1990 (exluding horticultural tractors)

Tractors	%*	Number of tractors	Average HP	Total HP
Smaller than 24 HP	2	12,500	20	250,000
24—34	15	93,750	29	2,718,750
34—50	40	250,000	42	10,500,750
50—65	25	156,250	57	8,906,250
65—80	13	81,250	72	5,850,000
Bigger than 80	5	31,250	100	3,125,000
	100	625,000		31,350,000

* Considering the actual production, the distribution in other countries and the other developments this percentage is changed than the park available 1971.

Comparison of Turkish Agricultural Mechanization Level with Other Countries

In comparing the mechanization level of various countries with the level in Turkey we have chosen such countries that are socio-economically similar to us.

Besides that, since in the determination of agricultural mechanization level, the other tools and machinery are a function of the tractor, number of tractors, amount of land cultivated by the tractor, and the amount of cultivable land per tractor, are chosen as acceptable criteria.

As it is seen from the **table 10**, distribution of tractors is very different and also the tractor distribution pattern of each country in time is different. According to **table 10**, among these countries which are mainly mediterranean countries, in 1969 Italy is first with 584,214 tractors, Spain is second with 220,000 tractors and Turkey is third with 95,709 tractors.

If we make a comparison for the agricultural mechanization by means of the cultivated area per tractor, we see that with 20.9 ha Italy is first, with 43.13 ha Greece is second, with 71.33 ha Spain is third and Turkey with 263.6 ha comes 6th after Egypt.

There is a close relation be-

Table 10. Distribution of tractors according to the years and agricultural area in a number of countries

Countries	Years	Total area	Total area cultivated	Average number of tractors according to the years 1948—52	1965	1969	1970 Hectar per tractors
Greece	1966	13,194	2,780	7,140	40,128	64,490	43.13
Yugoslavia	1969	25,580	7,539	6,266	45,420	68,199	110.50
Iran	1960	16,480	11,302	—	—	—	646.00
Iraq	1964	43,492	7,309	439	6,500	11,200	652.60
Syria	1968	18,518	5,577	855	7,775	8,500	656.11
Turkey	1969	78,058	25,231	20,292	52,964	95,709	263.60
Egypt	1969	100,145	2,725	—	14,500	16,200	168.20
Spain	1968	50,475	15,692	14,799	147,884	220,000	71.33
Italy	1969	30,123	12,221	60,519	419,943	584,214	20.92

Source: FAO, Annuarie de la Production, 1970.

tween a country's economic development and intensity of tractor use.

This comparison also proves that the mechanization level of Turkey is rather low according to the amount of cultivated land and the amount of crop obtainable.

The efforts of mechanization which raise the quantitive and qualitative increment must be used correctly and the rate must also be increased. Turkey is looking for the ways to realize the mechanization by the layouts which give the highest efficiency with the agricultural input employed. Progressive methods and devices in agricultural applications are being selected for high productivity rates. On the other hand necessary machinery park to evaluate the agricultural crops and prepare for the marketing is being established and in addition to these mojor agricultural inputs, food and raw material manufactories are getting forced.

Agricultural Machinery Manufactory and the Matters Related to Mechanization

The machinery park of Turkey is not big enough for high mechanization level which is sufficient as a basis in development. So machinery amount must be increased rapidly.

Agricultural machinery production has started as manufacturing spare parts and montage of the machine parts imported. But this manufactory has been almost an industry at present consisting about 7 factories capable for mass-production and approximitly 600 small enterprices.

Manufactory of Turkey had an increment of 9.9% between the years 1968-1972 but this increment occured on the direction of consumption goods not on the investment goods likewise the all developing countries. Although the portion of the investment goods manufactory in general manufactory is approximately 45% in developed countries, 25% in developing countries, in Turkey this portion has raised to 14% in 1972 and the portion of agricultural machinery subsector in this rate is only 9.3%.

That means that agricultural machinery manufactory sector need a great support.

Following solutions will reflect the limiting factors in the manufactory of agricultural machinery.

1) To provide sufficient, high quality cheap raw material for domestic machinery industry.
2) Amount of credit for building material and qualified workers must be increased.
3) To determine an industrial policy adequate for agricultural machinery conditions of Turkey.
   (a) Technical fundamentals of domestic production must be determined,
   (b) Main industrial branches which support the domestic production must be confirmed,
   (c) Sufficient energy sources must be supplied,
   (d) Policy of adequate price must be arranged,
   (e) Develope of insurance law to support the production of agricultural machinery,
   (f) Stopping montage type production,
   (g) The relations between Turkey EEC must be arranged avoiding to be upset of the domestic production,
   (h) Increment of standardization must be realized,
   (i) To provide an organization in the manufactory,
   (j) Design of manufactory units suitable for the necessities of Turkey,
   (k) Setting a control system for the production,
   (l) Possibilities of cooperatives and credits must be supported.

In such supported conditions, progressive steps of domestic agricultural machinery manufactory must take a direction to the following targets:

1) Strong and adequate design,
2) Facing towards mass production,
3) Suitable material usage,
4) Good labor,
5) Sale organization,
6) Reliable service and spare part facilities,
7) Steady offer.

Mechanization level of farming increases as fast as the domestic machinery manufactory does. The possibility of providing of expected utilization from the mechanization will increase when domestic industry meets the necessities of Turkey as quantity and quality.

On the other hand a common education in different levels must be realized for domestic machinery production and mechanization. Agricultural mechanization and the activities, to strengthen the machinery need an adequate and strong planning in the production of agricultural machinery basically.

Matters Related to the Elements Which Increase the Productivity in Agricultural Mechanization

Employment of agricultural machinery and equipment for farm and farming applied methods is an important aspect of mechanizing agriculture. Productivity is primarily the result of to get machinery and usage of them.

Applying the principles of machinery selection.

In order to select the right machinery some elements must be taken in to consideration, such as purchase conditions, cost, work analysis, etc. Otherwise expected uses of machinery can not be obtained.

1. Purchase principles

Purchasing proofs must primarily be depended on a suitable selection of the structure of farm. Secondarily trade mark, firm, model, construction, ease of operation, ease of calibration, spare part, service, ability of fitting of work and conditions, high ability of maneuver, comford and safety are the properties which must be taken into consideration when purchasing machinery. But in Turkey, farmers have not much choice on this subject because offer of the machinery is rather limited in the market since the machinery manufacturing is poor as mentioned before in the chapter of machinery production matters. In additions to these factors work-study and value study must be done to achieve to a suitable selection and purchasing.

2. Value and work analysis

Value analysis are the analysis of purchase and operational cost. The results of these analysis provide determining the machinery suitable for the structure and the character of farms. Depreciation, operational cost such as; cost of fuel and oil, maintain and repair, cost of operator, fixed costs; interest on investment, taxes, cost of shelter can be calculated by these analysis. These costs differ due to the technical, economical and educational conditions of country. Without having taken into considerations of these factors the suitable selection can not be achieved.

In Turkey, farmers are disapointing about the mechanization because of the wrong work organizations and wrong machinery which they applied. This matter basically related with the lack of knowledge.

Another factors effect on the productivity of agricultural activities are the rate of work, strength of construction and functional construction which are related with the characteristics of the machinery. These factors also differ for different farm and country conditions.

Fundamentals of operation are as important as selection. These are; calibration, effective usage; utilize from the abilities of machine as much as possible, economical usage, using the time efficiently. These fundamentals unfortunately are not being applied by the farmers in a wide extent because mechanization has been thought as employing machinery instead of manpower and it has not been given importance to the education necessary to use machinery.

Conclusion

When we look into present state of Turkish agriculture we can say shat mechanization level is rather low in spite of high potential of land, water, climatic factors etc. As much as we succeed to decrease the obstacles influencing the agricultural mechanization we can get more benefit from agriculture and rate of economic development will increase. We can summerize these abstacles as follows.

1) Inefficient agriculture and traditional process
2) Inadequate economic structure and shortage of factors of production (Particularly on small farms)
3) Weakness in public administration
4) Social problems
5) Primitive trade applications
6) Limited capital and investment
7) Limited returns
8) limiting factors both agriculture and industry

It is generally recognised that one of the main obstacles to increased productivity in Turkey is the small size of the farms and the parcellisation of holdings which limit the use of machinery and the application of modern practices. We review the present obstacles to farm mechanization and put forward certain recommendation and conclusions with a view to overcome them. It is considered that if these recommendations are put into effect they will do much to speed up mechanization • on farms and thereby raise the general level of technical efficiency of Turkish agriculture.

Small farms in Turkey is a family farm providing enough work for the farmer and his family. The use of animal as draught power in these farms will continue to play an important role in mechanization for many years. On the other hand adaptation and technical development of animal drawn equipment will be needed. There is a limit to the amount of machinery and this limit stops complete mechanization on small farms. By mechanization production would furthermore be increased by the wider use of agricultural machinery. And also livestock products the wider use of electric fences and modern apparatus for the preparation of animal feed would lead to greater and more ecnomic meat and dairy output. Socially, mechanization also give the farmer better working conditions and would respond to the needs of younger generation of farmers. Many of them prefer mechanical to traditional methods of farming. But all these must be depended on some researches which connected with background of Turkish agriculture.

The first thing to do in Turkey is land and agricultural reform. Many problems of agriculture can be taken into consideration by preparing these reforms. It is necessary to keep in mind to do these reforms is not easy we think. They involve many problems, obstacles and difficulties. This is cause retarding of Turkish agriculture until present. We have recognized the basic problems of agriculture in Turkey and determined the solutions. Mechanization is one of the solutions. We have to take into consideration all solutions together in a reform plan. Besides that there is no short way to become developed country for Turkey. In fact the Turkish government are spending more energy for this purpose.

The perfect mechanizational activities and progress have been realized in state farms in Turkey which are excellent examples for the farmers who want to mechanize and get more profit from per unit of investment. Mechanization of state farms has been planned by the experts and supported by government.

At present Turkey has some technical obstacles to the further mechanization. The price of agricultural machinery are high because of present structure of the industry. High rates on imported machinery prevents rapid mechanization. The nature and characteristics of farms at present is not suitable either motorization or complete mechanization. For this reason we have to pay attention to choose adequate way and method for mechanization of farms. When the difficulties were examined some basic operation maybe suggested.

We believe that mechanization will be very helpful for Turkey's developing if it organized very carefully. The Turkish farmers can get more advantages because of mechanization as resumed follows.

1) Efficient use of manpower.
2) Efficient use of capital
3) Reduced cost and so more income
4) Basic improvements possible
5) Provide more manpower and raw materials to industry
6) Provide adequate intensive agriculture
7) Provide higher standard of living.

We hope that more intensive and effective studies will be carried out by related establishments for the advanced agriculture and industry on which efforts are getting focused in Turkey.

The principle aim is to increase the labor productivity, strengthening the domestic manufactory, using suitable machinery effectively on the way to develope the agricultural mechanization by the scientific studies which accelerate this development.

As much realization as this development accelerated by the scientific researches of Agricultural Faculties, National Productivity Center State Planning Organization and applications of Ministry of food and Agriculture, private and official manufacturers, Turkey will have the financial accumulation and get the forces which may be transferred to the industrial sector.

We hope that these activities will be accelerated taking into consideration the developed country's methods and activities by the related establishments.

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Problems at Paddy Drying and Rice Whitening in the Philippines

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Preface

The author researched on the matters about paddy drying, storing and rice whitening in the Philippines on the spot as an agricultural consultant of the World Bank from August to September in 1975. The investigation was aimed at defining the proper method that decreases rice grain losses in an after-reaping process in the Philippines. The investigation was focused especially at a whitening loss of rice grain and at the same time it was conducted about the problems at drying and storing processes as general objects.

It is very difficult to resolve the problems perfectly in this short period, since this investigation involves vast problems. The author wrote the report, therefore, discussing with Japanese agricultural leaders and investigators who reside in the Philippines about the state of agriculture at present and the problem, and referring the past reports.·〔Report on Drying, Storing and Milling in the Philippines, Nov. 1975, Kobe University〕 The author will describe the outline of Philippine agriculture, the mechanization state and the investigative and technical problems at drying and rice whitening processes here.

Outline of Philippine Agriculture

The population rise rate in the Philippines is 3% per year in last 10 years. On the other hand, the increase rate of rice production is hanging low with 2.1% per year. It is necessary to import the rice about 300,000 tons a year, as the food production rise cannot follow the population increase. About 10 years ago it was expected as so called "Green Revolution" to avoid the food crisis by planting the high quality rice developed by IRRI. The effect on the production increase by the improved rice, however, was lower than that expected due to various reasons, so that the policy down to date seems to be reconsidered.

It is possible there to harvest the rice 2 or 3 times a year by planting the new variety, since the Philippines is the tropical country where the rice would grow all year provided an adequate irrigation is maintained. The irrigated area at present, however, amounts to only 30% of the entire paddy areas and most rice productions are depend on a rainfall. Then a stable rice production cannot be expected from the paddy field with also no drainage facilities. The average unit production is still 1.7 ton/ha, ie. 1/3 of that in Japan, because the expensive techniques such as a supply of fertilizers or a prevention of plant disease and insects are so hardly applied as the irrigation, though the technique was built up in order to increase the production (about 5 ton/ha).

As for a labor problem, the labor is in excess, since an employment increase is still only 0.34% in 1973, though a labor supply increases at the rate of 3% each year. So that the wages for the labor such as a daily work are 8 pesos/person a day in busy seasons (at rice planting) or

※The author worked in Faculty of Agriculture, Kobe Univ. to end of March in 1976.

5~6 pesos/person in slack seasons (at weeding). Since the wages are very low, the concern in the mechanization of agriculture is considerably different from that in Japan. Furthermere the average paddy area per household is around 3 ha and they are not blessed economically. Accordingly, it is cheaper to utilize the manual labor or animals (a buffalo) than to use the machines. As a result, the farm mechanization would be restricted to large farmers.

Drying of Paddy

In the case of the traditional single rice cropping in the past with planting during the rainy season and harvesting during the dry season, a natural sunlight could be used for drying the paddy. As multiparous varieties have been spread and a change in cropping season has been brought about by an adoption of a double cropping, a natural cycle of rainy and dry seasons has become inadequate. In addition to that, weather conditions (especially a precipitation) vary by year and district as **Fig.1** and typhoons cause a dmage annually. As result, it is hard to achieve a stable rice production. **Fig.2** indicates the relations between the precipitation and the state of planting and harvesting of both single and double croppings a year. The fact that some rice has to be harvested during the rainy season can be observed from the figure. In order to get a stable harvest, free from the weather conditions, artificial drying facilities are indispensable. According to NGA's (National Grain Authority's) estimation, 5% of gross rice

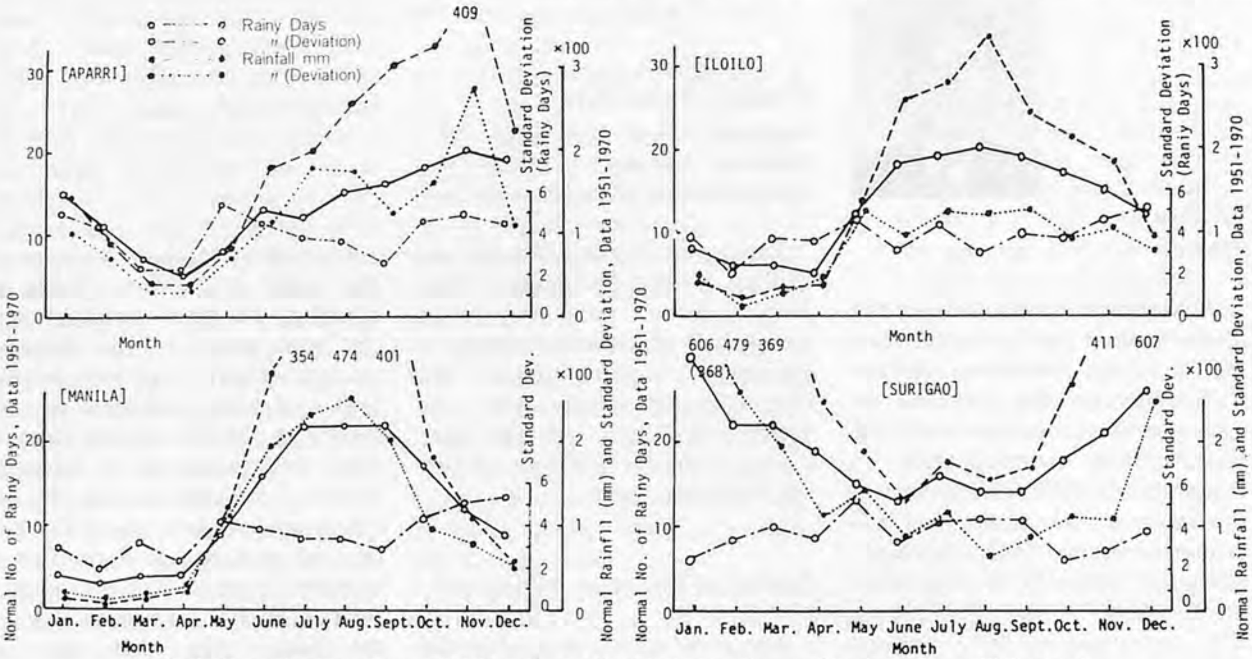

Fig.1. Normal rainy days, rainfall and standard deviation. (Source: Weather Bureau, Philippines)

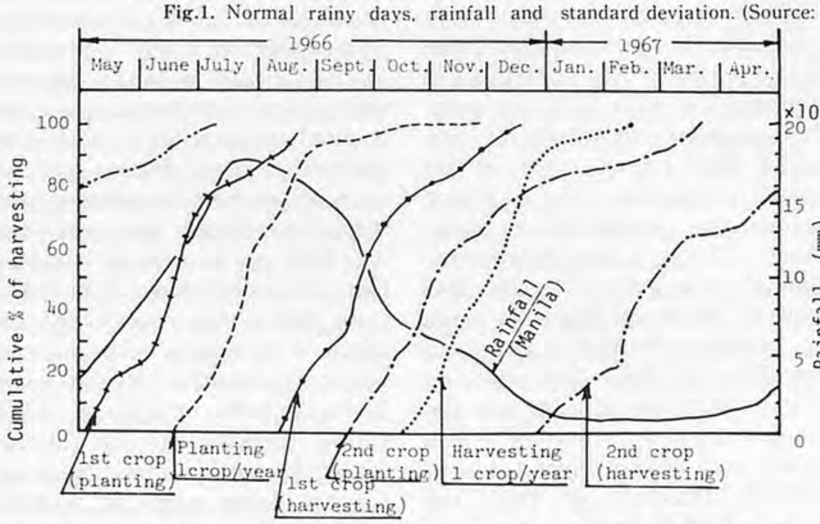

Fig.2. Planting and harvesting cycles of single and double croppings (Central Luzon, 1966~1967).

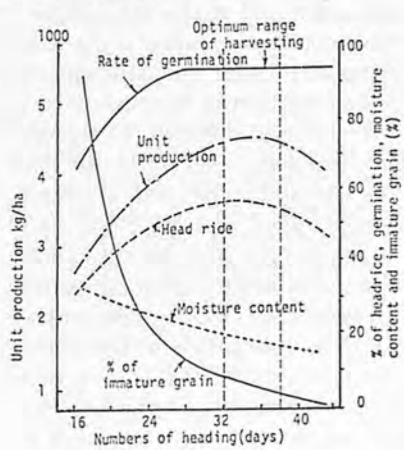

Fig.3. Percentage of head rice, germination, moisture content and immature grain, and unit production at harvesting season.

product is lost due to the fact that a drying process is not mechanized. The government (NGA) is trying to take measure to promote an improvement of drying method.

Various Problems at Drying

1) Moisture Content of Paddy Harvested

The rice product increases gradually as shown in **Fig.3**, as the harvesting period approaches, and reaches a constant value. On the other hand, the moisture content of paddy decreases inversely and reaches about 20% in the optimum harvesting period. This moisture content, however, depends upon weather conditions, harvest period, degree of early or late reaping, degree of lodging and grain position of heads **Tab.1** shows the result of investigations in Malaysia; the considerable differences due to various conditions of harvest can be observed.

Well matured whole paddy in the optimum harvest period is generally 20 to 22% in moisture content. However, immature grains have so high percentage of moisture content, that the moisture content of harvested paddy may vary, depending on the degree of mature and of mixing of immature grains. Since the improved multiparous breeds, now in wide use, have relatively low degree in purity line, a mature stage is not uniform, resulting in an increase of the imматureg grain. As a mixing rate of immature grains, as indicated in **Tab.2**, is in general as much as 15~20%, the paddy right after harvest contains the moisture of 22~25%.

Table 1. Examples of moisture content of paddy harvested in Kedah (1970).

No.	Harvest season and reference		Variety	Moisture content
1	Middle July		Ria Secondary	22.0%
2	- do -		C-4-63	23.8
3	Late July	(Top of panicle)	C-4-63	21.2
		(Middle of panicle)	C-4-63	21.4
		(Bottom of panicle)	C-4-63	22.0
4	- do -	(In gunny bag)	Mahsuri X IRS	20.4
5	Early August	(Standing hills)	Bahagia	19.6
		(Lodged hills)	Bahagia	21.8
6	Middle August	(Standing hills)	Bahagia	21.4
		(Lodged hills)	Bahagia	28.2
		(Bending hills)	Bahagia	22.8
7	Late August	(Kept in gunny bag for 3 days)	Bahagia	25.4

Note: Measurement was repeated 2-3 times on the same material. Measured by the infrared type (Kett F-1A) moisture content tester, by Mr. Takatsugu Horiuchi.

Table 2. Distribution of mixing rate of immature paddy.

Rate of immature paddy %	5.0%	5.1-10.0%	10.1-15.0%	15.1-20.0%	20.1-25.0	25.1-30.0%	30.1%
Number	0	2	3	4	2	0	1
%	0	16.7	25.0	33.3	16.7	0	8.3

Note: Number of testing samples was 12.

Table 3. Moisture extraction tests on paddy by sun-drying (1970).

	Conditions		Moisture content		Drying hours	Drying speed	Reference
	Time	Weather	Raw	Dried			
A	10 : 30—15 : 30	Fair	20.0	8.0%	5.0hr	2.40%/hr	
			19.3	9.0	5.0	2.06	Harvested
	13 : 00—16 : 30		21.0	11.0	3.5	3.25	in early June
B	9 : 00—17 : 00	Slightly	19.7	12.2	8.0	0.94	on concrete floor
		Cloudy	19.6	12.8	8.0	0.85	on jute mats
C	10 : 00—14 : 00	Fair	23.8	14.0	4.0	2.45	Harvested
			14.0	10.0	4.0	1.00	in early July
D	9 : 30—15 : 30		25.4	19.4	6.0	1.00	Harvested in late Aug.

Note: Datas are at Keda State, West Malaysia
Results of test are in June, July and August 1970

Furthermore, since the reaping is so often met with the rainfall that the paddy is threshed amidth the rainfall and asked to a dryer possessor to dry, the paddy containing the moisture content of 30% has somes to be dried. For such materials, it should be noted that a circulation type or a falling-down type dryer cannot be used, because the wet materials would block a circulation flow. When choosing a dryer, the fact that some paday may be ill selected and contains the grains of various moisture contents shold be taken care.

2) Occurrence of Kernel Cracking

There are many reports on cracking of rice kernels, but most of them are concerned with a "Japonica" breed. The occurrence mechanism of kernel cracking has been already almost clarified in the case of "Japonica" breed. In the case of "Indica" breed, however, only a few reports have been published, so that there are many unclear points about the kernel cracking of this breed.

Tab.3 indicates the data taken from the paddy layered on a concrete floor and let sun-dried; the cracking scarcely occurred even at the drying of which rate was about 3% per hour, In general, a short size grain breed ("Japonica") is relatively more vulnerable to cracking than a long size grain breed ("Indica"); that is to say, the "Indica" seems to have higher resistance against cracking than the "Japonica". According to test results on sun drying methods, the faster the drying speed is, the more the broken rice occurs at a milling process. This phenomenon seems to come from the fact that the grains are dried still more rapidly and these over-dried grains re-absorb the moisture during the night. Furthermore, the kernel crackings by external forces, for example, at the milling process seem to occur more in the long size grain breed ("Indica") than in

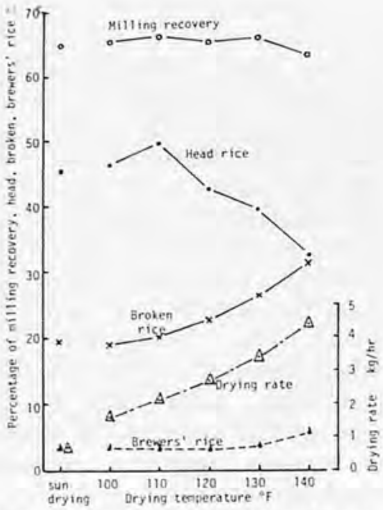

Fig.4. Drying rate and milling observation for each drying air temparature treatment (UPCA, 1964).

"Japonica", since the former is weaker against a bending and an impact than the latter.

3) Quality Deterioration at Drying by Heating

Fig.4 indicates a milling recovery rate, a rate of whole paddy and a rate of broken rice after milling, and a drying rate according to drying tempera'tures. As the temperature gets higher, the drying rate would accelerate, but the rate of broken rice would also increase. The rate of whole paddy would decrease and the milling recovery rate would also a little get lower, when the temperature surpasses 43.5°C(110°F).

According to examples of dryer use, though the drying air of 50°C is used as standard, no cracking of rice is observed. The reason why 50°C is used as a standard is that it is difficult to adjust the amount of gas through a burner so as to maintain the drying air temperature less than 50°C, since the outdoor temperature is considerably high. When the air temperature surpasses 54°C (130°F), Brewer's rice increases, which lowers the quality, so that the drying temperature should be held under 55°C.

4) Temporary Accumulation of Paddy with High Percentage of Moisture Content

Because of bad weather conditions, the paddy with high percentage of moisture content has to be accmulated sometimes. This possible duration of accumulation depends on the outdoor temperature, the moisture content of the paddy and so on. As shown in **Fig.5**, though the paddy was left outside for 2 fine days and the paddy temperature reached 37~38°C, decaying odor was formed and only some buddings were observed. As a result, the long size grain breed ("Indica") seems to be tough against high temperature.

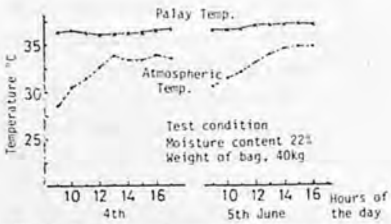

Fig.5. Change of paddy temperature in gunny bag.

The limit of duration of accumulation without causing the deterioration in quality, is not exactly clear, but NGA estimates that the paddy with the moisture content of 22~26% has to be dried within 24 or 48 hours after reaping and that the deterioration would occur, if the paddy were accumulated over that duration. Because the air temperature in the Philippines, being located in the tropical region, is quite high, the duration limit of accumulation would be less strict than the standard one in Japan. The details, hower, are not clear at this moment.

Drying Facilities

1) Scale of Facilities

The scale of drying facilities should correspond to a paddy collecting capacity and conditions of moisture content of collected paddy. The big facilities, however, cannot be expected now, because of present defective road networks and low capital powers of potential facility owners, as observed in actual milling facilities. The scale cannot be absolutely set up, since it varies due to community sizes and geographical conditions. A practical way at present, however, would be to start building small or medium scale facilities. After the effects of the facilities are fully recognized by people, the large scale ones should be built, if required.

The drying facilities also have very close interrelation with a paddy circulation mechanism, so that the actual conditions of contractors, millers and retailers should also be investigated at promoting the development of drying facilities.

2) Capacity of Dryers

If a purchase of raw paddy by the authority were possible, a large amount of paddy could be collected regardless of household divisions; the dryers of large capacity would then be adequate. At present, however, as a temporary storing of high moisture content paddy is difficult, the dryers with the capacity adequate for the drying paddy of each household are desirable. The amount of harvested paddy varies by each housebold, but the standard one of a household is said to be around 20~30 cavans (in actual conditions). Thecapacity of dryer should be determined on the basis of above value, and in addition, it should be such that the dryer can meet the fluctuations in amount.

3) Required Conditions in Planning

The required conditions in planning of the dryer are summarized as follows, considering the above discussion. The dryer should be:

① able to meet the varying need caused by the fact that requested amount of paddy to be dried varies according to each household, and that the moisture content of paddy is not uniform.

② able to treat both a rain-soaked paddy and an ill-selected paddy.

③ designed so as to have a

wide regulatable range of temperature, since the "Indica" breed is tougher against cracking and high temperature than the "Japonica".

④ designed without considering a laborsaving device, since a labor supply is abundant at present.

⑤ of simple mechanism, so that it can be made in the domestic factories and sold at a low price.

⑥ of high heat utility rate, considering the oil conditions. Also it should be a type which will allow easy remolding into one with a husk furnace as a heat generator in future.

⑦ such that it can be utilized for multi-purposes.

It is quite difficult, of course, to get a dryer satisfying all requirements listed above. Therefore, an adequate type dryer should be newly designed or chosen among the dryers on the market, determining the standpoint where the focus is placed.

Husk and Its Utilization

1) Utilization of Husk

All dryers contain heaters, since they are used at the bad weather. Usually a kerosene burner, which has a simple mechanism and is easy to handle, is used as the heater. As the dryers become popular, however, an increase of oil consumption is expected. It would cause a big trouble since the oil consumed in the Philippines is entirely imported.

On the other hand, a tremendous amount of husk produced at mills is mostly burnt or simply abandoned at present. A partial utilization of husk as a fuel for heater or motor has been long in existence, but a full-scale utilization has not been realized. Husk's calorific power is said to be 3,000 to 3,500 kcal/kg, and only around 40~45% of husk produced is necessary for providing the required calory for drying. It would be a great achievement to use the husk as a fuel, if possible, since at present its abandoning itself is causing some trouble.

2) Development of Husk Furnace

Husk occupies much space because it is bulky, and is not easy to handle since it causes much dusts. A husk furnace, consequently, would have to be large in size. Also it is difficult to make the fuel combustion continuously. These reasons have hindered the way for its practical use. By the recent investigations and experiments in Japan the following difficult points have been overcome in outline.

① Conveying and uniform supply of husk. ② Uniform combustion.

③ Exhaust device of fumigated husk and ash.

④ Smokeless combustion.

The husk furnace which satisfies above requirements is planned to be sold on the market soon.

Storing

Present Conditions of Storing

1) Harvest and Duration of storage

Fig. 6 indicates the monthly rice production and consumption in the entire Philippines. While the rate of rice consumption is fairly uniform, the production rate varies, necessitating the storing of paddy. In the case of the single cropping, the paddy harvested in fall must be preserved for an year till next fall. However, since in some regions in the

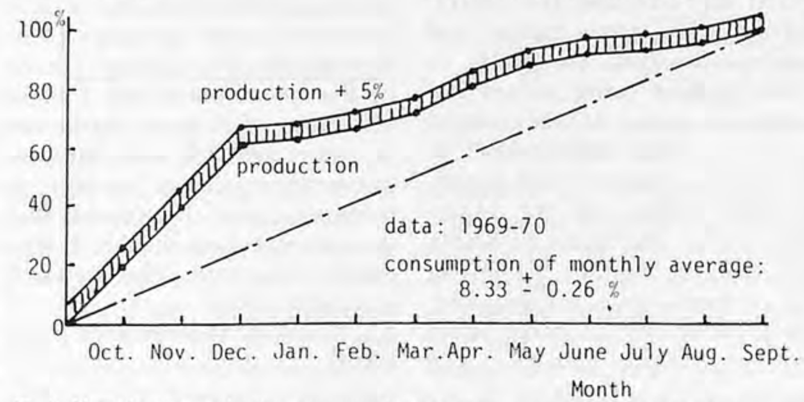

Fig.6. Monthly rice production, consumption and storage capacity in the Philippines.

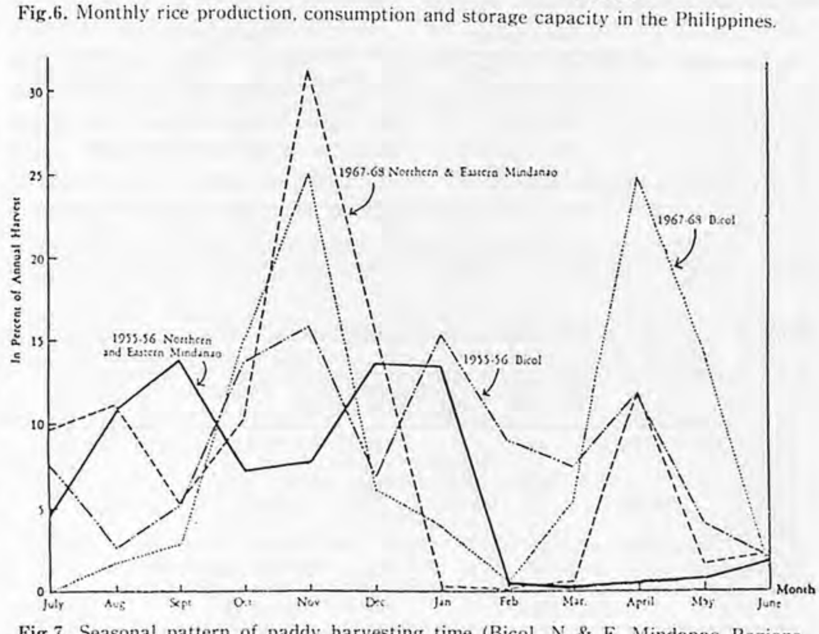

Fig.7. Seasonal pattern of paddy harvesting time (Bicol, N & E. Mindanao Regions 1955~56 and 1967~68).

Philippines now the double cropping is practiced and a harvesting time varies by year and region as shown in **Fig. 7** the maximum storing capacity is estimated to be 35% of the entire rice consumption. Furthermore, as each household stores the paddy for self-consumption which is not circulated on the market, the necessary storing amount would decrease to about a half of that mentioned above. **Tab. 4** indicates the duration of storage and the rate of storing amount in South East Asian countries. The duration of storage is short in each country.

2) Various Forms of storehouses and Storing

A form of storage is different among private farm houses, regional markets and the central market. At farm houses and regional markets, the paddy is stored without being packed and milled at need. At the central market a white rice, instead of the paddy, is packed and stored. A paddy storing has the advantage of that the paddy is hardly damaged by storing, but it occupied much space. On the other hand, the quality of stored white rice deteriorates easily. The white rice which is circulated on the market in the Philippines, however, is stored for only a short period, so that the white rice storage does not cause any actual problems at present.

The farm houses usually have small bamboo- or wooden storehouses. The big storehouses are now being built at the places where is easy of access. The percentages of storehouses by material are as follows; zinc-roof 50%, wooden 30%, knitting bamboo 15% and silo 5%.

Storing Techniques

1) Loss of Grain during Storage

Tab. 5 shows a list of the amounts of loss according to various causes. The biggest damage is caused by rats. The rat problem causes much trouble, since it cannot be solved by simple countermeasures. The damage caused by the moisture and heat follows in amount of damage, but it can be prevented by adequate adjustments of drying process. A damage caused by insects and diseases is not small; this is concerned also with the state of storing facilities.

2) Moisture Absorption of Dried Paddy

Table 4. Duration of storage.

Duration	Farm Level				Central Market			
	Philippines:	Vietnam*:	Thailand:	Nepal	Philippines:	Vietnam*:	Thailand:	Nepal
within a month	40		65	40	20	17.5	50	50
1—6 months	60	100	30		75	62.5	50	
6—12 months or more than 12 months			5		5			
Total	100	100	100	—	100	100	100	—

Note: *Except Mekong area. Source: APO data, Project No. SYP/VI/70 (1970)

Table 5. Percentage distribution of damages during storage according to cause.

	Philippines	Vietnam (Local Market)	Thailand (Farm Level)	India
Rodents	48	40	50	42
Birds	1	25	33	17
Insects	12	10	8	33
Molds	3			
Moisture	17			8
Heat	18			
Spillage	2	25	8	
Total	100	100	99	100

Note: Sum does not come to 100 percent because of rounding
Source: APO data, Project No. SYP/VI/70 (1970)

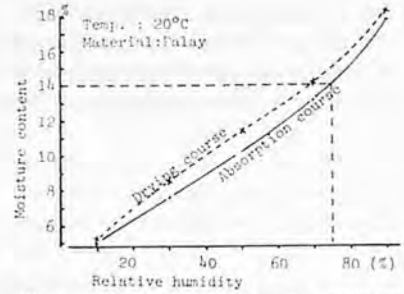

Fig.8. Equilibrium between relative humidity and grain moisture.

Dried paddy absorbs much moisture and deteriorates in quality, when it is placed under highly humid conditions. **Fig. 8** indicates a relationship between the relative humidity and the grain moisture content. The average humidity in various regions of the Philippines is around 80% (cf. **Fig. 9**), so that much effort, such as not to leave the doors of storehouse open, should be made during the high humidity season.

3) Damage Caused by Diseases and Insects

A generation of mold has much to do with the temperature and the humidity during the storing period. The relationships between the conditions required for mold generation and the weather conditions in Manila are as indicated in **Fig. 9**. The weather conditions in months July to December in Manila satisfy the required conditions for mold generation, so that much attention should be paid in storing during this period of year.

As shown in **Fig.10**, the temperature has much effect on the generation of a rice weevil, which causes much damage. The average outdoor temperature is usually close to 30°C, so that there is always a danger of its spead. However, since the duration of storage is usually within 6 months, it does not cause a critical problem at present. The problem of yellowing mold of rice is caused by insufficient drying (when the moisture content is higher than 13%), then an attention should be paid here also.

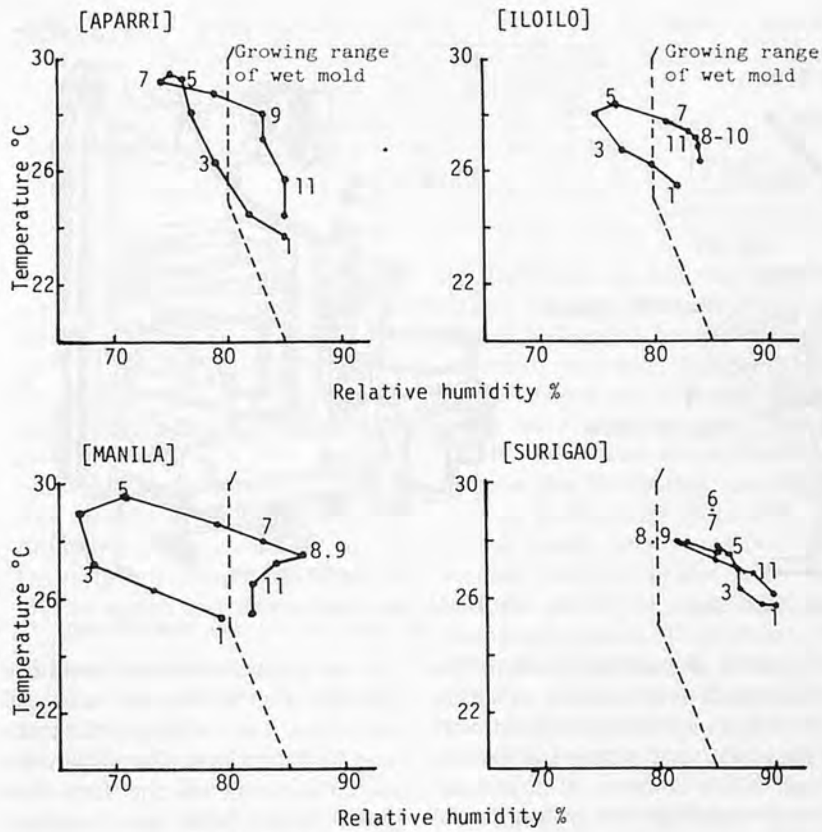

Fig.9. Weather Conditions and mold generation.

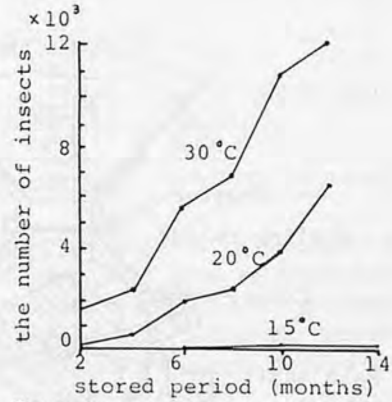

Fig.10. Increase of rice weevil at each temperature.

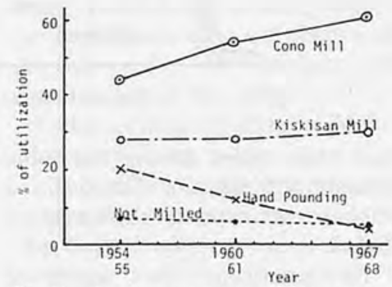

Fig.11. Annual utilizations of various milling methods.

Rice Whitening

Actual State of Utilization of Rice Whitening Machine

1) Distribution of Various Rice Whitening Machines

In the Philippines a mechanical power has been utilized for a rice whitening since quite early times, so that the rice whitening is the most mechanized area among the entire agricultural processes. The most popular rice whitening machines are Kiskisan and Cono types, processing 95% of the nation's gross rice yield. There were 14,000 mills in 1971 and Kiskisan type occupies dominant 80% of the machines used at mills. Only the rest 20% is Cono type.

Percentages of utilization of different methods are as shown in **Fig.11**; a hand pounding is decreasing and Cono type is increasing, while Kiskisan type shows little change. Kiskisan type is used for processing of individual farmer's rice at need. It is easy to handle, but its operation rate lowers often, and is in general inefficient. Cono is said to have a higher milling recovery rate by 4~5% than Kiskisan and its utilization rate increased to 60% in 1968. Recently, however, the rate has stopped to increase, and now the ratio is said to be such that 45% of paddy is processed by Kiskisan and 50% by Cono. Medium size Cono is widely used at mills, and its operation efficiency is high, since the paddy is bought up or commissioned from the farmers and processed in the lump. An average capacity of Kiskisan is 45 cavans/12 hrs and that of Cono is 132 cavans/12 hrs. The difference in capacity among the regions ranges between ± 30% of the average due to a size of the community and the paddy collecting capacity.

2) Various Rice Whitening Methods and their Characteristics

A comparison of milling recovery rates, rates of broken rice

Table 6. Comparison of different forms of milling in the Philippines.

Hand Pounding	Kiskisan Mills	Cono Mills	Rubber-roller Mills
	Milling Recovery (Percentage of weight of milled rice from the paddy milled)		
46—50	59—63 (55—60)	66—69 (60—65)	68—71 (64—70)
	Broken Rice from Milling		
Almost all broken	Large percentage	20—40%	Smallest percentage
	Capacity Range (cavans of palay/12-hour day)		
1—2	25-150	50-600	40-600
	Mill Products		
Brown rice with small brokens and bran mixed with husks.	Milled rice, small brokens mixed with bran and husks.	Milled rice, first and second quality bran (darak), small brokens (binlid), brewers rice (mata-mata) and husks (ipa).	

Source: "Rice Economy of the Philippines" by L.A. Mears, et al., the University of the Philippines Press.

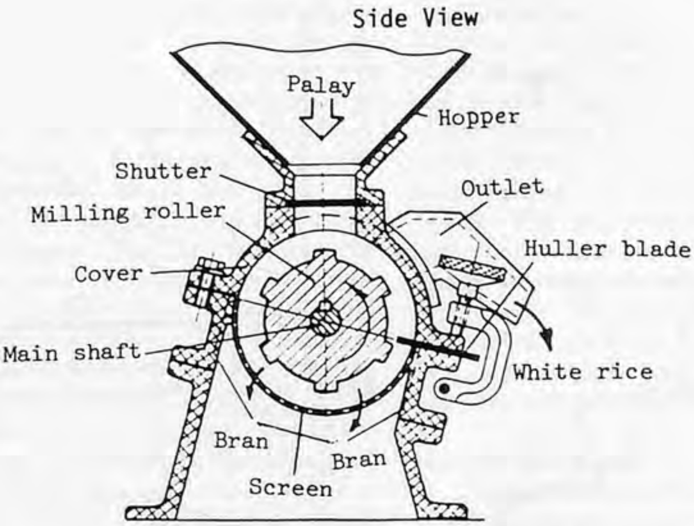

Fig.12. Kiskisan huller (Side view).

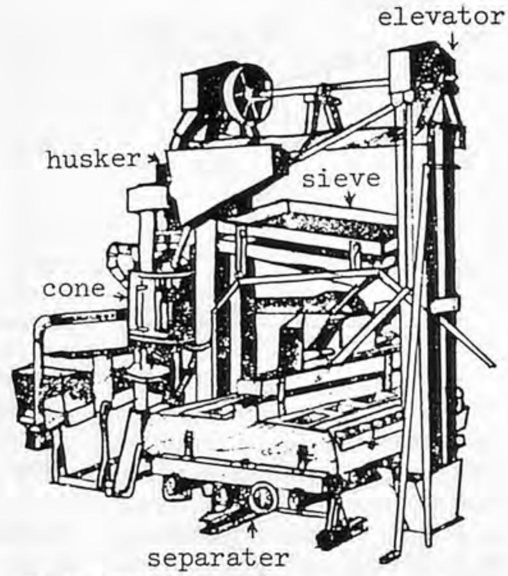

Fig.13. Cono type rice mill.
(60～65 & 90～100 cavs. paddy/12 hrs)

and efficiencies among the hand pounding, Kiskisan, Cono and a rubber roll type is shown in in **Tab.6.**

Kiskisan type —— seems to take after Engelberg type used in the U.S.A. and resembles a horizontal cylindrical friction type used in Japan. It is composed of a cylindrical roll with a groove and hollow cylindrical casing. A vertically movable blade is attached to the casing so as to adjust the gap between the blade and the roll. The revolution speed of the roll is about 400 rpm. The paddy is husked and hulled at the same time as it goes through the machine and is then separated into white rice, bran and husk by a revolving sieve attached to the bottom (cf. **Fig. 12**).

Cono type —— resembles the one used in Thailand, Burma and Malaysia. It is composed of a preliminary cleaning sieve, a disc husker, an aspirator, a paddy separator and a cone mill. Its working process is similar to that of Japanese type, but husking and hulling machanisms are different. The disk husker consists of 2 round iron mortars covered with an emery and set in vertical position. The upper mortar is fixed and the lower one is rotated, husking the paddy put in between the both of them by friction. The Cone mill is composed of an inner reversed cone covered with the emery and a cone-shaped casing, which is made of an iron net or a honeycombed iron sheet. A rubber resistant blade is attached to the inner wall of the casing. A whitening action is controlled by adjusting the gap between the inner cone and the casing by moving the inner cone vertically (cf. **Fig.13**).

Rubber roll type —— The paddy is husked by 2 rubber rolls and a resulting brown rice is sent through a paddy separator and hulled. There are a grinding type and a friction type for milling; they are often in combination or the friction type is used alone (especially for the small one). There are other small type machines using a jet air or an impact type husker in place of the rubber roll, omitting the brown rice selection process.

3) Operation Efficiency

Amounts of paddy processed by Kiskisan and Cono are said to be 45 and 50% of the gross rice yield respectively, and their milling recovery rates are 60% and 65% respectively. The operation efficiencies calculated from the regional gross yields and the processing capacities per year, on the assumption that the machines operate for 12 hrs/day and 250 days/year, are 48% by Kiskisan and 68% by Cono. The difference of 20% is due to the fact that most Cono mills have medium size machines and moreover they can be operated systematically, as the mills buy up and store the paddy. On the other hand, Kiskisan mills do not have warehouses but are operated on individual request by farmers.

As for the operation state of mill, it would be possible to maintain a uniform operation of

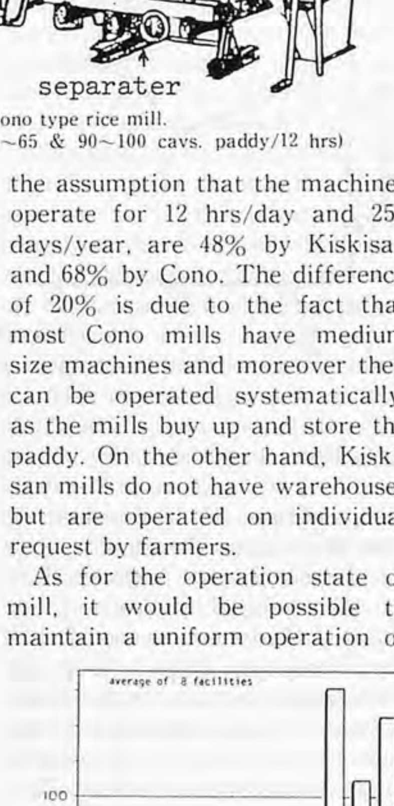

Fig.14. Monthly utilization of big milling facilities at Nueva Ecija Province. (Source: Papers and Reviews, "Rice and related Statistics", 1965)

Table 7. Size of paddy and rate of husking.

	Size of paddy (mm)			Rate		Rate of husking*	
	length ①	width ②	thickness ③	1/2	1/3	selected paddy	general paddy
Long paddy (Indica)	9.03	2.62	1.97	3.44	4.59	77.5%	75.0%
Short paddy (Japonica)	7.16	3.16	2.11	2.27	3.39	82.8	80.5

Note: *Brown rice/paddy

Table 8. Husked rate, milled rate and milling recovery rate.

	Husked rate	Milled rate	Milling recovery
Indica	72-75%	90-95%	64.8-71.3% (estimating)
PADDY →	BROWN RICE →	MILLED RICE →	
Japonica	79-82%	89-93%	70.3-76.3% (estimating)

the machines throughout a year, provided the warehouses of enough capacity were constructed at the mill. At present, however, the operation of machines are controlled by the amount of paddy bought up at a time and the reaping time as shown in **Fig.14**. The amount of yield in the entire Philippines is concentrated in December to March, but it varies alsl by region and year.

Milling Recovery Rate

1) Factors Influencing Milling Recovery Rate

ⓐ Difference by variety

Comparing the rates of milling recovery and head rice among 11 improved varieties, there is no significant difference by variety, resulting the milling recovery rate of about 70% and the rate of head rice of around 60% in any breeds. However, since there is a difference in shape between "Indica" and "Japonica", their ratios of brown rice to whole paddy in weight is distinctly different. The result of investigation using a few samples is shown in **Tab.7**; the samples of selected material have a difference of 5% in the ratio. Though a conclusion cannot easily be drawn from a few samples, it is apparent that "Japonica" would have a bigger ratio (ie. loss by milling) because of its smaller surface area than "Indica".

Comparative experiments on whitening processes of "Indica" and "Japonica" could not be found, but the milling recovery rate would be higher in general in the case of "Japonica" than "Indica", because the former's round shape makes a sugar layer easy to detach without harming the ends.

ⓑ Difference in selection degree

The milling recovery rate is firmly influenced by the amount of waste rice such as immature grains mixed in the paddy. The result of water selection of the paddy which was sampled at the mills in the Philippines, as shown in Tab. 2, was that 15 to 20% of of the paddy was immature, assuming that the grains with the specific gravity of more than 1.0 are whole grains. In contrast to that, the examples in Japan (in Country Elevators) indicate that the rate of whole paddy of 97～98% is ensured for the paddy selected by a paddy cleaner. A husking rate, the milling recovery rate and a milled rate, therefore, would be as such that shown in **Tab.** 8.

2) Mixing Rate of Broken Rice

Tab. 9 shows the mixing rate of broken rice for 13 samples of rice which were processed at mills or sold on the market. Treating a grain of size under one half of the kernel as a broken rice, the mixing rates of broken rice seem in general to be around 15%. The samples showing high rates are those processed by Kiskisan, and many samples had a very low rate of head rice of under 2%.

The problem of broken rice is also discussed in Thailand, Cambodia and Malaysia. According to an investigation in Cambodia, the mixing rate of broken rice reaches about 40～50%.

3) Experimental Data of Milling Recovery Rate

Tab. 10 indicates the result of comparative performance test between Kiskisan which is most utilized and distributed in the Philippines and the rubber roll type conducted in UPCA (University of the Philippines College of Agriculture). Taking the average of 3 varieties, there are differences of 4% in the milling recovery rate and 21% in the rate of head rice between the both machines. Genrally, a higher percentage of broken rice would lead to increasing of the bran produced at milling process, resulting in

Table 9. Distribution of mixing rate of broken rice.

	Rate of broken rice					
	5.0%	5.1-10.0	10.1-15.0	15.1-20.0	20.1-25.0	25.1-30.0
Numbers	1	3	4	3	1	1
%	7.7	23.1	30.7	23.1	7.7	7.7

Note: Number of testing samples was 13.

Table 10. Comparative performance test of Kiskisan and rubber roll type rice mills using three varieties of paddy.

Rice mill type	Varietity used	Weight of paddy kg	Milled rice recovery by weight kg	Head rice recovery by weight from paddy kg	Rate of head rice against milling rice by weight
Kiskisan	Dinalaga	31.3	19.5(62.5%)	5.2(16.6%)	26.7%
	Intan	27.9	18.6(66.9%)	6.8(24.5%)	36.6%
	Wagwag	33.0	21.4(65.0%)	13.1(38.2%)	61.2%
(Average)			64.8%	26.4%	41.5%
Rubber roll*	Dinalaga	34.2	23.0(67.2%)	13.0(38.0%)	56.5%
	Intan	32.0	22.8(71.5%)	16.7(52.5%)	73.2%
	Wagwag	32.2	21.9(68.1%)	16.7(52.4%)	76.3%
(Average)			68.9%	47.6%	68.7%

Note: *Satake model SB-2B, data are from UPCA's tests.

lowering the milling recovery rate. Since Kiskisan is a huller to produce the white rice from the paddy in one process, an uneven milling would happen if the hulling in the milling part is delayed, and a maladjustment of roll often leads to an unwelcomed mixing of paddy in the product.

The test result in Thailand shows differences of 5% in the milling recovery rate and of 7% in the rate of broken rice between the European type (which is similar to Cono type) and the rubber roll type.

Furthermore, the comparison test result at IRRI between Cono and the rubber roll type makes clear that the husked rate of the former (ie. disc husker) is about 10% lower than that of the latter, but the rates of broken rice and coarse bran of the former is higher, leading to a lower milling recovery rate than the latter.

4) Causes of Lowering of Milling Recovery Rate

ⓐ Husking process

An observation on the whole grains and the broken rice is possible in case of Cono and rubber roll types, while in case of Kiskisan, which produces the white rice in one process, a quality check at a brown rice stage cannot be done. **Tab. 11** shows the result of comparison test of the machines at husking processes, though raw materials used in the experiment vary a little in the ratio of whole paddy to immature paddy. As the table indicates, Cono type has a very high rate of broken rice, in spite of its high mixing rate of paddy after husking. Since the iron disc husker adds much force on grains at husking process, some millings occur at the same time, making a condition for easy breaking of rice. On the other hand, in the case of rubber roll type, there are a few brokhen rice and also a few skin-damage of brown rice.

ⓑ Hulling process

Tab. 11 also compares the states of materials after husking

Table 11. Comparison of head, broken and others at husking and separating between two mill types (August, 1975). Unit:

	Cono Type			Rubber Roll		
	After husking	After separating	After milling	After husking	After separating	After milling
Head rice	23.65	42.72	0	72.23	78.60	18.02
Broken rice	35.66	57.13	99.91	9.32	21.36	81.20
large	30.58	44.22	77.48	8.44	18.81	69.91
small	5.08	12.91	22.43	0.88	2.55	11.29
Paddy	20.74	—	—	19.94	—	—
Husk	19.91	—	—	0.40	—	—
Others*	0.04	0.15	0.09	0.09	0.04	0.78
(total)	100.00	100.00	100.00	100.00	100.00	100.00
Raw material						
whole paddy**		83.45			81.44	
immature paddy***		16.55			18.56	

Note: *weed, stone etc. **sinking paddy in the water ***floating paddy in the water.

Table 12. Comparison of emery size between two types.

	Size of emery No.	Size of emery diameter (mm)	Note	rate	
Cono type	≒15-16	1.66	actual emery size		
			1.0-2.0	88.61%	97%
			0.5-1.0	2.35	3
			powder (cement)	9.04	—
Japanese type	≒30	0.85			
	36	0.71			

(brown rice stage) and after hulling by Cono and rubber roll types. (The rubber roll type was a combined type of grinding and friction types.) The reason why there is a great difference in the mixing rates of broken rice between two types would be due to:

Size of emery of grinder——Comparison of sizes of emery particles of Cono and Japanese types is shown in **Tab.12**. As the table indicates, Cono type has considerably larger emery particles than that of Japanese type. Therefore, a greater grinding force works on grains, increasing the rate of broken rice in case of Cono type.

Manufacturing of grinders and precision of machines——The grinding cone of Cono type is made of the cast iron covered by cement with the emery, which is kneaded with water first and put on the cone surface by hand, and then let dry for a day before it is used. On the other hand, the grinder of Japanese type is made by machine and sintered at 1,400°C in a high temperature furnace. This difference between the grinders of two types, depending on the manufacturing method or process and the precisions of machines, seems to affect the rate of broken rice.

ⓒ Breaking of immature rice into broken rice

Much waste rice is mixed in the paddy harvested in the Philippines and such paddy produces considerable amount of broken rice, when it is husked and hulled. According to the investigation on the paddy with the waste rice of 17~19%, the rate of broken rice after husking by the rubber roll type is relatively low, but it increases to 60% after hulling. On the other hand, in the case of Cono type 50% of the material is broken by the disc husker and almost all the rest would be broken by hulling. The immature paddy is in itself weak and vulnerable against the force, and is too apt to become the broken rice. (If the selection method and standards are improved, the rate of broken rice can be reduced.)

Reasons of Popularity of Kiskisan and Cono Mills

1) Kiskisan Mill

Considerable number of Kiskisan are utilized regardless of the fact that the type has the milling

Table 13. Products at Cono Mill as an example.

	Weight (kg)	%	Note
Paddy weight	493.5		1) variety: IR 20
Milled rice	324.8	65.74	2) moisture content: 15.4%
Bran (No.1)	29.6	5.99	3) capacity, paddy-477.6kg/hr miller rice-314.3kg/hr
〃 mata mata	5.2	1.05	
〃 fine broken	10.2	2.07	4) data: Professor Matsuda, 1973.
Husk bran (No.2)	6.0	1.21	
Husk	118.3	23.94	
Total	494.1	100.00	

recovery rate of 55~60% and high rate of loss. The reasons of its popularity are as follows:

ⓐ Operation on individual farmer's request —— Kiskisan mill operates for individual farmer's paddy and all products, ie. white rice, bran, husk and others, are given back to the farmer. Furthermore, since it operates right in front of the client, there is no worry for cheating. On the other hand, though there are some small size machines for individual operation, most Cono machiness are medium or large in size, processing grains in the lump, and the products are apportioned a according to the standard milling recovery rate.

ⓑ Much rice bran as a by-produt —— Kiskisan removes husk and bran simultaneously and put them out through a husk-outlet (+ a few brans) and a bran-outlet (+ a few husks) respectively. The bran includes mata mata (fine broken rice) and weighs 7 to 10% of the whole grain as shown in **Tab.13**. Since the husk is also crushed and mixed into the bran, the mixture which amounts to more than 2 times as much in quantity as one produced by other methods comes out through the bran-outlet. It is used as a feed for a cattle, and since its price is not controlled, it is sold by the price which is about 50~70% of that of controlled rice. Farmers consider the total income by using Kiskisan is about the same as that by using the rubber roll type, since they can obtain much bran in the case of the former.

ⓒ Cost of facilities ——Kiskisan is small size, occupies little space and is easy to operate, and the cost of facilities is less expensive than other types of machines. Its popularity is due to the generally low financial state of the people.

2) Cono Mills

Cono type has higher milling recovery rate by 5~6% than Kiskisan type, but compared to the rubber roll type, its rate is still a few percent lower. The reasons of its popularity are as follows:

ⓐ Having a processing capacity of 100~500 cavans/12 hrs, it provides a medium size facility suitable to the present conditions in the Philippines.

ⓑ It is relatively free of disorders, and the repairments such as a change of a wasted roll are easy. Furthermore, it endures quite long in workable condition. (Many examples of more than 20 years in use were reported.)

3) Grades and Prices of Rice

The present market price of rice of 1.90 P/kg is controlled by the government, but no special control is put on the mixing of broken rice. (The rice sold at black market is excluded here.) The broken rice lowers the quality of rice, so that in South East Asian countries the mixing rate of broken rice is controlled and the price of rice is so fixed as to go down as its mixing rate of broken rice goes higher. Until a recent time, the mixing rate of broken rice, shape, color and texture, mixing of stones and black grains, mixing rate of husk, mixing of diseased grains and chalky rice, ratio of other varities mixed and other elements were used as the criteria to grade the grains into 4 classes and the prices were fixed according to those classes. The grading is not practiced now, and the present free condition is becoming a big obstacle to spreading of the improved milling techniques.

Speading of Rubber Roll Method

The milling recoverery rate achieved by using the rubber roll type was indicated in the test mentioned above. **Tab.14** shows the calculated profit of a year of the rubber roll type, assuming that the type has higher milling recovery rate by 3% than Cono type and higher by 5% than Kiskisan type. The amount of white rice produced in a year is calculted from the actual state of utilization. According to the calculations, Kiskisan produces a profit worth P 9,400 and Cono produces that worth P 21,500. An evaluation of the bran is not taken into consideration here. If the mixing rate of broken rice is going to be used as a criterion for fixing the price of rice, the adoption of the rubber roll type will be indispensable.

Tab.15 indicates the result of comparative test of endurance between a Japanese synthetic rubber roll and a Philippine rubber roll of 10 inches only. The edurance time of the roll made of the raw rubber is generall about 30 hrs under normal operating conditions, with some variations due to width of the roll. On the other hand, the synthetic rubber

Table 14. Comparison of calculated profits between Kiskisan and Cono mills.

		Kiskisan	Cono	Note
Average capacity, cavans/hr.	1)	3.75	11.00	
Operating hrs./year	2)	2,000	2,400	
% of utilization	3)	50	50	
Operating capacity, cavans/year	4)	3,748	13,200	1)×2)×3)
Elevation of milling recovery	5)	5%	3%	
Profit, milled rice, kg.	6)	2,969	11,326	4)×5)
price, 6)×Pl. 90	7)	9,400	21,520	

roll shows more than twice longer endurance time than the raw rabber roll, but the result varies considerably depending on the qualities of grains. The synthetic rubber roll of 10 inches can process 400 tons of Japanese or the U.S. grains, while it can process only about 130 tons (about 1/3 of those mentioned above) of the South East Asian grains. Though some possible reasons are that the South East Asian grains are hard to be husked and their husk is tough, their physical properties are not entirely clarified yet. It is necessary to develop a new rubber roll of high endurance, because the present endurance time is too short even to utilize it as supplies. Furthermore, it is necessary to note at a planning of the facilities that the husking efficiency of "Indica" breed lowers to 60% of that of "Japonica" breed.

Tab.16 shows the prices of the rubber roll made in the Philippines and the synthetic one imported from Japan. Though the imported roll from Japan endures twice as long as that made in the Philippines, the end price is 8 times higher, that is, 4 times more expensive than the domestic one. It is said that the price would be cut to one half, if the rolls were imported from Taiwan, but still the domestic rubber rolls would be less expensive. Therefore, the domestic rubber roll of better quality should be produced. An expense charged by adopting the domestic rubber roll is P 0.08 to P 0.10 per 1 caven, and the expense is quite small, considering the increase of output achieved by using the rubber roll. ■ ■

Table 15. Husking capacity and endurance of rubber roll.

Width of roll	Husking capacity	Edurance (paddy) Cavans	Edurance (paddy) Ton	Operation hrs. of endurance	Note
3"	0.54t/h	350	15.4	28.5	
4	0.72	450	19.8	27.5	rubber*
6	1.08	800	35.2	32.6	
10	1.80		58.7	32.6	
synthetic** rubber roll 10"	1.80	(min.)	80.0	44.4	rice varieties at the South-East Asia
		(max.)	150.0	83.3	
		(mean.)	130.0	72.2	
	3.00		400.0	133.3	rice varieties at U.S.A., Japan etc.

Source: Marvex Industrial Corporation (Philippines).*
Satake Engineering Co., Ltd. (Japan).**

Table 16. Price of rubber roll.

Width of roll	Rubber roll Brand "MARVEX"	Imported synthetic roll CIF Manila	Imported synthetic roll Retail sale
2.5"	35	82 (2.3)	166 (4.6)
3	40	145 (3.6)	290 (7.2)
4	55	185 (3.4)	370 (6.8)
6	65	295 (4.0)	518 (8.0)
8		355	709
10	160	637 (4.0)	1274 (8.0)

Note: Unit price. P 1.00=44Yen
( ): Magnification based on MARVEX

INDEX TO ADVERTIZERS

Topics on and around Post-Harvesting Stage of Rice (2)

Significance of Mechanization of Rice Processing

by
Yasumasa Koga
Expert on Post-harvesting Technology,
ESCAP UN
Bangkok, Thailand

Many of agricultural engineers and researchers in the developing countries are devoted for the utilization, improvement and development of agricultural machinery such as tractors, combine harvesters, pumps, farming and crop protection machines, farm product processing machines, computorized machine utilization systems, etc.

Against such endeavours, there is such a criticism as that most of these studies are nothing but self-absorption and indulgence and not practicable at all. It points out that prevailing farming technology in the developing countries is too backward to apply any of these modern studies and what is urgently required at present is to study and figure out the ways and means for the improvement of existing primitive equipments used for farming works in localities into more effective ones.

In fact, it seems more effort should be paid for the improvement of existing local machines, equipments and tools used for farming works. It will directly uplift the efficiency of farming work as it does not require any alteration of farming work system. It will also bring forth the encouragement of local farm machinery manufacturing industry. Manufacturing of improved types of existing machines requires much less quantity of investment compared to that of modern or ultra-modern agricultural machinery. It will stimulate pursuance and inventiveness of the people concerned in proportion to the growth of technical knowledge, if such improvements should be widely accepted and utilized. This is quite different point from mere introduction of foreign technology.

Above that, most of the modern and sophisticated agricultural machinery are designed and manufactured so as to be used on the well-arranged field. Full mechanization can be put into practice economically only in the paddy field whose irrigation and drainage can be controlled as required, leveling is perfect and plot is large enough. Should such field condition fails, which is likely to be in the developing countries, then other devices have to be added to those machines in order to make them adapt to inferior local conditions which make them more complicated and delicate.

In short, farm mechanization has to start from what they are now, trying to improve it step by step in parallel with the industrialization and growth of farmers' inteligence, without trying to jump all at once.

One of the main objectives of farm mechanization is to increase the labour productivity thus reducing farming cost and enabling to cut labour peak time. Expenditure for the mechanization must be justified by the labour cost saved and the additional profit produced from this extra labour and altered farming system.

All of above arguement has nothing new and is well-known to many people. What we want to emphasize here is that above discussion is not always applicable to the mechanization of post-harvesting process of rice.

In the farming works in the

field there is not much difference between manual works and mechanized ones except that the former requires much more time and labour. Manually pumped water is as useful as mechanically pumped one for irrigation. Cattles can plow soil as good as power tillers do. Contrary to this, however man can be skillful in rice pounding he never can dehusk and whiten rice by use of mortar and pestle as good as machine does. As far as he cannot peel husk and bran off the kernel grain by grain, however much and skilled labour might be used manual work cannot cope with machine in performance.

Farming work in the field and post-harvesting work are distinctly different on this point. After paddy is harvested and threshed, it transforms into millions of separate paddy grains whose dimmensions and physical properties are analogous to large extent in each lot. Such a material is more advantageously handled by machines than manual work even though there must be careful considerations on the deviation of the properties. Thus, drying, classification and all of the other processing of paddy grain up to the final product of white rice had better be carried out mechanically not from the view point of economy of labour but for the success of the operation. Of course the required labour can be greatly saved by the mechanization. But it is not the main objective basically but it is rather a subsequent phenomenon.

Therefore, apart from the progress of farm mechanization which involves various factors as discussed above, the mechanization of post-harvesting process has to be pushed forward to some definite point in order to assure the retention of crop production. For example, rice pounding by use of mortar and pestle or dekki etc. Which is still practised in developing countries has to be abolished as quickly as possible. It is difficult to estimate how many percent of paddy is being manually pounded in this area but it is assumed there still exist to considerable extent in some countries.

This reminds us of the invention of steam engine by James Watt. According to Watt's estimation, his steam engine could reduce fuel consumption to 75% of Newcomen's. However, by use of Smeaton's boring machine for the manufacturing, mach of steam escaped from the cylinder in spite of much filing, grinding and packing work by skilled workers and he could not show off the expected result. It was only after the emergence of John Wilkinson's boring machine which could make air-tight cylinder successfully that Watt succeeded in his invention. Rice pounding might be today's Smeaton's machine. It allows steam to escape and annuls the toilsome harvest in spite of its careful manual elaboration.

Fig.1. View of a husking in Indonesia.

Fig.2. Husking by rice huller in Japan.

This implication is shown in the wide and quick diffusion of rubber-roll huskers among farmers in Japan. The number counted about 100,000 in 1933, ten years after the invention.

Of course this happened due to the special commercial custom in Japan that the farmers have to sell rice in form of brown rice. Their main concern was not to reduce labour but to eliminate unnecessary loss of rice throughout their work. Actually, Japanese farmers did not use anything like machines in those days for their farming work. Power threshers were used fairly extensively but still their number (about 68,000 in 1933) was much less compared to that of huskers. Power tillers and other field power machines appeared only after the world war II. Japanese farmers understood well that farming work in the field might be performed manually but post-harvesting process could not be done manually without sacrificing much of retention.

For the mechanization of post-harvesting process, it is not necessary to jump to a computorized large modern rice milling complex in any country. As in the case of agricultural mechanization in general it may be progressed step by step according to the natural and socio-economic situations encouraging indigenous devices and local industries. However the steps have to be much more quicker than before and at present and the certain standard must be attained in a short time by all means rather independently from the farming work in the field. This seems not so difficult task if the importance and the significance should be properly understood.■■

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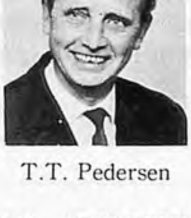    

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George B. Hanne

Degrees:

B.Sc. Mechanical Engineering, Cairo University 1945

M.Sc. Agricultural Engineering, Iowa State College, U.S.A. 1949

Ph.D. Agricultural Engineering, Michigan State University, U.S.A. 1951

Previous Experience:

Expert in farm machinery at the American Technical Co-operation Administration (point four) from Jan.4th 1953 to Nov. 19th 1955.

Consultant on the American Egyptian Organization for rural improvement from Jan. 3rd 1961 to 1st July 1961.

Consultant Permanent Council for the development of national Income from Feb. 9th 1955 to Dec. 31st 1955.

High Committee of Combined Rural Centres from June 1958 to June 1961.

Permanent Committee for Land Reclamation from March 1959 to June 1961.

El Nasr Import and Export Co. as general technical consultant from Feb. 1962 to June 1967 on Farm Mechanization.

Technical Manager at the Coca-Cola Export Corporation in U.A.R. and the Middle East including Cairo, Sudan, Ethiopia, Djibuti, Libya and special assignment in Lebanon and Pakistan March 1965 to June 1967.

Technical Consultant of the Egyptian Organization for the development of reclaimed land from May 1968 to Oct. 1969.

Technical Consultant to the General Company for Farm necessities and equipment, Tripoli, Libya, from 1970 to 1974.

Technical Consultant to many private and government organizations dealing with farm mechanization.

Technical Consultant on the Agricultural Mechanisation in Syria for Agricultural Organization affiliated to the League of Arab States June 1975.

Actual Position:

Professor and Chairman of Farm Mechanisation Department, College of Agriculture, Cairo University.

Siswadhi Soepardjo

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Married and have four children.

Education:

Sarjana—Universitas Indonesia, 1959.

MSAE—University of Kentucky, USP, 1971.

Ph. D—University of Kentucky, USA, 1974.

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Other:

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News from Korea

by Chang Joo Chung
Associate Professor
Department of Agricultural Engineering
College of Agriculture
Seoul National University
Suweon, Korea

KSAM held the Inaugral Meeting

The Korean Society of Agricultural machinery(KSAM) is founded to promote the science and art of farm machinery engineering and farm mechanizatin and to increase and extend the association of agricultural machinery engineers among themselves and with allied scientists, technologists and farm mechanization administrators in Korea.

The inaugral meeting was held on April 24, 1976 in the Farm machinery & Tool Industry Cooperative of Korea which is located in Seoul.

The members attended were about 70 people who were composed of agricultural engineers specialized in agricultural machinery from universities professional colleges, industries research institutions and farm-mechanization administrative offices.

In the inaugral meeting, the Society representation, directors, and administrative officers were elected according to the Society Constitution passed.

The president elected is Dr. Han Seong Keum, Director of Institute of Agricultural Engineering & Utilization. The vice presidents are Dr. Kim, Seong Rae, Professor of farm machinery at Chungnam University and Dr. Chung Chang Joo at Seoul National University.

The administrative office for the Society is located at the Deparment of Agricultural Engineering, College of Agriculture, Seoul National University, Suwon, Korea. Any informations and mails related to the Society may be forwarded to the address given above.

Letter from Sudan

by M.A.K. Bedri
Projects General Manager
Kenaf Projects
P.O. Box 1855
Khartoum, Sudan

Start Kenaf Projects in Sudan

I have left my previous Job as Director, Dept. of Agric. Engineering with the ministry of Agriculture to this new Job as Projects General Manager for Kenaf Projects and a very important project for manufacture and Assembly of trucks, Buses, Tractors, Combine Harvesters and Agricultural machinery to be established in Sudan and it is still in the negotiation stage. I am executing two kenaf Projects at present at a total cost of 18 Million Sterling Pounds per project, One of them in the Blue Nile Province at Abu Naama village which started production in early March and the second one in Bahr Elghazal Province at Tonj Town which is still under construction. Each one of them has its own fields of 30,000 feddans-(acres) of which 15,000 is planted kenaf and 15,000 ground Nuts in a two course rotation Kenaf is Hibiscus Cannabinis and its fibre is extracted by decontícators and retted to give clean fibre which is used for making B-Twill bags and Hesion cloth as substitute for Jute bags.

We get a production of 800 to 1000kg of dry fibre of kenaf per acre. This gives us a total of about 12,500 Tons which will be manufactured to give 10 million bags and 900 tons of cloth each year per factory working 3 shifts per day for 300 days per year. Each project has its own factory which were supplied by Messrs. Adriano Gardella S.P.A. of Denoa Italy who also supplied the kenaf harvesters, decontícators and fibre processing and refining machines.

Production of both kenaf and ground nuts is completely mechanized from land preparation to final extraction of fibre and ground nuts.

NEWS

News from Thailand

Invite Papers on Rural Development

The International Conference on rural development technology is going to be held from June 21 to 24 in 1977 at Bangkok in Thailand, sponsored by the Asian Institute of Technology and Canadian International Development Agency.

The purpose of this conference is to provide an opportunity to participants from all over the world to review the progress and state of integrated planning in rural development in Asia. It is intended to review needs, to suggest relevant resarch to be conducted, and to develop a strategy for education in the field in Asia.

Papers are invited on the following topics:

1. Rural industrialization.
2. Appropriate agricultural mechanization.
3. Appropriate infrastructure for rural development.
4. Agricultural innovation and transformation.
5. Role of markets and price mechanisms.
6. Planning for rual development-land reform, human settlements, the systems approach.
7. Role of education in rural development.
8. Rural social services.
9. Administration of rural development programmes.
10. Case studies in integrated rural development.

Intending authors are requested to return the attached from as soon as possible. Three copies of an abstract, in English, of not more than 500 words with, if necessary, a nominal number of figures should be submitted before October 31, 1976 to:

Dr.Gajendra Singh
Conference Secretary
Asian Institute of Technology
P.O. Box 2754
Bangkok, Thailand

Selection will be made on the basis of this abstract, and final manuscripts will be required by March 1, 1977. Papers should not exceed 6000 words. Instructions on the preparation of papers will be sent to the authors of accepted papers.

News from IRRI

by The International Rice Research Institute (The IRRI Reporter 2/76)

Root-Zone Placement stretches Scarce Agricultural Chemicals

Root-zone placement of insecticide

IRRI entomologists have found that systemic insecticides, packaged in capsules and placed in the rice root zone, control common insects pests, such as rice stem borers, leafhoppers, planthoppers, and whorl maggots, cheaper and more effectively than when conventionally applied. The pesticide is absorbed more readily from the root zone and the covering layer of soil protects it from heat, sunshine, volatilization, and drainage with overflowing water.

Insecticides applied in the root zone should be less hazardous to parasites and predators of rice pests, and to other nontarget organisms in the rice environment, than insecticides applied as foliar sprays or to the paddy water.

Background

The discovery that diazinon and gamma-BHC work as systemic insecticides when applied to paddy water was significant in the tropics, where rainfall often washes off foliar sprays. Paddy water application, however, requires more insecticide per treatment than foliar spray.

Later, scientists soaked the roots of rice seedlings in insecticide solutions before transplanting. They found that adding a "sticker" to the solution improved the initial effect of the insecticide and prolonged the residual effect.

But the "root-coat" treatment (soaking in an insecticide solution plus a sticker) provided only early protection; supplementary treatments were needed after the first 30-35 days.

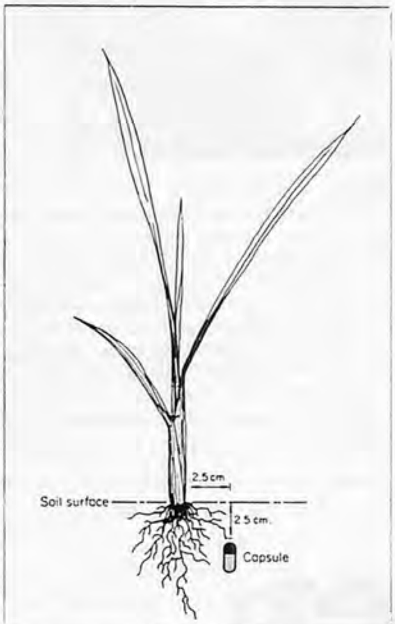
To further stretch the residual toxicity of insecticides and to decrease both rate and number of applications, IRRI entomologists began to test the concept of applying chemicals into the rice root zone.

Root-zone application

Granular formulations of insecticides that are available in Asian markets were placed inside small sections of paper straw. The open ends were sealed with wax, and minute holes were punched in the straw. The insecticide capsules were pushed by hand about 2.5 cm below the soil surface about

2.5 cm from each hill, from 3 to 5 days after transplanting (**fig. 1**). They were applied at the rate of 2kg a.i./ha to each hill at a planting distance of 25 × 25cm.

The entomologists found that 2kg/ha of insecticide applied only once to the root zone protects rice as well as 8kg/ha broadcast in four doses at 20-day intervals. Repeated experiments show similar results. With certain insecticides, the amount applied can be reduced to only 1 kg/ha without significantly impairing the efficiency of insect control.



Figi.1. Packaging insecticides in capsules and placing them into the rice root zone protects the insecticides and makes them more readily available to the plants.

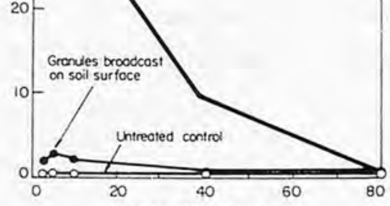


Fig.2. Ten times as much insecticide was absorbed by plants when applied by the root-zone method as when broadcast in the conventional manner.

Analysis of plant tissue at 10 days after treatment shows that 10 times more insecticide is absorbed by plants when applied to the root zone than when applied to the soil surface (**fig.2**). Even at 70 days after treatment, twice as much insecticide was found in plants that received the root-zone treatment as in plants that received other treatments.

Later, scientists replaced the less-soluble straw capsules with faster dissolving materials, such as gelatin capsules, paper capsules, tablets, and large granules. Insect control remained the same.

During the 1974 wet season, IRRI scientists used a modified grease gun to inject three insecticides, mixed in a urea slurry at 30kg N/ha, into the root zone of young seedlings. They found that only 1 kg/ha of chlordimeform, cartap, or carbofuran placed in the root zone controlled insects as well as 8 kg/ha of carbofuran granules applied conventionally to the paddy water.

Testing in other countries

Scientists are conducting similar research in India, Indonesia, Korea, Malaysia, the Philippines, and Pakistan (**fig. 3**). IRRI sends packaged formulations of insecticides to collaborating scientists to test under their own conditions.

Results from the international tests generally agree with those from IRRI. Certain insecticides, applied to the root zone, have also been found to effectively control gall midge, an insect pest common across mainland Asia but not found in the Philippines.

Fig.3. PAKISTAN. At the Kala Shah Kaku Rice Research Station, near Lahore, I. A. Dar, assistant entomologist (a former IRRI research scholar), is comparing root-zone application of the insecticide chlordimeform (right) with spot treatment (left). The rice variety is a tall, fine-grained basmati, for which the Punjab region is famous.

Modification in Indonesia

Scientists at the Lembaga Penelitian Pertanian Maros Experiment Station, Indonesia, modified the technique by mixing granular insecticides with mud, rolling, the mud into pills, and allowing the pills to harden in the sun.

Insect control was good (**Table 1**); the scientists report that the entire process should cost no more than transplanting. No spraying is required, and the insecticide can be applied at any time after transplanting, regardless of when it rains.

In later experiments, the scien-

Table 1. Insecticides applied to the root zone of rice plants significantly reduced dead heart damage and tungro incidence at the Lanrang Substation, Lembaga Penelitian Pertanian, Maros, South Sulawesi, Indonesia. 1973-74 dry season.

Treatment (Av. of 4 repl.)	Rate of application	Deadhearts (%)		Tungro (% infected hills)
		30 DT[a]	40 DT	
BPMC	2 kg a.i./ha	0.7	9.7	1.7
Carbofuran	2 kg a.i./ha	0.1	0.1	0.0
Cartap	2 kg a.i./ha	0.0	1.0	0.0
Chloridimeform	2 kg a.i./ha	0.2	1.0	3.1
Cytrolene	2 kg a.i./ha	0.1	0.5	0.5
Surecide[a]	5 kg a.i./ha	7.1	32.9	13.7
Control	0	11.1	54.2	37.0

[a]DT = Days after transplanting. [a]Applied in 5 applications, each at 1 kg a.i./ha.

tists sped up the process by mixing insecticides in large mudballs, then breaking off bits of mud and applying them directly into the field (without drying and hardening).

Equipment for root-zone application

IRRI engineers recently developed an experimental applicator that places granular insecticide and fertilizers into the root zone (fig.4). But granular insecticides are expensive in many countries, and not available in others. The scientists are now working on a machine to inject wettable powder or emulsifiable concentrate formulations of systemic insecticides as a liquid band.

Fig.4. Engineers are working with agronomists and entomologists to develop and test simple, inexpensive implements to speed chemical placement into the root-zone. Holding a prototype of a new liquid urea pesticide applicator are: right, Amir U. Khan, agricultural engineer; and left, Nestor Navasero, senior research assistant. The applicator is being demonstrated in the background.

Water Treatment and Sanitation:

A handbook of simple methods for rural areas in developing countries

This handbook is a completely revised edition of the popular Water Treatment and Sanitation and is now issued in now format, fully illustrated with clear drawings and diagrams. It is meant to fill the "knowledge gap" which still exists from the point of view of poor communities and their helpers, who must resort to simple and cheap methods to fulfill their basic needs. An adequate supply of good quality sefe water is essential to the promotion of public health. The purpose of this handbook is to make the possibilities of applying low cost techniques more widely known; and to present in a simple and logical form various aspects which must be considered when investigating the development of a water supply and sewage disposal scheme for a small community.

This book is intended for technicians, leaders of rural communities, administrators of schools or hospitals and others who wish to develop a water supply and sewage disposal scheme for their own use. The drawings show simple apparatus which could be copied and used by local communities to improve the quality of a water supply. The seven chapters of the book cover: The Selection of a Water Source and Simple Water Testing; Water Supply; Water Treatment; Foul Water and Excreta Disposal; Sewage Treatment; Final Water and Sludge Disposal; and Temporary and Emergency Treatment. In addition the glossary defines important terminology; and suggestions for further reading are given in a bibliography.

Edited by H.T. Mann and D. Williamson 92 pages. Illus. £1.50 net; £1.70 UK postpaid; £2.30 airmail and £1.70 surface mail.

Intermediate Technology Publications Ltd, 9 King Street, London WC2E 8HN, UK.

Text Book on Mechanization of Rice Farming

Mechanization is vitally important for the development of agriculture. Because meaningful mechanization my effect not only labour productivity but also land productivity, and finally it will contribute to the increased income of general production. Always, we have to consider how to maximize the land utilization and total product through the mechanization of farming.

For the lay-out of mechanization, we must examine the many factors which related to use of the machine; cropping system, variety and planting pattern, method of cultivation, field condition, covering acreage of the machine, and so on.

Therefore, principles of farm mechanization are defined and the factors of mechanization are formulated in the introductory chapter.

In the subsequent chapters available informations on the construction, performance, using method and maintenance of the machine, which are applicable to rice farming, are arranged as the essential basic knowledges.

In these chapters, special attention was paid as to be discussed on the adaptability of machine to the conditions of rice farming.

With final chapter, taking some examples, planning method of mechanization is introduced. For the planning of mechanization, it is indispensable that farmers and their advisers to be familiarized with estimation on the covering acreage of the machine and simple cost calculation.

Throughout all the chapters, it may be studied how the mechanization in paddy field differs from the mechanization in upland farming. Several charts will be useful for systematic consideration about planning of mechanization in varying conditions, and for the selection of suitable machine.

Edited by Isao Saegusa

190 page, 18.5 × 24.4 cm

Indo-Japanese Agricultural Extension Training Centre, Mandya, Karnataka State, India.

Reports on Training and Advice 1973-'75

—Performance of Indo-Japanese Cooperative Activities for Innovations of Rice Cultivation Technique

More than six years have elapsed since the establishment of the Mandya Farm as an Agricultural Extension Training Centre according to the IInd Agreement between Governments of Japan and India. During this period the training of Extension Workers and Progressive Farmers has been carried on as the major activity of this Centre. Especially, the training of AEOs and AAOs who form the nucleus of leadership in extension practices was considered as the most important activity of this Centre. Why such leadership training has been seriously considered is to prove that raising the technical ability of such leaders is the basic need for the development of agriculture in this country.

According to the idea stated above, more than 150 Extension personnel of the level of Assistant Agricultural Officers and more than 3 thousand technicians and farmers have received training of this Centre over the years.

During this long term, the performance of training practices and Applied Research, survey and investigation were issued as Training Reports and Advice Reports. The former are published from number 1 to 6, and the latter are from number 1 to 12 respectively.

While the first compiled report was issued in 1972 including Training Reports No. 1-3 and Advice Reports No. 1-8. The present edition, includes the followings; that is, Training Reports No. 4-6, and Advice Reports No. 9-12. No.12 is the final report.

The reported performance has been achieved by close cooperation between the Japanese Advisers and Indian Counterparts, and the survey and investigation of Advice Reports were obtained by the help of Long Term Trainees (Agricultural Extension Officers and Assistant Agricultural Officers in Karnataka State) of the Centre.

Edited by Isao Suetsugu

430 page,. 18.5×25.0cm

Indo-Japanese Agricultural Extension Training Centre, Mandya, Karnataka State, India.

Agronomic-Economic Research on Tropical Soils

Describes the objectives, methods, and accomplishments of USAID-sponsored Tropical Soils Program at N. Carolina State University (1970-1975). Major objective was to develop a methodology for making economically sound recommendations regarding use of fertilizers in developing countries in tropical regions, based on information gained from soil research in Latin America. Phase I was a two-year literature search. Phase II consisted of field and laboratory studies at Yurimaguas, Peru; Brasilia, Brazil; and Turrialba, Costa Rica. Progress was made in developing a fertility-capability soil classification system which groups soils having similar fertility management limitations. The system was used to group 678 Brazilian soil samples into 23 fertility-capability units; samples from 73 Peruvian sites, into five units. Fertilizer recommendations specified by unit groups dramatically increased economic returns from use of fertilizer. Long-term field experiments are needed to evaluate residual effects of liming and fertilization. Amazon jungle problems of yields require interdisciplinary research, with inputs from animal scientists, plant breeders, pest management specialists, and economists.

Edited by Sanchez, P.A

1975, 21 page-price $2.00

Soil Science Department, North Carolina State University, Box 5907, Raleigh, North Carolina 27607, USA.

Status of Grain Storage in Developing Countries

The main purpose of the study was to assemble information on the capacity, location, and types of grain storage currently available in developing countries, and to assess the storage conditions, problems, and deterrents to improvement. Data on storage capacities and locations for many developing countries are not readily available. A more complete study should be undertaken by a multilateral international organization. Data are included here for these Latin American countries: Argentina, Bolivia, Chile, Colombia, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Mexico, Panama, Peru, Trinidad, Uruguay, and Venezuela. For these African countries: Botswana, Chad, Dahomey, Ethiopia, Gambia, Ghana, Ivory Coast, Kenya, Lesotho, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Somalia, Rep. of S. Africa, Swaziland, Tanzania, Togo, Upper Volta, Aire, Zambia, Entente States. For Asian countries: Indonesia, Korea, Malaysia/Singapore, Philippines, Taiwan, South Vietnam. For the Near East: Afghanistan, Algeria, Bangladesh, Egypt, India, Iran, Jordan, Lebanon, Morocco, Nepal, Pakistan, Syria, Tunisia, Turkey. Much of the deterioration and loss of grain occurs not as a result of poor facilities but rather poor management in storage. Local managers lack knowledge of basic principles of grain storage.

Edited by Pedersen, J. R.

1975, 249 page-price $19.95

Food and Feed Grain Institute,

Kansas State University, Manhattan, Kansas 66506, USA
(In Food & Feed Grain Institute. Special Rpt. No.3)

Two Books from Iowa State University Press

Farm Power and Machinery Management

Now in its sixth edition, this manual applies fundamental engineering principles to agricultural field operations. You can check on tractor field performance, hydraulic systems engine oil classification, and countless other potential trouble spots!

Donnell Hunt, author of this guide to the better use of farm equipment, is professor of agricultural engineering at the University of Illinois.

Some distinctive features of the sixth edition are :

- material on systems cycles
- tractor performance prediction, including new formulas for tractor horsepower
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- information on machinery selection with a discussion of machinery obsolescence and replacement
- new illustrations and tables showing recent developments in machines, farm practices, and technical specificantions

Farm Machinery Mechanisms

A guide to the fundamental mechanisms of farm machinery, this book unites the diverse technologies that comprise farm equipment design into one handy volume. And you'll wonder why no one thought of it sooner!

Donnell Hunt, in tandem with Lester Garver, a consultant for solving farm equipment marketing problems, wrote Farm Machinery Mechanisms. Their years of diversified experience enable them to give you valuable advice on the constraction and action of mechanisms as an aid to understanding the operation, service, and maintenance needs of farm machinery.

Farm Machinery Mechanisms gives you a closer look at

- organization of the farm equipment distribution industry
- orthographic and assembly drawings
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- graphical solutions to motion problems
- effect of the material strength, type of loading, and energy considerations on design of parts
- detailed study of power transmission component parts and of hydraulic systems

Iowa State University, Ames, Iowa 50010, USA.

The library of Technion-Israel Institute of Technology (p.o. Box 4910, Halfa, Israel.) in Israel has publications all over the world concerning the whole agriculture. It is periodically publishing the library catalogue.

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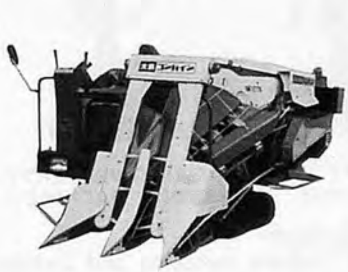

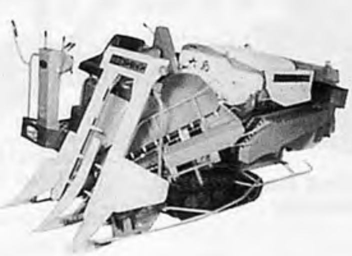

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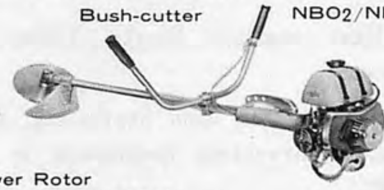
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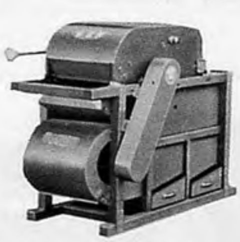
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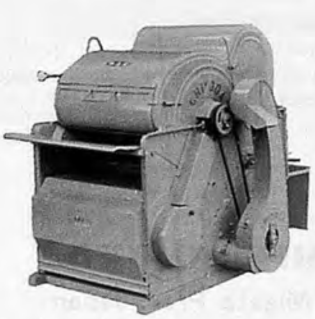
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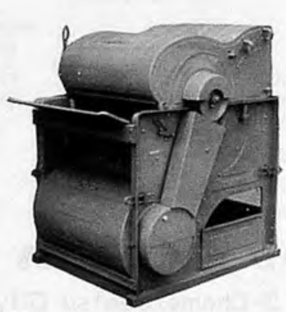
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