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PERT ANALYSIS--KOREAN CROP BREEDING PROJECT

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INTRODUCTION

Since its inception in the early 1960s by the Office of Special Projects, United States Navy, the Program Evaluation and Review Technique (PERT) has been successfully used in the planning, scheduling, controlling and evaluation of a variety of both public and private projects. Unlike its earlier counterparts, Gantt charting and Critical Path Analysis, PERT is uniquely suited for use in the evaluation of research and development projects for which precise time estimates cannot be made.

The use of PERT to evaluate the Korean Crop Breeding Project has produced general items of information which may be helpful to the project administrative staff in planning and executing the remainder of the project. First, to initiate the evaluation a network diagram was developed from information contained in the project funding proposal.[1/] The network diagram which encompasses the entire project enables both interested individuals and project administrative personnel to better understand the interrelationships which exist between the various project sub-components. Second, the evaluation has generated a listing of activities which fall on the critical path. Such a list provides the administrative staff with those activities which must be completed within their expected times. Any delay in the completion of one of these activities will result in a delay in the completion of the project, unless time lost on earlier activities is made up on successor activities by scheduling overtime, adding manpower or other management action. Third, the analysis provides a listing of slack or floats times for those activities not on the critical path. With this knowledge the administrative staff can manipulate manpower from those activities which are not crucial to the completion of the project to those that are.

1/ Ministry of Agriculture and Forestry, Office of Rural Development, "Crop Improvement AID Loan Project", August, 1973.

LIMITATIONS OF THE ANALYSIS

It is readily apparent that the results of any PERT analysis are only as good as the time estimates provided for each activity. The estimates used in the present analysis were provided by a variety of professors at Michigan State, each a specialist in the given sub-component of the research for which estimates were solicited and each with moderate to heavy experience in overseas research. A listing of those contacted is presented in Appendix 1. Although the estimates do incorporate the best professional estimates available here, they should be re-examined by the administrative staff in Korea and adjusted if necessary to reflect existing in-country conditions.

The network diagram may also require modifications due to omissions and adjustments in the existing research proposal. For example, the networks staff education component contains only activities which describe Korean Ph.D. and on-the-job training in foreign institutions (i.e., U.S. universities, IRRI and CIMMYT). The project staff may wish to expand this component to include both formal and informal training in Korean institutions. Also, as research commences and more detailed information becomes available it may be desirable to break down each activity as it appears in the present network into more finely defined subcomponents. It is hoped that through the process of delineating the activities more accurate time estimates may appear.

METHOD OF ANALYSIS AND RESULTS

The conversion of the Korean Crop Breeding Project proposal in a format compatible with the PERT technique required a compilation of project objectives implicitly or explicitly presented in the project documentation, the delineation of events and activities needed to accomplish these goals, the sequencing of events in such a manner as to insure an efficient flow of project activity and the tying of specific project activities to time estimates provided by

various professionals, each a recognized expert in his respective area. An examination of the research proposal generated the rather extensive array of project goals listed below:

1. Project administration

   a. To develop an administrative organization capable of initiating and guiding the multiplicity of activities and relationships necessary for successful project completion

2. Rice research

   a. To develop new lowland rice varieties which exhibit qualities such as higher yield potential, shorter maturation and hightened disease resistence, improved quality and greater resistance to cold

   b. To breed and select new upland rice varieties with characteristics similar to those sought in the lowland varieties

   c. To develop rice milling and production equipment compatible with the new seed varieties

   d. To upgrade Korean research facilities, techniques and staff utilized in rice research

3. Soybean research

   a. To develop new varieties of soybean having the characteristics of higher disease and insect resistence, increased yield potential, resistance to cold and shorter maturation period and improved quality

   b. To develop a soybean extension program to disseminate existing cultural practices concerning local soybean production to the Korean farmer

   c. To upgrade Korean research facilities, techniques and staff utilized in soybean research

4. Wheat and barley research

   a. To develop new varieties of wheat and barley which are higher yielding, shorter maturing, less susceptible to indigenous pests and disease, more tolerant to cold and more adaptive to growing on poorly drained paddy soils

   b. To develop wheat varieties with superior milling qualities including higher protein content and more desirable baking qualities

   c. To upgrade Korean research facilities, techniques and staff utilized in wheat barley research

5. Potato research

   a. To develop new and improved indigenous potato varieties

   b. To devise new techniques for the testing of seed, the storage of potato production and the processing and marketing of potatoes

6. Multiple cropping research

   a. To develop land use and conservation recommendation expressly related to the production of the new varieties

   b. To develop sets of cultural practices for the most feasible multiple cropping patterns

   c. To provide the project administrative staff with economic yield and cost information pertinent to the chosen multiple cropping patterns

   d. To develop farm machinery compatible with the production of the new seed varieties

7. Seed foundation

   a. To develop a new organization capable of reproducing and storing the new seed varieties in quantities sufficient to meet anticipated demand

8. Extension

   a. To develop an extension program capable of disseminating the new seed, production inputs and cultural practices associated with the new varieties.

To develop the network diagram which provides the basis for the PERT analysis each of the goals stated above was examined and broken down into a number of separate activities and events which were deemed necessary to accomplish the goal. In this context activities indicate time consuming operations such as the ordering and installation of research equipment or the breeding and selection of new seed lines. Events on the other hand indicate an instantaneous point in time representing the completion of one activity and the readyness to begin a new one. Once designated the events and their corresponding activities were arranged in the sequential order appearing in the network diagram which accompanies this report. As mentioned above, time

estimates were then provided in consultation with a number of specialists for each activity in the diagram.

Because of the large number of activities associated with the project a computer program adapted from one developed by Roy Harris was employed using the CDC 6500 facility at Michigan State University. A copy of the program and the input format are present in Appendix 2.[2/] The analysis of the project required the following data inputs: 1) the definition of the activity with respect to predecessor and successor event numbers, 2) a description of the event, and 3) estimates of the most optimistic (TO), most pessimistic (TP) and most likely times (TL), associated with completion of the activity. Expected times (TE) for each activity is calculated using the following formula:

$$TE = \frac{TO + 4(TL) + TP}{6}$$

The results of these calculations and the program input data are presented in Table One below.

[2/] The computer program appearing in Appendix 2 has been modified and expanded since the completion of this report. The newer version incorporates a calendar dating program which endogenously calculates a running index of workdays for each event and adjusts these indexes to reflect holidays and non-workdays. Because of the assumptions made in the newer version, calendar dates associated with events on the critical path which appear on page 17 of this report may vary slightly from those that would be generated using the new version. A detailed explanation of the PERT methodology and the new program can be found in "Pert Programming Methods for Project Appraisal--A Computer Program," which will appear as a Michigan State University Agricultural Economics Report 290 in the near future.

TABLE ONE INPUT DATA AND EXPECTED TIMES FOR EACH ACTIVITY

NO.	ACTIVITY DISCRIPTION	PRED	SUC	TO	TL	TP	EXPECTED TIME
53	BUILDING UP PRODUCTION CAPICITY	29	30	12.9[illegible]	27.95	51.60	29.38
54	DUMMY ACTIVITY	30	107	0.00	0.00	0.00	0.00
55	ADJUSTING AND TESTING MACHINERY--RICE	31	32	12.90	17.90	25.80	18.38
56	MARKET RESEARCH CONDUCTED	32	33	12.90	21.05	25.80	20.48
57	ORGANIZATION AND OPERATION OF PRODUCTION UNIT	32	34	4.30	8.60	12.90	8.60
58	BUILDING UP PRODUCTION CAPACITY	33	35	4.30	10.03	21.50	10.99
59	BUILDING UP PRODUCTION CAPACITY	34	35	4.30	10.03	21.50	10.99
70	DUMMY ACTIVITY	35	107	0.00	0.00	0.00	0.00
71	BEGIN SOYBEAN BREEDING	36	41	0.00	0.00	0.00	0.00
72	LINKAGES WITH US BREEDERS DEVELOPED	36	37	25.80	35.83	51.60	36.79
73	PURCHASING NEW LAB AND LIBRARY EQUIPMENT	36	38	25.80	35.83	51.60	36.79
74	COLLECTION OF INFO ON SOYBEAN PRODUCTION	36	39	4.30	12.90	21.50	12.90
75	CONDUCTING STAFF TRAINING--SOYBEAN	37	40	12.90	25.80	51.60	28.00
76	DUMMY ACTIVITY	37	41	0.00	0.00	0.00	0.00
77	DUMMY ACTIVITY	38	41	0.00	0.00	0.00	0.00
78	CONDUCTING STAFF TRAINING COURSE	39	43	8.60	25.80	38.70	24.60
79	DUMMY ACTIVITY	40	42	0.00	0.00	0.00	0.00
80	BREEDING AND SELECTION OF LINES FOR TESTING	41	42	154.80	206.40	258.00	206.40
81	CONDUCTING FIELD TRIALS	42	44	51.60	103.20	154.80	103.20
82	CONDUCTING EXTENSION PROGRAM--SOYBEAN	43	45	25.80	51.60	77.40	51.60
83	FINAL SELECTION OF IMPROVED VARIETIES	44	45	25.80	55.30	103.20	58.77
84	DUMMY ACTIVITY	44	71	0.00	0.00	0.00	0.00
85	DUMMY ACTIVITY	45	94	0.00	0.00	0.00	0.00
86	DUMMY ACTIVITY	46	81	0.00	0.00	0.00	0.00
87	COLLECTING BREEDER SEED VARIETIES	46	97	0.00	0.00	0.00	0.00
88	DEVELOPMENT OF RELATIONSHIP WITH CIMMYT	47	49	4.30	13.60	25.80	14.08
89	PURCHASE OF NEW LAB AND LIBRARY EQUIPMENT	47	50	25.80	12.90	21.50	12.90
90	BEGIN WHEAT BREEDING	47	52	0.00	35.83	51.60	36.79
91	PURCHASE OF NEW LAB AND LIBRARY EQUIPMENT	47	52	0.00	0.00	0.00	0.00
92	BEGIN BARLEY BREEDING	48	52	25.80	35.83	51.60	36.79
93	CONDUCTING STAFF TRAINING	48	53	0.00	0.00	0.00	0.00
94	DUMMY ACTIVITY	49	51	4.30	8.60	12.90	8.60
95	DUMMY ACTIVITY	50	52	0.00	0.00	0.00	0.00
96	DUMMY ACTIVITY	50	53	0.00	0.00	0.00	0.00
97	DUMMY ACTIVITY	51	54	0.00	0.00	0.00	0.00
98	BREEDING AND SELECTION OF LINES FOR TESTING	52	54	154.80	206.40	258.00	206.40
99	BREEDING AND SELECTION OF LINES FOR TESTING	53	55	154.80	206.40	254.00	206.40
130	CONDUCTING FIELD TRIALS--WHEAT	54	56	51.60	103.20	154.80	113.20
131	CONDUCTING FIELD TRIALS--BARLEY	55	57	51.60	103.20	154.80	113.20
132	FINAL SELECTION OF IMPROVED LINES--WHEAT	56	58	25.80	55.90	103.20	58.77
133	DUMMY ACTIVITY	56	71	0.00	0.00	0.00	0.00
134	FINAL SELECTION OF IMPROVED LINES--BARLEY	57	58	25.80	55.90	103.20	58.77
135	DUMMY ACTIVITY	57	71	0.00	0.00	0.00	0.00
136	COLLECTING BREEDER SEED VARIETIES	58	81	0.00	0.00	0.00	0.00
138	DUMMY ACTIVITY	58	97	0.00	0.00	0.00	0.00
139	COLLECTING BREEDER SEED VARIETIES	59	81	4.30	13.60	25.80	14.08
140	COLLECTION OF INTERNATIONAL VARIETIES--POTATO	59	97	0.00	0.00	0.00	0.00
141	COLLECTION OF LOCAL VARIETIES	60	61	8.60	13.60	25.80	14.08
142	BEGIN POTATO BREEDING	60	62	2.20	35.61	38.70	31.62
143	EVALUATING SEED TESTING TECHNIQUES	60	63	0.00	5.38	12.90	6.10
144	DEVELOPING SEED STORAGE TECHNIQUES	60	63	0.00	0.00	0.00	0.00
145	DUMMY ACTIVITY	61	63	0.00	25.80	38.70	34.70
146	DUMMY ACTIVITY	62	63	0.00	0.00	0.00	0.00
147	BREEDING AND SELECTION OF BREEDER SEED	63	64	154.80	266.50	412.30	272.25
148	DUMMY ACTIVITY	64	65	0.00	0.00	0.00	0.00
149	DUMMY ACTIVITY	64	71	0.00	0.00	0.00	0.00
150	DUMMY ACTIVITY	64	81	0.00	0.00	0.00	0.00
151	COLLECTING BREEDER SEED VARIETIES	64	97	4.30	13.60	25.80	14.08
152	DUMMY ACTIVITY	65	94	0.00	0.00	0.00	0.00
153	DUMMY ACTIVITY	66	87	0.00	0.00	0.00	0.00
154	DUMMY ACTIVITY	66	94	0.00	0.00	0.00	0.00

TABLE ONE INPUT DATA AND EXPECTED TIMES FOR EACH ACTIVITY

NO.	ACTIVITY DESCRIPTION	PRED	SUC	TO	TL	TP	EXPECTED TIME
125	COLLECTION OF LOCAL CROPPING AND LAND USE DATA	67	68	9.60	12.90	17.20	12.93
126	PURCHASE OF LAB AND LIBRARY EQUIPMENT	67	69	25.80	35.83	51.60	36.79
127	STUDYING FARM MACHINERY NEEDS	67	70	4.30	8.60	12.90	8.60
128	COMMENCE EXPERIMENTAL TRIALS	67	71	0.00	0.00	0.00	0.00
129	INVENTORYING UPLAND SOIL PROBLEMS	67	73	12.90	19.65	25.80	19.55
130	DUMMY ACTIVITY	68	71	0.00	0.00	0.00	0.00
131	ACQUISITION OF FARM EQUIPMENT TO BE TESTED	68	74	4.30	13.61	25.80	14.09
132	DUMMY ACTIVITY	69	71	0.00	0.00	0.00	0.00
133	ACQUISITION OF EQUIPMENT TO BE TESTED	70	74	4.30	13.61	25.80	14.09
134	CONDUCTING EXPERIMENTAL TRIALS ON X-CROPPING	71	72	51.60	103.20	154.80	103.20
135	CALCULATION OF INITIAL YIELD AND COST ESTIMATE	72	75	4.30	12.18	17.20	11.70
136	CONDUCTING FIELD TRIALS--X-CROPPING	72	76	25.80	51.60	71.40	50.57
137	DUMMY ACTIVITY	72	77	0.00	0.00	0.00	0.00
138	DEFINING SOIL PROBLEM AREAS AND TESTING	73	77	51.60	103.20	154.80	103.20
139	SELECTION AND ADJUSTMENT OF FARM MACHINERY	74	78	25.80	51.61	77.40	51.60
140	ADJUSTING YIELD AND COST ESTIMATES	75	79	4.30	6.48	8.60	6.47
141	DUMMY ACTIVITY	76	78	0.00	0.00	0.00	0.00
142	ADJUSTING YIELD AND COST ESTIMATES	76	79	4.30	6.48	8.60	6.47
143	BEGIN ADJUSTED TRIALS	76	81	0.00	0.00	0.00	0.00
144	MAKING RECOMMENDATIONS FOR SOIL CONSERVATION	77	80	4.30	9.31	17.20	9.79
145	DUMMY ACTIVITY	78	79	0.00	0.00	0.00	0.00
146	ADJUSTING MACHINERY REQUIREMENTS	78	84	0.00	5.01	12.30	5.49
147	ADJUSTING COST AND YIELD ESTIMATES	79	83	4.30	6.48	8.60	6.47
148	DEVELOPING EXTENSION FIELD MANUAL	80	87	17.20	37.26	51.60	36.31
149	ADJUSTING FIELD TRIALS FOR NEW SEEDS	81	82	25.80	55.90	103.20	58.77
150	ADJUSTING YIELD AND COST ESTIMATES	82	83	8.60	12.90	21.50	12.90
151	ADJUSTING MACHINERY REQUIREMENTS	82	84	0.00	5.01	12.30	5.49
152	SELECTING OPTIMAL CROPPING PATTERNS	82	85	4.30	12.90	21.50	12.90
153	SELECTING OPTIMAL CROPPING PATTERNS	83	85	4.30	12.90	21.50	12.90
154	SELECTING OPTIMAL CROPPING PATTERNS	84	85	4.30	12.90	21.50	12.90
155	DEVELOPING EXTENSION FIELD MANUAL	84	87	17.20	37.26	51.60	35.31
156	DETERMINING LAND USE REQUIREMENTS	85	86	4.30	9.53	17.20	9.88
157	DEVELOPING EXTENSION FIELD MANUAL	85	87	17.20	37.26	51.60	36.31
158	DUMMY ACTIVITY	86	87	0.00	0.00	0.00	0.00
159	PLANNING EXTENSION PROGRAM FOR NEW VARIETIES	87	98	12.90	22.93	34.70	23.89
160	DEVELOPING RURAL GUIDANCE TRAINING PROGRAM	87	99	17.20	37.26	51.60	36.31
161	STUDYING SEED DISTRIBUTION NEEDS	88	93	4.30	13.50	25.80	14.08
162	CONDUCTING INITIAL NEGOTIATIONS WITH WORLD BANK	88	90	4.30	17.90	34.40	18.38
163	DEVELOPING LOAN PORTFOLIO	89	91	8.60	17.20	25.80	17.20
164	DEVELOPING LOAN PORTFOLIO	90	91	8.60	17.20	25.80	17.20
165	CONDUCTING FINAL NEGOTIATIONS WITH WORLD	91	92	12.90	22.93	34.70	23.97
166	SELECTING AND ORGANIZING STAFF	92	93	17.20	23.90	51.60	25.05
167	LEASING OR CONSTRUCTING FACILITIES	92	94	8.60	27.20	51.60	28.17
168	DUMMY ACTIVITY	93	94	0.00	0.00	0.00	0.00
169	PURCHASE OF EQUIPMENT FOR SEED REPRODUCTION	93	95	4.30	18.60	38.70	19.57
170	COLLECTING BREEDER SEED VARIETIES	93	97	4.30	13.61	25.80	14.08
171	RENTING OR BUYING LAND FOR SEED PRODUCTION	94	95	12.90	25.80	38.70	25.80
172	BUILDING UP PRODUCTION--NEW SEED VARIETIES	95	104	38.70	53.00	73.10	53.97
173	BUILDING UP PRODUCTION--NEW SEED VARIETIES	96	104	38.70	53.00	73.10	53.97
174	BUILDING UP PRODUCTION--NEW SEED VARIETIES	97	104	38.70	53.00	73.10	53.97
175	ORGANIZING SEED PACKET PRODUCTION	98	100	4.30	23.25	51.60	24.82
176	ACQUIRING EQUIPMENT FOR EXTENSION PROGRAM	98	101	25.80	35.83	51.60	36.79
177	CONDUCTING COMMUNICATIONS CAMPAIGN	98	102	12.90	30.91	51.60	31.29
178	CONDUCTING STAFF TRAINING SESSIONS	99	103	4.30	8.60	12.90	8.60
179	INCREASING PRODUCTION CAPACITY--SEED PACKETS	100	105	4.30	15.75	21.50	14.81
180	BEGIN EXTENSION PROGRAM	101	107	0.00	0.00	0.00	0.00
181	DUMMY ACTIVITY	102	106	0.00	0.00	0.00	0.00
182	BEGIN EXTENSION PROGRAM	102	107	0.00	0.00	0.00	0.00
183	CONDUCTING FARM DEMONSTRATION PROJECT	103	106	12.90	25.80	38.70	25.80
184	DUMMY ACTIVITY	104	105	0.00	0.00	0.00	0.00
185	BEGIN EXTENSION PROGRAM	105	107	0.00	0.00	0.00	0.00
		106	107	0.00	0.00	0.00	0.00

TABLE ONE INPUT DATA AND EXPECTED TIMES FOR EACH ACTIVITY

NO.	ACTIVITY DESCRIPTION	PRED	SUC	TO	TL	TP	EXPECTED TIME
167	CONDUCTING FULL SCALE EXTENSION PROGRAM	167	168	51.60	154.80	258.00	154.80

It should be noted that both the activity descriptions and the predecessor and successor event numbers match those appearing on the flow charts of each sub-component and on the master network diagram. The flow chart of each research sub-component appears in Appendix Three while the master network diagram appears as Chart one which accompanies the report.

Having calculated the expected time for each activity the program determined the float time associated with each event. Float time indicates the amount of time an event can be delayed without affecting the completion date of the project. Float times, estimated in weeks are presented in Table Two below.

Float times provide an important source of information to the project administrative staff in evaluating and adjusting resource allocations. The greater the float time associated with an activity the greater the likelihood of shifting the resources devoted to that activity to activities on the critical path without increasing the project completion data. In most instances such shifts will result in decreasing the project completion date.

Table Three below lists those events which have float times greater than 25 weeks. Also included is a description of the events to help in identifying their location on the network diagram.

TABLE THREE: LISTING OF FLOAT TIMES IN EXCESS OF 25 WEEKS WITH EVENT DESCRIPTIONS

Project subcomponent [1]	Event No.	Description	Float Time [2]	
			Weeks	Months
PO	11	Research steering committee formed	40.1	9.3
PO	13	Koreans selected to complete Ph.D degree	185.2	43.0
PO	14	Koreans selected to attend external short courses	246.6	57.3
PO	15	Koreans complete Ph.D programs	185.2	43.0
RR	19	Staff training completed at IRRI	201.6	46.8
RR	22	New field equipment purchased	309.6	72.0
RMD	24	Collection of milling machinery	267.5	62.2
RMD	25	Collection of rice field equipment	266.0	61.8
RR	26	Final selection of improved lines-rice	95.0	22.0
RMD	27	Trials of rice milling machinery	267.5	62.2
RMD	28	Market research-rice milling machinery	440.0	102.3
RMD	29	Production facilities organized	267.5	62.2
RMD	30	Production goal reached-milling machinery	267.5	62.2
RMD	31	Rice equipment trials conducted	266.0	61.8
RMD	32	Machinery adjustment completed-rice	266.0	61.8
RMD	33	Market research completed-rice machinery	266.0	61.8
RMD	34	Production facilities organized	277.9	64.6
RMD	35	Production goal reached-rice machinery	266.0	61.8
SE	39	Information on bean production collected	563.0	124.6
SR	40	Staff training completed at U.S. universities	178.4	41.4
SE	43	Extension staff trained-soybean extension	563.0	130.9
SE	45	Extension program conducted	563.0	130.9

SR	46	Final selection of improved lines-soybean	95.0	22.0
WBR	51	Staff training completed at CIMMYT	221.7	51.5
WBR	58	Final selection of improved lines-wheat	95.0	22.0
WBR	59	Final selection of improved lines-barley	95.0	22.0
PR	60	Organization of potato research team	42.5	9.8
PR	61	International potato varieties collected	42.5	9.8
PR	62	Local potato varieties collected	68.0	15.8
PR	63	Potato breeding begun	42.5	9.8
PR	64	Final selection of improved lines - potato	42.5	9.8
RR	65	Seed testing techniques developed	308.1	71.6
PR	66	Seed storage techniques developed	559.2	130.0
MCR	67	Multiple cropping research team organized	309.6	72.0
MCR	68	Yield, cropping and land use data collected	333.5	77.5
MCR	69	Laboratory and library equipment secured	309.6	72.0
MCR	70	Farm machinery needs studied	491.1	114.2
MCR	73	Upland soils problem studied	452.2	105.1
MCR	74	Equipment to be tested acquired	486.7	113.1
MCR	75	Initial cost and yield estimates calculated	97.6	22.6
MCR	77	Soils problem area defined and tests conducted	125.3	29.1
MCR	78	Machinery selected and adqustments made	65.2	15.1
MCR	79	Economic cost and yield estimates adjusted	58.7	13.6
MCR	80	Recommendations for soil conservation made	125.3	29.1
MCR	86	Land use requirements determined	27.4	6.3
SF	88	Seed foundation planning begun	624.7	145.2
SF	89	Seed distribution needs studied	629.0	146.2
SF	90	Initial negotiations with world bank completed	624.7	145.2
SF	91	Loan portfolio developed	624.7	145.2
SF	92	Final negotiations with world bank	624.7	145.2
SF	93	Staff selected and organized	627.8	146.0
SF	94	Facilities constructed or leased	308.1	71.6
SF	95	Land bought or leased	308.1	71.6
SF	96	Equipment for seed production secured	634.1	147.4
SF	97	Breeder seed collected	218.5	50.8
SF	104	Seed production reaches required level	218.5	50.8

1/ Sub-component abreviations used are:

PO Project organization
RR Rice research team
RMD Rice machinery development
SE Soybean extension program
SR Soybean research team
WBR Wheat-barley research team
PR Potato research team
MCR Multiple cropping research tea-
SF Seed foundation

2/ The calculation of the float time in months was done by assuming a uniform number of weeks (4.3) per month.

As Table Three indicated, the largest float times occur in the Korean educational elements of the rice, soybean and wheat-barley research components, the rice machinery development unit, the extension component of the soybean research unit, the seed storage and testing elements of the potato research component, the soils and equipment development elements of the multiple cropping research unit and the elements in the seed foundation component. If the existing project as presented in the research proposal is accepted this would mean that the majority of activities which exhibit large float times will fall outside the direct control of the administrative unit. While this precludes any substantive reallocation of resource it does point to the important fact that the administrative unit does have control over resources allocated to all activities on the critical path. Further, knowledge of the float times associated with these exogenous components does provide general performance standards which must be met by external agencies carrying out the functions. Failure to comply with these time parameters may require the administrative unit to assume control over the function being performed by the external agency or to apply political pressure on the agency to bring their operation within the overall project time schedule.

A more precise analysis of Table Three points out that activities associated with the development of farm and processing equipment all have high float times. In most instances this is due to their linkage with components occurring in the latter stages of the projects. For example, completion of the activities associated with the development of rice milling machinery are required to occur just prior to the launching of the full scale extension program. If local conditions dictate that such equipment be developed to process existing varieties the float times associated with these activities under the present analysis become irrelevant. What does become important is the expected completion times associated with each activity. By employing these times with respect to rice machinery development one could expect

adequate supplies of both milling and farm machinery to appear on the market around June of 1977. Also, potato testing and storage facilities could be developed for existing varieties by September of 1976 for the former and January of 1977 for the latter.

This type of analysis could be extended to encompass the inclusion of the soybean extension program which would focus on the distribution of existing information relevant to endogenous soybean production. If such a program is deemed necessary to increase present soybean output, as is suggested in the project proposal, it could be conducted and completed by September of 1977.

It should be noted that under this method of analysis the project sub-goals associated with each of these components become project goals unto themselves. This means that each component acquires its own critical path with a resulting elimination of float times appearing in Table Two. To assure completion of the components by the dates mentioned would require either their absorption into the administrative structure of the project or a firm commitment by the external agency conducting the operation.

The float times appearing in Table Three also indicate that the organization of the potato and multiple cropping research teams may be delayed without affecting the overall completion date of the project. Under the present organizational structure both teams are designated for initiation by January of 1977. Due to the presence of float time in each of the components, the organization of the potato research team may be put off until October of 1977, while the organization of the multiple cropping research team can be delayed until January of 1983 without affecting the project completion date.

As mentioned earlier the calculation of float times provide the administrative unit with information useful in decisions concerning efficient resource allocations. Resources devoted to activities having high float times in some instance may be reallocated to activities having low float times or activities appearing on the critical path. In the case of the former reallocation would assure completion of the

activity by the latest time while the latter would in most cases cause a decreas in the project completion date. A listing of activities having relatively short float times appears below in Table Four.

TABLE FOUR: LISTING OF FLOAT TIMES LESS THAN 25 WEEKS WITH EVENT DESCRIPTION

Project subcomponent[1]	Event No.	Description	Float Time[2] Weeks	Months
PO	4	Korean administrative officer selected	22.8	5.3
PO	6	Project steering committee organized	22.5	5.2
PO	7	Administrative unit organized	17.4	4.0
PO	9	Korean staff selected and hired	17.4	4.0
RR	17	Relationship with IRRI developed	23.2	5.3
WBR	49	Relationship with CIMMYT developed	24.0	5.5
MCR	84	Machinery requirements fine tuned	7.4	1.7
EP	98	Extension program planning completed	7.2	1.6
EP	100	Seed packet production facilities operating	7.2	1.6
EP	101	Equipment for extension program secured	10.0	2.3
EP	102	Communications campaign completed	15.2	3.5
EP	105	Seed packet production at required level	7.2	1.6

[1]Subcomponent abbreviations used:

PO Project organization
RR Rice research team
WBR Wheat-barley research team
MCR Multiple cropping research team
EP Extension program

[2]Monthly float times were calculated by assuming 4.3 weeks per month

The activities associated with relatively short float time generally appear in the project organization and extension components. When compared with the results presented in Table Three there seems to be little evidence to support any resource reallocation from activities of high to low float times. This is due to the location of the low float activities at the beginning and end of the project. Reallocation of resources to these activities is impossible since they either preclude

or follow the undertaking of the high float activities. Resources organized for these latter activities have not been assembled or have been exhausted at the time when they could be used in the low float activities. The low float time associated with the extension component might suggest future indepth analysis and commitment of resource by the Korean government to the agency carry out this phase of the project.

Float times associated with the development of relationship with IRRI and CIMMYT do however suggest a strategy to be followed in developing these cooperative linkages. Under the existing project structure each of these agencies would perform two functions: 1) provide for the exchange of new lines and technological knowledge concerning these lines to the project; 2) provide the environment for upgrading project staff. When approaching these agencies the former function should be considered as a high priority item because of its crucial relationship with the crop breeding activities. The latter function because of its association with high float time activities, i.e., staff training, should be given low priority in the initial agreements. Once the exchange programs are formalized and in operation then the staff training function should be explored in depth.

The calculation of float time for each activity is an essential step in determining those activities which fall on the critical path.[2/] Activities on the critical path are presented in Table Five with specific event completion dates. This latter step was done exogenous to the computer program in an attempt to tie those events which will require close administrative supervision to actual calendar dates. Such a step is essential in organizing administrative action in line with event completion requirements.

2/ A complete listing of activities both on and off the critical path with earliest and latest time estimates appears in Appendix Four.

TABLE FIVE: CRITICAL PATH ANALYSIS WITH EVENT COMPLETION DATES

Project Subcomponent	Event No.	Description	Completion Date
PO	1	Project funding approved	Jan. 1, 1974
PO	2	Selection of a project director	June 1, 1974
PO	3	Selection of a project co-director	June 1, 1974
PO	5	Selection of an American administrative officer	Sep. 12, 1974
PO	8	Recruitment of research team leaders	Apr. 18, 1975
PO	10	Selection and hiring of American staff	Apr. 6, 1976
PO	12	Designation of research teams	May 6, 1976
RR	16	Organization of rice research team	Jan. 1, 1977
SR	36	Organization of soybean research team	Jan. 1, 1977
WBR	47	Organization of wheat research team	Jan. 1, 1977
WBR	48	Organization of barkey research team	Jan. 1, 1977
RR	18	Securing new laboratory and library equipment/rice	Aug. 21, 1977
RR	20	Beginning rice breeding	Aug. 21, 1977
SR	37	Linkages with U. S. breeders developed-soybean	Aug. 21, 1977
SR	38	Purchase of new laboratory and library equipment/ soybean	Aug. 21, 1977
SR	41	Beginning soybean breeding	Aug. 21, 1977
WBR	50	Purchase of new laboratory and library equipment/ wheat-barley	Aug. 21, 1977
WBR	52	Beginning wheat breeding	Aug. 21, 1977
WBR	53	Beginning barley breeding	Aug. 21, 1977
RR	21	Breeding and selection of lines for testing/rice	Aug. 21, 1981
SR	42	Breeding and selection of lines for testing/ soybean	Aug. 21, 1981
WBR	54	Breeding and selection of lines for testing/wheat	Aug. 21, 1981
WBR	55	Breeding and selection of lines for testing/barley	Aug. 21, 1981
RR	23	Field trials/rice	Aug. 21, 1983
SR	44	Field trials/soybean	Aug. 21, 1983
WBR	56	Field trials/wheat	Aug. 21, 1983
WBR	57	Field trials/barley	Aug. 21, 1983
MCR	71	Beginning experimental trials on cropping patterns	Aug. 21, 1982
MCR	72	Conduct experimental trials - multiple cropping	Aug. 12, 1986
MCR	76	Conduct field trials - multiple cropping	Aug. 12, 1986
MCR	81	Begin adjusted trials on new seed lines	Aug. 12, 1986
MCR	82	Adjusting field trials for new seeds	Oct. 3, 1987
MCR	83	Adjusting yield cost estimates	Feb. 1, 1988
MCR	85	Selecting optimal cropping patterns	April 3, 1988
MCR	87	Developing extension field manual	Jan. 15, 1989
EP	99	Developing rural guidance training program	Sep. 1, 1989
EP	103	Conducting staff training sessions	Nov. 1, 1989
EP	106	Conducting farm demonstration projects	Apr. 27, 1990
EP	107	Beginning extension program	Apr. 27, 1990
EP	108	Completing full-scale extension program	Apr. 27, 1993

Before discussing these results of Table Five in detail, it should be noted that the dates presented are only estimates and may vary slightly from actual completion dates due to assumptions made in their calculation. For example, initial estimates of event completion time were provided in months, not weeks. Conversion of these estimates to the weekly ones presented in the analysis was done by assuming a standard 4.3 weeks per month or 51.6 weeks per year. In addition calculations were based on the customary five-day work week experienced in the United States, not the five and one-half day work week occurring in Korea Also, legal holidays occurring in Korea were not considered in the estimates. The net result of the three assumptions is the addition of fifteen work days per year to the project. While this additional work time would not significantly alter completion dates in the earlier stages of project implementation it might cause some over-estimations in the latter stages. For example, if a ten-year period is assumed, the net effect of the three assumptions would result in the addition of approximately twenty-seven work weeks to the project or an equal decrease in event completion dates. This tendency toward over-estimation should be considered when interpreting the results.

As Table Five indicates the critical path moves from the administrative organization component, to the rice, soybean and wheat-barley research team component, through the multiple cropping research unit and on to the extension program component.

The analysis that the total projected project duration from initial funding to the completion of the extension program is 19 years, 4 months. This is almost double the ten year period which the project proposal estimates as necessary to achieve the desirable target yields. In addition, the analysis strongly indicates that the five year period covered by the five million dollar A.I.D. loan will not be sufficient to cover the termination of research activities by the five teams. Completion of these activities would occur at the end of the multiple cropping

research component and would require 15 years, 9 months.

Decreases in these times could be incorporated into the project if the experimental trials on the various cropping patterns could be conducted prior to the selection of new seed lines by the appropriate research teams. This would mean that the most promising lines would be fed directly into the multiple cropping field trials. Such an alternative was examined by adjusting the appropriate events in the network diagram. These adjustments, while not altering the critical path, did decrease the projected project completion time to 17 years, 7 months. If the project were terminated at the close of the multiple cropping research activities, as was done above, a time period of 13 years, 2 months would be involved. Again, both time periods exceed the recommended ten and five year periods outlined in the project proposal.

The make-up of the project as presently formulated does not exclude further structural modifications. However, it is felt that modification that might be attempted would only cause rather minor decreases in the necessary time period. The presence of an extended planning horizon as indicated by the analysis, points to the necessity of administrative action in a number of areas. For example, the administrative staff may feel it necessary to: 1) adjust the AID and Korean cash flows to reflect the longer project period; 2) reevaluate the goals and priorities of the various project components to bring them more in line with the project target dates as suggested in the proposal; and/or 3) reevaluate the net benefit streams associated with various project components to reflect changing market and institutional conditions within a twenty rather than ten year planning horizon. While these are important considerations which require further investigation, they do not fall within the scope of this analysis and should be taken up by the project administrative staff at a later date.

SUMMARY AND CONCLUSIONS

The preceding analysis was undertaken to provide the project administrative staff of the Korean Crop Breeding Project with information pertinent to the planning, scheduling, controlling and evaluation of research activities necessary in attaining program goals stated in the project proposal. Inputs used in the analysis included events or activities expressly mentioned or implied in the project proposal and estimates of activity completion times provided by specialists at Michigan State University and the World Bank. Outputs resulting from the analysis include a network diagram graphically displaying the interrelationships existing between the various project components, an analysis of the float time associated with each project activity and a designation of those activities deemed critical to the completion of the project.

The network diagram indicates that any long-term project planning effort initiated by the administrative staff will necessitate the initiation and development of the following cooperative relationships between the staff and certain public or private organizations;

1. Relationships with the College of Agriculture, Seigon National University and the Office of Rural Development (crop experiment stations) should be continued and strengthened to assure the efficient operation and staffing of the various research units.

2. Relationships with IRRI, CIMMYT, international potato research organizations and U. S. universities involved in soybean research should be developed where they do not exist and strengthen where they presently exist. This will facilitate the transfer of new lines to be tested by the various project research units and provide opportunities for the upgrading of Korean staff.

3. Relationships with privately owned farm machinery and rice processing equipment manufacturers should be developed to assure the availability of the appropriate equipment in sufficient quantities to handle production of the new seed varieties. In addition, liaison between the administrative staff and the National Agricultural Cooperative Federation should be encouraged to assure the appropriate distribution points for both machinery and other production inputs necessitated by the new varieties.

4. Liaison with the rural guidance component of the Office of Rural Development should be encouraged in the latter phase of the research project to facilitate the planning and implementation of an extension program devoted to the introduction of the new crops to the Korean farmer.

5. A relationship with the Seed Foundation should be encouraged to assist them in the planning and development of their facilities to coincide with the development of new lines by each of the research units.

The analysis of the float time associated with each of the project activities provide an important source of information to the project administrative staff in their evaluation of resource allocations. The analysis has generated the following information and recommendations:

1. Activities with relatively high float times occur in the Korean educational elements of the rice, soybean and wheat-barley research components, the rice machinery development components, the extension component of the soybean research unit, the seed storage and testing elements of the potato research component, the soils and equipment elements of the multiple cropping research unit and the elements of the seed foundation component.

2. Because most of the components listed in one fall outside the direct control of the administrative unit, resource reallocation is severely limited from these components to those on or near the critical path. These float times, however, do provide the administrative staff with performance standards which must be met by the external agencies.

3. Analysis of the float times does indicate that all activities crucial to the completion of the project do fall under the direct control of the project administrative staff.

4. Analysis appears to indicate that the initiation of the potato research team may be delayed until October, 1977 while the multiple cropping research team may be organized as late as January, 1983. If adjustments are made in the research structure to provide for the introduction of promising new lines directly into the multiple cropping field trials (thus bypassing the experimental trials) organization of the multiple cropping team would have to occur no later than February, 1981. Such adjustments delay the initiation of the potato research component until January, 1979.

5. Low float times generally are associated with activities in the administrative organization and extension program components. Resources devoted to high float time activities dealing with the selection and processing of Korean staff eligible for additional training should be shifted to the low float time activities in this component. In addition the administrative staff should make a substantial effort to build up a strong relationship with the rural guidance component of the Rural Development Office to assist them in planning their extension programs so that they can be accomplished within the rather restricted time constraints indicated in the analysis. The early soybean extension program may be the vehicle used in building this rapport.

6. Because of the high float times associated with Korean staff training activities, negotiation with international agencies such as IRRI and CIMMYT should initially emphasize the formalization of ties to facilitate the transfer of new varieties. Once this is accomplished negotiations may be undertaken to facilitate further staff training.

By combining information contained in the network diagram with the calculation of float times for each event, the program is able to generate a critical path. As was mentioned, events falling on this path must be completed by the date specified or delays in the overall project completion date will occur. The results of this stage of the analysis indicate that;

1. The critical path flows from the project administrative component, to the rice, soybean and wheat-barley research units, on to the multiple cropping research component and finally through the extension component to the completion of the full-scale extension program.

2. Target dates dealing with projected yield increases and termination of research activities are highly underestimated. The analysis indicates that to accomplish the increased yields recommend a period of 19 years, 4 months is required rather than the ten year period stated. Under this analysis, termination of research activities would occur within a 15 year, 9 month period not the five year period sighted. Adjustments in the structure of the project dropped these time periods down to 17 years 7 months and 13 years, 2 months respectively. It was felt that further modifications, while possible, would not significantly de-escalate these time periods.

3. Because of the results summarized in two, it will be necessary for the project administrative staff to;

   a. adjust the A.I.D. and Korean cash flows to reflect the longer project period, and/or

   b. reevaluate the goals and priorities of the various project components to bring them more in line with the project target dates as suggested in the proposal, and/or

   c. reevaluate the net benefit streams associated with the various project components to reflect changing market and institutional conditions within a twenty rather than ten year period.

APPENDIX 1

Listing of Specialists Consulted on the Project

Specialists were consulted to provide information necessary in constructing a network diagram of the project and in determining estimates of expected project completion times for each event. A listing of those consulted with their area of specialization and institutional affiliation is listed below;

Dr. Glen Johnson	Professor, Department of Agricultural Economics, M.S.U., and Director, Korean Agricultural Sector Team	Administrative organization
Dr. Merle Esmay	Professor, Department of Agricultural Engineering, M.S.U.	Machinery development
Dr. Erving Wyeth	Director, Institute for International Agriculture, M.S.U.	Extension program
Dr. J. Price Gittinger	Economic Development Institute, International Bank for Reconstruction and Development	Seed foundation
Dr. Milo Tesar	Professor, Department of Crop and Soil Science, M.S.U.	Rice, soybean and wheat-barley research
Dr. Norman R. Thompson	Professor, Department of Crop and Soil Science, M.S.U.	Potato research
Dr. Ray Cook	Professor and Chairman Emeritus, Department of Crop and Soil Science, M.S.U.	Multiple cropping research

APPENDIX 2

Computer Program and Input Format

```
C
C     PROGRAM CRIT IS DESIGNED TO DETERMINE THE CRITICAL ACTIVITY PATH
C     REQUIRED TO COMPLETE A GIVEN PROJECT. THE CRIT PROGRAM IS BEING USED
C     TO DETERMINE THE CRITICAL PATH OF A CROP IMPROVEMENT LOAN PROJECT IN
C     KOREA.
C
C       PROGRAM NAME--KOREAN CROP IMPROVEMENT AID LOAN PROJECT
C
C       PROGRAM USER--MARTIN HANRATTY
C                     DEPARTMENT OF RESOURCE DEVELOPMENT
C                     MICHIGAN STATE UNIVERSITY
C
C       FOR FUTURE USE OF THE CRIT PROGRAM--
C                     REFER TO FILE--HANRATTY--AEC 952
C                     OFFICE 331E NATURAL RESOURCES BLDG.
C                     MICHIGAN STATE UNIVERSITY
C                     EAST LANSING, MI.  48824
C
      PROGRAM CRIT  (INPUT,OUTPUT,TAPE61=INPUT,TAPE62=OUTPUT)                  A    2
C     COPYRIGHT JUNE 1968 BY D HARRIS                                          COC  3
      THIS VERSION FOR CDC 3100                                                A    4
      DIMENSION N(125), E(125), L(125), P(375), S(375), T(375), R(375),        A    5
     1LAG(125), TO(375), TL(375), TP(375), CP(125), KL(125), A(375,5)          A    6
      DIMENSION ALPHA(10)                                                      A    7
      COMMON N, M1                                                             A    8
      REAL M, L, LAG                                                           A    9
      INTEGER S, R, P, CP                                                      A   10
C     REMARK -- N(I) IS THE NUMBER OF EVENT I                                  A   11
C     REMARK -- P(I) IS THE EVENT PRECEDING ACTIVITY I                         A   12
C     REMARK -- S(I) IS THE EVENT SUCCEEDING ACTIVITY I                        A   13
C     REMARK -- R(I) IS THE NUMBER OF THE I*TH-RANKED ACTIVITY                 A   14
C     REMARK -- E(I) IS THE EARLIEST TIME FOR EVENT I                          A   15
C     REMARK -- L(I) IS THE LATEST TIME FOR EVENT I                            A   16
C     REMARK -- M IS THE MINIMUM TIME TO COMPLETE THE PROJECT                  A   17
C     REMARK -- T(I) IS THE EFFECTIVE TIME TO COMPLETE ACTIVITY I.             A   18
C     REMARK -- TP(I) IS THE PESSIMISTIC TIME TO COMPLETE ACTIVITY I.          A   19
C     REMARK -- TL(I) IS THE LIKELY TIME TO COMPLETE ACTIVITY I.               A   20
C     REMARK -- TO(I) IS THE OPTIMISTIC TIME TO COMPLETE ACTIVITY I.           A   21
C     REMARK -- LAG(I) IS THE FLOAT TIME ASSOCIATED WITH EVENT I               A   22
C     REMARK -- N1 IS THE NUMBER OF EVENTS                                     A   23
C     REMARK -- N2 IS THE NUMBER OF ACTIVITIES                                 A   24
C     REMARK -- N4 IS THE NUMBER OF EVENTS ON THE CRITICAL PATH                A   25
      MT = 61                                                                  COC 26
      MO = 62                                                                  COC 27
C     INITIALIZE                                                               A   28
    1 READ (MT,96) ALPHA
      WRITE(MO,97)
      WRITE(MO,97) ALPHA
      DO 2 I=1,125                                                             A   30
      N(I) = 0                                                                 A   31
      E(I) = 0.                                                                A   32
      L(I) = 0.                                                                A   33
      LAG(I) = 0.                                                              A   34
      KL(I) = 0                                                                A   35
    2 CP(I) = 0                                                                A   36
      DO 3 I=1,375                                                             A   37
      P(I) = 0                                                                 A   38
      S(I) = 0                                                                 A   39
      T(I) = 0.                                                                A   40
      TO(I) = 0.                                                               A   41
      TL(I) = 0.                                                               A   42
    3 TP(I) = 0.                                                               A   43
      JFLG = 0                                                                 A   44
C     READ ACTIVITIES                                                          A   45
      DO 4 I = 1,375                                                           A   46
      READ (MT,48) P(I), S(I), TO(I), TL(I), TP(I), (A(I,J),J=1,5)             A   47
      N2 = I-1                                                                 A   48
      IF(P(I).EQ.0) GO TO 5
    4 CONTINUE                                                                 A   50
      PRINT 100
  100 FORMAT(' STATEMENT 4 PASS THRU.')
C     CALCULATE EVENT LIST
    5 N1 = 1                                                                   A   51
      DO 9 I = 1, N2                                                           A   52
      DO 5 J = 1, N1                                                           A   53
      IF (P(I) .EQ. N(J)) GO TO 7                                              A   54
    6 CONTINUE                                                                 A   55
      N1 = N1+1                                                                A   56
                                                                               A   57
```

```
      N(N1) = P(I)                                                      A  58
   7  DO 8 J = 1, N1                                                    A  59
      IF (S(I) .EQ. N(J)) GO TO 9                                       A  60
   8  CONTINUE                                                          A  61
      N1 = N1+1                                                         A  62
      N(N1) = S(I)                                                      A  63
   9  CONTINUE                                                          A  64
C     CALCULATE EXPECTED TIME                                           A  65
      IF (JFLG-1) 17,15,17                                              A  66
  15  DO 16 J = 1, N2                                                   A  67
  16  T(J) = TO(J)                                                      A  68
  17  DO 18 JJ = 1, N2                                                  A  69
  18  T(JJ) = (TO(JJ)+4*TL(JJ)+TP(JJ))/6                                A  70
C     PRINT ACTIVITIES INPUT AND EXPECTED TIMES FOR EACH ACTIVITY       A  71
      WRITE (MO,57)                                                     A  72
      WRITE (MO,51)                                                     A  73
      WRITE (MO,58)                                                     A  74
      WRITE (MO,59)                                                     A  75
      KKK=9                                                             A  76
      DO 14 I = 1, N2                                                   A  77
      IF(KKK.LT.60) GO TO 999                                           A  78
      KKK=1                                                             A  79
      WRITE (MO,57)                                                     A  80
      WRITE (MO,51)                                                     A  81
      WRITE (MO,58)                                                     A  82
      WRITE (MO,59)                                                     A  83
 999  IF (TO(I)-TL(I)) 11,11,10                                         A  84
  10  WRITE (MO,53) I, (A(I,J),J=1,5), P(I), S(I), TO(I), TL(I), TP(I),
     1T(I)                                                              A  85
      KKK=KKK+1                                                         A  86
      GO TO 14                                                          A  87
  11  IF (TL(I)-TP(I)) 13,13,12                                         A  88
  12  WRITE (MO,54) I, (A(I,J),J=1,5), P(I), S(I), TO(I), TL(I), TP(I),
     1T(I)                                                              A  89
      KKK=KKK+1                                                         A  90
      GO TO 14                                                          A  91
  13  WRITE (MO,55) I, (A(I,J),J=1,5), P(I), S(I), TO(I), TL(I), TP(I),
     1T(I)                                                              A  92
      KKK=KKK+1                                                         A  93
  14  CONTINUE                                                          A  94
C     RANK ACTIVITIES ON ASCENDING PREDECESSOR NUMBER                   A  95
      DO 21 I = 1, N2                                                   A  96
  21  P(I) = I                                                          A  97
      N9 = N2                                                           A  98
  22  N9 = N9-1                                                         A  99
      NA = 0                                                            A 100
      DO 24 I = 1, N9                                                   A 101
      KP = P(I)                                                         A 102
      KP1 = P(I+1)                                                      A 103
      IF (P(KP)-P(KP1)) 24,24,23                                        A 104
  23  P1 = P(I)                                                         A 105
      P(I) = P(I+1)                                                     A 106
      P(I+1) = P1                                                       A 107
      NA = 1                                                            A 108
  24  CONTINUE                                                          A 109
      IF (NA-1) 25,22,25                                                A 110
C     FIND EARLY EVENT TIMES                                            A 111
  25  DO 27 I = 1, N2                                                   A 112
      KP = P(I)                                                         A 113
      N3 = P(KP)                                                        A 114
      CALL INT (N3, K)                                                  A 115
      I1 = K                                                            A 116
      KP = R(I)                                                         A 117
      N3 = S(KP)                                                        A 118
      CALL INT (N3, K)                                                  A 119
      I2 = K                                                            A 120
      KP = P(I)                                                         A 121
      A = E(I1)+T(KP)                                                   A 122
      IF (E(I2)-A) 26,27,27                                             A 123
  26  E(I2) = E(I1)+T(KP)                                               A 124
  27  CONTINUE                                                          A 125
C     RANK ACTIVITIES IN DESCENDING ORDER OF SUCCESSOR                  A 126
      DO 29 I = 1, N2                                                   A 127
  28  R(I) = I                                                          A 128
      N9 = N2                                                           A 129
  29  N9 = N9-1                                                         A 130
      NA = 0
```

```
                      DO 31 I = 1, N3                                          A 131
                      KP = S(I)                                                A 132
                      KP1 = S(I+1)                                             A 133
 160                  IF (S(KP)-S(KP1)) 30,31,31                               A 134
                30    R1 = S(I)                                                A 135
                      S(I) = S(I+1)                                            A 136
                      S(I+1) = R1                                              A 137
                      N8 = 1                                                   A 138
 165            31    CONTINUE                                                 A 139
                      IF (N8-1) 32,29,32                                       A 140
                C     FIND LATE EVENT TIMES                                    A 141
                32    DO 34 I = 1, N2                                          A 142
                      KP = S(I)                                                A 143
 170                  N3 = S(KP)                                               A 144
                      CALL INT (N3, K)                                         A 145
                      I1 = K                                                   A 146
                      KP = S(I)                                                A 147
                      N3 = S(KP)                                               A 148
 175                  CALL INT (N3, K)                                         A 149
                      I2 = K                                                   A 150
                      KP = S(I)                                                A 151
                      T = L(I1)+T(KP)                                          A 152
                      IF (L(I2)-T) 33,34,34                                    A 153
 180            33    KP = S(I)                                                A 154
                      L(I2) = L(I1)+T(KP)                                      A 155
                34    CONTINUE                                                 A 156
                      KP = S(I)                                                A 157
                      N3 = S(KP)                                               A 158
 185                  CALL INT (N3, K)                                         A 159
                      K = S(K)                                                 A 160
                      DO 35 I = 1, N1                                          A 161
                35    L(I) = K-L(I)                                            A 162
                C     CALCULATE FLOAT (LAG)                                    A 163
 190                  DO 36 I = 1, N1                                          A 164
                36    LAG(I) = L(I)-E(I)                                       A 165
                C     PRINT EVENT TIMES                                        A 166
                      WRITE (MO,67)                                            A 167
                      WRITE (MO,68)
 195                  WRITE (MO,69)                                            A 167
                      WRITE (MO,69)                                            A 168
                      KKK=1                                                    A 169
                      DO 37 I = 1, N1
                      IF (KKK.LT.52) GO TO 970
 200                  KKK=1                                                    A 170
                      WRITE (MO,67)                                            A 171
                      WRITE (MO,68)                                            A 172
                      WRITE(MO,69)                                             A 173
                      WRITE (MO,69)                                            A 174
 205            970   WRITE (MO,61) N(I), E(I), L(I), LAG(I)                   A 175
                      KKK=KKK+1                                                A 176
                37    CONTINUE                                                 A 177
                C     DERIVE THE CRITICAL PATH                                 A 178
                      K = 1                                                    A 179
 210                  DO 39 I = 1, N1                                          A 180
                      IF (ABS(LAG(I))-0.001) 38,39,39                          A 181
                38    LAG(I) = 0.0                                             A 182
                      CP(K) = N(I)                                             A 183
                      KL(K) = L(I)                                             A 184
 215                  N4 = K                                                   A 185
                      K = K+1                                                  A 186
                39    CONTINUE                                                 A 187
                      N5 = N4-1                                                A 188
                      DO 42 I = 1, N5                                          A 189
 220                  I1 = I+1                                                 A 190
                      DO 42 J = I1, N4                                         A 191
                      IF (KL(I)-KL(J)) 42,43,41                                A 192
                40    IF (CP(I)-CP(J)) 42,42,41                                A 193
                41    ITEMP = KL(I)                                            A 194
 225                  JTEMP = CP(I)                                            A 195
                      KL(I) = KL(J)                                            A 196
                      CP(I) = CP(J)                                            A 197
                      KL(J) = ITEMP                                            A 198
                      CP(J) = JTEMP                                            A 199
 230            42    CONTINUE                                                 A 200
                C     PRINT ACTIVITY TIMES                                     A 201
                      WRITE (MO,67)                                            A 202
                      WRITE (MO,69)                                            A 203
                      WRITE(MO,64)                                             A 204
```

```
      WRITE (60,64)                                                     A 198
      KKK=1                                                             A 199
      DO 45 I = 1, N2
      IF(KKK.LT.52) GO TO 960
      KKK=0
      WRITE (60,67)
      WRITE (60,59)
      WRITE(60,54)
      WRITE (60,64)
  960 N3 = P(I)
      CALL INT (N3, K)                                                  A 200
      T1 = K                                                            A 201
      N3 = S(I)                                                         A 202
      CALL INT (N3, K)                                                  A 203
      I2 = K                                                            A 204
      D = L(I2)-E(I1)                                                   A 205
      IF (ABS(T(I)-D)-.000001) 44,43,43                                 A 206
   43 WRITE (60,65) P(I), S(I), (A(I,J),J=1,5), T(I), D                 A 207
      KKK=KKK+1                                                         A 208
      GO TO 45                                                          A 209
   44 WRITE (60,66) P(I), S(I), (A(I,J),J=1,5), T(I), D                 A 210
      KKK=KKK+1                                                         A 211
   45 CONTINUE                                                          A 212
C     RETURN FOR NEXT SET OF DATA                                       A 213
      GO TO 1                                                           A 214
C                                                                       A 215
C                                                                       A 216
C                                                                       A 217
   46 FORMAT    (11A7)                                                  A 218
   47 FORMAT    (14H1PROGRAM CRIT  ,11A7,//)                            A 219
   48 FORMAT    (2I3,3F7.2,3X,4A10,A8)                                  A 220
   51 FORMAT    (* TABLE ONE     INPUT DATA AND EXPECTED TIMES FOR EACH AC  A 223
     1TIVITY*)
   52 FORMAT    (1H0* NO.              ACTIVITY DISCRIPTION              A 224
     1     PRED     SUC      ID      TL      TP      EXPECTED TIME*,/)  A 224
   53 FORMAT    (1H ,I3,3X,4A10,A8,2I7,F8.2,2F7.2,8X,F8.2)              A 225
   54 FORMAT    (1H ,I3,3X,4A10,A8,2I7,F8.2,2F7.2,8X,F8.2)              A 226
   55 FORMAT    (1H ,I3,3X,4A10,A8,2I7,F8.2,2F7.2,8X,F8.2)              A 227
   59 FORMAT    (* TABLE TWO     LIST OF FLOAT TIME BY ACTIVITY*)       A 231
   60 FORMAT    (1H0* EVENT     EARLIEST TIME     LATEST TIME       FLOAT  A 232
     1*,/)
   61 FORMAT    (1H ,I4,4X,F10.2,8X,F10.2,5X,F10.2)                     A 233
   64 FORMAT    (1H0* PREDECESSOR  SUCCESSOP                ACTIVITY DI  A 236
     1SCRIPTION          ACTUAL TIME  MAXIMUM TIME*,/)                  A 236
   65 FORMAT    (1H ,4X,I3,9X,I3,6X,4A10,A8,F9.2,F13.2)                 A 237
   66 FORMAT    (1H ,4X,I3,9X,I3,6X,4A10,A8,F9.2,F13.2,5X,13HCRITICAL PAT  A 238
     1H)                                                                A 238
   67 FORMAT    (1H1,//)                                                A 239
   68 FORMAT    (1H0,//)                                                A 240
   69 FORMAT    (* TABLE FIVE     LISTING OF THE ACTUAL AND MAXIMUM COMPL  A 241
     1ETION TIMES FOR EACH ACTIVITY*,/,15X,* AND THE DESIGNATION OF ACTI  A 241
     2VITIES ON THE CRITICAL PATH*)                                     A 241
      END                                                               A 242-
```

```
                      SUBROUTINE INT (N3, K)                                    A   1
                      COMMON N, N1                                              A   2
                      DIMENSION N(125)                                          A   3
                C     FIND INTERNAL NUMBER ,K, OF EVENT N3.                     A   4
     5                DO 1 J = 1, N1                                            B   5
                      K = J                                                     B   6
                      IF (N(K)-N3) 1,2,1                                        B   7
                 1    CONTINUE                                                  B   8
                      PRINT 3, N3                                               B   9
     8                STOP                                                      B  10
                 2    RETURN                                                    B  11
                C                                                               A  12
                C                                                               A  13
                C                                                               A  14
    15          C                                                               A  15
                 3    FORMAT     (///,19H NO EVENT NUMBER   ,I3)                A  16
                      END                                                       A  17-
```

```
CORE MAP .19.23.52.  NORMAL                CONTROL                                  000100    026203    026005    000176
---+TYPE---LOAD MODE --L1--L2-----TYPE----------USER---+++---CALL----------FWA LOAD--LWA LOAD--BLNK COMN--LENGTH--
FWA LOADER  040700  FWA TABLES  036734
-PROGRAM----ADDRESS-                    --LABELED---COMMON----ADDRESS-
COIT        000100
INT         017475
GETBA       017512
STOP        017551
SYSTEM$     021237                                EXECMSG     021237
                                                  CONECIO     021237
INPUT0$     022362
KODE2$      022510
KEAKE0$     024134
OUTPUT$     025711
-----------END OF MAP---
```

STATEMENT NO. | CONT. | **FORTRAN CODING FORM** (O-5430)

PROGRAM: | NAME: | IDENTIFICATION NUMBER

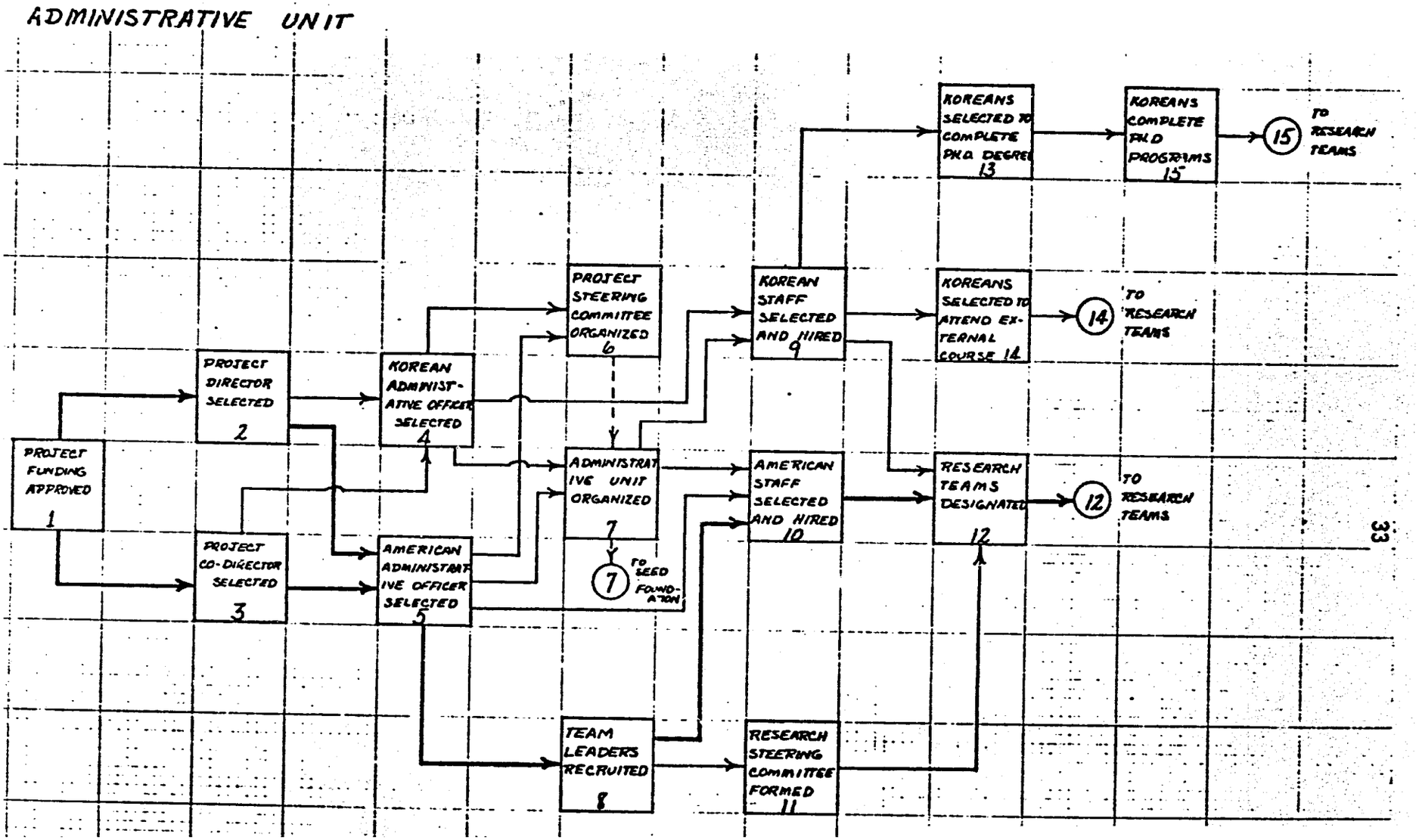
PAGE: | DATE:

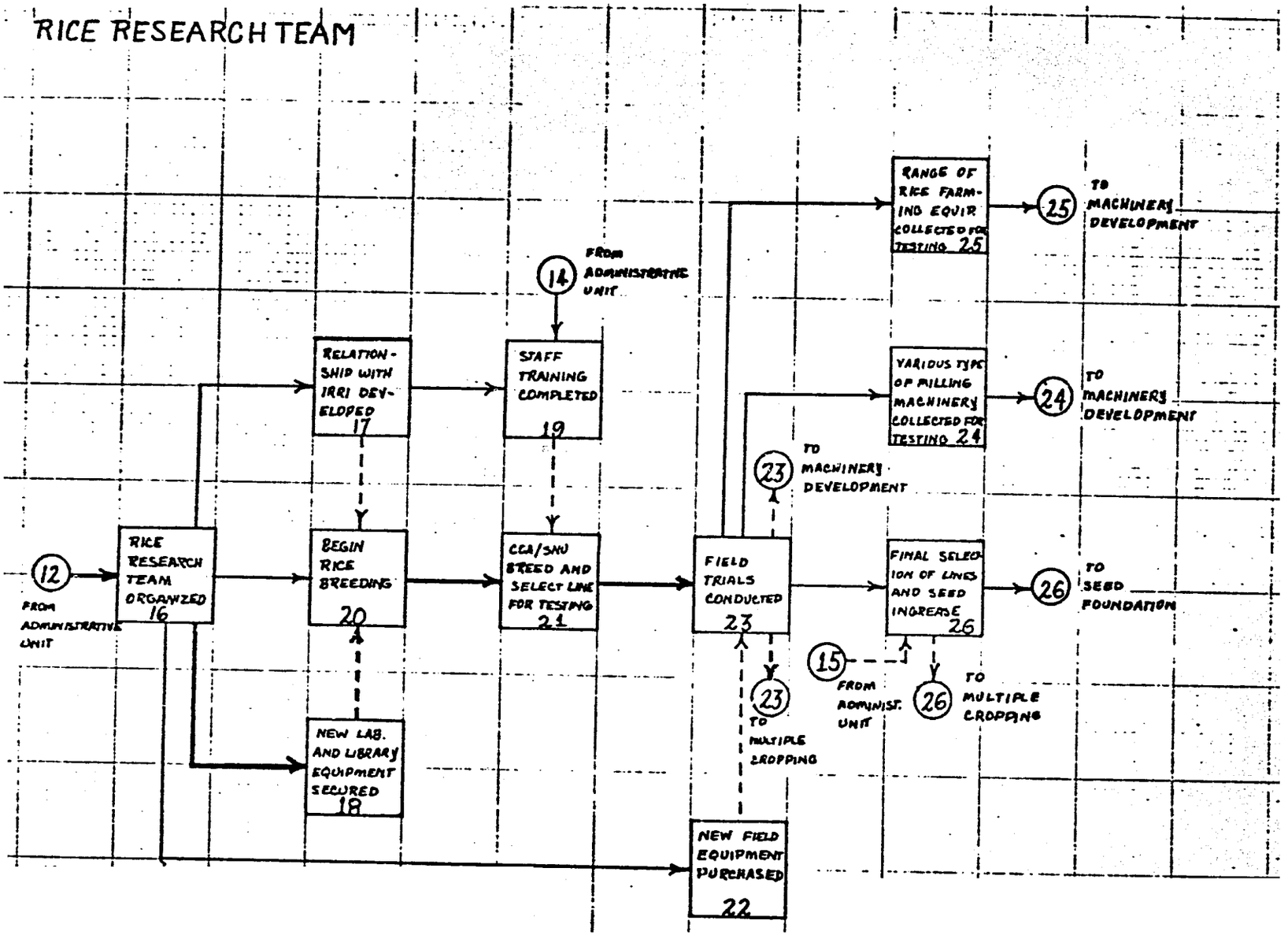
INPUT FORMAT

2 3	4 5 6	7 8 9 10 11 12 13	14 15 16 17 18 19 20	21 22 23 24 25 26 27	28 29 30	31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72	73 74 75 76 77 78 79 80
PREDECESSOR EVENT NUMBER	SUCCESSOR EVENT NUMBER	OPTIMISTIC TIME ESTIMATE	MOST LIKELY TIME ESTIMATE	PESSIMISTIC TIME ESTIMATE	BLANK	EVENT DISCRIPTION	

APPENDIX 3

Flow Charts of Project Components


ADMINISTRATIVE UNIT
PROJECT FUNDING APPROVED 1
PROJECT DIRECTOR SELECTED 2
PROJECT CO-DIRECTOR SELECTED 3
KOREAN ADMINISTRATIVE OFFICER SELECTED 4
AMERICAN ADMINISTRATIVE OFFICER SELECTED 5
PROJECT STEERING COMMITTEE ORGANIZED 6
ADMINISTRATIVE UNIT ORGANIZED 7
7 TO SEED FOUNDATION
TEAM LEADERS RECRUITED 8
KOREAN STAFF SELECTED AND HIRED 9
AMERICAN STAFF SELECTED AND HIRED 10
RESEARCH STEERING COMMITTEE FORMED 11
KOREANS SELECTED TO COMPLETE PH.D. DEGREE 13
KOREANS SELECTED TO ATTEND EXTERNAL COURSE 14
RESEARCH TEAMS DESIGNATED 12
KOREANS COMPLETE FIELD PROGRAMS 15
15 TO RESEARCH TEAMS
14 TO RESEARCH TEAMS
12 TO RESEARCH TEAMS


RICE RESEARCH TEAM
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(23)
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(23)
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(25)
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VARIOUS TYPE OF MILLING MACHINERY COLLECTED FOR TESTING 24
(24)
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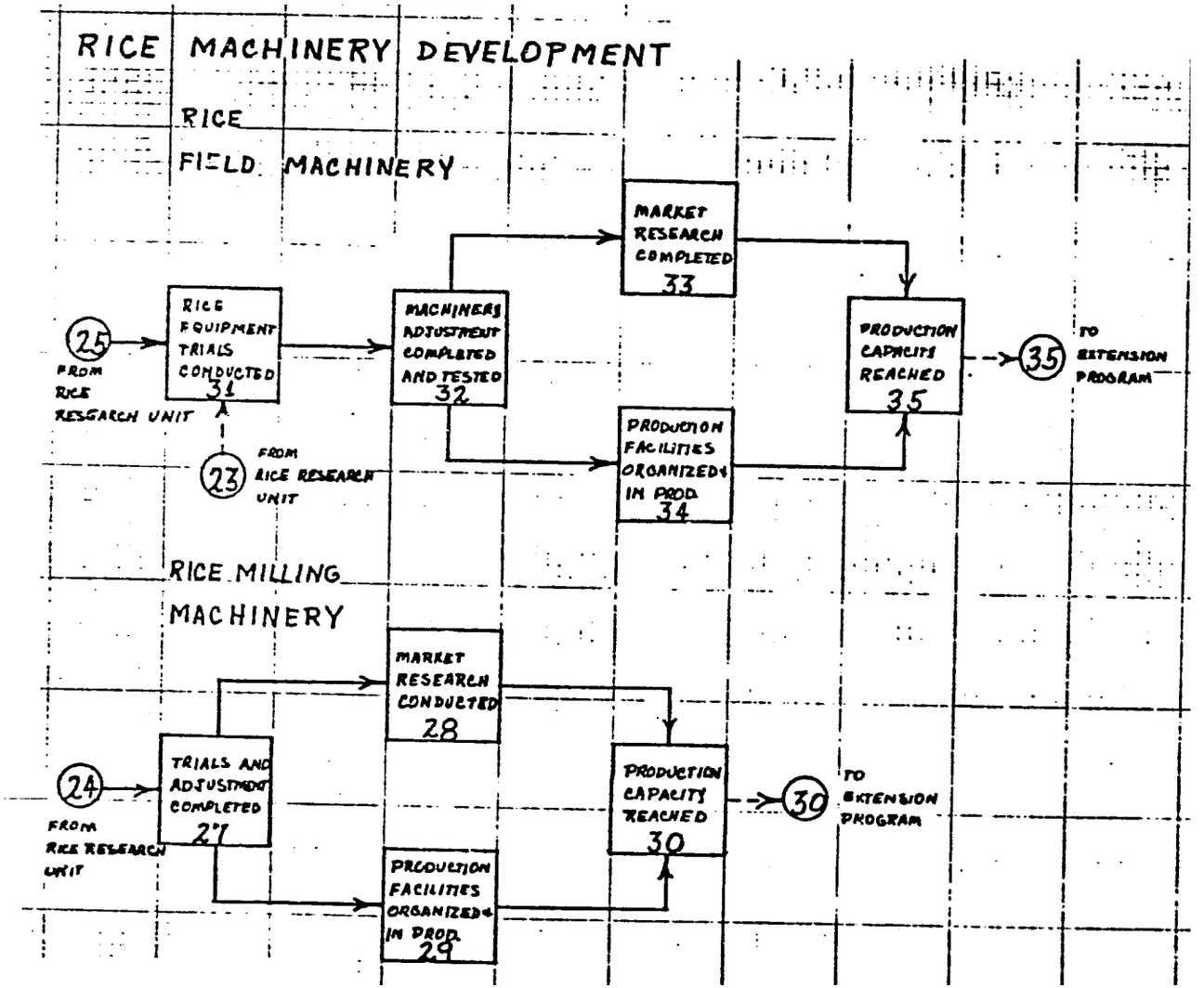
FINAL SELECT-ION OF LINES AND SEED INCREASE 26
(26)
TO SEED FOUNDATION
(15)
FROM ADMINIST. UNIT
(26)
TO MULTIPLE CROPPING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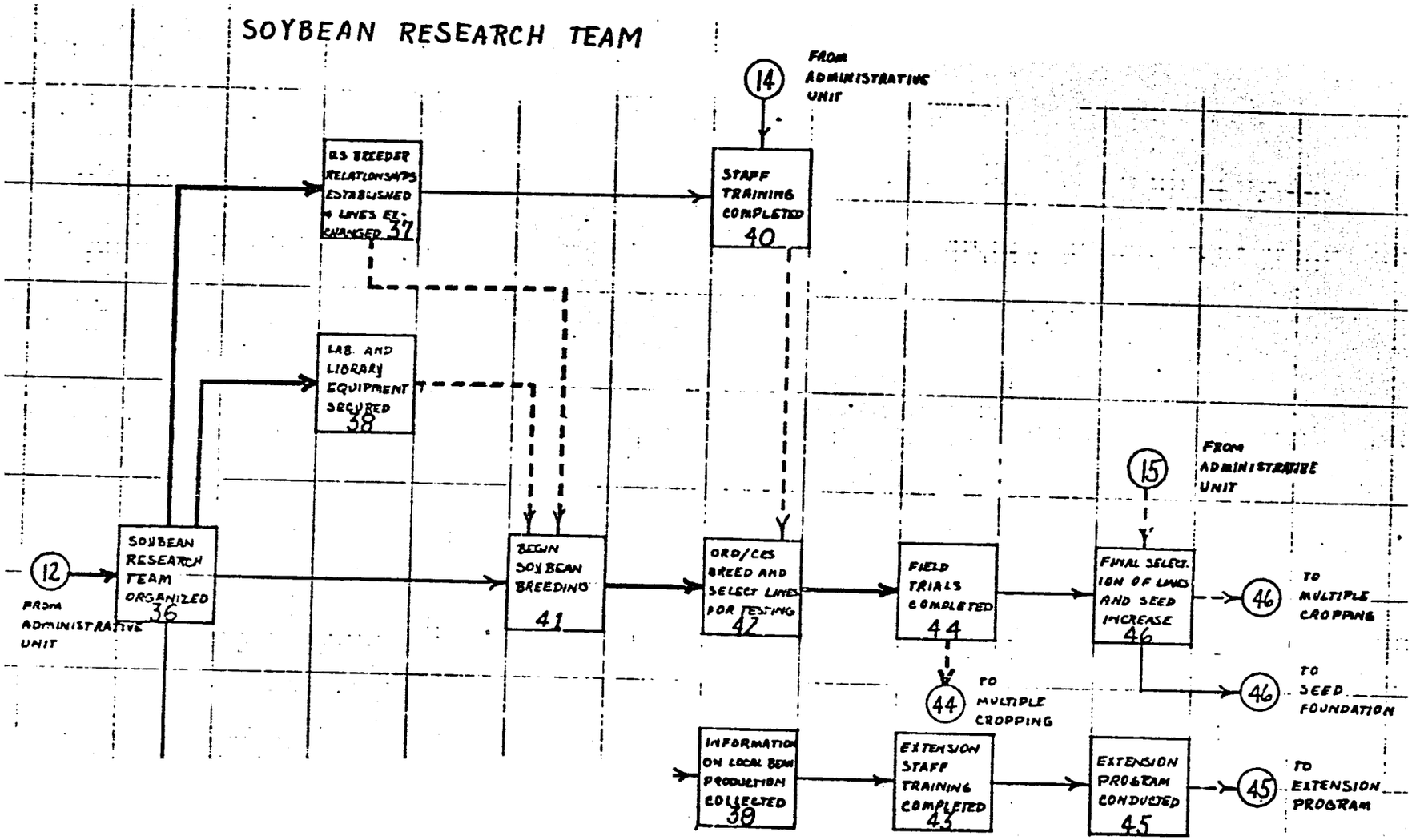
30 TO EXTENSION PROGRAM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12
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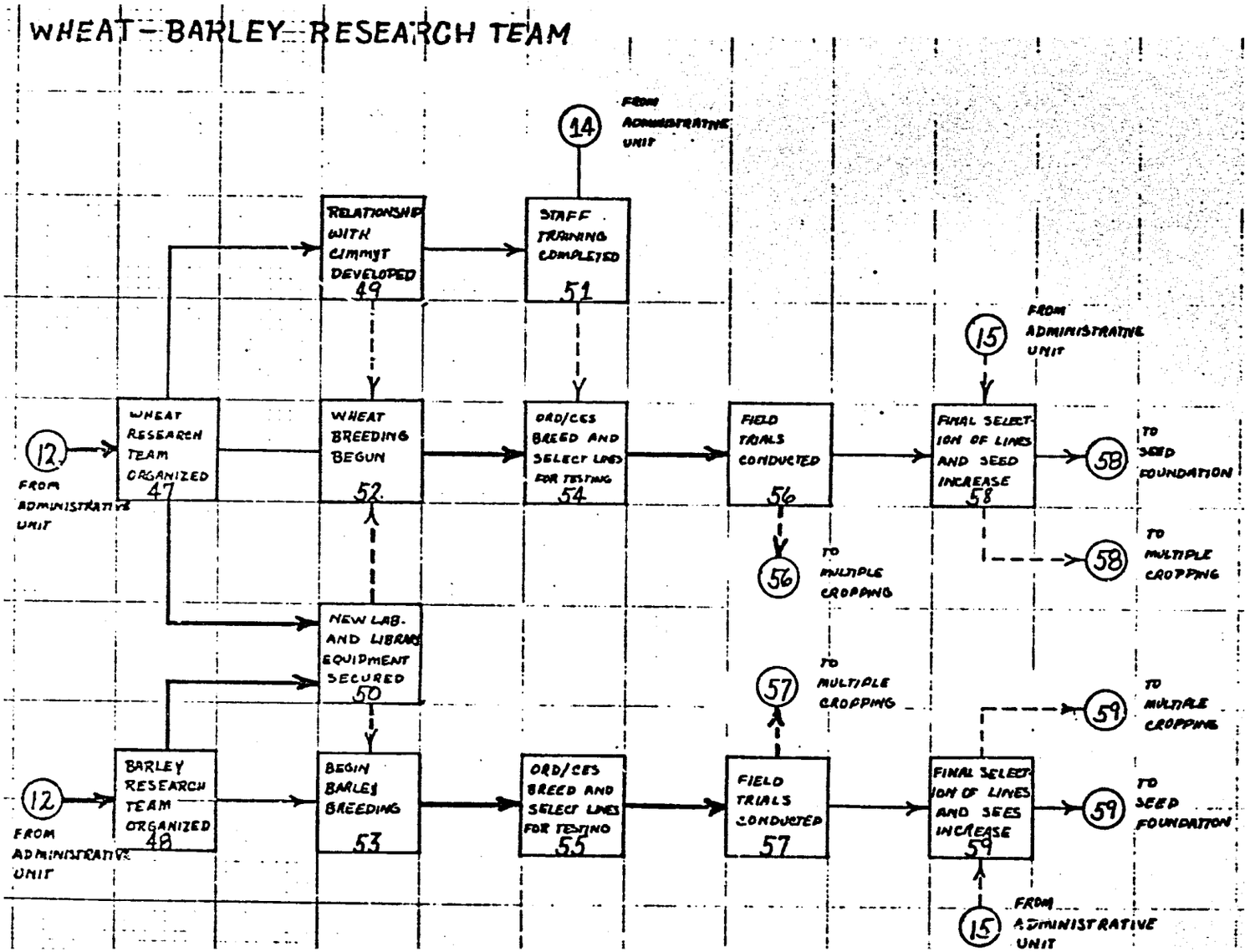
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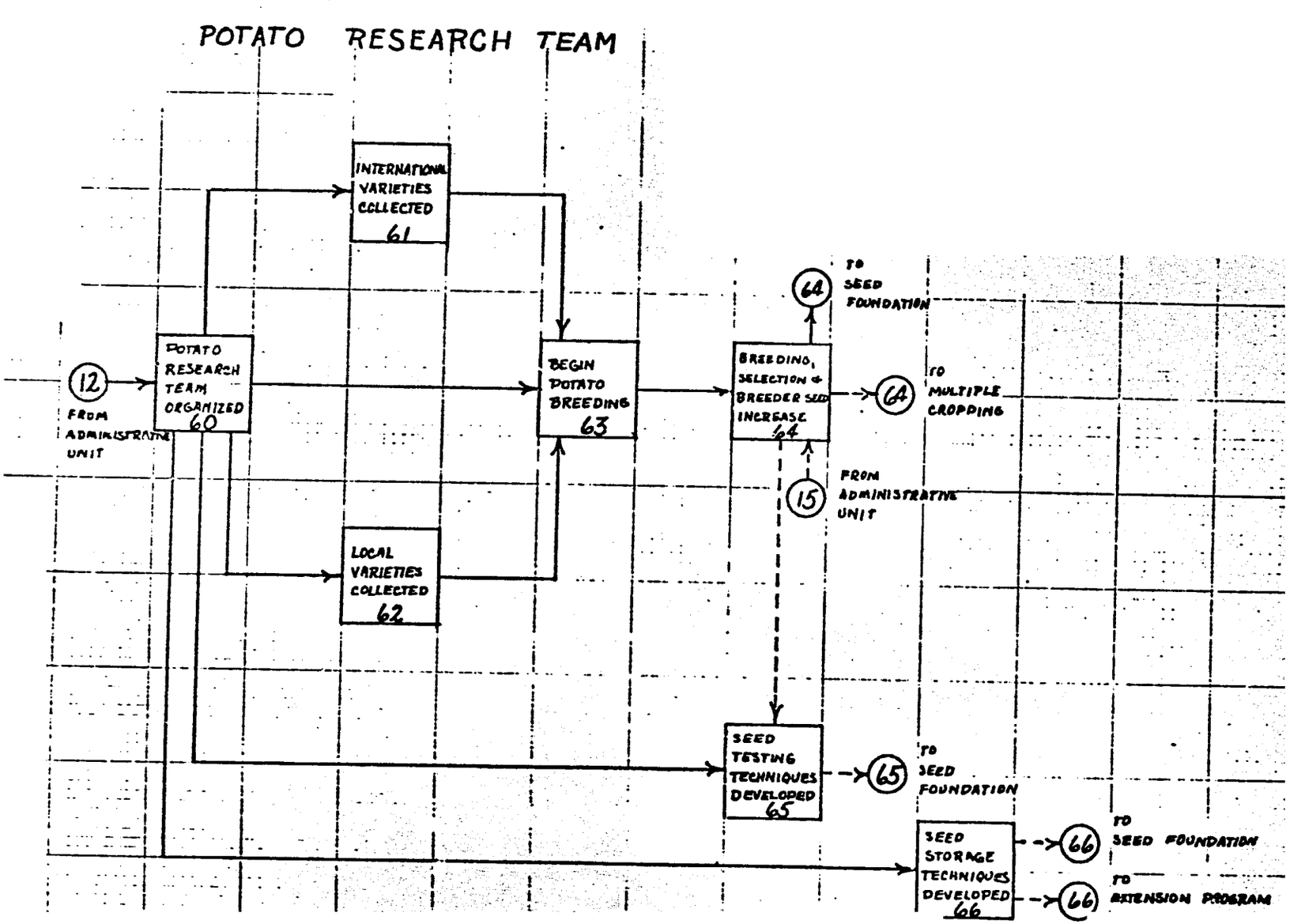
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66
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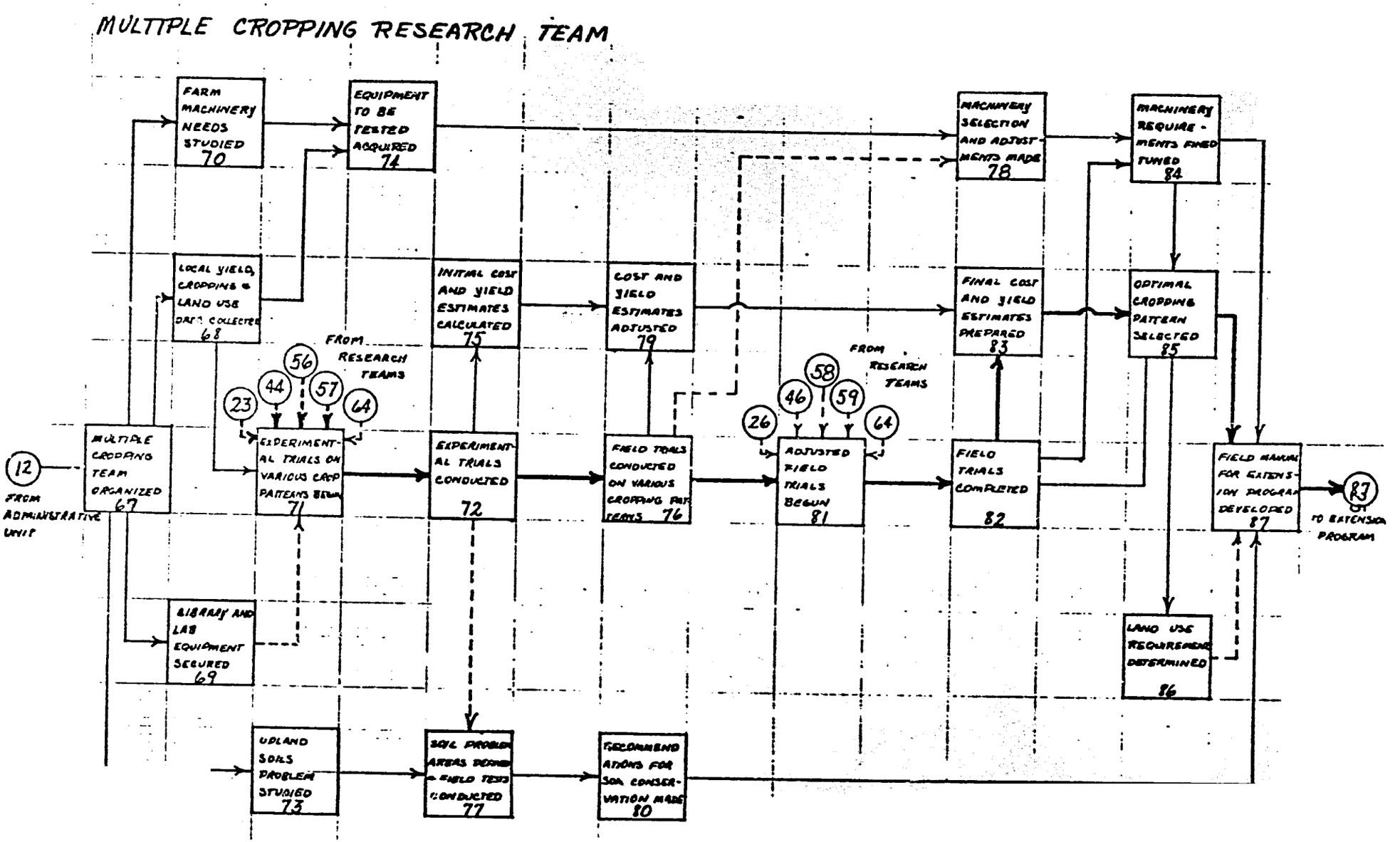

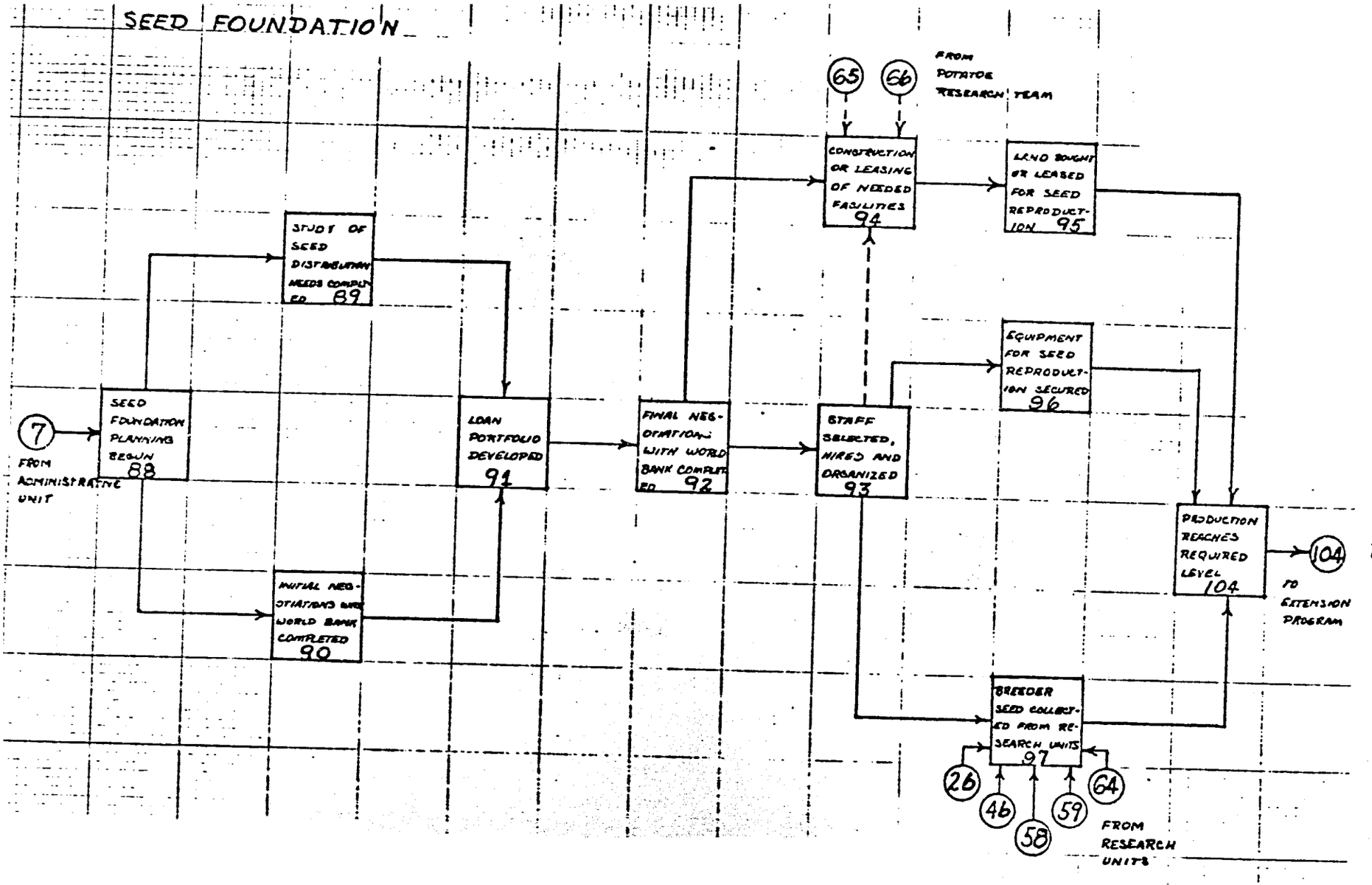
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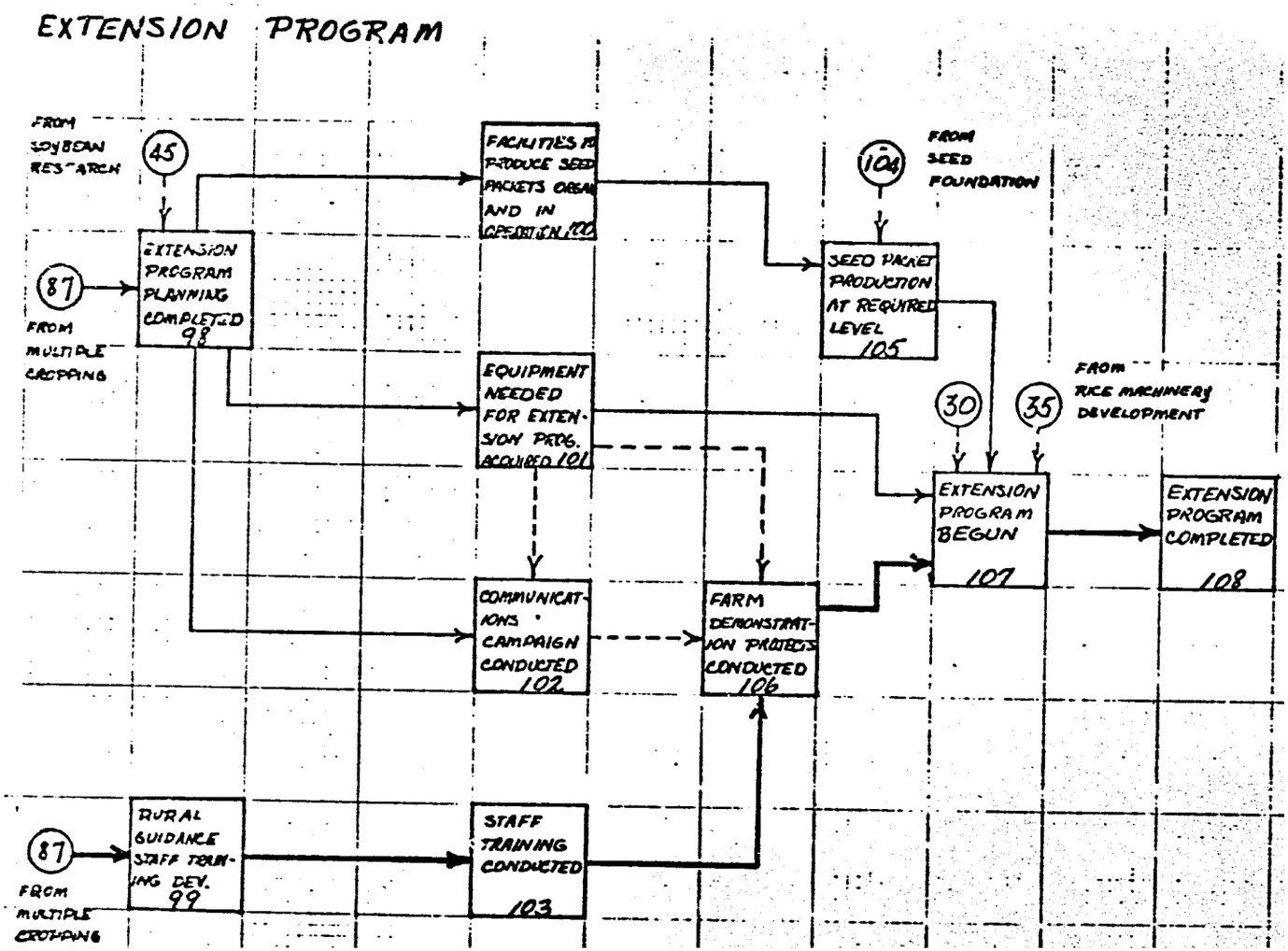
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APPENDIX 4

Listing of Actual and Maximum Completion Times for Each Activity and the Designation of Activities on the Critical Path

LISTING OF THE ACTUAL AND MAXIMUM COMPLETION TIMES FOR EACH ACTIVITY
AND THE DESIGNATION OF ACTIVITIES ON THE CRITICAL PATH

PREDECESSOR	SUCCESSOR	ACTIVITY DISCRIPTION	ACTUAL TIME	MAXIMUM TIME	
1	2	SELECTION OF A PROJECT DIRECTOR	25.80	25.80	CRITICAL PATH
2	3	SELECTION OF A PROJECT CO-DIRECTOR	25.80	25.80	CRITICAL PATH
2	4	SELECTION OF AN AMERICAN ADMINISTRATION OFFICER	8.60	31.37	
2	5	SELECTION OF A KOREAN ADMINISTRATION OFFICER	13.94	13.94	CRITICAL PATH
3	5	SELECTION OF AN AMERICAN ADMINISTRATION OFFICER	8.60	31.37	
3	6	ORGANIZATION OF PROJECT STEERING COMMITTEE	13.94	13.94	CRITICAL PATH
4	9	SELECTION AND HIRING OF KOREAN STAFF	9.80	37.59	
5	7	ORGANIZATION OF PROJECT ADMINISTRATIVE UNIT	49.21	86.80	
6	7	ORGANIZATION OF PROJECT STEERING COMMITTEE	14.81	37.59	
7	8	ORGANIZATION OF PROJECT ADMINISTRATIVE UNIT	0.80	32.25	
8	10	SELECTION AND HIRING OF AMERICAN STAFF	14.81	32.25	
9	11	RECRUITMENT OF RESEARCH TEAM LEADERS	49.21	81.46	
10	11	DUMMY ACTIVITY	31.34	31.34	CRITICAL PATH
10	9	SELECTION AND HIRING OF KOREAN STAFF	0.00	22.45	
10	12	SELECTION AND HIRING OF AMERICAN STAFF	49.21	66.65	
11	11	DUMMY ACTIVITY	0.00	66.65	
11	10	SELECTION AND HIRING OF AMERICAN STAFF	0.00	624.71	
11	11	ORGANIZATION OF RESEARCH STEERING COMMITTEE	50.17	50.17	CRITICAL PATH
11	12	DESIGNATION OF RESEARCH TEAMS	10.03	50.17	
11	13	SELECTION OF KOREANS FOR PH.D. COURSE WORK	4.33	21.77	
11	14	SELECTION OF KOREANS FOR SHORT COURSES-EXTERNAL	24.60	209.77	
12	12	DESIGNATION OF RESEARCH TEAMS	14.39	264.95	
12	15	ORGANIZATION OF RICE RESEARCH TEAM	4.33	4.33	CRITICAL PATH
12	36	ORGANIZATION OF SOYBEAN RESEARCH TEAM	4.33	44.45	
12	47	ORGANIZATION OF WHEAT RESEARCH TEAM	29.38	29.38	CRITICAL PATH
12	43	ORGANIZATION OF BARLEY RESEARCH TEAM	29.38	29.38	CRITICAL PATH
12	51	ORGANIZATION OF POTATO RESEARCH TEAM	29.38	29.38	CRITICAL PATH
12	57	ORGANIZATION OF MULTIPLE CROPPING RESEARCH TEAM	29.38	29.38	CRITICAL PATH
13	15	COMPLETION OF PH.D. PROGRAMS	29.38	71.90	
14	19	COMPLETION OF STAFF TRAINING--RICE	187.77	338.98	
14	51	COMPLETION OF STAFF TRAINING--SOYBEAN	29.38	372.93	
14	57	COMPLETION OF STAFF TRAINING--WHEAT	29.38	275.95	
15	25	DUMMY ACTIVITY	29.38	275.95	
15	46	DUMMY ACTIVITY	0.00	338.93	
15	58	DUMMY ACTIVITY	0.00	338.93	
15	59	DUMMY ACTIVITY	0.00	338.93	
15	64	DUMMY ACTIVITY	0.00	333.93	
15	17	DEVELOPMENT OF RELATIONSHIP WITH IPRI	0.00	185.17	
15	14	SECURING OF NEW LAB AND LIBRARY EQUIPMENT	13.62	36.79	
15	20	TESTS RICE RESEARCH	36.79	36.79	CRITICAL PATH
15	22	PURCHASING NEW FIELD EQUIPMENT	0.00	36.79	
17	19	COMPLETION OF STAFF TRAINING--IRRI	36.79	346.33	
17	27	DUMMY ACTIVITY	28.00	229.57	
18	20	DUMMY ACTIVITY	0.00	23.17	
19	21	DUMMY ACTIVITY	0.00	-.00	CRITICAL PATH
20	21	BREEDING AND SELECTION OF SEED LINES FOR TESTING	2.00	201.57	
21	23	FIELD TRIALS--RICE	206.40	206.40	CRITICAL PATH
22	23	DUMMY ACTIVITY	103.20	103.20	CRITICAL PATH
23	24	COLLECTION OF MILLING MACHINERY FOR TESTING	0.00	309.60	
23	25	COLLECTION OF RICE FARMING EQUIPMENT FOR TESTING	14.13	281.55	
24	26	FINAL SELECTION OF IMPROVED VARIETIES	14.13	281.07	
25	31	DUMMY ACTIVITY	59.77	153.77	
26	71	DUMMY ACTIVITY	0.00	295.49	
26	27	TRIALS OF MILLING EQUIPMENT	0.00	-.00	CRITICAL PATH
26	31	CONDUCTING EQUIPMENT TRIALS--RICE MACHINERY	25.80	293.27	
26	81	DUMMY ACTIVITY	15.42	231.40	
27	97	COLLECTING BREEDER SEED VARIETIES	0.00	95.00	
27	28	MARKET RESEARCH CONDUCTED	14.08	232.61	
27	29	ORGANIZATION AND OPERATION OF PRODUCTION UNIT	29.38	460.25	
27	30	BUILDING UP PRODUCTION CAPICITY	8.60	276.07	
			29.38	305.45	

LISTING OF THE ACTUAL AND MAXIMUM COMPLETION TIMES FOR EACH ACTIVITY
AND THE DESIGNATION OF ACTIVITIES ON THE CRITICAL PATH

PREDECESSOR	SUCCESSOR	ACTIVITY DISCRIPTION	ACTUAL TIME	MAXIMUM TIME	
29	30	BUILDING UP PRODUCTION CAPICITY	29.38	296.85	
30	107	DUMMY ACTIVITY	0.00	267.47	
31	32	ADJUSTING AND TESTING MACHINERY--RICE	18.38	284.36	
32	33	MARKET RESEARCH CONDUCTED	20.48	296.46	
32	34	ORGANIZATION AND OPERATION OF PRODUCTION UNIT	8.60	285.46	
33	35	BUILDING UP PRODUCTION CAPACITY	10.99	276.96	
34	35	BUILDING UP PRODUCTION CAPACITY	10.99	298.95	
35	107	DUMMY ACTIVITY	0.00	265.98	
36	41	BEGIN SOYBEAN BREEDING	0.00	36.79	
35	37	LINKAGES WITH US BREEDERS DEVELOPED	36.79	36.79	CRITICAL PATH
36	38	PURCHASING NEW LAB AND LIBRARY EQUIPMENT	36.79	36.79	CRITICAL PATH
36	39	COLLECTION OF INFO ON SOYBEAN PRODUCTION	12.90	575.91	
37	40	CONDUCTING STAFF TRAINING--SOYBEAN	29.00	206.40	
37	41	DUMMY ACTIVITY	0.00	-.00	CRITICAL PATH
38	41	DUMMY ACTIVITY	0.00	-.00	CRITICAL PATH
39	43	CONDUCTING STAFF TRAINING COURSE	24.60	587.61	
41	42	DUMMY ACTIVITY	0.00	178.40	
41	42	BREEDING AND SELECTION OF LINES FOR TESTING	206.40	206.40	CRITICAL PATH
42	44	CONDUCTING FIELD TRIALS	103.20	103.20	CRITICAL PATH
43	45	CONDUCTING EXTENSION PROGRAM--SOYBEAN	51.60	614.01	
44	46	FINAL SELECTION OF IMPROVED VARIETIES	58.77	153.77	
45	71	DUMMY ACTIVITY	0.00	-.00	CRITICAL PATH
45	98	DUMMY ACTIVITY	0.00	563.01	
45	81	DUMMY ACTIVITY	0.00	95.00	
45	97	COLLECTING BREEDER SEED VARIETIES	14.08	232.61	
47	49	DEVELOPMENT OF RELATIONSHIP WITH CIMMYT	12.90	36.79	
47	51	PURCHASE OF NEW LAB AND LIBRARY EQUIPMENT	36.79	36.79	CRITICAL PATH
47	52	BEGIN WHEAT BREEDING	0.00	36.79	
48	50	PURCHASE OF NEW LAB AND LIBRARY EQUIPMENT	36.79	36.79	CRITICAL PATH
48	53	BEGIN BARLEY BREEDING	0.00	36.79	
49	51	CONDUCTING STAFF TRAINING	8.60	230.29	
49	52	DUMMY ACTIVITY	0.00	23.89	
50	52	DUMMY ACTIVITY	0.00	-.00	CRITICAL PATH
50	53	DUMMY ACTIVITY	0.00	-.00	CRITICAL PATH
51	54	DUMMY ACTIVITY	0.00	221.69	
52	54	BREEDING AND SELECTION OF LINES FOR TESTING	206.40	206.40	CRITICAL PATH
53	55	BREEDING AND SELECTION OF LINES FOR TESTING	206.40	206.40	CRITICAL PATH
54	56	CONDUCTING FIELD TRIALS--WHEAT	103.20	103.20	CRITICAL PATH
55	57	CONDUCTING FIELD TRIALS--BARLEY	103.21	103.20	CRITICAL PATH
56	58	FINAL SELECTION OF IMPROVED LINES--WHEAT	58.77	153.77	
56	71	DUMMY ACTIVITY	0.00	-.00	CRITICAL PATH
57	59	FINAL SELECTION OF IMPROVED LINES--BARLEY	58.77	153.77	
57	71	DUMMY ACTIVITY	0.00	-.00	CRITICAL PATH
58	81	DUMMY ACTIVITY	0.00	95.00	
58	97	COLLECTING BREEDER SEED VARIETIES	14.08	232.61	
59	81	DUMMY ACTIVITY	0.00	95.00	
59	97	COLLECTING BREEDER SEED VARIETIES	14.08	232.61	
60	61	COLLECTION OF INTERNATIONAL VARIETIES--POTATO	31.62	74.14	
60	62	COLLECTION OF LOCAL VARIETIES	6.10	74.14	
60	63	BEGIN POTATO BREEDING	0.00	74.14	
60	65	DEVELOPING SEED TESTING TECHNIQUES	38.70	611.97	
60	66	DEVELOPING SEED STORAGE TECHNIQUES	32.79	611.97	
61	81	DUMMY ACTIVITY	0.00	42.51	
62	63	DUMMY ACTIVITY	0.00	69.03	
63	64	BREEDING AND SELECTION OF BREEDER SEED	272.25	314.76	
64	65	DUMMY ACTIVITY	0.00	308.09	
64	71	DUMMY ACTIVITY	0.00	42.51	
64	81	DUMMY ACTIVITY	0.00	196.29	
64	97	COLLECTING BREEDER SEED VARIETIES	14.08	333.89	
65	94	DUMMY ACTIVITY	0.00	309.09	
66	97	DUMMY ACTIVITY	0.00	569.24	
66	94	DUMMY ACTIVITY	0.00	559.19	

LISTING OF THE ACTUAL AND MAXIMUM COMPLETION TIMES FOR EACH ACTIVITY
AND THE DESIGNATION OF ACTIVITIES ON THE CRITICAL PATH

PREDECESSOR	SUCCESSOR	ACTIVITY DISCRIPTION	ACTUAL TIME	MAXIMUM TIME	
67	69	COLLECTION OF LOCAL CROPPING AND LAND USE DATA	12.93	346.39	
67	69	PURCHASE OF LAB AND LIBRARY EQUIPMENT	36.79	346.39	
67	71	STUDYING FARM MACHINERY NEEDS	9.60	499.65	
67	73	CONDUCT EXPERIMENTAL TRIALS	0.00	346.39	
69	71	INVENTORING UPLAND SOIL PROBLEMS	19.55	471.73	
69	74	DUMMY ACTIVITY	0.00	333.45	
69	71	ACQUISITION OF FARM EQUIPMENT TO BE TESTED	14.59	506.82	
70	74	DUMMY ACTIVITY	0.00	329.60	
71	72	ACQUISITION OF EQUIPMENT TO BE TESTED	14.39	505.15	
72	75	CONDUCTING EXPERIMENTAL TRIALS ON X-CROPPING	103.20	103.20	CRITICAL PATH
72	76	CALCULATION OF INITIAL YIELD AND COST ESTIMATE	11.70	109.29	
72	77	CONDUCTING FIELD TRIALS--X-CROPPING	50.57	50.57	CRITICAL PATH
73	77	DUMMY ACTIVITY	0.00	125.34	
74	78	DEFINING SOIL PROBLEM AREAS AND TESTING	103.20	255.38	
75	79	SELECTION AND ADJUSTMENT OF FARM MACHINERY	31.65	538.33	
76	73	ADJUSTING YIELD AND COST ESTIMATES	6.47	104.65	
76	73	DUMMY ACTIVITY	0.00	65.20	
76	81	ADJUSTING YIELD AND COST ESTIMATES	6.47	65.20	
77	80	BEGIN ADJUSTED TRIALS	0.00	-.00	CRITICAL PATH
78	79	MAKING RECOMMENDATIONS FOR SOIL CONSERVATION	9.79	135.13	
78	84	DUMMY ACTIVITY	0.00	65.20	
79	83	ADJUSTING MACHINERY REQUIREMENTS	5.49	71.67	
80	87	ADJUSTING COST AND YIELD ESTIMATES	6.47	65.20	
81	82	DEVELOPING EXTENSION FIELD MANUAL	36.31	161.65	
82	83	ADJUSTING FIELD TRIALS FOR NEW SEEDS	58.77	58.77	CRITICAL PATH
82	84	ADJUSTING YIELD AND COST ESTIMATES	12.90	12.90	CRITICAL PATH
82	85	ADJUSTING MACHINERY REQUIREMENTS	5.49	12.90	
83	85	SELECTING OPTIMAL CROPPING PATTERNS	12.90	25.80	
84	85	SELECTING OPTIMAL CROPPING PATTERNS	12.90	12.90	CRITICAL PATH
84	87	SELECTING OPTIMAL CROPPING PATTERNS	12.90	20.31	
85	86	DEVELOPING EXTENSION FIELD MANUAL	36.31	58.52	
85	87	DETERMINING LAND USE REQUIREMENTS	8.89	36.31	
86	87	DEVELOPING EXTENSION FIELD MANUAL	36.31	36.31	CRITICAL PATH
87	93	DUMMY ACTIVITY	0.00	27.42	
87	93	PLANNING EXTENSION PROGRAM FOR NEW VARIETIES	23.89	31.09	
88	89	DEVELOPING RURAL GUIDANCE TRAINING PROGRAM	36.31	36.31	CRITICAL PATH
88	91	STUDYING SEED DISTRIBUTION NEEDS	14.09	643.10	
89	91	CONDUCTING INITIAL NEGOTIATIONS WITH WORLD BANK	18.35	643.13	
90	91	DEVELOPING LOAN PORTFOLIO	17.20	646.21	
91	92	DEVELOPING LOAN PORTFOLIO	17.20	641.91	
92	93	CONDUCTING FINAL NEGOTIATIONS WITH WORLD	23.87	648.58	
92	94	SELECTING AND ORGANIZING STAFF	25.05	652.89	
93	94	LEASING OR CONSTRUCTING FACILITIES	28.17	652.89	
93	95	DUMMY ACTIVITY	0.00	527.83	
93	97	PURCHASE OF EQUIPMENT FOR SEED REPRODUCTION	19.57	653.63	
96	95	COLLECTING BREEDER SEED VARIETIES	14.09	653.63	
95	104	LEASING OR BUYING LAND FOR SEED PRODUCTION	25.80	333.89	
97	104	BUILDING UP PRODUCTION--NEW SEED VARIETIES	53.97	362.06	
98	104	BUILDING UP PRODUCTION--NEW SEED VARIETIES	53.97	684.33	
98	100	BUILDING UP PRODUCTION--NEW SEED VARIETIES	53.97	272.59	
98	101	ORGANIZING SEED PACKET PRODUCTION	24.82	32.01	
98	102	ACQUIRING EQUIPMENT FOR EXTENSION PROGRAM	36.79	46.82	
99	103	CONDUCTING COMMUNICATIONS CAMPAIGN	31.29	45.82	
100	103	CONDUCTING STAFF TRAINING SESSIONS	8.60	8.60	CRITICAL PATH
101	107	INCREASING PRODUCTION CAPACITY--SEED PACKETS	14.81	22.00	
102	105	BEGIN EXTENSION PROGRAM	0.00	15.53	
103	107	DUMMY ACTIVITY	0.00	15.53	
104	105	BEGIN EXTENSION PROGRAM	0.00	15.53	
105	106	CONDUCTING FARM DEMONSTRATION PROJECT	25.80	25.80	CRITICAL PATH
105	107	DUMMY ACTIVITY	0.00	218.53	
106	107	BEGIN EXTENSION PROGRAM	0.00	7.20	
			0.00	0.00	CRITICAL PATH

LISTING OF THE ACTUAL AND MAXIMUM COMPLETION TIMES FOR EACH ACTIVITY
AND THE DESIGNATION OF ACTIVITIES ON THE CRITICAL PATH

PREDECESSOR	SUCCESSOR	ACTIVITY DISCRIPTION	ACTUAL TIME	MAXIMUM TIME	
107	109	CONDUCTING FULL SCALE EXTENSION PROGRAM	154.89	154.89	CRITICAL PATH