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(For the period July 1, 1966 to Feb. 8, 1967)

and

WORK PLAN

(For the period Feb. 8, 1967 to Feb. 7, 1968)

Contract No. AID/csd-834

For Research on Farm and Equipment Power Requirements for Production of Rice and Associated Food Crops in the Far East and South Asia

by

Loyd Johnson

Stanley Johnson

Copies of this report have been filed with:

1. U.S. A.I.D., Washington, D.C., John R. Wilson Office of Technical Cooperation and Research (25 copies)

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A. PROGRESS REPORT: July 1, 1966 to February 8, 1967 (ca. 7 months)

1. ANALYSIS OF RICE FARM OPERATIONS IN CENTRAL LUZON.
(See Appendix B-Operational Plan I.B.1.)

There is a lack of reliable quantitative information on rice farm operations in Southeast Asia. In order to study the potential for mechanization of paddy rice farming, these data are necessary.

As a starting point, because of the proximity to I.R.R.I., a survey was initiated in May, 1966, to obtain basic engineering and economic data on the rice areas of Central Luzon, Philippines. Data was and is continuing to be collected on the farm operations sequence, the pattern of water use, and the soil and crop conditions of these areas by a weekly sampling of a number of rice fields. In order to define the sample, a preliminary observation trip was made to six of the Central Luzon provinces, Laguna, Bulacan, Nueva Ecija, Pangasinan, Tarlac, and Pampanga. As a reference point for each sampled site, kilometer posts along the major highways were used, measuring a "site" outward 25 meters from the road edge. A survey route of 800 kilometers was planned so as to require two men to travel five days per week and observe a maximum number of sites. A final survey list of 145 sites was determined, consisting only of rice land. Where practicable, sites were selected on alternate sides of the road.

In the rural areas, motels and hotels are few and generally of poor quality and service. To prevent excessive cost and loss of time in searching for lodging, a vehicle with a body suitable for sleeping two men was purchased. The two men leave each Monday morning on the route shown in the map (Fig. 1), and collect the data observed on the form shown as Figure 2. This particular form is completed for sites 1 to 30 for the 30th week of the year, July 11-17, 1966. Some of the sites were idle, some plowed, etc., though at that particular date, all sites had water. The surface water and soil depth were measured. A notation was made if the site needed weeding, nitrogen, or insecticide, if there were particular diseases, and if there were other pertinent comments to make. A brief description of each of the items noted in this form appears on the back of Figure 2. Figure 3 shows a summary for one particular site, No. 4, for all the weeks from Week No. 23 (May 23-29) to Week No. 48 (November 14-20). The first reading shows site No. 4 to be in a plowed condition, proceeded to planted, to vegetative, to reproductive, to mature, to harvested, to idle, and then back to a plowed condition in a span of 25 weeks. Data of the same nature are obtained for all sites as well as a yield sample to determine the factors which are of the greatest effect on yield and on the utilization of the sites for growing rice.

In addition, in conjunction with the Agricultural Economics Department, interviews are being taken with the operators farming the sites. The type of data obtained from the questionnaire form is attached as Table 1. The data from the survey forms will be compared with the results of the weekly observations. Data from the site measurements and interviews should provide a tentative basis for conclusions on the extent of and potential for mechanization.

Two pictures of the sites are enclosed as Figures 4 and 5. The first figure pictures the kilometer post alongside the highway, and a view of the paddies in a dry state prior to the monsoon. Figure 5 presents a view of the rice paddy at site no. 8 during the vegetative growth stage.

A summary of observations from the sites collected to date has been made. Special attention was given to time in land preparation. Cumulative tables and figures of the different stages of growth of the rice farms were prepared separately for one-crop and two-crop farms (Figs. 6, 7). One is struck by the symmetry of the cycles of land preparation and crop growth for the one-crop farms (Fig. 6). At the onset of the monsoon season, the farmers prepare the land; then they transplant the seedlings; the rice grows through the vegetative stage and, with flowering, into the reproductive and mature stage; finally the crop is harvested and the land is again left in an idle state. The two-crop rice farms (Fig. 7) show a somewhat different pattern. As in the one-crop sites, most of the farms were still dependent on the first monsoon rain for the "wet" season land preparation. However, a comparison of Figures 6 and 7 shows that land preparation was considerably more timely for the two-crop farms.

If one assumes a similar period of crop growth for both one- and two-crop cycles, mechanization can affect land preparation, and, to some extent, the harvest sequences. By compressing the time involved in these operations, the farmer has more time to add a second crop, whether it is rice or another crop.

Figure 8 presents in a 360° circle the data on farm operations for all rice farms in order to illustrate the cyclical pattern of the operations. Since the Central Luzon area lies to a large extent in the Pampanga river drainage area, the flow of the Pampanga river as measured in millimeters per day was plotted in the circle. The cropping pattern of the area conforms with the rainfall and run-off pattern.

Two other figures have been prepared to aid in illustrating the sequence of farm operations. Figures 9 and 10 picture the 112 non-irrigated and 29 irrigated sites, respectively. These figures present the different farming operations in cumulative totals for a particular time of the year. The figure for the non-irrigated sites shows that most of the sites were in an idle state at the start of the survey, May 23, 1966. Quickly, as the monsoon rains started, the majority of farmers began land preparation. After the seedlings were transplanted and until flowering, the rice was categorized as being in the vegetative stage. After flowering and through harvesting, the rice was termed in the reproductive stage. Over 50 percent of the farmers had started land preparation by June 13, and 50 percent had harvested their rice by December 17, a period of five months. Allowing for a growing season of 120-130 days, the remaining 20-30 days were spent in land preparation and harvesting.

The figure for the 29 irrigated sites provides further emphasis of the large percentage of the two-crop farmers who waited for the monsoon rains to start before preparing their land. The time for the second crop, however, varies considerably, since rainfall is not one of the considerations at that time of the year.

2. A STUDY OF HAND TRACTORS IN THE PHILIPPINES.
(See Appendix B-Operational Plan I.B.2.)

A cooperative research project was conducted with the Agricultural Engineering Department, University of the Philippines College of Agriculture, to study

the use of hand tractors on lowland rice farms in Laguna Province.[1/] A survey of owners in the province indicated the presence of 400 units. The first 3 units were purchased in 1960. Total number of hand tractors in farms in Laguna has grown rapidly as follows:

Year	No. of Units Purchased	No. on Farms
1960	3	3
1961	11	14
1962	41	55
1963	87	142
1964	53	195
1965	139	334
1966 (part of year)	66	400

These hand tractors are largely the tractive type tiller to pull plows, comb harrows and small trailers. They are usually sold with both plow and comb harrow, but the comb harrow is most widely used. A total of 365 comb harrows have been purchased for use with tractive type tillers compared to only 37 rotary type tillers purchased. Equipment repairs were highest during the first year of operation and consisted mainly of replacing wheel axles and bearings, cylinder heads, contact points, ignition coils, spark plugs, and condensers.

Timed tests of harrowing operations indicate that about 540 to 740 square meters may be harrowed in a single pass per rated horsepower hour of the tiller. Thus, a 6-Rhp tiller could make a single pass on 1 hectare in about 2.6 hours. From 3 to 5 passes of the harrow are required for complete land preparation on soft soils. Hence, a 6-Rhp tiller could not be expected to complete all harrowing of more than 1 hectare per day. Fuel consumption of gasoline was about 4 to 6 liters/ha for complete harrowing. Only a few tests were made on the rotary tilling of flooded fields but those few indicate about 10 to 16 liters/ha of diesel and 10 to 27 liters/ha of gasoline were required for rotary tilling one hectare, while plowing averaged about 33 liters/ha of gasoline. Based on one liter of gasoline providing about 3.3 Rhp-hrs. of machine power, the following are estimates of power requirements for preparing lowland rice fields in Laguna Province:

Method A (Plow and harrow):

Plowing	33 x 3.3	=110 Rhp-hr
Harrow, 3 passes	5 x 3 x 3.3	= 50 Rhp-hr
Total		160 Rhp-hr/ha

Method B (Rotary tiller and harrow):

Rotary tiller, 1st pass	20 x 3.3	= 66 Rhp-hr
Harrow, 3 passes	3 x 5 x 3.3	= 50 Rhp-hr
Total		116 Rhp-hr/ha

[1/] University of the Philippines Research Project No. 2413 with I.R.R.I. under U.S.A.I.D. Contract No. AID/csd-834.

in Laguna, the rental rates of the 6-Rhp tiller for 8 hours is about $9.00 per day or about 90 kg of dry, clean rough rice at the farm. Rental rate including operator wage, fuel, repairs, depreciation, etc., is about $0.25 or 2.5 kg of palay per machine Rhp-hr assuming the machine operates only 75 percent of the time or 6 hours per day. The man and animal rental rate is about $2.50 per 8 hours but actual work is only about 6 hours. The cost would be about $0.40 per animal Rhp-hr which perhaps explains the rapid increase of hand tractors in Laguna, and the desire of farmers to hire the equipment.

In addition to the cooperative study with UPCA, animals and various types of power tillers are being hired to prepare land on the IRRI experimental fields (Fig. 11). Time studies and studies on quality of land preparation are being conducted for comparison with later yield samples from production plots.

3. A RELATED PROJECT OF THE INTERNATIONAL RICE RESEARCH INSTITUTE DEPARTMENT OF ECONOMICS UNDER RANDOLPH BARKER AND NARCISO DEOMAMPO.

(See Appendix B-Operational Plan I.B.3.)

Experimental plot work was conducted on the relationship of the yield of rough rice to land preparation, weeding, and fertilizer application. The study was done in the 1966 wet season. The experimental design involved the following treatments: (a) 2 varieties of rice, (b) 5 levels of land preparation, (c) weeding treatments, and (d) 6 levels of fertilizer. There were 360 possible treatment combinations. Standard I.R.R.I. practices were followed for insect and pest control, and water management. The preliminary results for the 1966 wet season are summarized in Figures 12 and 13. Only two levels of weeding are shown. The two single-harrowing and two double-harrowing treatments were combined since yields for these treatments did not differ significantly. Results are shown separately for the two varieties, IR8 and BPI-76. With the lowest level of land preparation (no harrowing) the two varieties respond almost identically. However, with improved land preparation, yields for IR8 exceed those for BPI-76 by approximately one metric ton (1,000 kg) per hectare. The advantage of weeding is pronounced when land preparation is inadequate.

4. ADOPTING, TESTING AND DEVELOPMENT OF EQUIPMENT, AND CONTACTS WITH MANUFACTURERS.

(Appendix B-Operational Plan I.B.3.)

In 1965 and 1966, on I.R.R.I. funds, several 10- to 12-foot wide prototype rotary tillers were fabricated, field tested, and modified for better performance. Additional tiller units are being made on A.I.D. funds for use in preparation of land for farmers on a contract basis. The latest prototype for use on 50- to 60-horsepower tractors is 12 feet (360 cm) wide with provision for adding blades to increase the width up to 16 feet (500 cm) (Figs. 14 and 15). At a one mile per hour (1.6 KPH) forward speed, this unit will have a capacity of up to 2 acres (0.8 hectare) per hour. The goal is to develop equipment that will till over 0.5 hectare per hour even in small fields. The wide width has been found to be an advantage in reducing the number of turns, in tilling close to levees and in case of turning; as the width extends beyond the wheels, the exposed blades can chop into the levee for complete tillage. Also the width is greater than the turning radius, thus the tractor does not have to

make close turns which require backward and forward manuevers. The extra width requires fewer turns per plot and leaves a smoother surface.

A 160 inch-wide Sidewinder Tilther rotary tiller was purchased with A.I.D. funds for use in preparing dry fields, and for testing in wet fields. This unit has many promising features for minimum tillage plow-plant operations following the rice crop. The transmission depth control, and lift assist features are promising for use in wet land preparation. However, the blade shape and arrangement balls mud under wet conditions and the bearing seals require additional design.

Loyd Johnson has continued his contacts with manufacturers to interest them in developing equipment for the rice producers. He attended a conference on "Mechanization on the World's Rice" held in England, Sept. 26 to Oct. 1, 1966 by FAO and Massey-Ferguson. As a result of the conference, Mr. E. L. Barger, Product Planning Manager for M-F consented to be on the project planning committee, and arranged that his product planning engineers visit I.R.R.I. when in Asia.

Mr. W. J. Adams, Jr., Assistant Manager, Central Engineering Laboratories, Food Machinery Corporation, is interested in the rice mechanization program. Loyd Johnson visited the Central Engineering Laboratories and the Sidewinder plant while on vacation in 1966. FMC will probably follow up and develop equipment for the rice producer.

The Ford Motor Company, Overseas Tractor Operations, held a regional "Symposium on Asian Agriculture," Nov. 14 to 17, 1966, attended by twenty officials representing the governments of Ceylon, Thailand, Burma, Malaysia, South Vietnam, Indonesia, Okinawa, Japan, Taiwan and the Philippines. Top Ford Motor Company executives and dealers from the United States and Australia organized and attended the conference. The delegates visited I.R.R.I. on Nov. 14. I.R.R.I. representatives attended other sessions, to emphasize the need for development of equipment for rice production.

International Harvester has developed a four-wheel drive prime mover which shows promise for use in rice production. Loyd Johnson visited their plant in Australia, Jan. 21, 1967 to exchange views on the prime mover. Modifications are being made and one unit will be field tested in 1967.

Product planning economists, engineers, and sales personnel from John Deere, Case, and other companies have visited I.R.R.I. during 1966 and 1967. Each visitor is interested in the needs of the rice producer, and hopes to obtain some idea of how his company can fill the need. Their observations and interest will be one of the most important results of the project.

5. WITH A.I.D. ASSISTANCE, COOPERATIVE WORK WITH THE U.S. DEPARTMENT OF AGRICULTURE NATIONAL TILLAGE MACHINERY LABORATORY HAS STARTED. (Appendix B-I.B.9.)

The object of the study is to secure critical design information on rotor tines, spade lugs, and tire and wheel types for flooded soil conditions.

Mr. Shang Cheu Chang, a graduate student of Auburn University, was employed three months by I.R.R.I. on A.I.D. funds to work at the U.S.D.A. Tillage Laboratory on equipment to be used in the research programs on rotary tillage and traction.

Dr. J. H. Taylor is working on the traction aspects of the cooperative program, and Dr. L. W. Larson is working on the rotary tillage aspects.

The program will expand as rapidly as construction of equipment permits. The support of this cooperative program is largely from U.S.D.A. funds to pay for staff salaries and overhead with A.I.D. funds used for technicians and essential supplies.

6. PROJECT PERSONNEL: CALENDAR YEAR 1966. (Operational Plan II.A.)

In 1966 the following persons worked on the project:

Name	Category	Active man-months on project
Loyd Johnson*	Agricultural Engineer	6
Stanley S. Johnson	Agricultural Economist	1-1/2
Randolph Barker*	Agricultural Economist	3
B. H. Aguila	Junior Technician	4
E. O. Càsem	Asst. Agricultural Engineer	8
E. Ruiz	Junior Technician	8
J. Reyno	Laborer	5
M. Fabellar	Laborer	4
F. Latorre	Laborer	1
Roberto Bautista**	Asst. Agricultural Engineer	1
Cheu-Shang Chang***	Junior Technician	3

*Salaries of these regular I.R.R.I. staff members were not charged to the project.

** Salary of this University of the Philippines staff member was not charged to the project but a modest honorarium was paid.

*** Graduate student at Auburn University who was employed part time by I.R.R.I. to develop design information necessary for the I.R.R.I./A.I.D. cooperative project with the U.S.D.A. National Tillage Laboratory.

B. WORK PLAN: February 8, 1967 to February 7, 1968 (12 months)

1. ANALYSIS OF RICE FARM OPERATIONS IN CENTRAL LUZON.
(Appendix B-I.B.1.)

The site sampling of the 145 rice farming sites will be continued at least through the full crop year cycle, May 23, 1966-67. The first hand observations and measurements give a much needed understanding of the sequencing of farm operations. In order to perceive changes in farming methods as they take place in these areas, this type of survey will need repeating over a number of years. Recommendations as to long run commitments of these types of surveys will be made when the existing survey data have been analyzed.

The personal interviews with the operators of the sites covered most of the yearly farm operation. Additional data at the end of the year operations which include the harvesting and threshing operations will be obtained from representative selected farmers. Analysis of the type of data being received from the Central Luzon survey is providing much data of which the following is an example:

(1) Patterns of the sequence of farm operations.
(2) Varieties of rice in one- and two-crop sequences.
(3) Adequacy of cultural practices and the relationship with yield.
(4) Types and cultural practices of off-season crops other than rice.
(5) Water management and soil depth.
(6) Dependence of farmers on hired and contract services.
(7) Timeliness in plowing and harrowing.

An extension of the analysis of rice farm operations will be started for other rice growing areas which differ considerably from the Central Luzon area. One of the major considerations in choosing Central Luzon as an initial study area was that the rainfall characteristics of the area are typically tropical monsoon (Fig. 16), with high rainfall during the monsoon season and little or no rain during the "dry" or "off" season. Conclusions drawn from the monsoon rainfall pattern will have application to other similar patterns. Several other rainfall patterns exist in the Philippines in areas of high rice production. These are the Cagayan Valley of Luzon (Northeast of Luzon), the Bicol Region of Luzon (Southern Luzon), and the Cotabato Province of Mindanao. (See Fig. 17.)

The Cagayan Valley rainfall is somewhat "bimodal", with an early peak, followed by another heavier rainy season. The rice is planted and harvested in Isabela Province (Cagayan Valley) several months later than in the Central Luzon area.

Mindanao is another large land mass in the Philippines and is considered to be the "frontier" area. A large rice growing area is located in the Southwest part of Mindanao in Cotabato Province. The rainfall is not as seasonal as in Central Luzon, and has rain all year, though not enough to sustain rice production throughout the year by rainfall alone. This area is of interest as the low production density and relatively larger farms favor mechanization, while the distance from the Manila market will also necessitate mechanization to lower production costs for commercial production.

The Bicol Region of Luzon is a heavier rainfall area, somewhat seasonal, but having heavy rains throughout the year. This rain pattern is likely to be indicative of many areas that are characterized as non-seasonal rainfall areas.

These areas will be studied to see how farmers have adjusted rice production to different rainfall patterns. In this way, steps to mechanize farming can be postulated in accordance with local practice under local physical restrictions.

Project plans are to continue the economic and engineering analysis of rice farming operations into the Cagayan Valley this year. Analyses of the Bicol and Cotabato areas will be studied for possible inclusion in next year's research program.

As an aid to a more adequate sample of the rice farming regions, aerial photos have been obtained for a strip 2 to 4 km wide along the major highways in Central Luzon and Laguna. From these aerial photos, the 1967 rice sample areas in farm sequence surveys will be randomized and away from the highway. Prior to this, the sample area was confined to a person's observation from the roadside at kilometer posts of the national highways. In addition, aerial photos taken at random over the pertinent rice areas will bring in new data on conditions away from the highway and on the changes in the field. With these data, along with actual observation, knowledge of the actual rice operations and the factors that affect them will be obtained. Assessment of mechanization introduction is dependent on analysis of present farming methods.

An important factor in consideration of potential mechanization is actual field size and the access to the field. The aerial photos provide a means to estimate these types of data. From the photos, estimates are being made as to field size, land use, roadways, irrigation, and drainage patterns.

A study of contract operations is to be started. Present farming innovations indicate a decided movement toward the use of custom operations. This study will be undertaken using methods of personal interviews of farmers, and contacts with A.P.C. members (extension), machinery representatives and other knowledgeable persons. The study will examine all contracted operations, including land preparation, harvesting and threshing, and weeding.

Laguna Province of Central Luzon is the most highly mechanized of the provinces in land preparation, and has a large percentage of irrigated rice farms. Because of the close proximity to IRRI, the province offers an excellent opportunity to closely observe changes and innovations in a developing rice farming area. A study will be conducted to observe the practices as they change, especially when these practices involve mechanization.

2. STUDY OF TRACTORS IN THE PHILIPPINES.
(Appendix B-I.B.2. and 4.)

A study is being started to provide a comparison of work animals, five- to ten-horsepower hand tractors, and 40- to 50-horsepower standard tractors. The analysis of these power units will compare relative work performance (from time studies), computed costs, and fees charged by contractors per day or per unit of work.

Data on population and importation, sales and usage of tractors will be obtained and summarized to indicate the present and projected population and tractor usage.

3. I.R.R.I. STUDY ON RICE CULTURAL PRACTICES WITH EMPHASIS ON LAND PREPARATION. (Appendix B-I.B.3.)

Further replicated experimental plot work is now underway by Randolph Barker and Narciso Deomampo, in which land preparation is performed by hand tractors as well as by carabao power, with varying weeding rates and fertilizer levels. Figure 18 shows the design of the experiment, and Figure 19 shows the planting layout for one replication. The results of this experiment should provide corroboration for the work previously done in 1966. Further, conclusions on benefits of carabao vs. tractor power in land preparation can be tentatively made.

4. ADOPTING, TESTING AND DEVELOPING RICE PRODUCTION EQUIPMENT, AND CONTACTS WITH MANUFACTURERS. (Appendix B-Operational Plan I.B.3.)

The search for land preparation and harvesting equipment will be continued in 1967. Strain gage equipment will be purchased and used to measure rolling resistance, power use, and stresses in the tractor, power tiller, and other equipment. Work on rotary tillers will receive major emphasis in an attempt to complete a prototype with enough superior features to be used by manufacturers as a production model. Work on a thresher will be continued as time permits. The prototype thresher was made in 1966 with I.R.R.I. funds, but considerable additional testing and modifications will be required in 1967.

Contacts with manufacturers will continue in an effort to interest them in developing and producing suitable equipment. International Harvester-Australia will probably test a four-wheel drive articulated tractor during 1967. Massey-Ferguson has started marketing a small 7-foot combine. Project funds and staff time will not permit purchase of or even testing of many of the machines on the market. The emphasis will be:

(1) to observe demonstration of manufacturers'models with discussion and suggestions made directly to the manufacturer engineers when possible;

(2) to take other equipment on a loan basis or on hire for short periods for tests and observations;

(3) and where neither of the approaches are practicable, to purchase with project funds the most promising equipment. Usually equipment must be purchased when used as a basic machine on which modifications or changes in design are incorporated.

5. A MEETING OF THE PRINCIPALS CONCERNED WITH THE IRRI-AID FARM MECHANIZATION STUDY (CONTRACT AID/csd-834) IS PLANNED FOR JUNE 28-30, 1967 AT THE JOINT MEETING OF THE CANADIAN AND AMERICAN SOCIETIES OF AGRICULTURAL ENGINEERS TO BE HELD AT SASKATOON, SASKATCHEWAN, CANADA.

The purpose of the meeting is, firstly, to review the goals and progress of the project, and to promote coordination and communication between the different parties interested in the project. Secondly, the meeting may create an interest in the representatives of the farm machinery industry in the large potential farm machinery market in Southeast Asia.

The decision to meet at Saskatoon was made because:

(1) A Committee meeting held during the Annual Meeting of the A.S.A.E. and C.S.A.E. would be less costly to A.I.D. since many of the representatives would already be in attendance.

(2) There exists the need to attract industry into the field of sales of rice machinery designed for tropical conditions. The Annual Meeting of the A.S.A.E. and C.S.A.E. is a logical place to talk to industrial representatives.

Appendix B of the AID-IRRI Contract (Article I.B.8) states that a project committee is to be established. A tentative list of committee members who might attend the meeting includes:

Loyd Johnson	- -	Rockefeller Foundation
Douglas Caton or		
John Wilson	- -	A.I.D./Washington
Harold Koone	- -	A.I.D./Philippines
A. W. Cooper	- -	U.S.D.A. National Tillage Machinery Laboratory
E. L. Barger	- -	General Product Planning Manager, Massey-Ferguson
Stanley Johnson	- -	IRRI staff
J. Berlijn	- -	IRRI staff
La Von Fife	- -	Economist, International Harvester
Dean McKee	- -	Economist, John Deere
W. J. Adams	- -	Asst. General Manager Central Engineering Lab., Food Machinery Corporation
William Koeneke	- -	Product Planning Manager Overseas Tractor Operations Ford Motor Co. Detroit, Michigan

6. U.S.D.A. NATIONAL TILLAGE LABORATORY TILLAGE AND TRACTION STUDY.
(Appendix B-I. B.9.)

In 1967, Shang Cheu Chang will work with Dr. J. H. Taylor on the traction aspects of the study. Dr. L. W. Larson will continue working on rotary tillage. Construction of equipment in the shop will continue as components are delivered.

7. PROJECT PERSONNEL: CALENDAR YEAR 1967.
(Operational Plan II.A.)

For calendar year 1967 the following persons are expected to work on the project:

Name	Category	Projected Man-Months in Project, 1967
Loyd Johnson*	Agricultural Engineer	6
J. D. Berlijn**	Agricultural Engineer	10
Stanley S. Johnson	Agricultural Economist	12
Randolph Barker*	Agricultural Economist	3
Emilio Casem	Asst. Agricultural Engineer	12
Eliseo L. Ruiz	Junior Technician	12
Ben Hur Aguila	Junior Technician	12
Chang Cheu-Shang***	Junior Technician	1
Feliciano Jalotjot	Draftsman	12
Charito Llorca	Secretary	10
Videlia L. Go	Clerk-Typist	12
Mario Lescano	Tractor Mechanic Demonstrator	12
Juan P. Reyno	Laborer (Field Assistant)	12
Miguel G. Fabellar	Laborer	12

*Regular IRRI staff members. Salaries not charged to the project.

***Graduate student at Auburn University, employed parttime by IRRI on the IRRI-AID cooperative project with the USDA National Tillage Laboratory.

**Expected to arrive March, 1967.

* * *

Figure 1. Central Luzon Survey
The route is marked by the dotted line, with triangles locating the measured sites. Distances noted are in kilometers from Manila.

Figure 2. Central Luzon Survey Sequence of Farm Operations: Measurements and Observations During the Week of July 11-17, 1966 for 145 Rice Locations.

APPLICATION
SEQUENCE OF FARM OPERATIONS

PREPARED BY
Emilio O. Casem

1 2 3 LOCATION SITE	5 6 WEEKS WK	9 10 IDLE WEEKS Z	11 PLOWED 1	HARROWED 2	PLANTED 3	VEGETATIVE 4	REPRODUCTIVE 5	MATURE 6	HARVESTED 7	THRESHED 8	SEEDBED 9	13 14 SOIL MOISTURE - DRY d	16 17 WATER DEPTH b	19 20 SOIL DEPTH 35 PSI-CM c	22 23 SOIL DEPTH 70 PSI-CM d	25 HAND WORK e	26 ANIMAL WORK f	27 MACHINE WORK g	28 DRY CONDITION h	29 WET CONDITION i	30 DIRECT SEED j	31 TRANSPLANT k	33 NEEDS WEEDING m	34 LEAF BLIGHT n	35 BLAST o	36 NEEDS NITROGEN p	37 VIRUS DISEASE q	38 NEEDS INSECTICIDE r	39 LODGED s	40 WHITE HEAD t	41 RAT DAMAGE u	42 DEAD HEART v	44 BIRD DAMAGE x	45 FLOODED y	46 47 TILLER NO. Θ	49 50 ROW PLANTING Δ	51 52 RANDOM 11 Ψ
001	30		1										01	34	39			g		i																		
002	30					4							12	30	39													h							17		
003	30					4							01	15	31																				06		
004	30					4							09	29	31																				22		
005	30					4							04	27	32													h							14		
006	30	04											24	35	44																						
007	30		1										08	10	17		f			i																	
008	30					4							04	38	45								m												17		
009	30			2									03	14	28		f			i																	
010	30						5						15	25	27								m		p			h									
011	30					4							10	23	25													h							05		
012	30	30											08	17	18																						
013	30	13											02	26	32																						
014	30		1										35	00	14		f			i																	
015	30		1										01	09	14		f			i																	
016	30		1										13	08	30		f			i																	
017	30					4							05	28	35																				12		
018	30	30											15	05	10																						
019	30					4							02	30	43																				19		
020	30				3								20	05	06	e			i	k			m														
021	30			2									07	18	28		f			i																Ψ	
022	30				3								05	10	12	e			i	k																	
023	30		1										03	07	11		f			i																Ψ	
024	30				3								15	13	23	e			i	k																	
025	30				3								10	18	43	e			i	k																Ψ	
026	30				3								10	10	17	e			i	k			m													Ψ	
027	30									9			06	09	10	e			i	j																	
028	30				4								10	30	34																						
029	30			3									08	20	50	e			i	k															07		
030	30				4								10	16	23																					Ψ	
																																			15		

LOCATION (site) -- A point in the farmer's rice field some 25 meters from the edge of the road and one penetrometer length from the nearest levee.
WEEKS (WK) -- The number of weeks from December 21.
IDLE WEEKS (Z) -- The number of weeks the field is left as is after rice has been harvested or seedlings have been pulled out of the seedbed.
PLOWED (1) -- If plot is plowed and no subsequent operations in the field are performed.
HARROWED (2) -- If the plot is harrowed or rotary tilled and no subsequent operations in the field are performed.
PLANTED (3) -- If plot is planted to rice (direct or transplant) and is not a seedbed.
VEGETATIVE (4) -- If the previous week's observation is "planted", subsequent notations are vegetative until the plants reach the reproductive stage.
REPRODUCTIVE (5) -- The rice plant is at ear initiation up to a week before maturity.
MATURE (6) -- Grains start yellowing up.
HARVESTED (7) -- If mature rice has been harvested or cut with no signs of threshing in field.
THRESHED (8) -- If harvested rice has been threshed in the field or signs of threshing in the the plot are evident.
SEEDBED (9) -- If site is seeded as seedbed up to the time seedlings are pulled for transplanting.
SOIL MOISTURE - DRY (a) -- When the field is dry up to field capacity. Numbers 10 to 1 are used: 10, when soil is dry and requires some 10 cm of water to bring it to field capacity; 1, when soil is moist and at field capacity.
WATER DEPTH (b) -- This is the depth of water on the surface of the plot in cm.
SOIL DEPTH, 35 PSI-CM -- The depth of penetration of the cone penetrometer when a pressure of 35 psi is applied. (c)
SOIL DEPTH, 70 PSI-CM -- The depth of penetration of the cone penetrometer when a pressure of 70 psi is applied. (d)
HAND WORK (3) -- If farm operation is done with human hand or human power. Ex.: spading, or transplanting.
ANIMAL WORK (f) -- If farm operation is done with animal power. Ex.: animal-plowing.
MACHINE WORK (g) -- If farm operation is performed with machine power. Ex.: rotary-tilling.
DRY CONDITION (h) -- When plot is without surface water, when farm operations are performed.
WET CONDITION (i) -- When plot is with surface water, when farm operations are performed.
DIRECT SEED (j) -- If seeds are sown directly to the field without coming from the seedbed.
TRANSPLANT (k) -- If seedlings are taken from the seedbed and planted to the site in rows or at random.
NEEDS WEEDING (m) -- If live weeds exist in the plot and are of the size and number to compete with the rice plant for nutrition, water, and solar radiation.
LEAF BLIGHT (n) -- If there are leaves with white spots along their margin up to the tip, with the upper portion appearing to be bleached.
BLAST (o) -- If there are reddish-brown or white oblong spots with streak of collapsed tissue of brownish color in the aerial portions of the rice plant.
NEEDS NITROGEN (p) -- If rice plants which are on vegetative or reproductive stage show signs of pale to yellowish leaves characteristic of nutrient deficiency.
VIRUS DISEASE (q) -- (1) Tungro, tillering slightly reduced; stunting; yellowing; rusty blotches; (2) Yellow dwarf, profuse tillering; severe stunting; general yellowing; (3) Grassy stunt, profuse tillering; severe stunting; narrow leaf blade chlorosis; rusty dots; (4) Orange leaf reduced tillering; inconspicuous stunting; orange and rolled leaves; rapid death.
NEEDS INSECTICIDE (r) -- If insects and allied pests are present or near rice plants.
LODGED (s) -- If rice plants are inclined to side some 45 degrees or more to the horizontal.
WHITE HEAD (t) -- If there are emerging panicles that are white or dead.
RAT DAMAGE (u) -- If there are signs of rats eating up seeds, or any portion of rice plant.
DEAD HEART (v) -- If there are emerging shoots which are dead.
BIRD DAMAGE (x) -- If there are signs of birds eating seeds or rice grains.
FLOODED (y) -- If water level in plot is unusually deep or above top of surrounding levees.
TILLER NO. (θ) -- Average no. of live tillers of 2 to 3 hills in plot. Counting starts a week after transplanting up to maximum tillering stage. Now revised to -- Average no. of tillers of 2 to 3 hills in plot at reproductive (late) to harvest period.
ROW PLANTING (Δ) -- If seeds or seedlings are planted in rows.
RANDOM PLANTING (ψ) -- If seeds or seedlings are planted at random.

Table 1. MATERIALS IN IRRI INTERVIEW SCHEDULE FOR CENTRAL LUZON, 1966

1. Name - address - household members

2. Field workers in the family

3. Tenure of operator

4. Land use

5. 1st and 2nd crop varieties and quantity of seeds:

6. Cultural practices including equipment used:

7. Calendar of operations, which includes:

   (1) field operation
   (2) date started and finished
   (3) total days elapsed for each operation (8-hour days)
   (4) number of men, animals and equipment listed by categories of: operator, family, hired and exchange labor
   (5) cost of cultural operations either in pesos or cavans of palay, and other remarks

8. Inventory of tools and equipment and work animals (This includes the value of the item and the rental cost.)

9. Information on when the sample area was prepared relative to the other fields

10. Irrigation information: rainfed, gravity irrigated, pump irrigated, availability of water during growing season both in the rainy and dry season

    (a) Cost of irrigations
    (b) Note: there is no question on the type of pumps or depth of well

11. Landlord's name and address

12. Harvesting and milling operation and cost

Figure 3. Central Luzon Survey Sequence of Farm Operations: Summary of Measurements and Observations for Two Rice Locations, Sites No. 3 and 4.

APPLICATION
SEQUENCE OF FARM OPERATIONS

PREPARED BY
Feliciano C. Jalotjot

1 2 3	5 6	9 10	11									13 14	16 17	19 20	22 23	25	26	27	28	29	30	31	33	34	35	36	37	38	39	40	41	42	44	45	46	47	49	50	51	52
LOCATION	WEEKS	IDLE WEEKS	PLOWED	HARROWED	PLANTED	VEGETATIVE	REPRODUCTIVE	MATURE	HARVESTED	THRESHED	SEEDBED	SOIL MOISTURE - DRY	WATER DEPTH	SOIL DEPTH 35 PSI-CM	SOIL DEPTH 70 PSI-CM	HAND WORK	ANIMAL WORK	MACHINE WORK	DRY CONDITION	WET CONDITION	DIRECT SEED	TRANSPLANT	NEEDS WEEDING	LEAF BLIGHT	BLAST	NEEDS NITROGEN	VIRUS DISEASE	NEEDS INSECTICIDE	LODGED	WHITE HEAD	RAT DAMAGE	DEAD HEART	BIRD DAMAGE	FLOODED	TILLER NO.	ROW PLANTING	RANDOM II		
SITE	WK	Z	1	2	3	4	5	6	7	8	9	a	b	c	d	e	f	g	h	i	j	k	m	n	o	p	q	r	s	t	u	v	x	y	θ	Δ	Ψ		
003	23/24	02											02	21	32																								
003	27/28			2									02	24	32			9		i																			
003	29				1								02	23	38	e				i		k															Δ		
003	30/37					8							02	24	32								4	3	1	6	1	7											
003	38/44						7						01	23	29								4	4		3		3				2							
003	45							1				04		21	24														1	1									
003	46								1			05		15	23	e																							
003	47		1										05	29	32			9		i																	POWER TILLER		
003	48																																						
004	23/24		2										05	20	43		f		h																				
004	25				1								01	25	33	e				i		k															Δ		
004	26/35					10							03	28	31								4	2		3	2	5											
004	36/42						7					00		30	31								5	7	3	4	1	4		3									
004	43							1				03		24	27														1	1									
004	44								1			03		25	27	e																							
004	45/46	02										02		28	30																								
004	47/48																																						

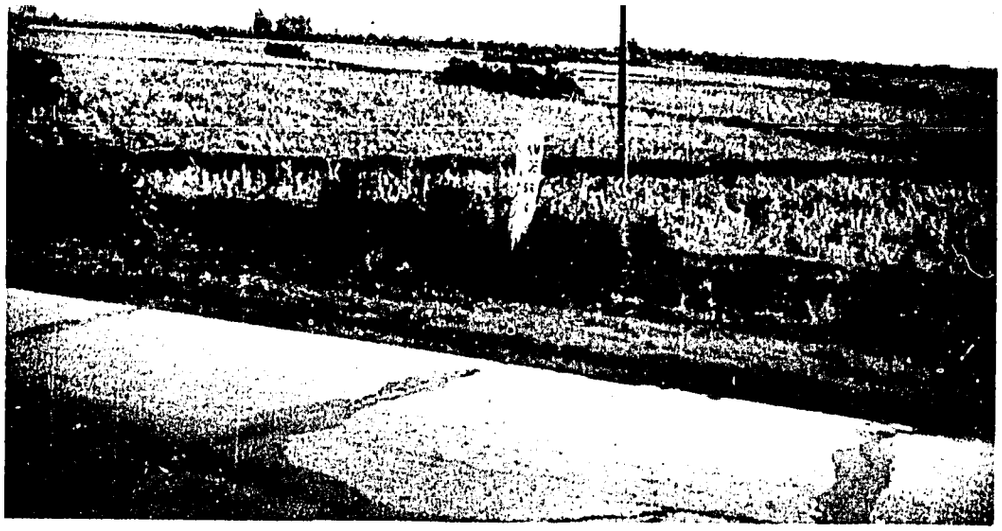


Figure 4. A view of riceland in dry condition between crops. The sites were measured 25 meters out from the side of the road at the kilometer post. The kilometer post locates the site 106 km north of Manila, and 2 km from Santa Rosa.

Figure 5. A picture of rice site #8 in the vegetative stage. The field is irrigated and lies in Laguna Province, south of Manila.

Fig. 6

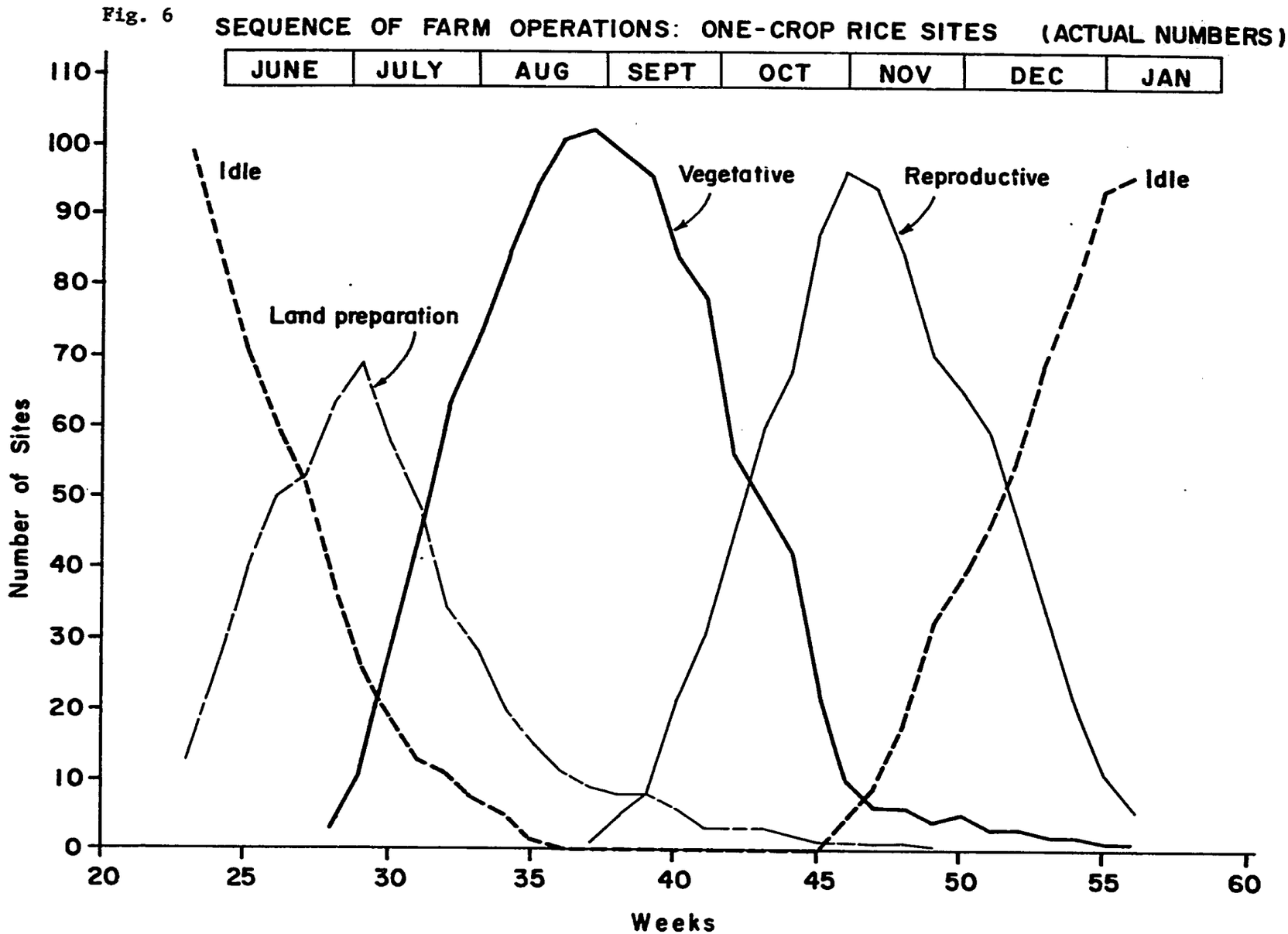

SEQUENCE OF FARM OPERATIONS: ONE-CROP RICE SITES (ACTUAL NUMBERS)
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
Idle
Land preparation
Vegetative
Reproductive
Idle
Number of Sites
0
10
20
30
40
50
60
70
80
90
100
110
20
25
30
35
40
45
50
55
60
Weeks

Fig. 7

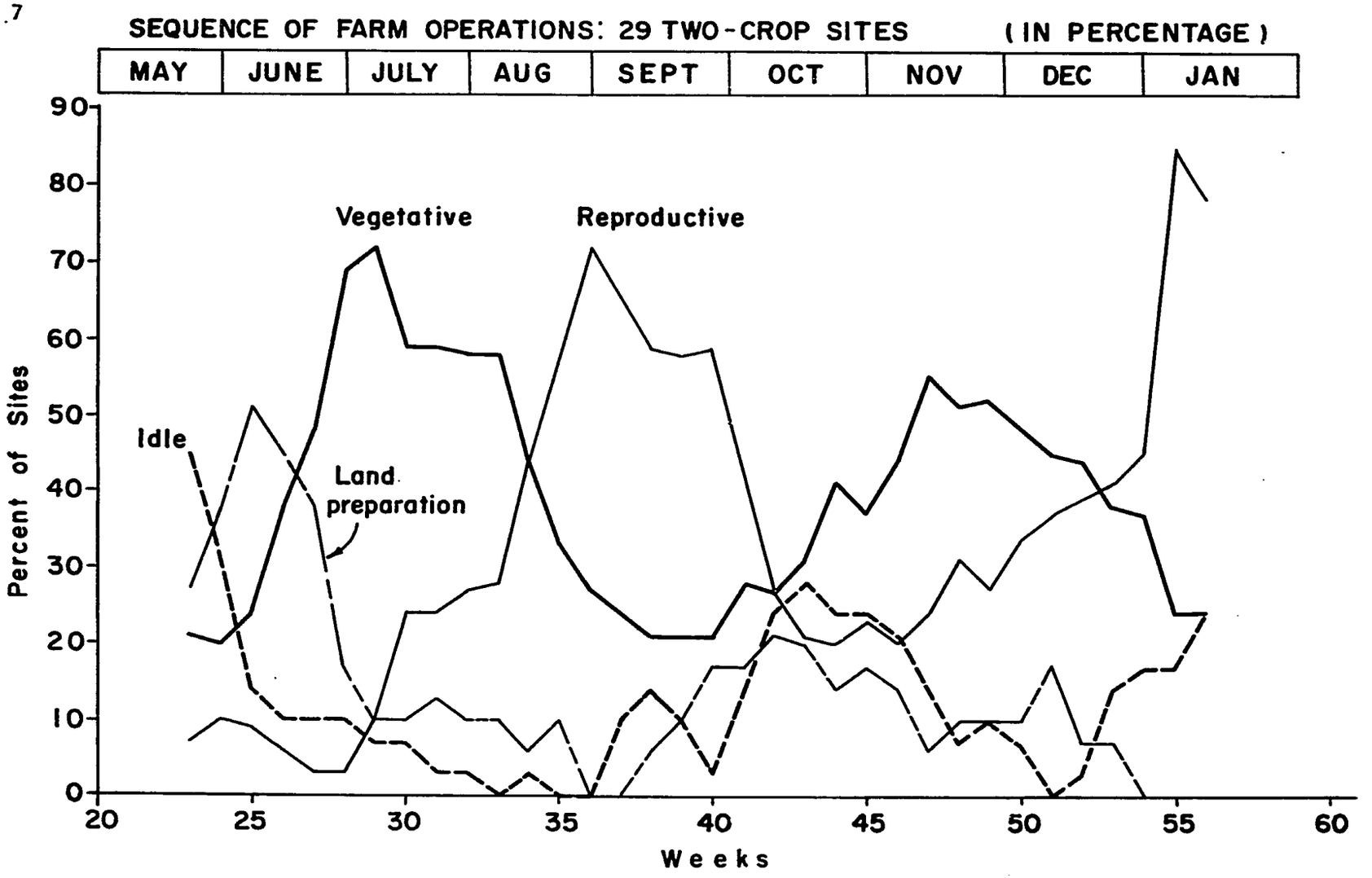
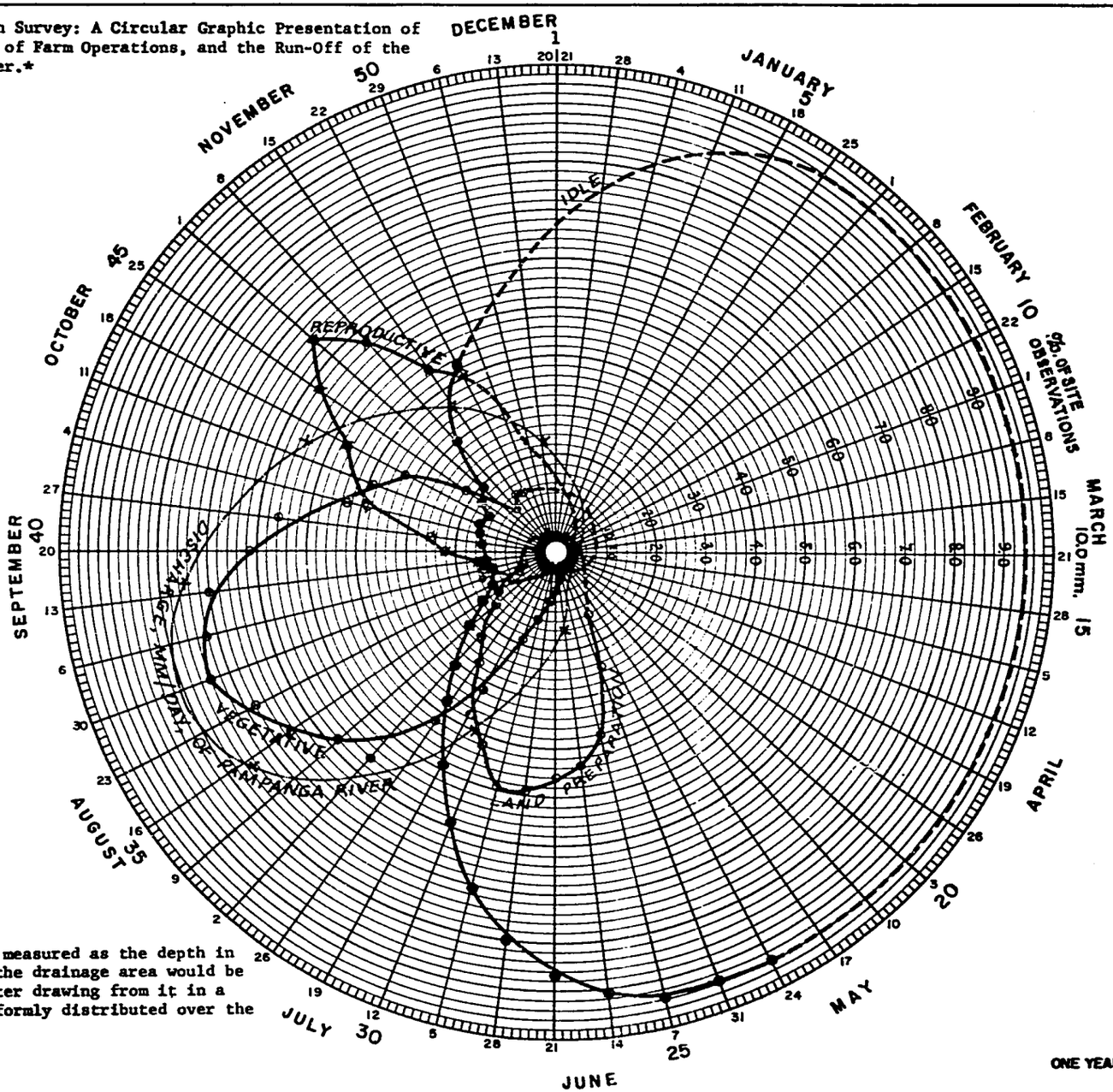

SEQUENCE OF FARM OPERATIONS: 29 TWO-CROP SITES
(IN PERCENTAGE)
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
Vegetative
Reproductive
Idle
Land preparation
Percent of Sites
0
10
20
30
40
50
60
70
80
90
20
25
30
35
40
45
50
55
60
Weeks

Figure 8. Central Luzon Survey: A Circular Graphic Presentation of the Sequence of Farm Operations, and the Run-Off of the Pampanga River.*



*The stream run-off is measured as the depth in millimeters to which the drainage area would be covered if all the water drawing from it in a given period were uniformly distributed over the area.

JAN.20, 1966

ONE YEAR – 52 WEEKS – 364 DAYS

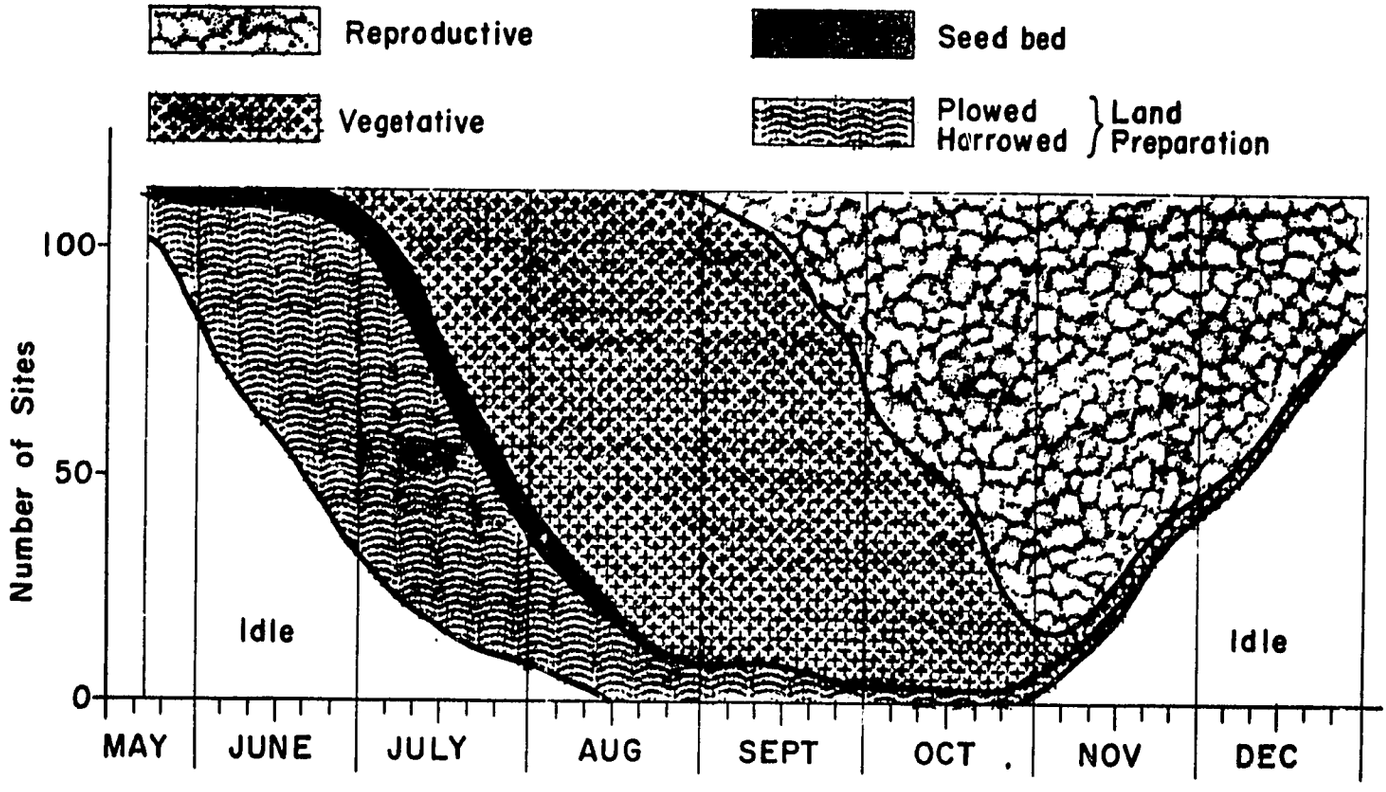


Figure 9. Central Luzon Survey: Cumulative Totals of the Stages of the Sequence of Farm Operations, 112 Non-Irrigated Rice Sites.

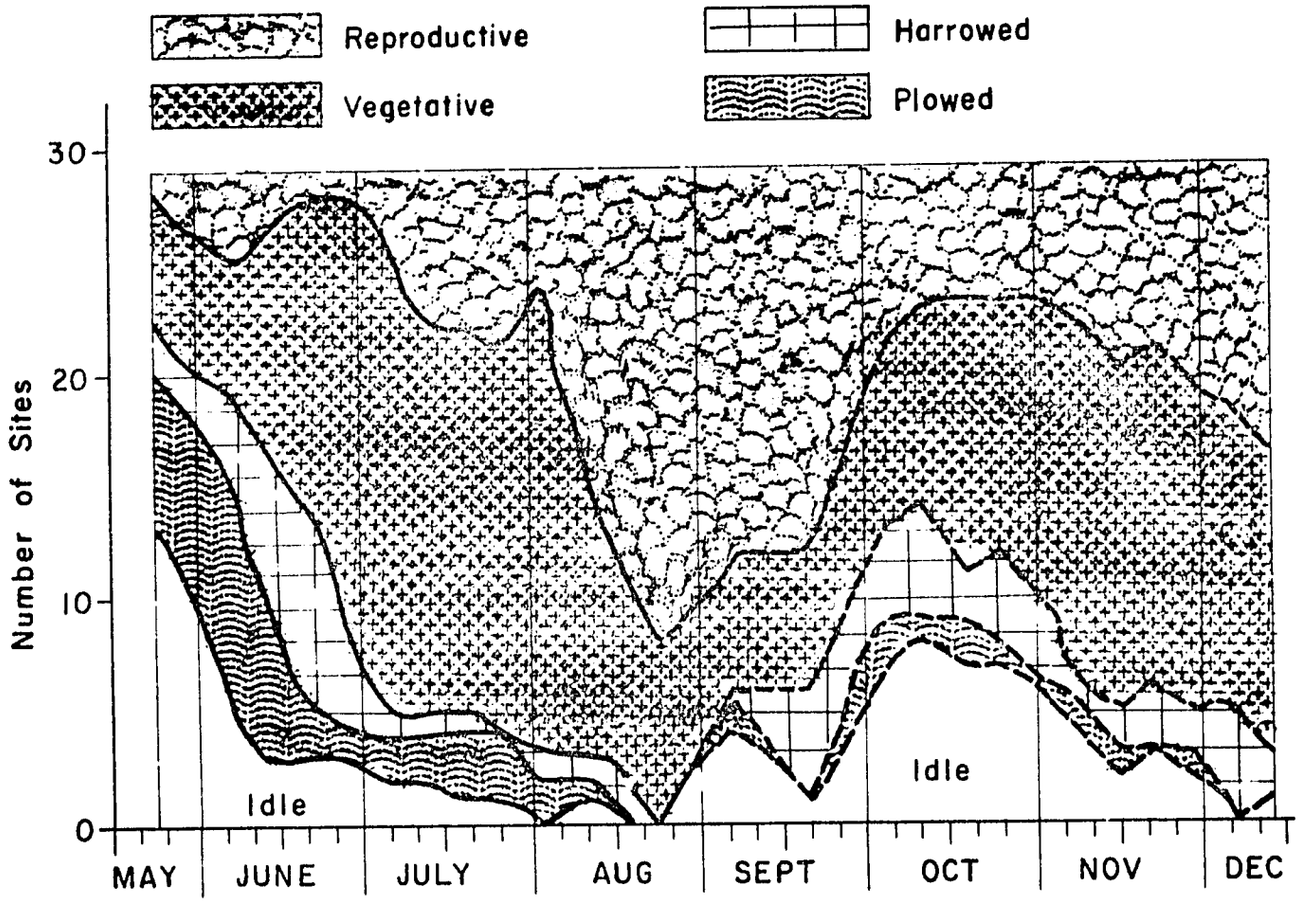


Figure 10. Central Luzon Survey: Cumulative Totals of the Stages of the Sequence of Farm Operations, 29 Irrigated Rice Sites.

Figures 11(a) and (b). A hand tiller with cage wheels and comb harrow can prepare soft soils by 3 to 5 passes.

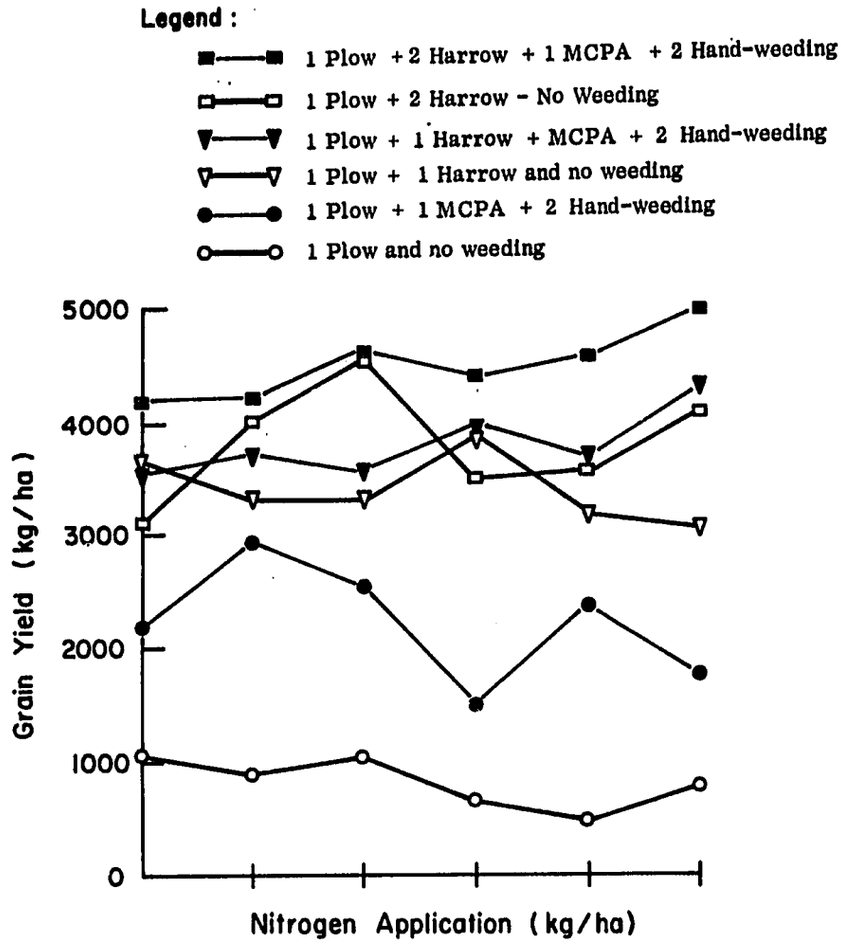


FIG. 12 Effects of harrowing and weeding on yield of IR8 with varying levels of nitrogen (IRRI wet season, 1966).

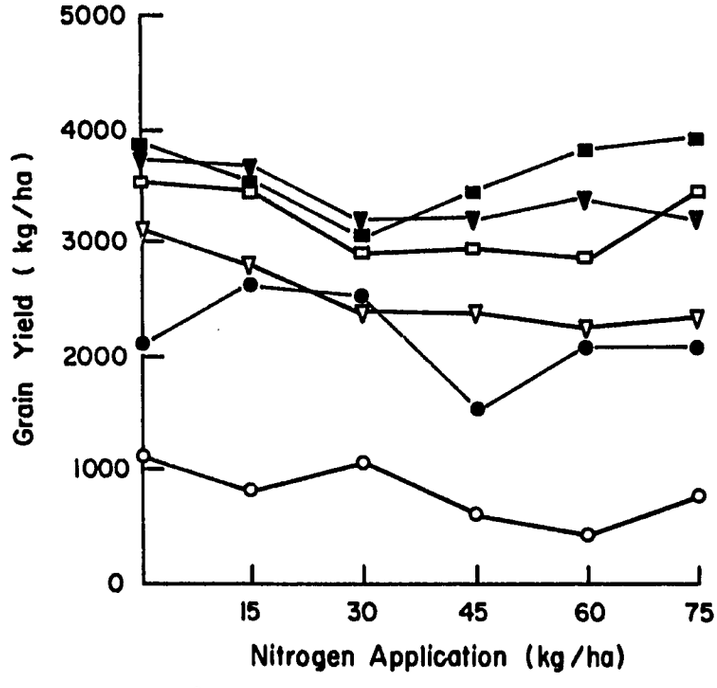


FIG. 13 Effects of harrowing and weeding on yield of BPI-76 (non-seasonal) with varying levels of nitrogen (IRRI wet season, 1966).

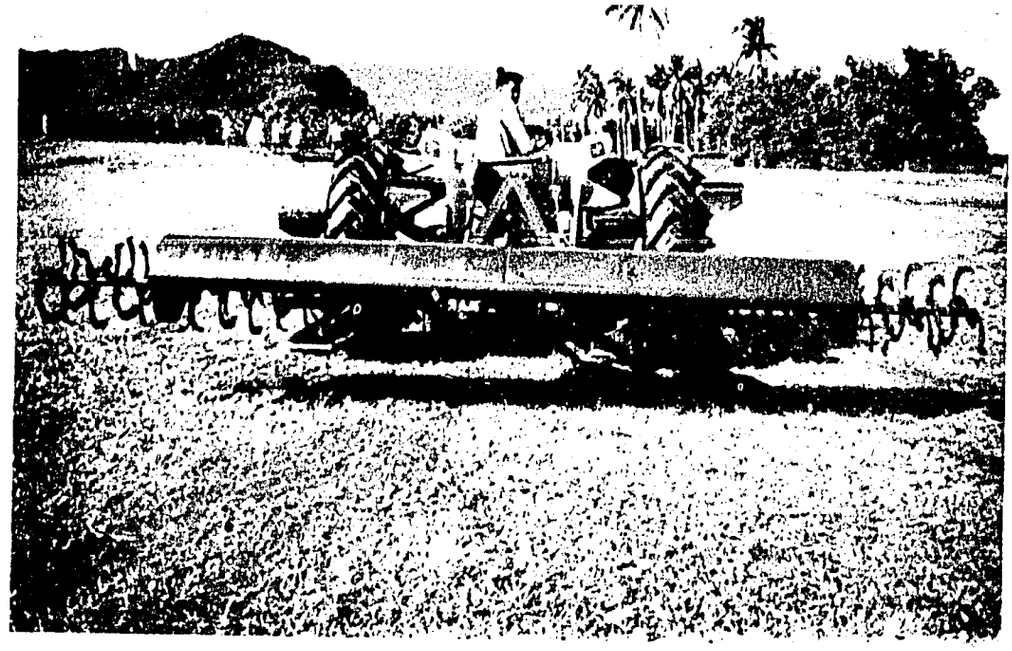


Figure 14. A 12-foot wide (360 cm) rotary tiller unit with additional blades to 16 feet (500 cm).

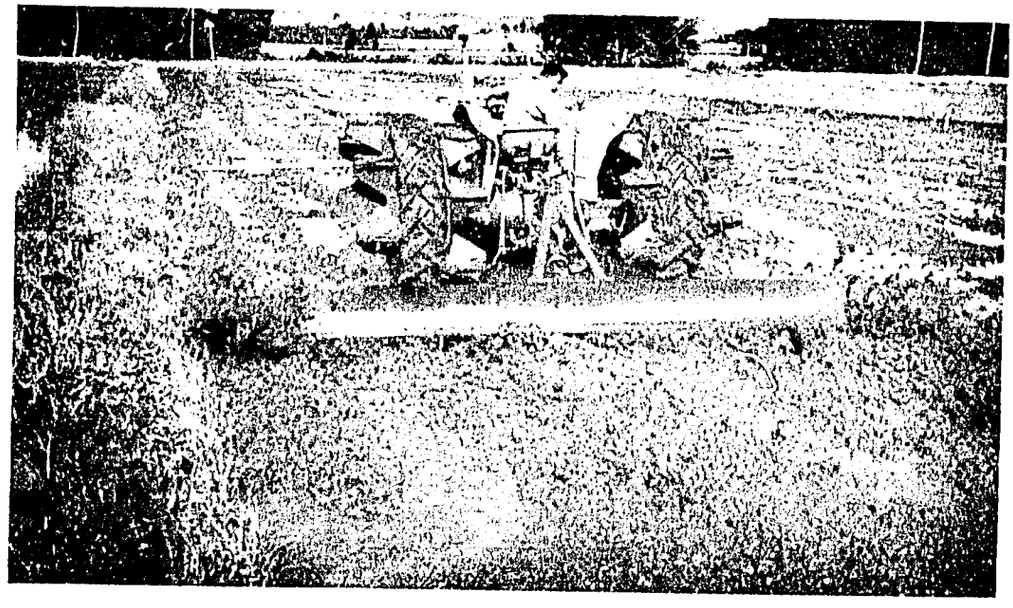


Figure 15. The extended rotary tiller in use on a soft paddy soil.

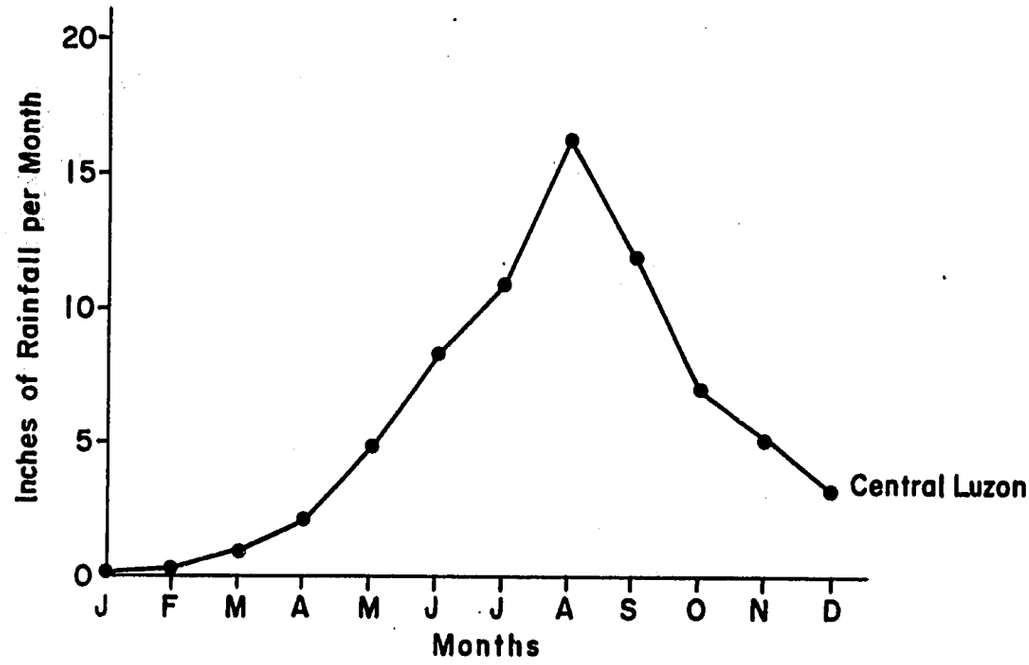


Figure 16 : Average annual rainfall in the Central Luzon area (Cabanatuan City, Nueva Ecija)

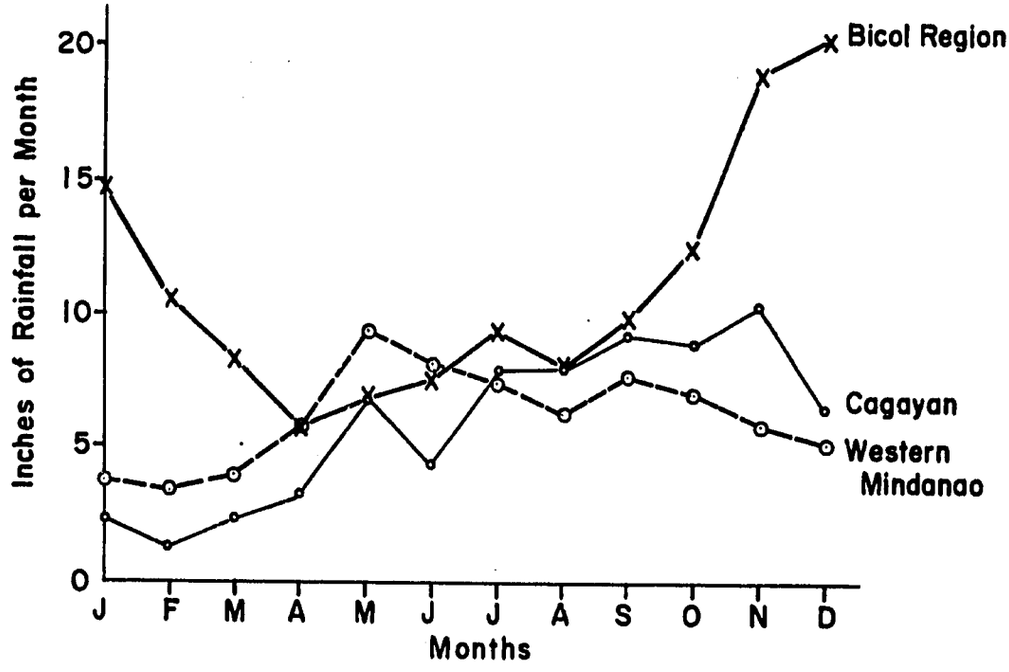


Figure 17 : Average annual rainfall for the following regions: Cagayan Valley (Echague, Isabela Province); Bicol Region (Legaspi, Albay Province); Western Mindanao (Kabacan, Cotabato Province)

FIGURE 18. I. R. R. I. Study on the interactions of animal and machine land preparation, weeding, and fertilizer application: Design of experiment, dry season, 1967.

Plowing & Harrowing after one week
6 passes (animal)

DAT \ W \ LP	8	1	4	3	6	10	7	5	2	9	LP / W	5	9	8	3	7	2	10	1	4	6						
35	30	0	120	30	30	60	90	150	90	120	7	45	30	15	75	45	15	15	0	30	75						150 N
0	0	30	120	90	30	30	90	60	0	90	28	0	75	60	60	45	75	75	0	45	75						120 N
7	90	30	90	30	60	120	60	30	90	0	14	60	0	60	75	45	75	0	30	75	15			IR8			90 N
21	120	60	120	60	30	120	0	30	120	120	35	30	15	15	15	0	60	45	0	0	75						60 N
14	60	90	0	120	150	30	90	0	0	120	0	60	60	60	[illegible]	30	45	0	45	15	45						30 N
28	30	120	0	150	60	30	120	90	0	0	21	15	0	45	60	0	45	60	30	0	0	35	28	21	14	7DAT	0
W \ LP	4	3	8	2	6	1	5	7	9	10	LP / W	6	5	9	10	2	1	7	3	8	4						
14	60	0	0	0	45	0	15	15	30	15	7	0	0	150	0	0	0	90	120	60	0	35					
0	0	45	75	30	30	30	45	75	75	15	21	90	0	30	30	30	0	60	90	0	150	28					
7	15	45	75	60	15	15	30	30	15	0	14	90	30	90	0	60	60	60	0	30	120	21		H-4			
28	15	75	75	0	0	15	15	0	45	60	28	150	0	150	0	30	0	90	60	90	150	14					
35	60	30	0	0	45	45	45	45	45	15	0	0	0	120	120	120	0	0	0	90	30	7					
21	30	15	30	30	15	75	45	45	15	15	35	120	0	90	30	0	120	30	60	90	30	0	15N	30N	45N	60N	75N
W \ LP	9	2	4	1	10	3	6	5	8	7	LP / W	4	10	5	7	1	3	6	2	9	8						
21	90	0	0	90	150	30	60	120	30	90	35	0	0	120	60	30	90	150	60	0	0	0	7	14	21	28	35
28	90	90	60	150	150	90	90	30	60	0	28	90	120	60	30	30	0	0	120	60	0	30N					
7	90	150	60	120	30	0	30	120	150	30	21	30	0	150	150	150	0	0	150	0	150	60N		IR8			
0	30	30	90	90	0	60	90	30	60	30	14	30	90	120	30	150	150	60	150	0	0	90N					
35	30	150	150	150	90	0	0	30	60	0	0	0	90	90	60	30	150	120	150	0	30	120N					
14	30	90	90	0	120	30	0	90	90	0	7	150	150	90	0	150	90	90	60	0	0	150N					
W \ LP	6	1	7	2	5	3	10	8	9	4	LP / W	8	5	6	4	2	1	7	3	10	9						
21	45	45	75	0	0	75	75	0	60	45	14	45	45	0	15	30	15	60	15	45	45	35					
14	60	45	0	45	0	60	60	15	15	0	28	15	45	30	0	15	75	30	0	0	0	28					
7	60	45	0	45	0	30	60	60	0	0	7	0	15	0	45	0	30	75	0	45	45	21		H-4			
28	45	60	75	60	60	15	15	0	30	60	21	15	60	30	15	15	0	30	0	0	45	14					
35	30	30	30	75	15	45	0	45	30	75	0	0	15	75	60	75	75	0	30	60	0	7					
0	0	0	45	0	0	75	45	15	15	45	35	60	0	0	15	15	15	75	0	30	0	0	15N	30N	45N	60N	75N
	35					36						37					38					39					

Methods of Land Preparation

(1) Tractor - Plow and harrow after one week - 5 passes
(2) Tractor - Plow and harrow after one week - 4 passes
(3) Tractor - Plow and harrow after one week - 3 passes
(4) Tractor - Plow and harrow after one week - 2 passes
(5) Tractor - Plow and harrow after one week - 1 pass
(6) Tractor - Plow and immediate harrow - - - 1 pass
(7) Animal - Plow and harrow after one week - 6 passes
(8) Animal - Plow and immediate harrow- - - - 3 passes
(9) Animal - Plow only
(10) Zero tillage

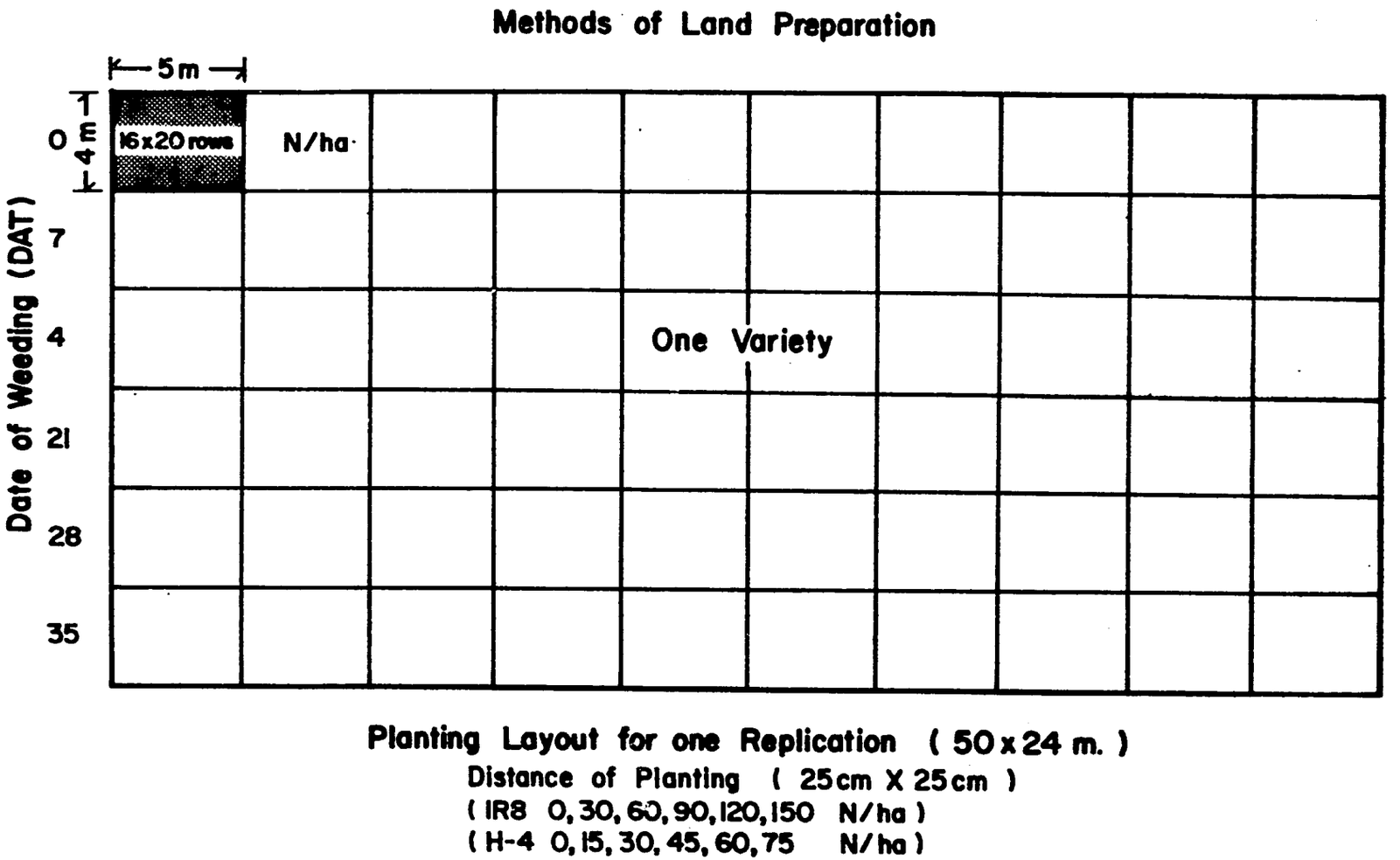



Figure 19. I.R.R.I. Study on the Interactions of Animal and Machine Land Preparation, Weeding, and Fertilizer Application: Planting Layout for one Replication.