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DESIGN REPORT

ON

CITRUS AND VEGETABLE RESEARCH PROJECT

IN

THE PEOPLE'S REPUBLIC OF BANGLADESH

DECEMBER 1977

JAPAN INTERNATIONAL COOPERATION AGENCY

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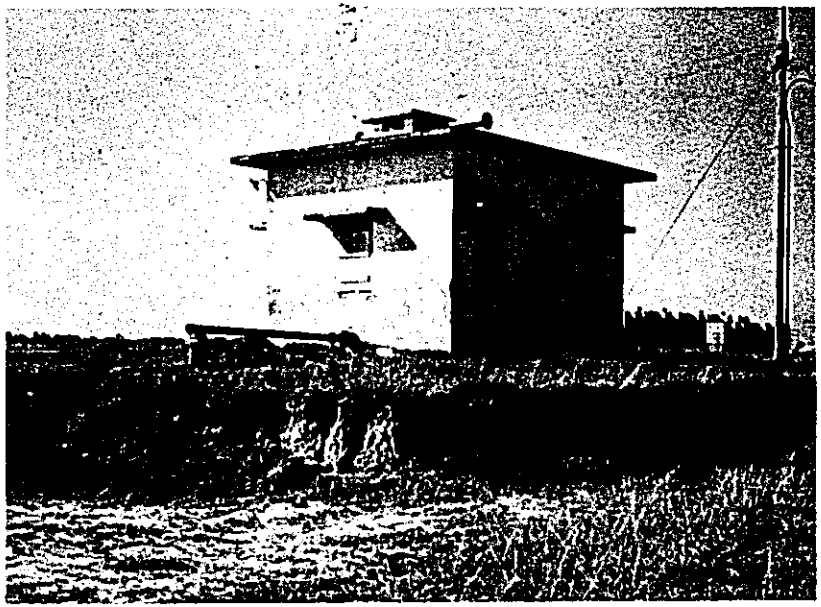
Proposed site for the reseach coop in vegetable and fruit at Joydepur. In the back is CERDI Project.



Bangladesh-style pump shed.

Open-air shop along the river bank

Citrus Experiment Station of Sylhet.

Vegetable and fruit

Vegetable and fruit are being landed from the river boats in early morning.

PREFACE

The present report covers the outcomes of the survey activities during 44 days (September 26 to November 8, 1977) by the Team which was dispatched to Bangladesh in reply to the request of its Government regarding the Horticultural Research Cooperation Project. The aims of this Team were to work out the Master Plan for establishing and operating the horticultural research project and to identify, through deliberations between the authorities concerned of the Bangladesh Government and the Team, the mutually agreeable scope and contents of the assistance to be provided by the Japanese Government in regard to this Project.

In full realization of the significance of the Project, the authorities concerned of the Bangladesh Government responded to our proposals with due eagerness and offered hearty cooperation to the Team; it was due to such a friendly atmosphere that this Project could have been pushed forward from planning stage to implementation stage through signing of the Record of Discussions in Dacca on November 3, 1977.

I am very happy in submitting this report and sincerely hope that it would serve as a guide book for operation and technical performance of the Project through the joint efforts of the two Governments of Bangladesh and Japan. I wish to express, on behalf of the entire Team members and myself, heartfelt gratitude for the warm cooperation and valuable advices given the Team by the officials of the Ministry of Planning, the Ministry of Agriculture, particularly its agencies such the Horticultural Development Board, the Agricultural Research Council, the Bangladesh Agricultural Research Institute and the Bangladesh Agricultural Development Corporation.

December, 1977

Masamoto Yasuo
Team Leader
for
Japan International
Cooperation Agency

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SUMMARY

1. Bangladesh Agriculture

Bangladesh, with the total area of 142,824 sq.km (approximately 40% of that of Japan) and a rapidly increasing population at an annual growth rate of 3% (estimated total population in 1977 being 80 million), is fatally handicapped to attain self-sufficiency in food by the physical reason that 28 per cent of its land (45 per cent of its land under cultivation) is annually submerged during the rainy season due to overflooding of major rivers running through the country.

The total production of the principal food items for the last five years (1970-1974) average at:

Paddy	16,756,400	tons	
Maize	2,400	"	
Wheat	108,000	"	(ADB statistics)

To feed the whole nation, however, Bangladesh needs to annually import 2 million tons of rice (paddy equivalent). The socio-economic conditions prevailing in the rural area are extremely poor. To cite a few examples, Mr. Fukusato who was attached to CERDI reported the summary of his village survey which says that 57% of the land holders own less than 1 ha.; 26%, between 1 and 2 ha.; 12%, 2 to 3 ha.; and 10%, more than 3 ha., and 10% of the land holding farmers had to supplement their income by tilling bigger farmers' land on rental basis. This is concerning only the land-owning farmers; when the situation is looked at from the national viewpoint, 22% of the rural population remained landless (vide Agricultural Census in 1960) and, according to all the available information, their percentage is increasing every year. Another information says that only 6.4% of the rural households produce marketable surplus of rice and 16% of them produce as much as they consume all through the year and 35% of them can produce rice to feed them but for half a year only. The percentage of the rural households which need to buy rice for their own consumption all through the year is as high as 35%.

These are the net contents of the national indices shown as 80% in illiteracy and $100 in per capita GNP. It is not an exaggeration to say that "Bangladesh peasants are born in debts, grown up in debts and buried in debts".

2. Necessity to Promote Vegetable and Citrus Production

India, Bangladesh's not very rich neighbour, produces 55-times more citrus for 8-times larger population, than Bangladesh. Every Indian is, therefore, eating 7-times more citrus than a Bangladeshi. Production of vegetables in this country, again, is very small even compared with other developing countries; it is estimated at about 73 maunds per acre against an average pre-acre production of 250 maunds among the advanced countries. Roughly speaking, Bangladesh is producing 1.4 million tons of vegetables (including potato) from 460,000 acres of land; their output can meet only one-third of the reasonable demand for vegetables in the country. The chronic malnutrition among the Bangladeshi is not only due to insufficient intake of proteins and deficiency of calories but also due to the lack of vitamins and minerals in their diet.

In view of attaining self-sufficiency in a balanced manner and realizing nutritional improvement of the nation, the urgency of increased production of vegetables and citrus as the supplementary nutrient to rice is keenly felt and, not being ignorant of this, the Government of Bangladesh is encouraging production of vegetables and citrus next to rice production, side by side with development of village industries, in order to improve the nation's nutritional level and to augment the rural income. In this connection, the Government of Bangladesh has adopted the development of horticulture and cottage industry as the important national policy besides rice which will not only improve the national nutritional level but contribute to the improvement of farmer's income. It was to implement the FAO Mission's recommendations (1973) for strengthening the institutions and organizations for developing vegetable and citrus production in the country that the Government approached the Japanese Government for cooperation in this field. The Government of Japan expects that the present

Project coupled with CERDI programme, would substantially contribute for nutritional improvement and rural income increase in the country.

The Bangladesh Government and people fully realize the importance of higher education and training in productive sciences and technology to make their determined efforts toward economic self-standing of their country successful.

CHAPTER I. THE AIMS OF THE SURVEY AND SURVEY TEAM'S ITINERARY

1. Background and Objective

The Government of Bangladesh was recommended by FAO, in the year 1973, to create and/or expand the facilities for increased production of fruits and vegetables and started the preparatory works concerning establishment of the research organizations aimed at improving the varieties and cultivation technique of citrus, initiation of the basic studies on the monsoon vegetables, and expansion of seed multiplication scheme meant for self-sufficiency in vegetable seeds for dry season cultivation. Most of these preparatory works could not have been materialized due to such reasons as the shortage of human resources and a lack of technical know-how, as well as the absence of necessary infrastructure and facilities. Subsequently, the Bangladesh Government approached the Japanese Government, in August 1975, with a request for cooperation in terms of diagnostic and analytical work by the experts who would help the Bangladesh Government grasp the prevailing conditions and identify the problem areas pertaining to citrus improvement and multiplication of vegetable seeds and consequently work out policies for their betterment. In response to this request, a team of experts on citrus improvement and seed multiplication was dispatched to Bangladesh from the Japan International Cooperation Agency (JICA) in February 1976. This confirmed the feasibility of technical cooperation in the agricultural sector specifically in the field of citrus and vegetable seeds.

Upon receipt of the report from the Japanese experts' team, the Government of Bangladesh requested the Government of Japan for all-round cooperation in materializing the development project; JICA dispatched in August 1976 a team of experts headed by Mr. Katsuo Nagasawa (this team was named "Bangladesh Horticultural Development Survey Team"). The collaboration in research on citrus and vegetable seeds between these two countries was given a definite direction by the study of this team. It was to replenish the data and information on details of the conditions relating to citrus and vegetable cultivation and socio-economics of the country which

could not have been collected by the Implementation Survey Team that a long-term survey specialist was sent to Bangladesh for seven months from March 1977. JICA continued formulation of the basic concept for cooperation in this respect through analysis of the periodical reports sent over from the long-term survey specialist until September 1977 when it dispatched "Citrus and Vegetable Research Project in Bangladesh Survey Team". The terms of reference given this Team were: (i) identification of the subject-matters of research and preparation of research programmes, (ii) preparation of a list of research aids to be supplied from Japan, (iii) designing of the experimental farms, (iv) their cost estimates, (v) preparation of the bi-lateral Record of Discussions, and (vi) signing of the R/D in the name of the Government of Japan.

2. Organization of the Team

Qualification	Name	Position
Team leader	Dr. Masamoto YASUO	Deputy Director, Agricultural & Forestry Planning and Survey Dept., JICA
Vegetable	Isamu ABE	Director of Morioka Branch Vegetable & Ornamental Crops Research Station, Ministry of Agriculture & Forestry
Citrus	Shunkichi IWASA	Resident Investigator in Dacca, JICA
Machinery	Masakiyo MORITA	Expert of Agricultural Machinery, JICA
Land consolidation	Yoji TAKAHASHI	Japan Engineering Consultants
Field irrigation	Motoo TAKI	Japan Engineering Consultants
Coordination	Keizo EGAWA	Agricultural Developmmet Co-operation Dept., JICA
	Masatoshi NAGATOMO	- do -

3. Survey Team's Itinerary

ITINERARY OF THE SURVEY TEAM

Month	Date	Week	Activities	Remarks
Sep.	26	Mon.	09:40 hrs. Left Tokyo 16:30 " Arrived at Bangkok	JL-717
	27	Tue.	10:50 " Left Bangkok 13:10 " Arrived at Dacca PM. Courtesy Call at the Embassy of Japan and discussion with Messrs. Matsumoto (Councillor) and Kawamata (Secretary) on itinerary	TG-303
	28	Wed.	09:00 hrs. Courtesy Call on Dr. Muhiuddin and Dr. Altaf Ali at the Planning Ministry (submission of draft R/D for their review) PM. Greeting to Dr. M.S.Alam Acting Director, BARI (President of Agricultural University) for discussion on the survey schedule and the basic ideas on cooperation	
	29	Thu.	08:00 hrs. Observation Trip to the construction-site of the Citrus and Vegetable Research Station at Joydevpur	Bangladesh authorities wished to postpone final decision on the site until the return of the BARI Director from Pakistan
	30	Fri.	07:00 hrs. Leader Yasuo, Morita, Iwasa and Egawa left for Ishurdi 16:00 hrs. Arrival at Ishurdi sub-centre headed by Mr. Ashraful Islam who told the Team that there would be no problem about establishment of experiment field	Accompanied by Mr. Hyder of BARI Takahashi and Taki remained in Dacca for quick decision on the experiment field site and for preparation of survey work Yasuo and his company stayed overnight at Ishurdi

Month	Date	Week	Activities	Remarks
Oct.	1	Sat.	08:00 hrs. Yasuo and his company left Ishurdi 16:00 hrs. Arrival at Rangpur sub-centre. Tentatively decided upon experiment field-site (1 ha for vegetable experiment field)	Overnight stay at Rangpur
	2	Sun.	08:00 hrs. Left Rangpur for Dacca 20:00 " Arrival at Dacca	Motor-journey took very long time due to one-lane traffic along the highway
	3	Mon.	Meeting at CERDI; observation trip to Joydevpur for selection of candidate-site of the experiment field	Assisted by Dr. Nakata and other experts of CERDI and Mr. Wada, its Coordinator
	4	Teu.	Leader Yasuo visited the Embassy of Japan to make progress report on the survey and to pay greeting prior to his temporary return to Japan; he strongly requested BARI to make the earliest decision on the site of experimental field	Leader Yasuo left for Japan
	5	Wed.	09:40 hrs. Joint Meeting at the Ministry of Planning Bangladesh Representatives: Dr. Muhiuddin, Planning Ministry Dr. Nurul Islam, - do - Mr. M.S.Alam, Home Ministry Japanese Representatives: Mr. Kawamata, Secretary of Embassy of Japan Team members consisting of Messrs. Morita, Abe, Taki and Egawa As the Ministry of Agriculture was represented by Mr. Razzaque (counterpart officer of Mr. Iwasa) alone, it was decided to have another meeting with the Ministry of Agriculture.	The Joint Meeting was meant for presentation of the Bangladesh representatives' views and comments on the draft R/D which had been submitted by the Team earlier. The views and comments given by the Bangladesh representatives were cabled by the Japanese Embassy to the Ministry of Foreign Affairs in Tokyo.

Month	Date	Week	Activities	Remarks
Oct.	6	Thu.	Observation trip to BADC's Kashinpur experimental field (studies on farm consolidation)	
	7	Fri.	Data arrangement by Abe, Morita and Egawa	Takahashi and Taki left for the main centre at Joydevpur for designing of its field
	8	Sat.	07:00 hrs. Morita, Abe and Iwasa left for Sylhet being accompanied by M/s.Razzaque and Kazi Reaul Hoque	Takahashi and Taki worked at Joydevpur for surveying of the main farm
			17:30 hrs. Arrival at Sylhet, visited the Office of the District Agricultural Officer, and proceeded to Guest House	Overnight stay at Sylhet Guest House
	9	Sun.	08:00 hrs. Left Sylhet for Jaintiapur	Takahashi and Taki attended at desk work
			09:15 hrs. Arrival at Jaintiapur and met Mr.N.A.Bashar, Chief of Citrus Research Station and inspected the research farm with him	Egawa left for Japan
			Saw Mr. Okamoto, a member of JOCV in the afternoon	Overnight stay at Sylhet
	10	Mon.	07:30 hrs. Left Sylhet for Comilla	Takahashi and Taki plane surveying
			14:30 " Arrival at BARD, Comilla Observation of its activities	
			19:20 hrs. Arrival at Dacca hotel	
	11	Teu.	Listened to Dr.Nakata's opinions regarding research farms/exchange of opinions with Mr.Kawamata, Secretary of the Embassy of Japan and Mr. Tanaka, Chief of JICA Dacca Office	Takahashi and Taki worked at surveying of the experimental field
	12	Wed.	Opinions expressed by Mr. Okamura of Shimidzu Construction Company re deep-well pump for experimental field/study on the deep-well pump of BRRI.	Site observation by Dr. B.Doza at presence of all the Team members

Month	Date	Week	Activities	Remarks
Oct.	13	Thu.	Discussion with Mr. Kawamata and Mr. Tanaka on the proposed farm site/memorandum to Dr. Nakata, CERDI Leader/checking on irrigation pumps with BADC	Problem arouse as the originally proposed site belongs to the land under the jurisdiction of US.AID
			16:30 hrs. Discussion on R/D with Dr. B. Doza: all the Team members participated the meeting which was also attended by Mr. Kawamata and Mr. Tanaka	Alteration of the originally proposed site
	14	Fri.	Preliminary reconnaissance of the newly proposed site with Dr. Nakata	
			14:00 hrs. Final dicision on the site for experimental field with the attendance of Mr. Bhuyan of BARI	Master plan drawings were left out to the Team
	15	Sat.	Survey on irrigation pumps at CERDI and BRRI	Irrigable areas {7 ha / 5 acres
			Mr. Kobayashi of Komatsu Engineering Co. supplied information about bulldozer	
			Discussion with Mr. Tanaka on the reviewed results of R/D	
			Plane view tracing of the Master Plan drawings	
	16	Sun.	Plane view tracing of the Master Plan drawings	
	17	Mon.	Business session at BRRI/pump survey at CERDI/farm land surveying and data preparation	Borrowed drawings were returned to Mr Bhuyan, BARI
			Blue-printing of plane view drawings and their setting (8 prints)	
	18	Teu.	07:00 hrs. Abe left for Japan	TG-304
			Column erection ceremony at Joydevpur Centre attended by Takahashi and Taki	
			Surveying of the finalized site for the experimental field with the attendance of Mr. Bhuyan	

Month	Date	Week	Activities	Remarks
Oct.	19	Wed.	Surveying work of the research farm/desk work concerning it Progress reporting to Mr. Tanaka and discussion with him on the future work plan Exchange of opinions with the experts attached to CERDI Exchange of opinions with Mr. Kitai of Nichimen Co. re deep-well pumps	
	20	Thu.	Plane view drawings and soil volume calculation by Takahashi and Taki	
	21	Fri.	Discussion with Mr. Tanaka on R/D Discussion with Iwasa on the Team's future schedule	Coordinator Nagatomo returned from Bangkok by TG-303
	22	Sat.	Observation trip to the proposed site for Joydevpur the Citrus and Vegetable Research Station Study trip to the construction-site of CERDI undertaken by Shimidzu Construction Co.	
	23	Sun.	Discussion with the experts attached to CERDI	
	24	Mon.	Coutesy Call and reporting at the Embassy of Japan and courtesty calls at the Ministry of Agriculture and the Ministry of Planning	
	25	Teu.	Discussion with Mr. Kawamata on R/D and preliminary talks with the Ministry of Planning on R/D	Dr. Yasuo returned from Afghanistan by TG-303
	26	Wed.	Drafting of R/D and discussion with Iwasa	
	27	Thu.	Observation trip to Narayanganj-Narsingdi project area/Farewell Party for Iwasa	

Month	Date	Week	Activities	Remarks
Oct.	28	Fri.	Preliminary discussion on R/D at the Embassy of Japan and its re-drafting	Mr. Dekiba of the Ministry of Foreign Affairs arrived at Dacca by TG-303
	29	Sat.	Conference with the Ministry of Planning on R/D	
	30	Sun.	Re-drafting of R/D and preparation of Interim Report	
	31	Mon.	Re-drafting of R/D	
Nov.	1	Tue.	Re-drafting of R/D and discussion with CERDI experts	
	2	Wed.	Re-drafting of R/D Inspection trip to Joydevpur, the Citrus and Vegetable Research Station	
	3	Thu.	Signing of R/D and Interim Report	
	4	Fri.	Reporting to the Embassy of Japan and JICA Dacca Office	Dr. Yasuo left Dacca for Japan by TG-303
	5	Sat.	Discussion with Mr. Tanaka	
	6	Sun.	Preparation for Return to Japan	
	7	Mon.	Farewell greetings to Dr. Altaf Ali at the Ministry of Planning	Team members left Dacca with Mr. Dekiba for Japan by Biman
	8	Teu.		Team members arrived at Tokyo with Mr. Dekiba

CHAPTER II RESEARCH COOPERATION PROJECT

1. Vegetables

1-1 Vegetable production in Bangladesh

During the course of the survey conducted this time, the team checked the progress of the construction work of the Citrus and Vegetable Research Center and determined the site and scale of the experimental farm to be attached to the Center; the team also visited various experimental farms including that at Ishurdi which is proposed to function as a Sub-Center, the cotton experiment station farm in Rangpur, the citrus experiment station farm in Jaintiapur, the Kashinpur farm attached to the Agricultural Development Corporation and CERDI; frequent visits at the local markets proved to be very informative and the authorities concerned of the Government of Bangladesh provided the team with any valuable information.

The Kashinpur farm of the Agricultural Development Corporation is situated in the suburbs of the capital, Dacca, and this farm is operated as a suburban vegetable cultivation by distributing seeds and providing technical guidance for horticultural production. Seeding and cultivation of vegetables on the farm are being operated rather intensively. Seeds of capsicum and amaranthus were propagated as one of the other operation of the farm. Cabbage and cauli-flower of the rape family were showing their healthy growth, while tomato was found almost fruitless due probably to virus, though grown up to the third cluster. At the farm, Mr, Masamitsu Tazaki, the Japan Overseas Cooperation Volunteer, has been promoting the extension of the vegetable cultivation technique over the villages around the farm. In fact, the said farm plays a key role as a extension station for the propagated seeds to farmers. However, since the present administrative system of Bangladesh, in which any seeds should be spread to farmers after inspecting its experimental result attained at the said farm extended at the responsibility of the Horticulture Development Board, it appears that the Agricultural Development Corporation lacks its consistent role and function in extending the same result.

At a glance of local vegetables observed often on the way to go to the site of survey or in rural markets, there were no such kinds of vegetable varieties as conceivable in Japan. Most of them observed here and there were

of local varieties. Egg plants were relatively larger in total quantity among those vegetables on market sale. They were of utterly mixed local varieties ranging from long and round in shapes. The other vegetables on market sales were represented by white-gourd, bottle gourd, snake gourd, amaranthus, bitter gourd, Indian spinach and cucumber. Those mentioned above were all of the vegetables in season when the survey was conducted in October. The following are the vegetables being cultivated at the farm of the Agricultural Development Corporation over a year:

Winter vegetables: Cabbage cauli-flower, Chinese cabbage, radish, turnip, broccoli, carrot, cucumber, lettuce, potato, water melon, spinach, cayenne, eggplant, amaranthus, cowpea, snake gourd, bitter gourd, and tomato.

Summer vegetables: Eggplant, amaranthus, bitter gourd, cowpea, cucumber, okra, Indian spinach, bottle gourd and white gourd.

Among them all listed above, the vegetables grown up from the imported seeds are cabbage, radish and potato. The seeds of cabbage, Chinese cabbage and water-melon are imported from the Japanese seed companies. The seeds of potato are imported from Holland.

Monthly deliveries of vegetables to the market in Dacca are as tabulated below. Although this statistics may be rather outdated, only available 10 years ago, the situation does not change so significantly even today. Therefore, the data may show a full picture of the characteristic feature in vegetable production of Bangladesh.

Vegetable Deliveries to Dacca

Month	Quantity (ton)	Share (%) by month
January	95,850	12.29
February	104,050	13.35
March	96,600	12.39
April	75,530	9.69
May	87,210	11.19
June	77,550	9.95
July	41,200	5.28
August	45,250	5.80
September	41,960	5.38
October	35,460	4.55
November	27,660	3.55
December	51,300	6.58
Total	779,620	100

According to the above Table, the monthly delivery ranges from 28,000 tons to 104,000 tons. The beginning of dry season, Novermber, shows the lowest.

As observed from the previous data, the summer vegetables tend to be in shortage, especially leafy vegetables. In view of the present situation in Bangladesh, the first consideration must be given, for solution of the problem, to genetic improvement of so-called 'tropical vegetables' not only in Bangladesh alone but also in other countries of the Southeast Asia, as well as full utilization of the local varieties. For instance, amaranthus now on market sale in Bangladesh can be found its high yield in the other areas of the Southeast Asia. Cowpea, snake gourd and bitter gourd are also of low yield in Bangladesh. Seed selection of those vegetables of the rape family, such as cabbage and Chinese cabbage requested by Bangladesh should preferrably be improved by introduction of the suitable seeds from Japan. Propagation of vegetable seeds of the rape family requires proper climate condition (the cold zone in winter) and technical improvement in the propagation. The present level of such technique as being used by the Horticulture Development Board does not fully meet the requirement. It is most important to reserve pure lines of government seeds for crossing and also to firmly establish the pollinating technique (for example, bagging for prevention of open-pollination with the other varieties).

Climatic condition in winter is suitable for vegetable cultivation, especially for rape family. Consequently, it can be concluded that varieties from the Southeast Area are taken for summer vegetable and rape family as cultivated in Japan mainly for winter vegetable.

It is necessary to improve the technique of seedling vegetable during rainy season, particularly cyclone season. Efforts on increased production of summer vegetable should be made by lengthening cultivation period and securing quality and quantity of seeding which are obtained by improvement of facility and technique in seedling since in rainy season, seedling shows good root establishment.

1-2 General principle of research cooperation in horticulture

It is fully recognized that the agricultural leaders in Bangladesh now earnestly desire to obtain research cooperation in the field of breeding and seed propagation. It is considered necessary, in this connection, that the Citrus and Vegetable Research Center should provide the local technical staff with necessary technical training for execution of the Project, as well as technical research of vegetable breeding and its propagation technique. In fact, however, it is regrettable to mention that the technical level of those local staff is still low with little accumulation of knowledge and experience in the basic study of horticulture.

First of all, therefore, it is most urgently required to select suitable kinds and varieties of vegetables for each local condition and then to establish the most appropriate cultivating technique for each selected kind and variety. In order to do so, Japanese experience in the research development of vegetables should be traced back as an useful reference applicable to the future research trend in Bangladesh. It is, therefore, concluded that the research activity should start from the very preliminary step of the basic study rather than taking up as the subject of study such research area as may require abruptly the high technical level. It should start from selection of necessary genetic specimens for breeding.

Improvement of vegetable varieties must be made by re-examination of the varieties now being grown, by active introduction and experiment of new variety from abroad, by preparing necessary specimens for breeding through collection and classification of the local variety, and then by selecting the suitable variety for each locality and, furthermore, by taking hybrid for variety improvement. On the other hand, the technical level of the local staff should also be improved by close cooperation with the Japanese experts. In order to realize this in execution of the research activities, close coordination with CERDI and the Japan Overseas Cooperation Volunteer should naturally be required.

As the implementation plan for research cooperation, the annual project plan for research themes and shares assigned to the citrus and vegetable research center and its sub-center is as drafted in the attached Tables.

Principally, it is the main task of the research center to carry out the experimental research on vegetable breeding and propagation vegetable seeds. Then, the research should be carried out by constant efforts of cooperation with ARI, BRRI and CERDI on the bases of full consistency of both breeding service and technical guidance.

The experimental farm (No. 1 Field) in the research center will be used mainly for the purpose of characteristic survey on the introduced foreign seeds and local seeds and also serve as the seedling bed for cultivation experiment at the other experimental farm (No. 2 Field). No. 2 Field should provide the forum of cultivation experiment for the limited prospective variety of main vegetables with the crop rotation system of 3 or 4 years by use of green manure crops for efficient operation of the farm and soil improvement fertility. Normally, the Japanese experts will reside at the main research center. It is advisable that experts would visit the subcenters for technical guidance if and when necessary.

The facility for research and the equipment, including the material, to be used for operation of the experimental farm should preferrably be of simplified structure with less troubles and interchangeable for easy replacement.

Table 1 Research Subjects on Vegetables in Horticulture Research Center

(Annual draft plan)

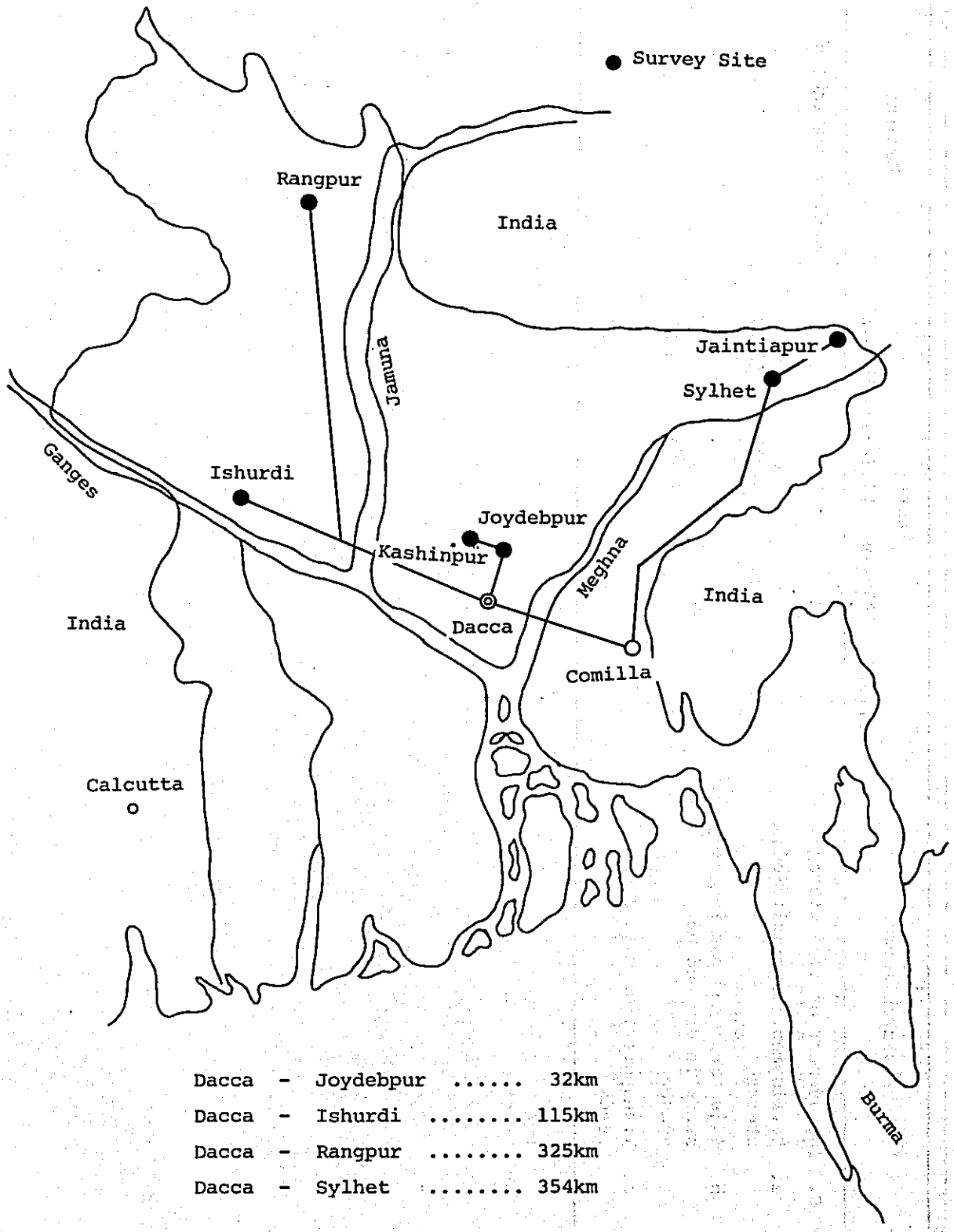
Research Themes	Years 1977~78	1978~79	1970~80	1980~81	Remarks
A. Seeding					
a. Collection of seeding material					Vegetables
(1) Introduction and trial test of foreign seeds	o (J)	o (JIR)	o (JIR)		Winter: Cauli-flower, cabbage, carrot, global cabbage, turnip, onion, garlic, raddish, cayenne, beet and lettuce
(2) Collection and classification of inherent seeds	o (J)	o (JIR)	o (JIR)		
b. Test on resistibility against virus					Summer: Cucumber, water-melon, pumpkin, ginger, melon, snake guard, white guard and bottle guard
(1) Investigation on infecting cause	o (J)	o (J)			
(2) Virus inoculation test			o (J)	o (J)	
c. Seeding of adaptable grade					
(1) Examination on adaptability of foreign grade and selection for adaptable grade			o (JIR)	o (JIR)	
(2) Seeding of inherent seeds of superior quality			o (JIR)	o (JIR)	
(3) Inter-seeding between inherent and selected superior seeds				o (J)	
(4) Seeding of the first filial generation				o (J)	

Note: (J) Joydebpur, Main Center
(I) Ishurdi, Sub-Center
(R) Rangpur, Sub-Center

Research Themes	Years				Remarks
	1977~78	1978~79	1979~80	1980~81	
B. Improvement of seed gathering method					
a. Flowering adjustment of vegetables					Various vegetables
(1) Method of vernalization & Method of naturalization in the post-treatment		o (J)	o (J)	o (J)	
(2) Development of low temperature treatment on mother stock		o (J)	o (J)	o (J)	
(3) Survey of effect on flowering habitude from environmental and cultivating conditions			o (J)	o (J)	
(4) Development of mixed-breeding control method			o (J)	o (J)	
b. Improvement of cultivating method for seed gathering					
(1) Characteristic survey of crop in relation to diathermancy and harvesting method		o (JIR)	o (JIR)	o (JIR)	
(2) Irrigation and manuring for seed gathering	o (J)	o (J)	o (IR)	o (IR)	
(3) Improvement of seed gathering system	o (J)	o (J)	o (IR)	o (IR)	
c. Prevention against seed insectious virus					
(1) Survey on infection of seeds	o (J)	o (JIR)			
(2) Establishment of seed disinfection		o (J)	o (JIR)	o (JIR)	

Research Themes	Years				Remarks
	1977~78	1978~79	1979~80	1980~81	
C. Improvement of seed storage					Various vegetables
a. Development of simplified storage		o (J)	o (J)	o (JIR)	
b. Adjustment and packing of seeds in dry and wet seasons			o (JIR)	o (JIR)	
c. Transportation method of seeds				o (JIR)	

Fig-1 Location Map



Dacca	-	Joydebpur	..... 32km
Dacca	-	Ishurdi	..... 115km
Dacca	-	Rangpur	..... 325km
Dacca	-	Sylhet	..... 354km

2. Citrus Fruits

2-1 Introduction

Bangladesh is now one of the poorest countries whose annual income per capita is 100 U.S. Dollars, only half of that of India. Today, on the strength of the international current trend toward increasing aid to the developing countries, Bangladesh looks as if it were providing a forum for the advanced countries to compete with each other in offering their aids. Especially, Japan ranks the top in extending the aid to Bangladesh. The Bangladesh Horticulture Research Cooperation Project (which is referred to as 'Citrus & Vegetable Seed Research Center' on the Bangladesh side), which is now on the threshold between Japan and Bangladesh, is one of those examples. The reason why this plan has been pushed forward between the two countries is certainly due to the sense of reliability upon Japan; Japan is the same Oriental country with the most developed technology in the world and is, therefore, regarded as the perfectly satisfactory partner in the international cooperation to Bangladesh. Especially, the citrus research project is the most desirable one with the view to increasing the farmers' income from increased production as the cashable products as well as supplying more nutrition of vitamin and mineral to the people. This aims at, concurrently, the intended curbing of citrus imports from both India and Pakistan.

With respect to the horticultural research cooperation, the survey team was delegated several times from Japan to Bangladesh in the past. Particularly, reflecting the situation in Japan its aid toward improvement and expansion of the facilities has been progressed rapdily to such an extent that the Project has already entered into the implementation stage. On the contrary, the responding pace to this Project on the side of Bangladesh has been moving with significant delay behind the original time schedule. Finally, the Project became ready for implementation in August 1977.

This report includes the summary of the research plan for citrus on the basis of the survey result so far attained by the survey team and, besides that, the record of information and data on citrus which became available during the 7-month stay in Bangladesh as the resident investigator.

2-2 Present status of citrus culture

Citrus culture in Bangladesh remains still at the primitive stage. As far as citrus culture is concerned, there is seldom seen any citrus orchard worthy of being named so, except some small-scale orchard existing in the governmental experiment or demonstration farm belonging to extension Agency. Species and varieties of citrus are limited to only a few: The principal varieties for propagation are such as (1) "seedless" for lemon, (2) "Kagzi" for lime, (3) "Malta" for sweet orange and (4) "Nagpuri" and "Khasia" for mandarin. (5) The seedlings of local pomelo varieties for pomelo. Lemon, lime and pomelo are distributed over the flat zone across the country. 60 percent of sweet orange and mandarin of the nation's total is concentrated in the region of Sylhet. Although the reliable statistic data on citrus is not available, it is roughly estimated that as of the year '75 the cultivated area of citrus totals to 15,000 acres and the total production amounts to 20,000 tons; 8,000 tons for lemon and lime, 4,000 tons for orange and 3,500 tons for mandarin and pomelo. Those fruits are carried to the market in small quantity by each farmer himself and appear on sale in fruits shops in Dacca and other cities. However, many of them often come from India or Pakistan rather than that produced in Bangladesh. Within the premises of each farmhouse, several citrus trees are planted as under plantation for coco-nut trees and Jack fruits. They are poor in growth with no good care for cultivation and produce only far less fruits than they should otherwise. Those very few fruits are harvested and delivered to the market to be exchanged for money which may normally be spent for purchase of staple food to eat. In accepting those foreign visitors who come to Bangladesh for general observation on citrus fruits culture, they are normally guided to the experimental station or demonstration farm operated by the governmental agency concerned. They find it difficult to take a look over the actual planting at the general farmstead unless sufficient time is allowed for their observation tour. It is not exaggerated to say that even a single fruit tree can not be seen by such foreign visitors if they try to see it on the road apart from the farmhouse.

2-3 Environmental condition viewed from citrus cultivation

A greater portion of the nation's whole land is flat. The land is divided into subtropical and tropical zones by the trapic of Cancer running in the center. Therefore, the air temperature ranges from 20°C to 30°C at annual avarage, which is too hot to cul vate main citrus originating from the Temperate Zones. Three large rivers such as Padma (downstream of the Ganges), Jamuna and Meghna run through the nation's land of Bangladesh from north to south and cause overflood every year, as the result of which one-third or sometimes half of the total land is submerged. The eastern half of the land is bordered by the hilly zone extending from Assam to Burma. However, the border line stretches mostly at the foot of the hilly zone and the apparently suitable topography for good growth of citrus is in the Indian territory beyond the boundary. Exceptionally, the Chittagong Hilltract remains as the hilly zone in the South but the prevailing temperature over that zone is highest because it belongs to the Torrid Zone. Besides that climate condition, the sea wind blowing in from the Bengal Bay in summer hits against the hilly zone in Chittagong and a part of it sweeps away through the Shylhet region, where most of the nation's citrus production are concentrated, bringing much rain and strong wind to that area.

On the other hand, the western half of the land consists solely of alluvial soil at low altitude except those easily submergible areas, though it is entirely left free from any influence by heavy rain and strong wind throughout a year, and therefore the lowland condition is generally unfavorable for citrus planting. Only the northwestern part of that region near the boundary makes an exception, enjoying the cold air flow to come down from the Himalayas in winter. Such climate condition may be advantage, theoretically speaking, for good coloration and ripeness of citrus. In reality, however, farmers in this area do not have strong desire yet to cultivate any commercial crops notwithstanding the fact that in the Indian territory beyond the boundary production of mandarin is very prosperous. Furthermore, the area does not provide the suitable site condition as the place of citrus production, in view of its geographical conditions that the area is far remote from the nation's capital and the large rivers cause traffic inconvenience.

Table 2 Monthly Average Precipitation by Typical Region (mm)

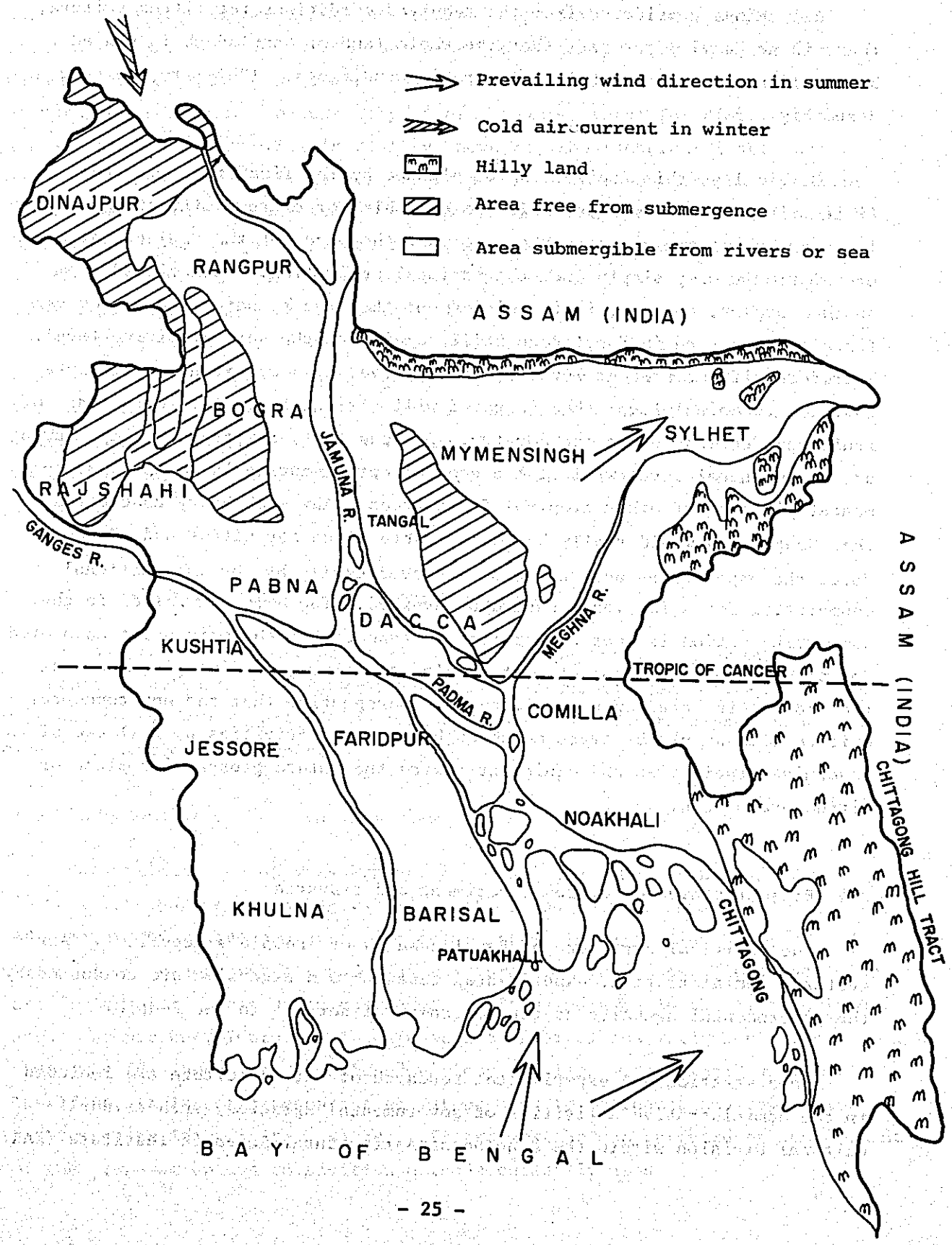
Region \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Dinajpur	3	3	13	41	330	349	536	713	246	184	3	-	2,420
Sylhet	23	33	51	160	700	1,319	714	1,282	221	512	1	-	5,016
Jessore	4	10	6	114	103	284	303	233	210	206	27	-	1,499
Ctg. H.T.	3	8	44	126	216	684	668	366	200	225	27	3	2,571

Table 3 Monthly Maximum and Minimum Temperatures by Typical Regions (°C)

Region	Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Dinajpur (Flat zone at north)	Max.	22.8	27.7	31.9	34.6	32.0	31.7	31.7	31.3	31.8	31.1	29.8	26.8	30.3
	Min.	9.0	12.6	16.6	26.5	23.0	25.8	25.3	25.8	24.4	22.8	18.5	13.5	20.3
Sylhet (Major citrus production area)	Max.	24.7	27.7	31.5	30.4	30.9	29.5	31.2	30.7	32.0	30.3	28.3	25.1	29.4
	Min.	11.1	14.5	20.6	21.1	22.4	24.7	24.5	24.7	24.4	22.9	19.6	13.9	20.4
Jessore (Flat zone at west)	Max.	24.6	27.4	32.1	32.7	31.7	31.5	29.3	30.5	30.9	29.8	28.3	25.7	29.5
	Min.	10.0	14.6	19.1	22.8	24.3	26.9	25.6	26.1	25.6	23.5	10.8	17.2	21.0
Ctg. H.T. (Hilly land at south)	Max.	26.1	30.3	33.8	33.2	33.3	31.1	29.4	30.6	33.1	32.9	29.2	25.2	30.7
	Min.	14.5	17.4	21.8	23.6	22.9	24.6	25.2	24.7	25.6	24.8	20.7	17.4	21.9

(Source: Statistic report by Bangladesh Government)

Fig-2 Natural Environment Around Citrus Area in Bangladesh



All things considered from the required conditions for citrus culture, there is no denying the fact that the whole land of Bangladesh is placed basically under the extremely unfavorable conditions. (Refer to Tables 2 & 3 and Fig. 2).

Originally, this Project is not planned by the fixed idea with the definite vision that Bangladesh will be suitable for citrus cultivation. Frankly speaking, no one can deny the fact that the plan for the Project was taken up relatively easy simply from the national aspiration. When viewed from another aspect, however, it is pointed out that the technique now being used for citrus culture in Bangladesh still remains at the very primitive level. Therefore, if the present level can be improved to some extent, it is sure that the technical level thus improved will ultimately result in increase of fruits production across the country. Besides that, the exepcted improvement at the technical level will give a good effect concurrently to the complemental planting of other tropical fruit trees. Any such hasty conclusion that Bangladesh would really be the suitable place for citrus and, therefore, the expected purpose could be achieved easily by the international cooperation for a few years should be avoided. The only one relief to the supporting nation is that cooperation in research is the main point advocated for planning of this Project. It should, therefore, be fixed in mind that the Project is based upon the long-range perspective that the environmental difficulties should be overcome through research activities by full use of the modernized facilities and equipment toward the future prospective place of citrus production.

2-4 Present status of citrus experiment and research

The political structure of Bangladesh is of 'People's Republic'. Agricultural administration, experimental research and extension are conducted by the governmental agencies as the governmental service to the People.

Demonstration and experimental research of citrus culture are included in the administrative activities of governmental agencies, such as Horticultural Division within the Bangladesh Agricultural Research Institute (BARI)

and other outside agencies such as Regional Research Stations, their sub-stations, Fruit Orchard and Soil and Water Conservation Technique, Project, Farm of Horticultural Development Board, Agricultural University and Academy of Rural Development. Concurrently, those agencies serve for distribution of nursery stocks to farmers. In reality, however, the technical level, at which the guidance for citrus culture is provided by those governmental agencies, remains very low and there are many farms where trees are left uncared since the time of original plantings. The experimental research activity appears to be just at its threshold for future development. As an example to explain this fact, here is a summary related to the citrus as cited from the report (1974) published by the Agricultural Research Institute (referring to Table 4). Most of the ten items in the report refer to introduction of new varieties and its propagation. As noted from those reported items, it may be advisable to try to solve those problems as the first step in the direction of research cooperation and, then, to promote shifting into the cultivating experiment.

2-5 Main objectives for citrus research project

In pushing forward the proposed research cooperation project on citrus, it should be noted that in view of the present situation the following points will become the major part of the research items. Views are expressed on each item mentioned hereunder.

(1) Introduction of foreign varieties

The ultimate end of this Project is to bring up the citrus industry. To meet this purpose, leading varieties of citrus must be determined. As aforementioned, there are five species of citrus in Bangladesh, such as lemon, lime, sweet orange, mandarin, and pomelo. Among those, lemon and lime are fruits of sourness which can be well cultivated even in the flat lowland area. At present, improvement and unification of citrus varieties are now under way for lemon with "seedless" variety and lime with "Kagzi" variety. Therefore, it is not necessary right at present to introduce any new varieties for those specific fruits. Rather, efforts must be concentrated on improvement of the propagation and cultivation methods currently used.

Table 4 An Example of Citrus Experimental Test Result in Bangladesh

(Source: Review of Researches of Division of Horticulture, Bangladesh Agricultural Research Institute, Dacca, Jan. 1974)

No.	Subjects	Remarks
1	Evolving lemon variety seedless lemon	-
2	Studies on groups of limes and lemons	Classified into the following four: Citron, Lemon, Lime and Rough
3	Experiment on the propagation of lemon cuttings	-
4	Introduction of Malta oranges in Bangladesh	-
5	Introduction and trial of mandarin orange varieties	Introduced grades: Kinnow, Dancy, Cleopatra, Feutrell's Early, Santra, Nagpuri, Sivelle Kimb
6	A comparative root stock trial between Pomelo and Khatti	Khatti is root stock in Pakistan. In Bangladesh Pomelo excels for beyond the others and is of wide use.
7	Propagational studies on orange plants	Bud-grafting is the best propagational method applicable to both sweet orrange and mandarin.
8	Determination of proper times of budding of orange	Two different terms: from iddle of October to late November and from middle of February to late April.
9	Effect of girdling on the fruiting of orange	Effect is recognized on Washington navel orange. No unfavorable effect to the succeeding year.

No.	Subjects	Remarks
10.	A study on the effect of storage on germination of seeds of Khasia orange	Sowing immeidately after seed-gathering, 12 hours later, 24 hours later or 168 hours later. Seeds sown immediately after gathering germinated in 39 days at the rate of 87 percent while seeds sown in 168 hours required 34.83 days at the rate of 78 per cent in germination. Another experimental result reveals that seeds sown immediately after seed-gathering germinated at the rate of 92.86 percent while seeds sown one month later germinated at 22.43 percent.

On the contrary, sweet orange and mandarin are fruits of sweet taste. They require low temperature at their ripening period for accumulation of sweetness and, therefore, must be cultivated on the inclined ground of the hilly area at a different elevation. It is obvious that the enthusiasm of the Bangladesh authorities concerned for the proposed research cooperation project is mainly because of their earnest desire to increase production of those sweet citrus fruits. As a matter of fact, however, the natural environment of Bangladesh can provide only the very limited area for such citrus culture. Therefore, it must be recognized that culture of sweet citrus should combat against difficult basic problems.

Now then, in the general recognition that sweet orange may be well-adapted for the western region from India where the climate condition is subtropical and dry while mandarin may grow well in subtropical or warm temperature climate conditions and even in high humidity condition in the eastern region from India, it is recommended that main importance should be placed upon mandarin for search and introduction of any new suitable varieties. It is said that people in Bangladesh take mandarin rather than orange, in nine cases out of ten, when they have the chance of making such alternative choice. This tory can further be justified by observation that mandarin is being produced everywhere in the Indian territory around Bangladesh. Therefore, the extensive survey will have to be conducted for search of the new varieties, not only in the territory of India, but also in other countries of the Southeast Asia, even as far as Taiwan and the southern part of the China Mainland. Even so, however, there still remain some hope for sweet orange. In fact, there are so many hybrids apparently of sweet orange family in different areas of the Southeast Asia.

For instance, in case of Taiwan where the tropic of Cancer runs through the center of the country, same as in case of Bangladesh, the citrus industry of Taiwan may give many useful suggestions to the research cooperation project of Bangladesh going to be jointly operated by cooperation between Bangladesh and Japan, in view of the fact that Japan extended, once before, its hands to the growth of the citrus industry in Taiwan.

Pomelo is included herein in the category of sour citrus. However, the effort to turn this into sweetness must be exerted as the task for introduction of the new variety. As observed in Bangladesh, pomelo grows up in good condition in this flat area, each being grown up to a big tree of large trunk diameter. It appears, therefore, that no difficult problems are basically observed with regard to pomelo cultivation and, furthermore, that the public demand for pomelo is high in the country. Then, it is expected that improvement can be achieved easily for pomelo by introduction of new varieties with while and soft flesh of plentiful sweetness, as is seen anywhere in the Southeast Asia. Therefore, pomelo should be regarded most importantly as the major item to play the decisive role in the research cooperation project.

As the result of observation on implementation of this Project from the aspect of new varieties introduction as aforementioned, it may be concluded that lemon and lime of sour fruits should follow the current policy of establishing "seedless" and "Kagzi" as the main varieties for each of them respectively and the utmost importance should be attached to mandarin among all sweet citrus. However, since considerable lead time should be required until the main varieties for commercial production will have been finally established after introduction of the new varieties for mandarin, it is advisable that new introduction for improved varieties of pomelo should be advanced for conversion of sourness into sweetness of pomelo for such transitional period of mandarin.

(2) Selection of root stock for grafting and improvement of propagation *method*

The problem requiring the urgent solution for promotion of citrus culture is related to selection of the root stock for grafting. In Bangladesh, Pomelo is the only tree solely used as the root stock. However, it has not been so selected after any experimental research. It may be because of such simply reasons that seeds were readily available and the grafting method taught by the Europeans was the technique applicable only to bud grafting. Normally, Pomelo seedling grows up vigorously in large size of

trunk and permits easy bud-grafting. However, since its tap root goes into far depth of the ground with a few number of lateral roots, it sometimes is hard to remain alive after transplantation of the nursery stock in the field and, coupled with insufficient care, is apt to die in many instances.

In view of this situation, it is urgently required to start with the observation nursery for selection of the root stock for grafting by collection of typical citrus samples now being used for this purpose in other citrus producing region of the world. Comparative study must be made by use of various samples, such as sour orange in the U.S. and Europe, trifoliate orange in Japan and other locally bred oranges in Bangladesh (for instance, "Nagpur" and "Khasia mandarin", etc.) or any other citrus-related species growing in the tropics. The observation nursery for selection of the root stock gives no definite prospect for its result and requires many years to go through. Therefore, apart from and in parallel with the present use of the Pomelo root stock as it is today, new effort for search of the appropriate stock must be made as one of the long-range tasks.

Incidentally, lemon is bred solely by the method of gooting, sometimes by cutting. In Bangladesh, most of lemon trees grow in bush like shrubbery. Their branches bearing fruits are too small to bear fruits of high yield. Their weakness against wind damage or driness may derive from shallow rooting of the stocks taken out from their mother plant. Since the high efficiency of propagation can not be expected from application of the gooting method, it is considered necessary to try to find appropriate root stocks for grafting of lemon.

(3) Improvement of cultivation method

It is not exaggerated to say, as observed from the present status in Bangladesh, that the citrus trees is simply planted rather than cultivated. Therefore, there are too many points still to be improved to be enumerated, one after another, with regard to the cultivating method. Among them all, the main point of improvement being urgently required is to concentrate the

conventional technique solely to the handling of nursery stocks before and after their transplantation into the field. Taking up the field preparation for transplantation, for instance, the hole conventionally digged to round size of 2 ft. diameter must be expanded to square size of 3 ft. on each side with due consideration to good drainage. On the inclined surface, the hole bottom for the planting must be leveled off horizontally. Then, with the target to bring up the nursery stock to a configuration with trunk of 2 ft. diameter, the lower sprouts or buds must be nipped out and lateral branches must be twisted off, thus luring a single branch in the vertical position firmly by use of a supporting bar. At the same time, utmost care must be provided for manuring and protection from noxious insects.

The maintenance period under the fullest care after transplantation into the field may be, at least, 1.5 to 2 years.

All mentioned above refer to only the starting point for improvement as the present condition may demand. This will apply to technical guidance to be provided for the farmers. On the other hand, research effort must be continued through experiments for new accumulation of the fundamental data to be required for plantation and cultivation cares.

(4) Disease problems

Virus infection is always taken up as the problem for citrus culture in the tropics. This problem must be dealt with as one of the specialized subjects for experimental research. However, no effective countermeasures can yet be taken at the farmer's field. Normally, the responsible loader for citrus culture development tend to attribute his poor result of experiment trial only to the problem of virus infection. In many cases, however, careful observation on leaves reveals that there may be considered such dual cause as combined with lack of proper nutrition. Therefore, before such virus problem is taken up seriously, another effort must be paid toward keeping vigorous growth of trees by any possible cultivating method.
As a matter of course, effort must be made for concentrated care before and

after transplantation as aforementioned. Besides that, every possible means must be used for protection of the bearing trees, for instance, constant care to remove withered branches, covering with herbage all around the foot of tree or, if necessary, any effective attempt to expand the scope of rooting by digging deep even on one side. In parallel with such maintenance care, clear distinction must be made to separate virus infection from lack of nutrition when it is taken up as the subject for study. Careful watch must be kept on virus constantly in relation to the varieties and rootstock conditions.

Table 5 Experimental Research Plan on Citrus Fruits

Purpose	Policy		
To conduct extensive and appropriate study on citrus as the care plan of the citrus industry in Bangladesh	1) Full use of knowledge experience and skill of the Japanese experts 2) Assignment of the researchers to the countries abroad (Japan, etc.) for study) 3) Effective introduction of the achievements on citrus studies in other foreign countries as well as in Japan.	1. Seeding	To gather a wide range of citrus grades (including root stock) and determine the major loading grade. Selection of virus non-poisonous ontogeny.
		2. Nutritional physiology	To prepare basic data on improvement of manuring care.
		3. Infection	To investigate outbreak of infection and establish the countermeasure. Especially to try to attain non-poisonous ontogeny of virus.
		4. Noxious insects	To establish the protective measures against harm from insects and put stress upon study of the virus-carrying insects by clarifying their routes of birth.
		5. Cultivation	To attach importance to general cultivation, especially maintenance care at the time of plantation. To prepare the guideline for maintenance work.
		6. Training	To make expansion and improvement of facilities in Center as the forum for on-the-job training.
		7. Distribution	To distribute mother trees to the spreading organs interested.

Table 6 Citrus Experiment Research Themes Planned by Years

Subjects & Items	1977~78	1978~79	1979~80	1980~81
1. Seeding				
(1) Collection of domestic and foreign grades (including root stock)	M.	M.S.	M.S.	
(2) Adaptability test on collected grades		M.S.	M.S.	M.S.
(3) Grade cultivation by seedling			M.	M.
(4) Discovery of non-poisonous ontogeny of virus		M.	M.	M.
(5) Preservation of mother stock		M.	M.S.	M.S.
(6) Root stock test	M.S.	M.S.	S.	S.
2. Nutritional physiology				
(1) Nutritional analysis on affected trees		M.	M.	M.
(2) Diagnosis of undernourishment		M.	M.	M.
3. Virus infection				
(1) Identification of virus disease		M.	M.	M.
(2) Non-poisonous conversion of virus			M.	M.
(3) Production of resistible virus individual by raccination of weak toxin				M.
(4) Survey on frequency of main diseases		M.S.	M.S.	S.
(5) Protection test on virus infection		S.	S.	S.

Subjects & Items	1977~78	1978~79	1979~80	1980~81
4. Harmful insects				
(1) Research on insects as carrier of infection			M.	M.
(2) Frequency of birth on major insects and their protection		M.S.	M.S.	S.
5. Cultivation				
(1) Comparative experiments on cultivation method	M.	S.		
(2) Effect of shading trees and selection of kind	M.	S.	S.	
(3) Experiment on maintenance care for saplings		M.S.	M.S.	S.
(4) Experiment on manured cultivation		M.S.	M.S.	M.S.
(5) Protection against overflood and storm damages and soil improvement		S.	S.	S.
(6) Setting of display farm	M.	M.S.	S.	S.
6. Training				
(1) Technical training for promoters and farmers			M.S.	M.S.-
7. Distribution				
(1) Breeding of selected grade				

Note: M ..... Main center (Joydevpur)
S ..... Sub center (Jaintiapur, Ishurdi)
- ..... Long-range continuous programme

Table 7 Citrus Plantation Plan

Center	Place	Purpose		1977~78	1978~79	1979~80	1980~81	Total	Test Item No.
Main center	Environ of main building (30a)	Sampling material	Orange	20	20	-	-	100	1-5 5-1 5-3
			Mandarin	30	30	-	-		
	Reclaimed area (24a)	Ditto	Lemon	-	100	-	-	180	1-5
			Lime	-	80	-	-		5-3
	New orchard (300a)	Mother stock (100a)	Grade	150	150	-	-	500	1-1 3-5 1-2 5-3 2-2 5-4 3-4 5-6
			Root stock	100	100	-	-		
		Root stock test (150a)		-	700	1,000	-	1,700	1-6
		Sapling (50a)		5,000	10,000	(10,000)	-	15,000	1-3
	Nursery farm	Harmful insect test (5a)		-	500	500	-	1,000	1-4 3-2 4-1 2-1 3-3 4-2 3-1 3-5
Subcenter	Cultivated area (300a)	Root stock test (150a)		-	-	300	450	750	1-6
		Cultivation test (100a)		-	-	250	250	500	
		Sapling (50a)		-	25,000	(25,000)	(25,000)	25,000	4-1
Subcenter	Newly expanded area (200a)	Cultivation test (150a)	Lemon	-	150	350	-	750	3-4 5-6 3-5 5-6 5-3
			Lime	-	150	100	-		
		Sapling (50a)		-	10,000	(10,000)	(10,000)	10,000	4-1

2-6 Experimental research plan on citrus

All things considered as aforementioned, the experimental research plan has been drafted, including as much contents as possible of the investigation reports previously published twice (May 1976 and January 1977), as shown in the annexed Tables, with regard to the research items. (See Tables 5 and 6. Incidentally, the citrus planting plan is summarized for experimental research as shown in Table 7.

2-7 Progress status of project

This Project was taken up as the subject for discussions by the technical survey team twice in the past since 1976. Since then, by effort of the survey team dispatched to aid construction of the facility the construction plan for the main research center has been well on the road. Now, the definite shape has been given to the Project after dispatching of the survey team in charge of detailed design service. For the corresponding period, however, the draft plan on the Bangladesh side has not as yet been finalized. For this reason, the local fund to be required for levelling-off of the construction site and other spendings budgeted on the Bangladesh side failed to become available in time for the schedule, as the result of which any possible delay was anticipated in the progress of the construction work.

After the resident investigation of JICA, together with his local counterpartner, urged strongly the authorities concerned to move ahead promptly, the final approval could be obtained from the Planning Committee on August 25 1977, so that the Project began moving forward. At the same time, the staffing organization plan for the Project was finally determined as shown in the annexed Table (Table 8), though each component staff is still under consideration for final selection.

As concerns farm land improvement and expansion, the necessary budgetary fund was previously prepared as infrastructural project fund on the part of the Japanese Government. However, no arrangements could not be proceeded with as expected, since the detail on its spending purpose was left unknown until the time the survey team in charge of detailed design was dispatched to

Table 8 Plan on Assignment of Project Staffing

(August 1977)

Name of the Post		Number of the Post
A. Officers	Speciality	
1. Principal scientific officer	Director	1
2. Senior scientific officer	Virology	1
3. "	Veg. pland breeding	2
4. "	Citrus	2
5. "	Plant pathology	1
6. "	Vegetable	1
7. Scientific officer	Plant nutrition	1
8. "	Entomology	1
9. "	Vegetable	1
10. Statistical officer		1
Sub total		12
B. Staff		
1. Field assistant		4
2. Stenographer		1
3. Head clerk-cum-accountant		1
4. Clerk-cum-typist		4
5. Store keeper-cum-clerk		4
6. Tiller-cum-pump driver		4
7. Driver		2
8. Laboratory attendant		2
9. Gardener		8
10. Peon		4
11. Watchman		8
Sub total		42
Total		54

Bangladesh. Therefore, finally upon arrival of that survey team it was decided that the farm improvement plan should include 3 ha farm to be exclusively used for citrus experiment, 24 ha reclaimed land around the main building of the research center and some area for paddy fields.

Incidentally, prior to entering into cooperation with Japan this Project was newly established by partial delegation of the jurisdiction on fruits (Harticultural Division of BARI) and vegetables (Vegetable Division), which had been under administrative control of BARI. Particularly, among many fruit trees only the citrus appears to have been upgraded separately from all the rest.

The 'Citrus and Vegetable-seed Research Center' as named by Bangladesh for this Project should originally mean 'Citrus-seed and Vegetable-seed', in which 'Citrus-seed' may not be expressed appropriately in the real meaning. As we understand this by our own interpretation, the Government of Bangladesh may intend to avoid any conflict on jurisdiction with such crops as conventionally controlled by BARI with additional wording of 'seed' to the end of 'citrus'. In fact, however, there will be no problem in this regard, since citrus can be regarded as the separate item completely independent of the other fruit trees.

2-8 Conclusion

At present, the Bangladesh Government shows its highest interest in the proposed project and look forward to grant of the aid from Japan. Although the natural environment around the cultivating area of citrus may be crucial and the economic environment may have much still to be improved, there still remain much room for technical improvement with new establishment of the Project. For future implementation of the project on citrus research, it is concluded that the method of cultivating sour-taste citrus should be firstly improved, particularly starting from concentrated use of the conventional technique for handling of yound trees and, in parallel with that, the excellent varieties to convert pomelo from sourness to sweetness should be introduced by further research effort.

From those aspects of research activities it is believed that the purposes of improving nutrition of the nation's people as well as increasing the personal income of each farmer will be achieved ultimately. As the second step, further effort should be exerted to introduce the new varieties for sweet citrus, especially attaching importance to mandrain. It is advisable, in this connection, that any technology as the countermeasure against strong wind and much rainfall should be formulated systematically, together with the effort to try to search for the suitable site for citrus culture. Those techniques to be newly developed must be adaptable to the actual site condition as the result of the experimental research conducted at the main center and its sub-center involved. The research effort for experiment of the root stock for grafting must continue as one of the long-range project tasks. All such experimental researches as aforementioned must be pushed forward constantly with the concern over nutritiion shortage and virus infection which may be characteristic only in the tropical region.

In closing of this Report, it is added that the content of the Report is summarized from the data available to the survey team during the period of survey, in order to help further development of the Project, and compiled to present some basis on the result of survey, on which any experts to be delegated could depend as referential data.

CHAPTER III. DESIGN OF EXPERIMENTAL FIELDS

1. Selection of the Site for the Center

The Horticultural Research Center of Bangladesh will be located in Joydevpur about 20 miles north away from Dacca (See Fig. 1).

The site for the Center is, as shown in Fig. 2, located within the premises of the Joydevpur Agricultural Complex (ARI, BARRI, CERDI), which is commonly known as ABC Complex (600 acres in total area). The southern and eastern parts of the Center building will be regarded as Field No. 1 and the area along the south boundary wall as Field No. 2.

In accordance with the agreement reached between the competent officials of the Ministry of Agriculture of Bangladesh and the Agricultural Research Institute of Bangladesh (BARI), the Japanese Survey Team defined the boundaries of the sites for the experimental fields, drove pegs along the boundaries and surveyed the site in the presence of competent officials of BARI.

The ABC Complex consists of the following organizations:

A - ARI (Agricultural Research Institute)

B - BRRI (Bangladesh Rice Research Institute)

C - CERDI (Central Extension Resource Development Institute)

The lengths indicated in the drawing of the overall project shown in Fig. 2 are referred to 660 feet. An area of 660 square feet is equal to 10 acres.

Roads are to be constructed to run from east to west and from south to north so as to form a grid circuit.

The boundaries of the field sites were defined by referring to the boundary wall in the south and the new roads constructed under the master plan. The sites are located in higher parts of the Complex premises.

The total area of the proposed experimental fields is 19.74 acres (7.99 ha), which is divided into the following two areas:

Field No. 1	1.97 acres (0.8 ha)
Field No. 2	17.77 acres (7.2 ha)
Total	19.74 acres (8.0 ha)

1-1 Present conditions of proposed sites

(1) Field No. 1

The corresponding site consists of a tableland and lowland rice paddies and ranges in elevation from 19 to 30 feet.

This area drains northeast through a drainage canal along the tableland or overflow from the rice paddies.

(2) Field No. 2

This site is generally flat except a difference of elevation in some parts. It ranges in elevation from 32 to 35 feet.

The area consists of plowed fields, a wasteland and limited rice paddies. There are some farm houses and four reservoirs in the area.

Drainage is provided by existing canals within and around the area, and the water drains off northeast.

1-2 Acreage of experimental fields

The acreage of the experimental fields to be built in 1978 is limited by the project budget approved by the Japanese Government.

The acreage will be as follows:

Field No. 1	1.97 acres (0.8 ha)
Field No. 2	10.36 acres (4.2 ha)
Total	12.33 acres (5.0 ha)

LOCATION MAP

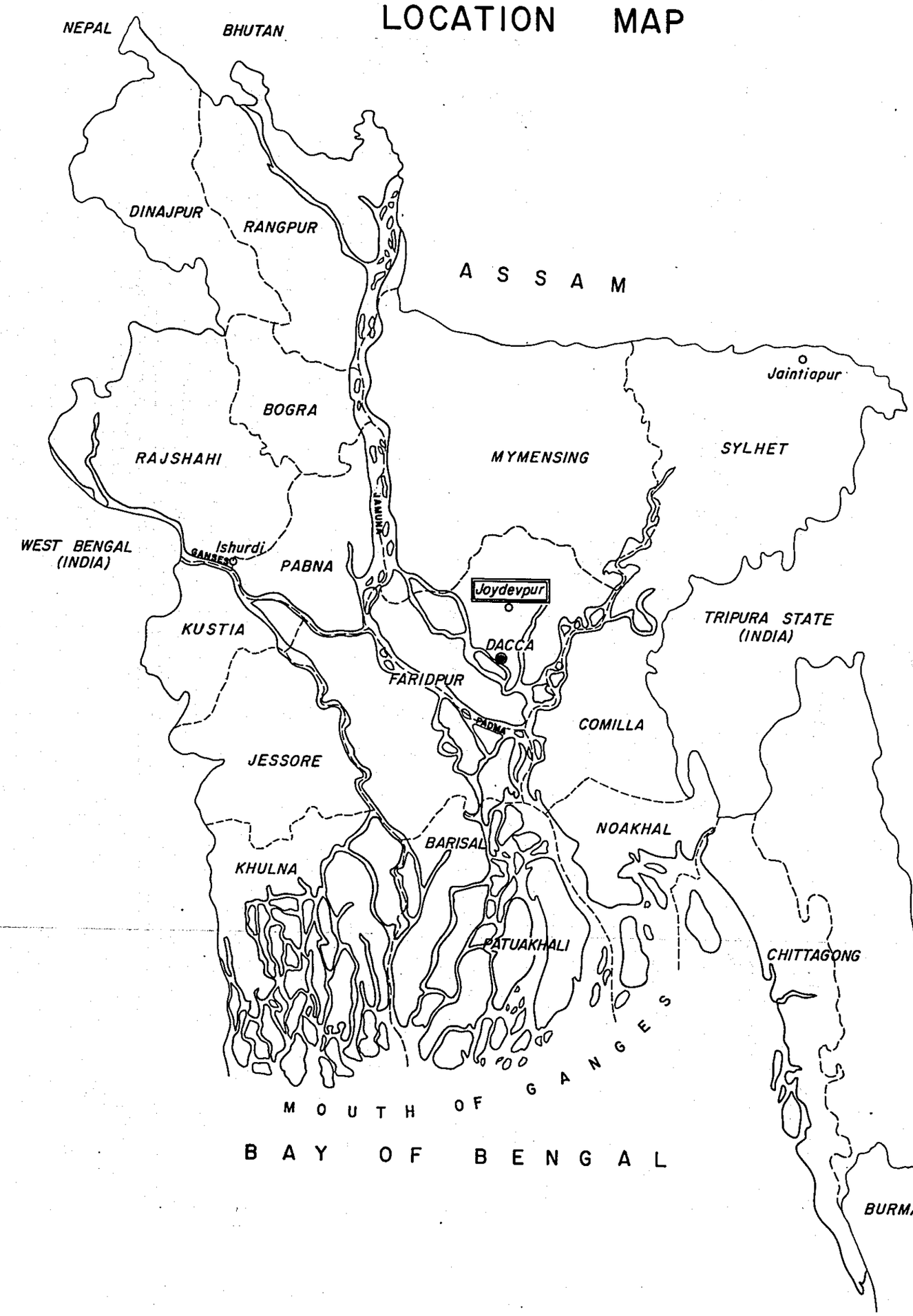
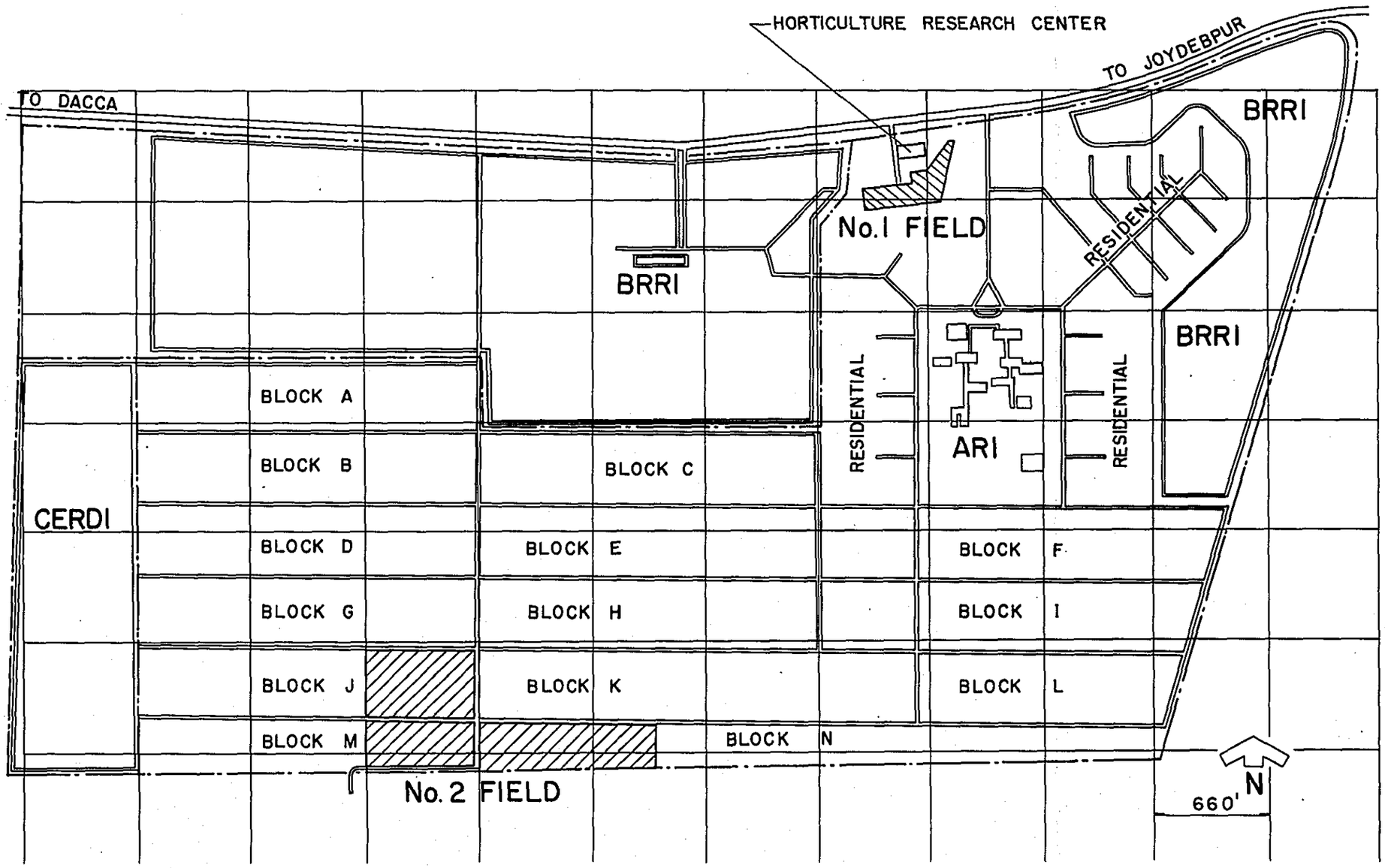
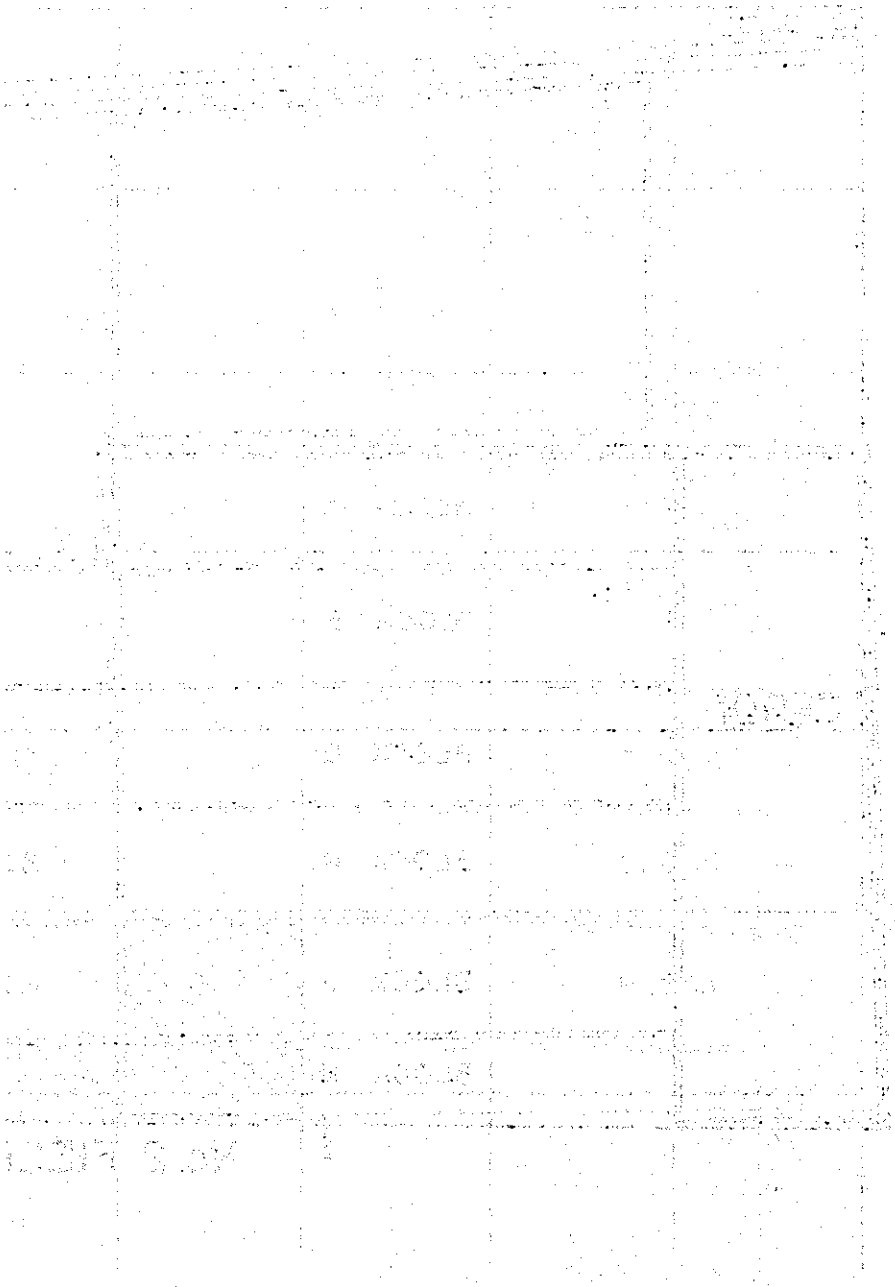


Fig-3

LOCATION OF EXPERIMNT FIELDS IN AGRICULTURAL COMPLEX





2. Determination of Facility Scale

2-1 Source of water supply

Rivers, reservoirs, and underground water are being utilized as a source of water supply. As a result of investigating the vicinity of the project sites, there exists no available source of surface water (rivers, reservoirs, etc.).

All water utilized in the Agricultural Complex (A.B.C. Complex) is supplied from underground sources. Therefore, the water utilized in the experimental fields will be supplied from underground sources.

The maximum quantity of irrigation water required for Field No. 1 is 0.14 cft/sec, since its area requiring cultivation is no more than 1.52 acres.

Pumping facilities will not be provided for Field No. 1, for the Field No. 1 will be supplied from the pumping facilities owned by ARI as in the case of the Horticultural Research Center.

In case of an emergency such as a breakdown of pumping machinery and so on, the necessary water supply will be obtained from a water tank that is located along the main road in front of the Center by means of a portable pump.

A 330 ft-deep well will be bored in Field No. 2 and a 6 in.-dia. underwater motor pump will be installed to obtain a maximum quantity of 1.8 m^3/minute. Two existing water tanks will be used only in an emergency.

2-2 Irrigation requirements

The irrigation requirements of the project will be used for the cultivation of vegetables and citrus. The maximum quantity of water consumption for this purpose is estimated at 5 to 8 min/day, varying with the kind and growth stage of the individual crop involved.

The water consumption for the project is, therefore, 8 mm/day, assuming pump operation of 6 hours/day, irrigation interval of 2 days and irrigation efficiency of 75%.

Taking account of the experimental nature of the proposed fields, the irrigation requirements of the project are determined to be an increase in twenty per cent of the calculated quantity including irrigation canal losses.

The proposed irrigation requirements of the individual field is calculated as follows:

(1) Field No. 1

The acreage of Field No. 1 to be cultivated is 1.52 acres, or 0.62 ha.

$$Qmax = \frac{I \cdot 2A \cdot 2.78}{N \cdot H \cdot E \cdot 1000} \times (1 + 20\%)$$

$$= \frac{8 \times 2 \times 0.62 \times 2.78}{2 \times 6 \times 0.75 \times 1000} \times (1 + 0.20\%)$$

$$= 0.004 \ m^3/sec = 0.24 \ m^3/min = 2.03 \ cft/min$$

where Qmax: Maximum irrigation requirements (cft)

I : Irrigation water depth per day (mm/day)

A : Acreage under irrigation (ha)

N : Number of irrigation days per month (day)

H : Irrigation hours per day (hour)

E : Irrigation efficiency

(2) Field No. 2

The acreage of Field No. 2 to be cultivated is 5.76 ha, i.e. 80% of the total acreage of the two experimental fields,

$$Qmax = \frac{I \cdot 2A \cdot 2.78}{N \cdot H \cdot E \cdot 1000} \times (1 + 20\%)$$

$$= \frac{8 \times 2 \times 5.76 \times 2.78}{2 \times 6 \times 0.75 \times 1000} \times (1 + 0.20\%)$$

$$= 0.03 \text{ m}^3/\text{sec} = 1.8 \text{ m}^3/\text{min} = 63.6 \text{ cft/min}$$

Therefore, a 6 in.-dia. submerged motor pump will be employed for irrigation purposes.

2-3 Method of irrigation

Generally, the method to be employed for irrigation is an important factor which greatly influences its economic effects.

In the present project, the sprinkler irrigation method will be adopted for Field No. 1 and the surface irrigation method (furrow irrigation) for Field No. 2. The adoption of the methods is based on an overall analysis of the locational, managerial and economic conditions of the experimental fields as well as the views of the vegetable and citrus experts consulted.

2-4 Irrigation planning

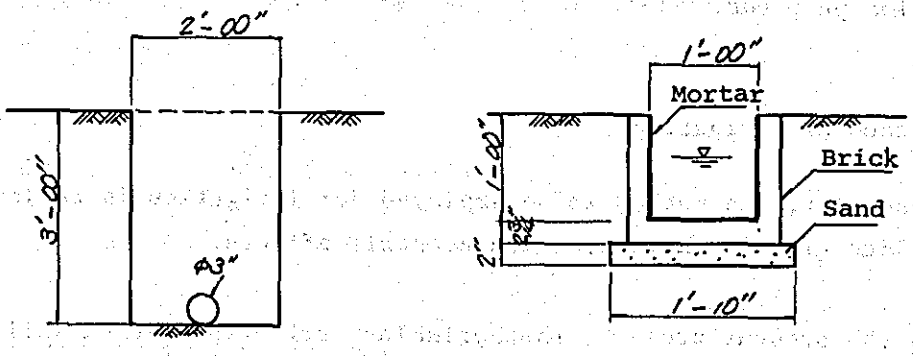
In view of the experimental nature of the proposed fields, it is considered impracticable to divide them into several sections, and then to irrigate these sections by a follow-on system.

However, each field will be divided into two equal parts for irrigation purposes and each part will be irrigated every two days.

For Field No. 1, irrigation water supplied from the pumping facilities owned by BARI will be stored in the suction reservoir and then supplied in a maximum quantity of 0.004 m^3/sec by employing a 2 in.-dia. pressure pump with an output of 3.7 KW. The water supply pipe will be a 3 in.-dia. steel pipe (See Fig. 8).

For Field No. 2, a maximum quantity of 0.03 m^3/sec will be pumped up by a 6 in.-dia. vertical turbine pump and the water will be led into a brick irrigation canal (30cm x 30cm) through a discharging reservoir (See Fig. 9).

Typical Cross Section of Irrigation Canal



(1) Field No. 1

(i) Calculation of head

Loss of head, h_1, at straight pipe (ϕ3")

h_1 = 1.8 m/100 m x 237.7 m = 4.28 m

Loss of head, h_2, at bent pipe

$h_2 = h_1 \times 10\% = 0.43$ m

Loss of head, h_3, around pump

h_3 = 5.0 m

Required pressure in injection pipe

h_4 = 13.3 m

Therefore, the total head, H is

$$H = h_1 + h_2 + h_3 + h_4$$
$$= 4.28 + 0.43 + 5.0 + 13.3$$
$$\fallingdotseq 23.0 \text{ m}$$

- Sprinkler pump

Diameter	2"
Delivery	240 ℓ/min
Total head	23 m
Required motive power	5 ps ≒ 3.7 KW
Revolution per minute	4,000 rpm

(2) Hydraulic calculation for Field No. 2

Calculation is made by Manning's formula applicable to open canals.

$$Q = A \cdot V$$

$$V = 1/n \times R^{2/3} \times I^{1/2}$$

where Q : Discharge
A : Cross-sectional area of flow
V : Velocity of flow
n : Coefficient of roughness
R : Depth
I : Gradient of canal

(1) Determination of cross section

$Q = 0.03 \text{ m}^3/\text{sec}$
$n = 0.013$
$b = 0.30 \text{ m}$
$h = 0.15 \text{ m}$

$A = b \cdot h = 0.045\ m^2$

$R = 0.045/0.60 = 0.075$

$R^{2/3} = 0.178$

$V = Q/A = 0.03/0.045 = 0.67\ m/sec$

$I = (nV/R^{2/3})^2 = 1/420 \fallingdotseq 1/400$

Therefore, the width of the canal is 30 cm, the depth of water 15 cm and the gradient of the canal 1/400.

(ii) Calculation of loss (Siphon)

Pipe diameter $\phi 200$

Cross-sectional area $A = 0.0314\ m^2$

Discharge $Q = 0.03\ m^3/sec$

Coefficient of roughness, $n = 0.013$

Velocity of flow $V = Q/A = 0.96\ m/sec$

Hydraulic gradient $I = \dfrac{124.45 \times n^2 \times V^2}{D^{4/3} \times 2g} = 0.00846$

- Fricitional loss hf

  Pipe length $L = 7.00\ m$

  $hf = L \times I = 0.059\ m$

- Inflow and outflow loss

  $he = 1.5 \times \dfrac{V^2}{2g} = 0.071\ m$

- Total loss

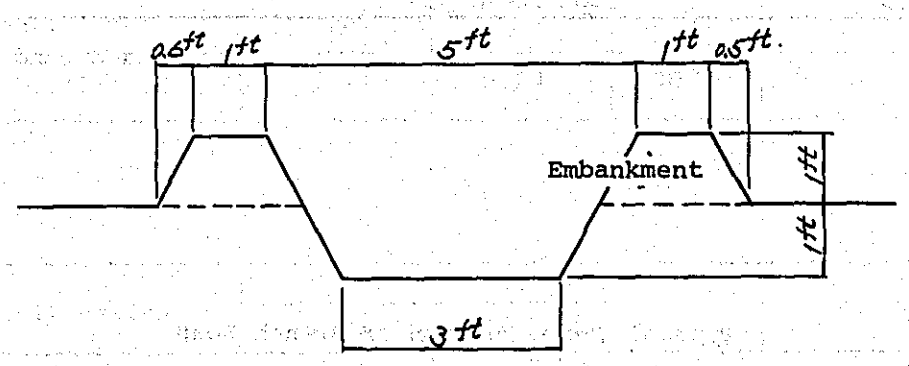
  $\Delta h = hf + he = 0.130\ m$

2-5 Drainage planning

Water drained from the experimental fields will be channeled to the existing external drainage canals through proposed internal canals to be led northeast via the drainage system of the ABC Complex (See Figs. 8 & 9).

The drainage canal will be an excavation without timbering, whose standard cross section is shown below.

Typical Cross Section of Drainage Canal



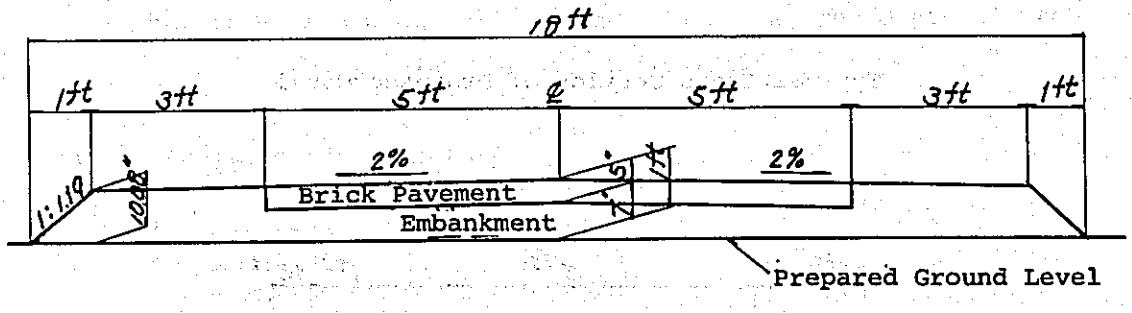
2-6 Road planning

Road planning has been made in such manner as to provide easy access to all parts of the experimental fields where many different varieties of crop are to be cultivated on trial.

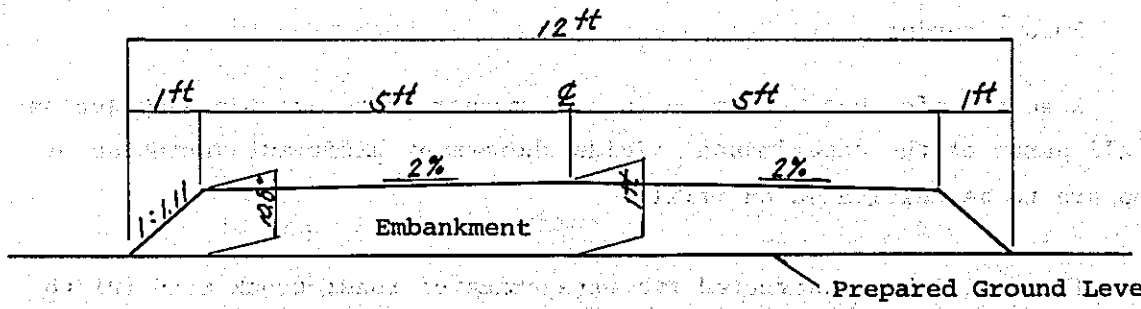
There will be constructed two categories of road: trunk road (width 5.00 m) and branch road (width 3.00 m).

The standard cross sections of the roads are shown below.

Typical Cross Section of Main Road



Typical Cross Section of Branch Road



2-7 Layout of facilities

The layouts of the experimental fields are shown in Figs. 5 to 9.

Land Utilization Schedule

Field No. 1

Classification	Area		%	Remarks
	Acres	Ha		
Cultivated land	1.52	0.62	77.2	
Road	0.26	0.10	13.2	
Footpath between fields	0.10	0.04	5.1	
Drainage canal	0.09	0.04	4.5	
Total	1.97	0.80	100.0	

Field No. 2

Classification	Area		%	Remarks
	Acres	Ha		
Cultivated land	8.23	3.33	79.4	
Road (trunk)	0.23	0.09	2.2	
Road (branch)	0.31	0.13	3.0	
Footpath between fields	0.11	0.04	1.1	
Irrigation canal	0.19	0.08	1.8	
Drainage canal	0.14	0.06	1.4	
Reservoir	0.79	0.32	7.6	
Other field facilities	0.36	0.15	3.5	
Total	10.36	4.20	100.0	

Fig-5

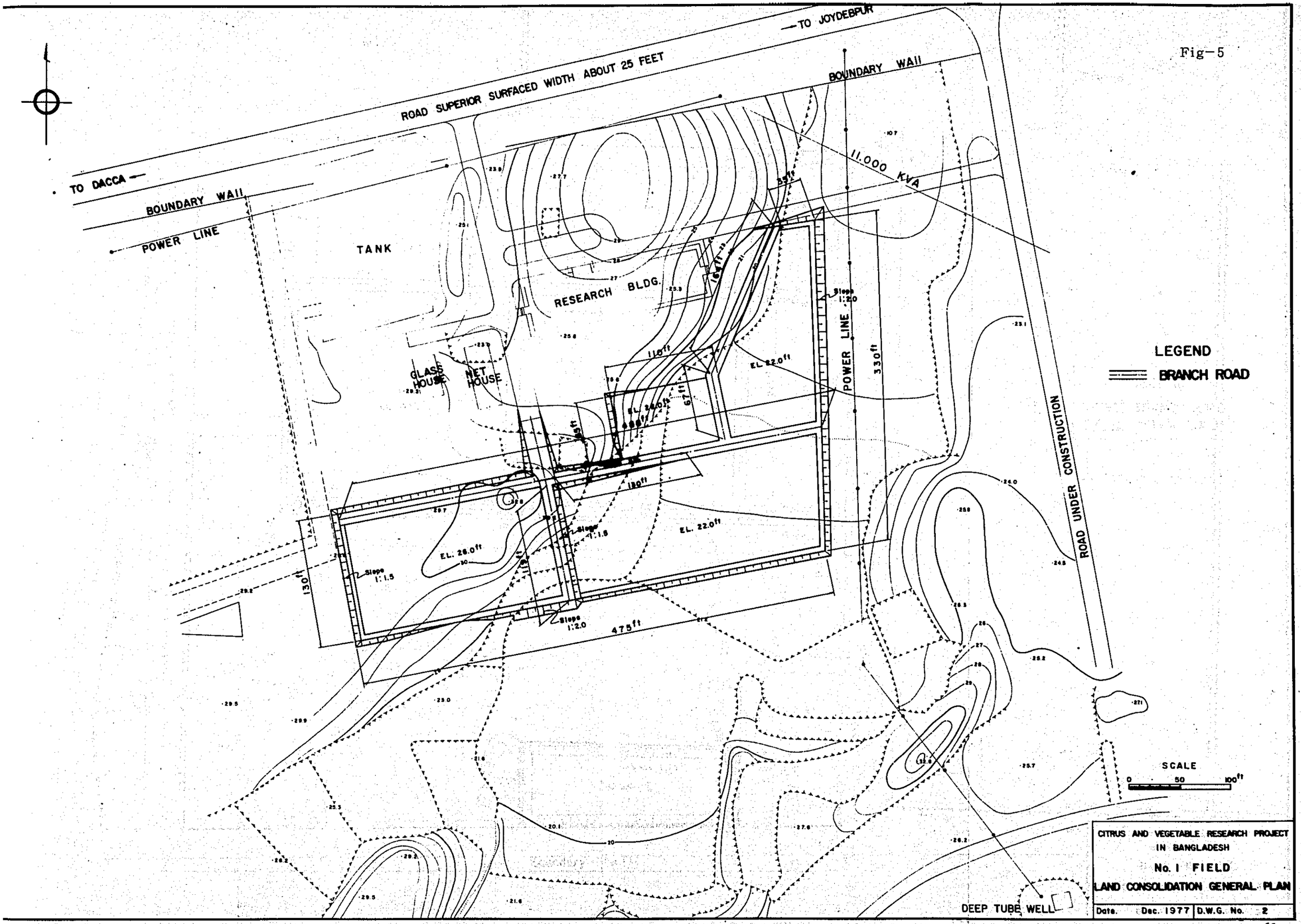
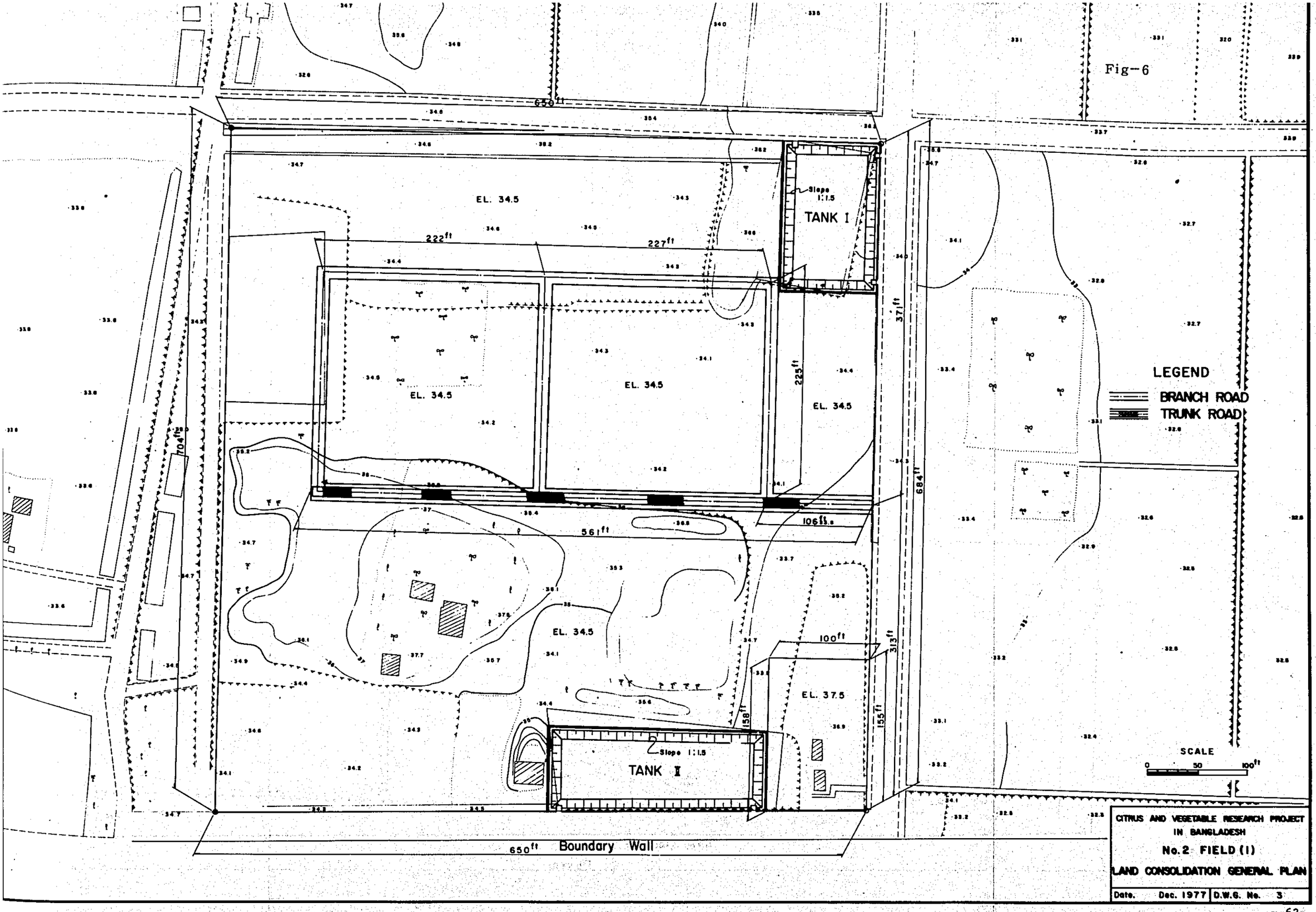

TO JOYDEBPUR
ROAD SUPERIOR SURFACED WIDTH ABOUT 25 FEET
TO DACCA
BOUNDARY WALL
BOUNDARY WALL
POWER LINE
TANK
RESEARCH BLDG.
11,000 KVA
GLASS HOUSE
NET HOUSE
EL. 24.0ft
EL. 22.0ft
EL. 26.0ft
POWER LINE
330ft
110ft
67ft
180ft
130ft
475ft
Slope 1:1.5
Slope 1:1.5
Slope 1:2.0
ROAD UNDER CONSTRUCTION
DEEP TUBE WELL
LEGEND
BRANCH ROAD
SCALE
0 50 100ft
CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH
No. I FIELD
LAND CONSOLIDATION GENERAL PLAN
Date. Dec. 1977
D.W.G. No. 2

Fig-6



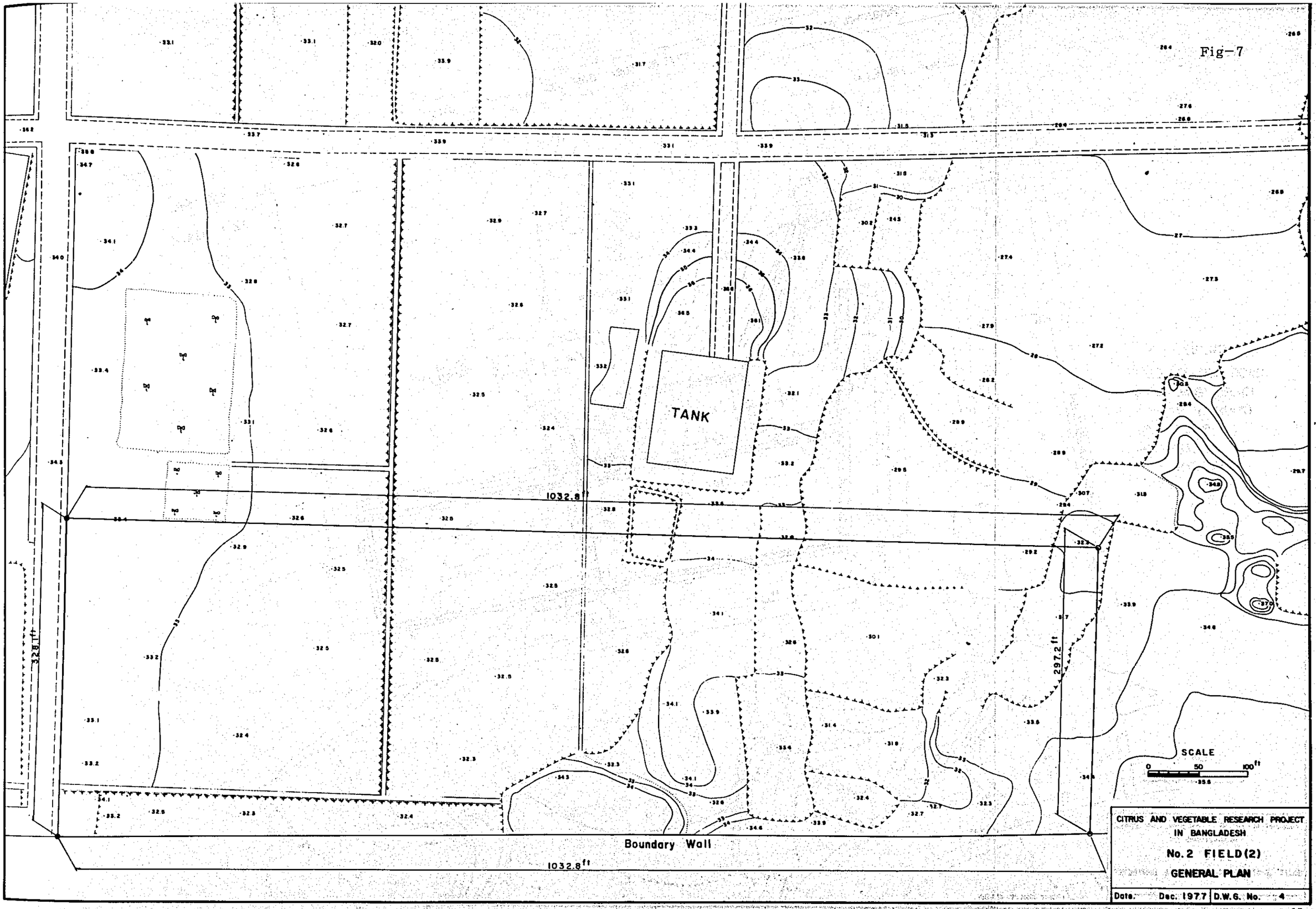
CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH

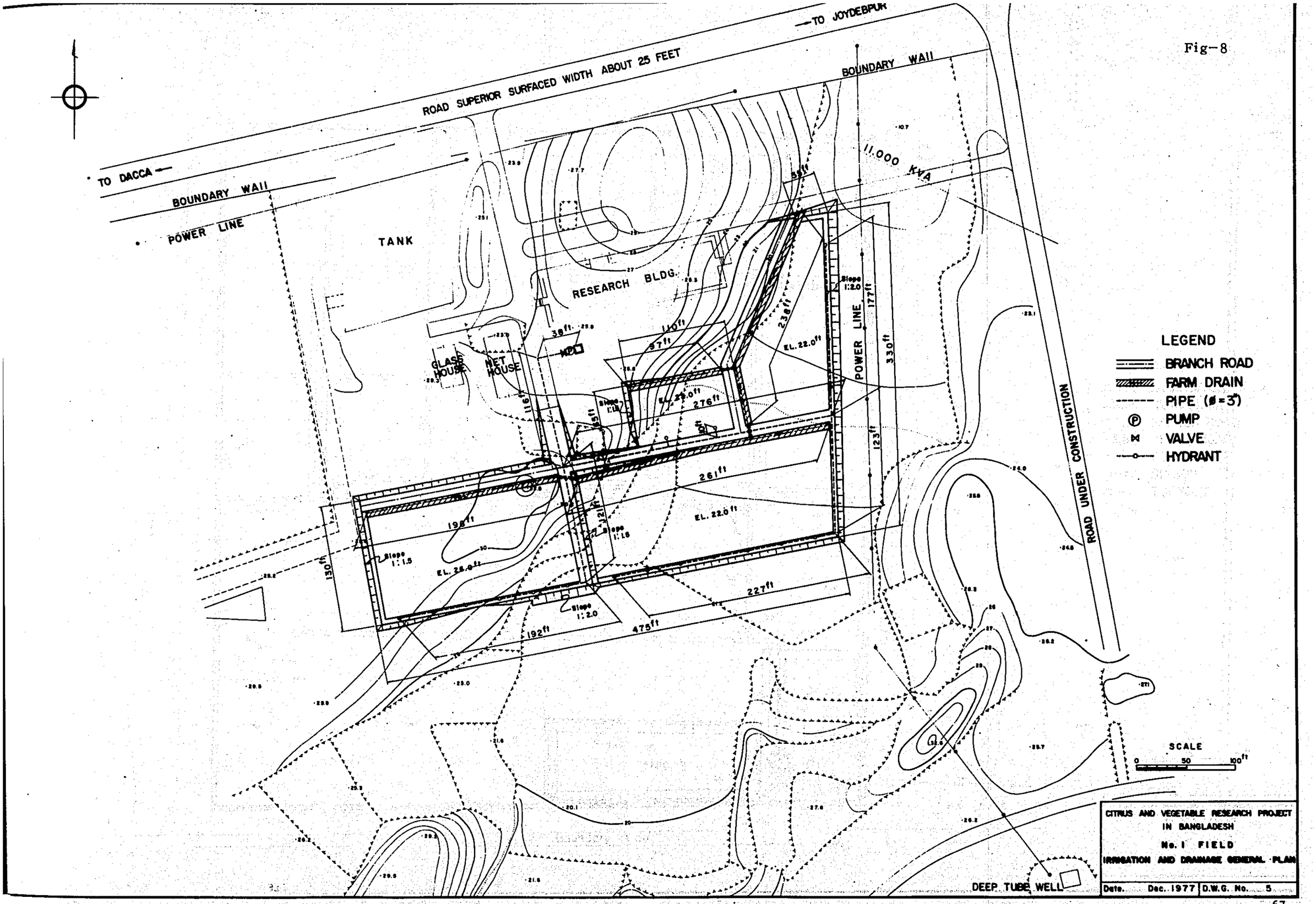
No. 2 FIELD (I)

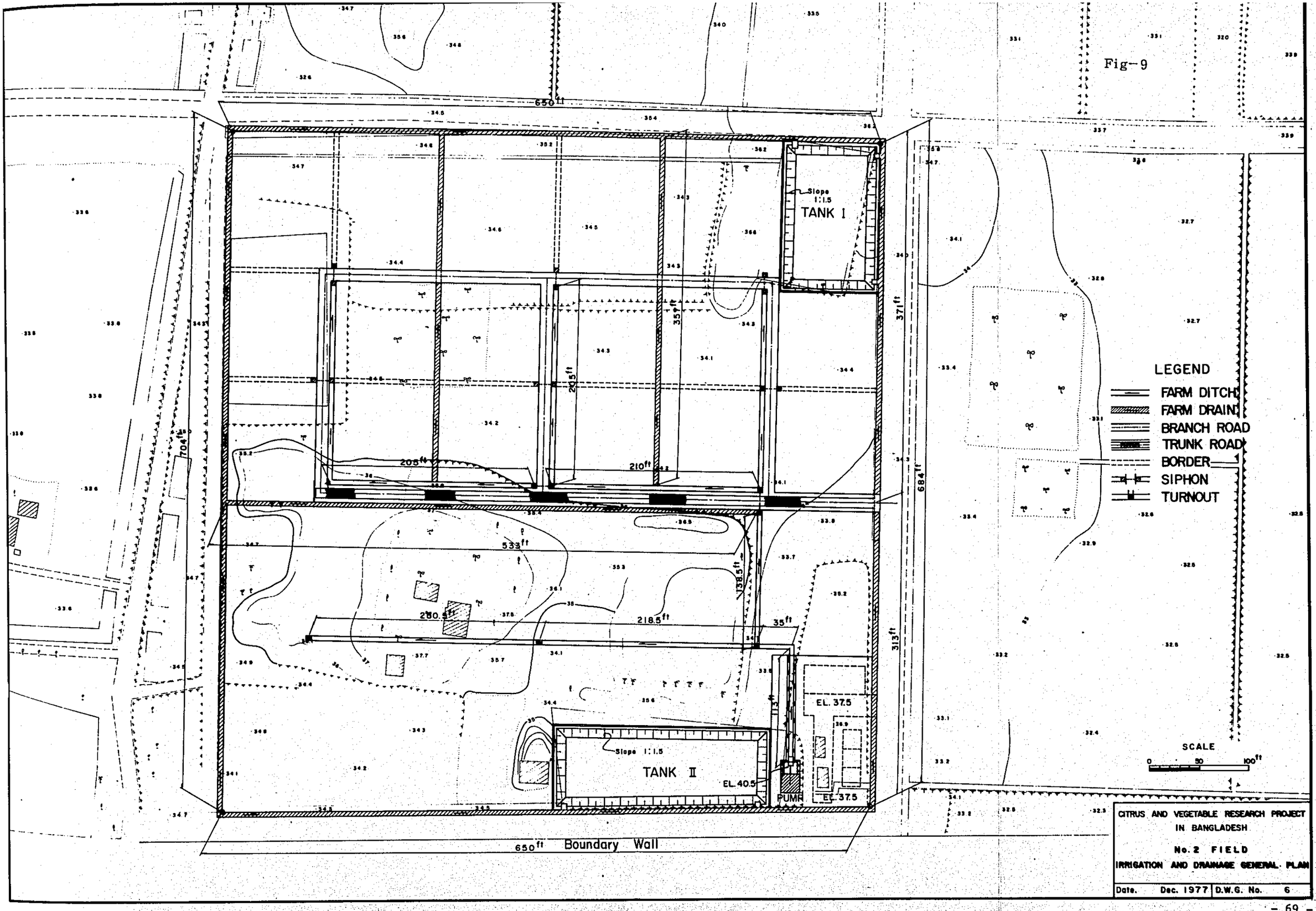
LAND CONSOLIDATION GENERAL PLAN

Date. Dec. 1977	D.W.G. No. 3

Fig–7


TANK
1032.8 ft
328 ft
297.2 ft
1032.8 ft
Boundary Wall
SCALE
0 50 100 ft
CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH
No. 2 FIELD(2)
GENERAL PLAN
Date. Dec. 1977
D.W.G. No. 4


TO JOYDEBPUR
ROAD SUPERIOR SURFACED WIDTH ABOUT 25 FEET
TO DACCA
BOUNDARY WALL
BOUNDARY WALL
POWER LINE
TANK
RESEARCH BLDG.
11,000 KVA
GLASS HOUSE
NET HOUSE
MDL
POWER LINE
Slope 1:2.0
177ft
330ft
238ft
110ft
97ft
EL. 22.0ft
EL. 25.0ft
276ft
261ft
123ft
198ft
EL. 22.0ft
EL. 28.0ft
130ft
227ft
192ft
475ft
ROAD UNDER CONSTRUCTION
DEEP TUBE WELL
LEGEND
BRANCH ROAD
FARM DRAIN
PIPE (ø=3")
PUMP
VALVE
HYDRANT
SCALE
0 50 100ft
CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH
No. 1 FIELD
IRRIGATION AND DRAINAGE GENERAL PLAN
Date. Dec. 1977
D.W.G. No. 5


650 ft
Slope 1:1.5
TANK I
35 ft
371 ft
205 ft
704 ft
210 ft
684 ft
533 ft
138.5 ft
280.5 ft
218.5 ft
35 ft
313 ft
EL. 37.5
Slope 1:1.5
TANK II
EL. 40.5
PUMP
EL. 37.5
650 ft Boundary Wall
LEGEND
FARM DITCH
FARM DRAIN
BRANCH ROAD
TRUNK ROAD
BORDER
SIPHON
TURNOUT
SCALE
0 50 100 ft
CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH
No. 2 FIELD
IRRIGATION AND DRAINAGE GENERAL PLAN
Date. Dec. 1977
D.W.G. No. 6

2-8 Design of deep well

Underground water will be used to irrigate Field No. 2. A deep well will be newly bored at the positions indicated in Fig. 7 and submerged motor pumps will be installed for pumping up underground water.

A fall in the water level resulting from the pumping-up operations will be caused in the areas within a radius of 350 to 400 m from the wells. The wells in the premises of the ABC Complex will not be affected by such a fall in the water level.

Soils of the project sites consist of clay extending from the ground level to a depth of 50 m, and underlying sand layers.

The static underground water level lies at a level of 6.0 m below the ground level in early October. In the present project, the underground water level for pumping operations is to be 30.0 m below the ground level.

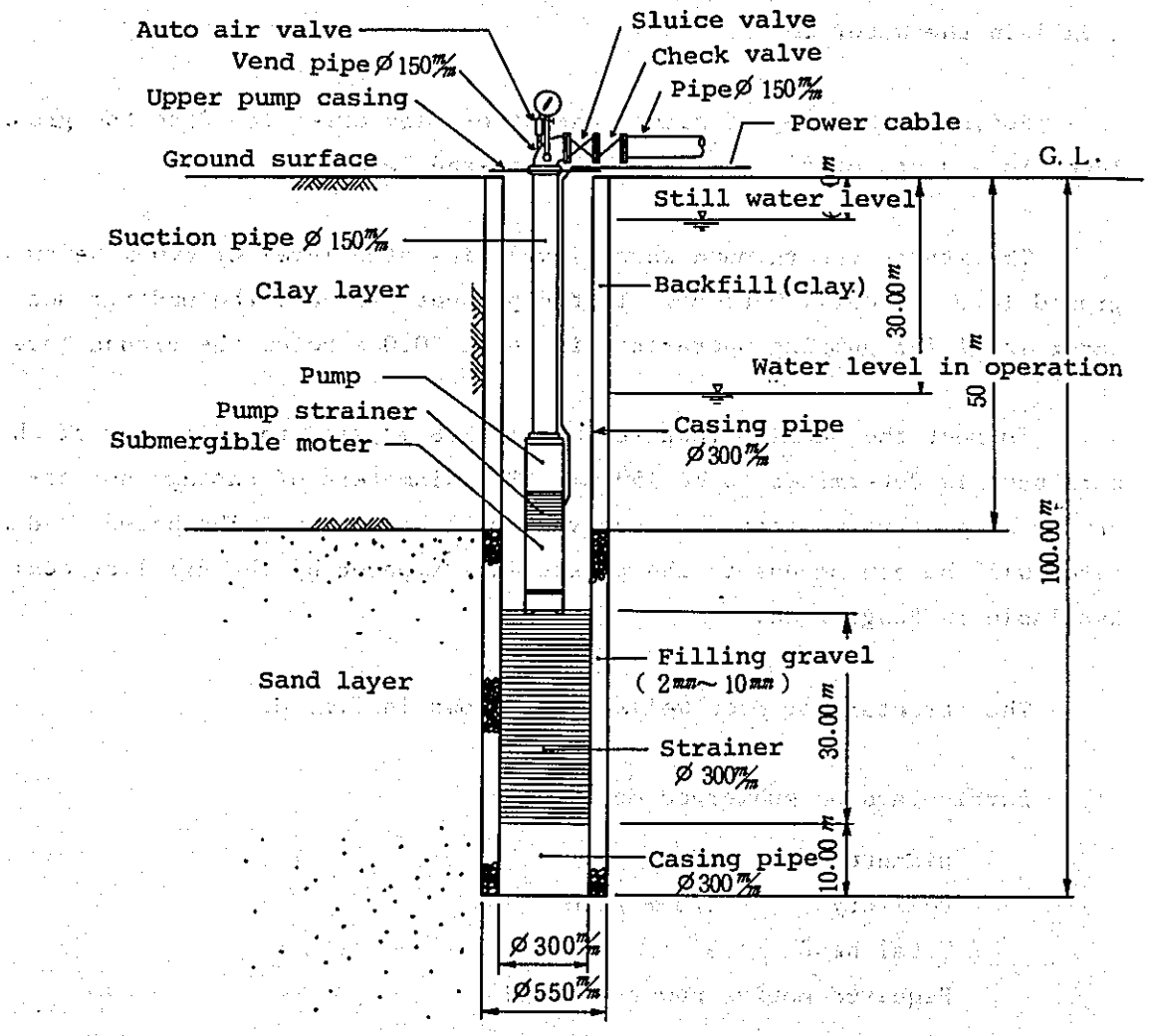
To meet the pumping requirements of 1.8 m^3/min, the diameter of the well pump is determined to be 150 mm. The diameters of casings and strainers to be penetrated into the deep well will be 300 mm. The borehole diameter will be 550 mm due to the constraints imposed by the drilling equipment available in Bangladesh.

The structure of deep wells is as shown in Fig. 8.

- Particulars of submerged motor pump

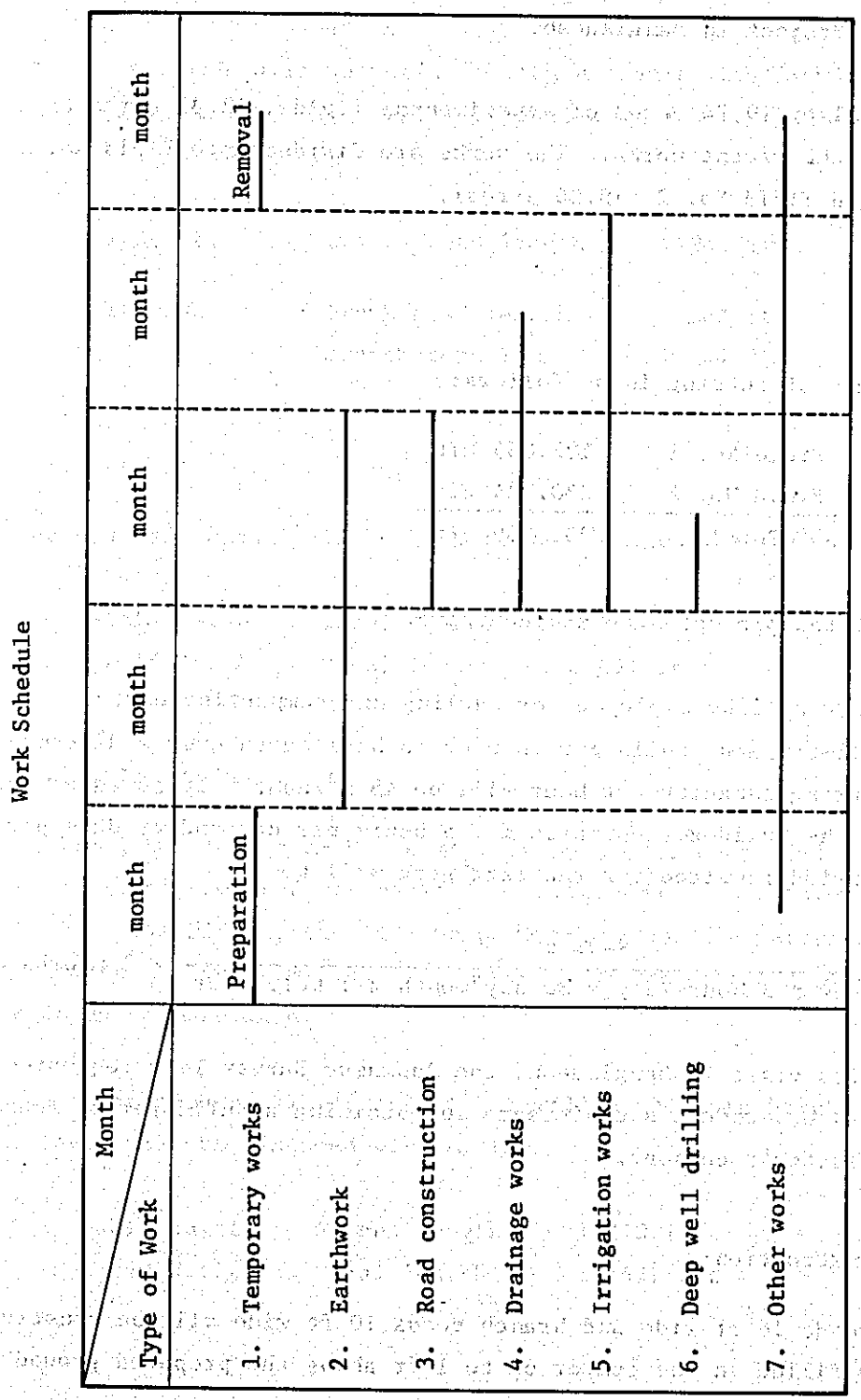
Diameter	6"
Delivery	1.8 m^3/min
Total head	35 m
Required motive power	19 KW

Fig-10 Structure of Deep Well



3. Construction Planning

3-1 Work schedule



3-2 Outline of works

The works involve the construction of two experimental fields in the premises of the ABC Complex in Joydevpur as a part of the Citrus and Vegetable Research Project in Bangladesh.

Of a total of 19.74 acres of experimental fields, 12.33 acres of land is involved in the recent works. The works are divided into Field No. 1 (1.97 acres) and Field No. 2 (10.36 acres).

(1) Earthwork

The volume of cutting is as follows:

Field No. 1	102.035 cft
Field No. 2	230.224 cft
Total	332.259 cft

Soils of the project site are cohesive.

Bulldozers will be employed for hauling and compacting earth. Assuming an 11-ton/hour bulldozer is used to haul earth over a distance of 30 m, the working capacity per hour will be 45 m^3/hour. It is taken for granted that the bulldozer operates for 5 hours per day and 20 days per month, the period required for the earthwork will be

$$\frac{9409\ m^3}{45\ m^3/\text{hour} \times 5\ \text{hours/day} \times 20\ \text{day/month} \times 1\ \text{bulldozer}} = 2\ \text{months}$$

During its visit to Bangladesh, the Japanese Survey Team requested the Bangladesh Government's assistance in obtaining a bulldozer on lease, and got the latter's consent.

(2) Road construction

Trunk roads 16 ft wide and branch roads 10 ft wide will be constructed. They will be filled in the center up to 1 ft above the prepared ground

level and the fill will be compacted thoroughly. The roads will have 2% cross grades.

The trunk roads will be surfaced with a figured brickwork 10 ft wide by 5 inches thick, which will be founded by a 1 ft-thick sand layer to keep its base even.

Field No. 1	Branch road length	840 ft
Field No. 2	Trunk road length	561 ft
	Branch road length	1,124 ft

(3) Drainage works

The drainage canal will be an 5 ft-wide excavation without timbering.

Field No. 1	Canal length	794 ft
Field No. 2	Canal length	2,601 ft

(4) Irrigation works

In Field No. 1, a trench 2.0 ft wide by 3.0 ft deep will be excavated in the center of the road and backfilled after laying a 3 in.-dia. water pipe in it. The pipe laying will be performed when the materials including the pipes arrive from Japan. Some delay is anticipated in the arrival of the Japanese materials.

The irrigation canal in Field No. 2 will be an open brick canal whose inside faces will be finished with mortar.

Field No. 1	Trench length	1,270 ft
Field No. 2	Canal length	1,765.5 ft

(5) Deep well drilling

Deep wells 22 inches in diameter and 300 ft in depth will be drilled and a 12 in.-dia. casing pipe and strainer will be penetrated into them.

The strainer will be positioned as close to the center of the bosehole as possible, and the opening between the strainer and the borehole face will have to be filled with gravel to prevent the strainer from being clogged.

The blind pipe above the strainer will be covered with clay to avoid contamination.

CHAPTER IV. PROVISION PLANNING OF FARM IMPLEMENTS

A plan for provision of farm implements to the Horticultural Research Center of Bangladesh was prepared by the Japanese Survey Team during its visit to the country. The plan was financial from the budgetary framework of ¥40,000,000 for fiscal year 1977 and ¥70,000,000 for fiscal year 1978.

The applications and types of the equipment to be provided as well as the equipment supply situations in Bangladesh are described as follows:

1. Present Supply Situation of Farm Implements in Bangladesh and Problems Involved

In the Delta zone in East Bengal, in which supplies provisions of the 83 million Bangladesh people, nearly every land arable for paddy rice plant during the rainy season is under Amon rice plant cultivation. This rice crop gives a higher yield in the northern part of the country and a lower yield in areas surrounding the capital city, Dacca. Its yield per hectare is as low as about 1.3 tons in terms of unhulled rice.

Preparation and cultivation of the rice paddies are, for the most part, performed by cattle and buffalos. The employment of tractors and power-driven tillers is limited to a small number of large-scale farms, tea plantations and State-operated pilot farms. These equipment are all imported, and according to a BADC (Bangladesh Agricultural Development Corporation) report, there are about 250 farm tractors and 800 power tillers in the country. Most of the tractors and power tillers including spare parts are from advanced countries, but not a few of them are as good as scrapped due to very rough handling.

The tractors are produced in the U.S., England, West Germany, East Europe, the U.S.S.R. and Japan. The power-driven tillers are all Japanese products, but a shortage of spare parts renders many of them unserviceable.

Irrigation pumps currently being in service in Bangladesh are mostly products of K.S.B. (a Bangladesh-West German joint venture) located in

Tollgi. Pumps manufactured by the Ebara Works, Ltd. of Japan are in service at shallow wells, rivers and irrigation ponds, since they are of low head. Irrigation pumps designed for deep wells (up to 70 m in depth) tend to be employed.

Chemicals sprayers and pulverizers are used at State-operated pilot farms and tea estates, but their employment by farmers is still very limited.

Under these circumstances, the employment of farm implements in Bangladesh is prerequisite for an increase in agricultural output. However, the rapid introduction of sophisticated farming equipment contradicting with the actual farming situation in Bangladesh would be uneconomized from technical and physical points of view. It is, therefore, desirable that farm implements including machines applicable to soils and other local conditions should be introduced as their demand arises, and the supply of spare parts must be thoroughly taken into consideration.

2. Agricultural Machinery Required for Operation of Horticultural Research Center

Japanese technical cooperation in the operation of the newly inaugurated Horticultural Research Center is expected to last for a period of five years, that is, three years as agreed in the Record of Discussions and an extension of about two years.

All materials and equipment necessary for the plowing, cultivation, weeding, blight and vermin control, harvesting and related investigations must be supplied from Japanese sources, apart from some farm implements and nitrogenouse fertilizers.

Agricultural machines and implements to be supplied to the Horticultural Research Center must be suited to the local conditions. If this is not the case, the equipment supplied may be short-lived. It is also important that a minimum of indispensable farm machines and implements be provided.

Needless to say, maintenance of the equipment supplied should be performed with proper care. For this purpose, one of the Japanese experts to be sent to the Horticultural Research Center must be skilled in the maintenance and care of agricultural machinery.

3. Intended Uses of Farm Machinery and Reasons for Selection of Types

(1) Tractor

The proposed experimental fields are of fine-grained cohesive soils which are easy to get sticky during rainy months and hard during dry months. Since it is difficult to prepare the soil and to plow it, it is planned to obtain sandy soil from rivers to mix it with the existing cohesive soil of a certain area of the proposed experimental fields.

For this purpose, 35 HP tractors will be employed and 1-ton-capacity dump trailers used for hauling sandy soil. Attachments, such as plows and harrows, will be rather smaller to avoid too much strain to the tractors operating under rather hard soil conditions.

Provision has been made for the supply of spare parts equivalent to 30% of the tractor price and which should be sufficient to meet 3-year requirements.

(2) Chemicals sprayer

The sprayer selected is of a portable type which, by the use of a long hose, can cover all parts of the experimental fields. The reasons for the selection of the portable sprayer are that a substantial quantity of chemicals must be applied to vegetables to protect them against blight and insect damage, and that manpower required for spraying of chemicals in orchards can be minimized.

Spray gun nozzles will be available in five different types for use in vegetable gardens and in orchards.

It will be convenient to carry sprayers on a trailer pulled by a 10 HP power tiller.

(3) Power tiller

The soil of the experimental fields must, after plowing by a large tractor, be carefully prepared for sowing and transplanting vegetables in order to assure the sound growth of the crops.

A 10 HP tiller will be used primarily in Field No. 1. It will also be employed for making a nursery bed for vegetables and for cultivation and weeding of the orchards. In addition, the power tiller will be provided to three subcenters to assure the smooth performance of their farm works.

(4) Cultivator

A cultivator will be used for cultivation of vegetables. Cultivation performs the functions of weeding and improving air permeability of soils, thereby promoting the growth of vegetables.

The cultivation is likely to be used with advantages on the cohesive soils of the proposed experimental fields. It can also be employed to weed and cultivate the orchards. Cultivators will be furnished to the subcenters.

(5) Power mower

A power mower will be used to mow the orchards for assuring the sound growth of young fruit trees. It is eight times more efficient than a hand mower. The power mower will be provided to the subcenters.

(6) Portable farm sulements

Farm implements locally available, such as plows and sickles, will be used for the farm work at the experimental fields. However, they are mostly of inferior quality and are not adequate for the purpose of improving efficiency in farm work.

For this reason, a sufficient quantity of farm implements for performing the work at the experimental fields will be supplied from Japan.

(7) Agricultural chemicals

Agricultural chemicals have been supplied from the U.S. and the U.N. in 200-liter drums. Chemicals, such as Malathon, EPN and Diazinon, apparently accounted for a greater part of the supplied chemicals. However, most of the chemicals stored in warehouses were found to have become ineffective. Many 50 kg cardboards containing powdered chemicals were also observed in storage.

Taking the above situation into consideration, it is considered appropriate to supply agricultural chemicals as the demand actually arises. Every care must be exercised to avoid waste of expensive chemicals when supplied to the experimental fields; for in the locality a very hot, humid weather lasts for a long period of time, and there is a shortage of suitable storage space for chemicals.

4. Irrigation Pump

(1) Deep well pump (for Field No. 2)

An annual rainfall of nearly 3,000 mm recorded in Dacca and its vicinity is concentrated during the July-September period. On the other hand, during the dry season lasting for almost six months, it is impossible, in most parts of Bangladesh except lowlands along rivers, to grow vegetables, unless the vegetable gardens or fields are irrigated.

The proposed Fields No. 1 and No. 2 are elevated about 1 m above the adjoining rice paddies and are, therefore, well drained during the rainy season. However, they need to be irrigated with about 8 mm of water per day for the raising of crops during the dry season. Since there are no rivers in the neighborhood and nearby irrigation ponds are small, it is necessary to drill a deep well and install a pump with adequate capacity.

The particulars of the well are as follows:

Pumpage	1.8 m^3/min
Depth of well	100 m
Driving water level	30 m

A 415V, 4 pole, 3 phase, 50 Hz power source is available at a distance of 400 m from the site of the well pump, and it is easy to make connection with the power source.

Soils of the deep well site consist of clayey soil extending from the ground surface to a depth of nearly 30 m and underlying fine-grained sand layers rich in underground water. An ample supply of water can be expected by boring to a depth of 100 m and inserting a casing pipe into the borehole (according to a survey conducted by B.A.D.C., CERDI and Shimizu Construction Co., Ltd. of Japan).

The permissible interval between well pumps in the Joydevpur area is 400 m.

(2) Pump for sprinkler (for Field No. 1)

The 5-acre Field No. 1 will be irrigated with water supplied by the existing pumping station owned by BARI.

Irrigation will be performed by the sprinkler method using a long pipe to raise crops in an efficient way.

(3) Portable irrigation pumps

Portable pumps will be employed to irrigate orchards, vegetable gardens and green manure from water nearby irrigation ponds. Portable pumps will be provided to the subcenters to facilitate their farm works.

5. Vehicles

The communication facilities in Bangladesh are poorer than generally imagined in Japan. During the rainy season, almost all roads except trunk roads are impassable to average vehicular traffic.

The Horticultural Research Center in Joydevpur is connected with Rangpur, Sylhet and Ishurdi by roadways which are paved, but are uneven in many places and for the most part, provide only a single lane, except in the vicinity of Dacca.

The distances and travel time required between Joydevpur and the three localities mentioned above are given below.

To Ranugpur: 320 km, 12 hours
Two ferry trips (4.5 hours) involved.

To Sylhet : 350 km, 11 hours
Four ferry trips involved.

To Ishurdi: 120 km, 7 hours
One ferry trip (3 hours) involved.

During rainy periods, it is advisable to use high-performance vehicles. If an automobile develops a mechanical breakdown on a trip in provincial areas, it may well be a big trouble for the travelers concerned.

The Japanese Survey Team members had a bitter experience during their stay in Bangladesh. Two hours after their departure from Dacca in a rent-a-car, the car engine developed a trouble and all the team members had to continue their trip in a jeep.

Since the gasoline price in Dacca is high as evidenced below, it is highly desirable to use diesel engine cars wherever it is possible.

Gasoline	21 takas per gallon
Light oil	11 takas per gallon

(US$1.00 = 15 takas)

(1) 4-wheel vehicles

Four-wheel vehicles are necessary for the purpose of making a technical guidance trip to provincial areas as well as for the Center's own activities.

(2) Station wagons

Two station wagons are needed for liaison with the headquarters in Dacca.

(3) Microbus

A microbus will be provided for the transportation of the Center personnel and visitors.

(4) Motorcycles

Motorcycles will be used for official purposes, and will also be provided to the subcenters. At the present time, each subcenter owns only an automobile.

(5) Bicycles

Bicycles will be used for official purposes by the Center and the subcenters. At the present time, the subcenters have no motorcycle or

bicycle. These vehicles are essential for facilitating communication between the subcenters and the Center/experimental fields.

(6) Medium-size trucks

4-ton trucks and 1-ton pickup trucks are required to facilitate the transport of materials and equipment to the experimental fields.

6. Laboratory Equipment

(1) The laboratory equipment consist of those items requested by the Survey Team members. They are destined primarily for the use in the laboratory of the Horticultural Research Center, but they will be used by the subcenters if necessary.

(2) Cooling unit

Coolers will be installed in the laboratory and the office of the Center. They are indispensable for research work carried out in a hot, humid weather like that of Bangladesh.

The Center building is not an old fashioned building with high ceilings, but a modern one requiring coolers.

Coolers are used in the office and the laboratory of the nearby BRRI building.

7. Storage of Agricultural Machinery and Implements and Supplied Equipment

The supplied equipment are expected to be delivered to the project site by May 1978. It is necessary to make early arrangements to provide storage space for the equipment. It is also necessary to build a warehouse

near the proposed experimental fields to store agricultural machines and implements.

During its visit to Bangladesh, the Japanese Survey Team arranged for the supplied equipment to be stored in the BARI owned warehouse temporarily after delivery. However, this warehouse is located in Dacca, some 40 km distant from the project site. Because of the inconvenience to be encountered, the supplied equipment will be transferred to a new warehouse at the project site as soon as it is completed.

CHAPTER V. TECHNICAL COOPERATION PLAN FOR CITRUS AND VEGETABLE RESEARCH PROJECT OF BANGLADESH

1. Future Development of Research Project and Problems

As earlier mentioned, the Records of Discussions on Technical Cooperation in 3-year Citrus and Vegetable Research Project of Bangladesh were signed on November 3, 1977 between the Ministry of Planning of the People's Republic of Bangladesh and the Detailed Design Team organized by the Japan International Cooperation Agency and headed by Dr. Masamoto Yasuo of the Agency.

Back in February 1976, a 4-man team headed by Sueyoshi was sent to Bangladesh by the JICA to survey the actual conditions of the citrus improvement and vegetable seed proliferation projects in that country and to work out the necessary remedial measures. Subsequently, two more similar JICA survey teams were sent to Bangladesh. Earlier in 1977, citrus and vegetable experts were sent to the country to carry out a long-term survey.

On the other hand, in or around 1972 Youth Cooperation Corps members began to be sent to the Agricultural Extension Training Institute (AETI) and the Bangladesh Agricultural Development Corporation (BADC). The close cooperation of the YCC members with Bangladesh farmers and extension officials has been appraised highly.

It is important to reflect all those activities in the future Japanese technical cooperation in the citrus and vegetable research project of Bangladesh.

2. Outline of Project

(1) Executing agency

Japanese side : JICA
Bangladesh side: Ministry of Agriculture (ARI)

(2) Executing personnel

The Project will be implemented primarily by the competent counterpart personnel of the People's Republic of Bangladesh with the assistance of Japanese experts.

(3) Despatching of Japanese experts

Japanese experts will be sent to Bangladesh in accordance with the following schedule:

	1977	1978	1979	1980	1981
Team leader	⊢———	———	———⊣	----------	----------
Citrus expert	⊢———	———	———⊣	----------	----------
Vegetable expert	⊢———	———	———⊣	----------	----------
Coordinator	⊢———	———	———⊣	----------	----------

(4) Receiving of trainees

Training of Bangladesh officials in Japan will be performed in accordance with the following program:

	1977	1978	1979	1980	1981
Technical trip	2	2	1	1	1
Citrus	1				
Vegetables	1	3	3	3	3

(NOTE) This training program may be changed according to progress in the Project and annual allocation of trainees.

(5) Supplied materials and equipment

Materials and equipment to be supplied to the Project under the Japanese Government financial aid are as shown in the following program:

	1977	1978	1979	1980	1981	Total
Budget	40,000	70,000	90,000	70,000	50,000	320,000
Major equipment	Vehicles	Construction materials and equipment	Laboratory equipment	Laboratory equipment	Laboratory equipment	
	Construction materials and equipment	Laboratory equipment	Farm equipment and implements	Sapre parts	Farm equipment and implements	
	Others	Others	Others	Others	Others	

(NOTE 1) The number of Japanese experts in the above specialities to be sent to Bangladesh will be not more than five.

(NOTE 2) Experts in the above and other specialities may be sent for a short period, if necessary.

(NOTE 3) Japanese experts will be posted in the main Center, and will visit subcenters for technical guidance, as necessary.

3. Details of Project and Method of Implementation

(1) Outline of implementation

In the initial stage of the Project, it is indispensable to conduct adaptability tests on the field as well as basic research work, such as the selection of superior-grade varieties and virus control.

Seed production and distribution and agricultural extension education are pleaded for the later stage of the Project.

(2) Importance of branches of Research

(i) Citrus

Virus control is prerequisite for citrus development.

(a) Basic research work, such as the search for sound parent trees and the detection of viruses.

(b) Comprehensive research, including blight and vermin control, study of fertilizer, etc.

(c) Adaptability tests on the field and setting-up of model farm.

(ii) Vegetable

(a) Rearing of superior-grade plants and establishment of the method for extraction of their seeds.

(b) Comprehensive research, including blight and vermin control, study of fertilizers, etc.

(c) Production of seeds, distribution of seedlings, and setting-up of model farm.

Coordination and exchange of information among research workers, cooperation of Japanese experts and the use of high-precision laboratory equipment are the key factors in the successful research work on citrus and vegetables. For this reason, it is advisable to base the research activities in ARI in Dacca (Joydevpur).

APPENDIX I. METEOROLOGICAL DATA

Rainfall Recorded Extremes	Joydebpur Station
1. Maximum Annual Rainfall	111.84 inches in 1973-74
2. Minimum Annual Rainfall	43.25 inches in 1951
3. Maximum Monthly Rainfall	69.10 inches in Aug. 1950
4. Maximum Daily Rainfall	8.10 inches on Aug. 21, 1950 & Sept. 18, 1973

Monthly Rainfall

Station: Joydebpur

(in inches)

Month / Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
1964				9.43	12.50	9.16	20.16	9.21	8.87	17.00	0.30	0.00	
65	0.00	0.05	0.00	0.75	10.40	23.30	12.86	19.30	4.90	0.90	0.35	0.05	72.86
66	0.15	0.00	0.10	2.37	3.35	17.20	13.30	19.30	16.00	9.61	1.90	0.45	83.73
67	0.85	0.03	5.07	4.73	10.35	12.10	12.50	21.65	7.90	2.90	0.00	0.02	78.10
68	0.00	0.04	1.97	4.18	8.43	22.26	14.90	13.48	6.47	1.45	0.78	0.00	73.96
69	0.02	0.00	3.35	8.08	4.43	14.35	14.91	19.62	11.06	3.35	1.55	0.00	80.72
70	0.29	0.09	0.35	2.87	5.43	8.75	15.02	11.17	4.48	17.27	0.42	0.00	66.14
71	0.00	0.00	0.00	0.94	10.75	13.77	13.70	24.75	10.59	2.89	3.80	0.00	81.19
72	0.00	0.50	1.27	6.15	4.67	8.68	7.01	10.78	6.40	2.55	0.00	0.00	48.01
73	0.32	4.60	0.73	7.90	20.35	21.09	20.63	16.63	12.10	5.41	1.39	2.80	113.95
74	0.00	0.00	3.54	6.80	9.36	9.80	23.35	9.78	14.45	5.10	0.00	0.00	82.18
75	0.00	0.05	0.85										

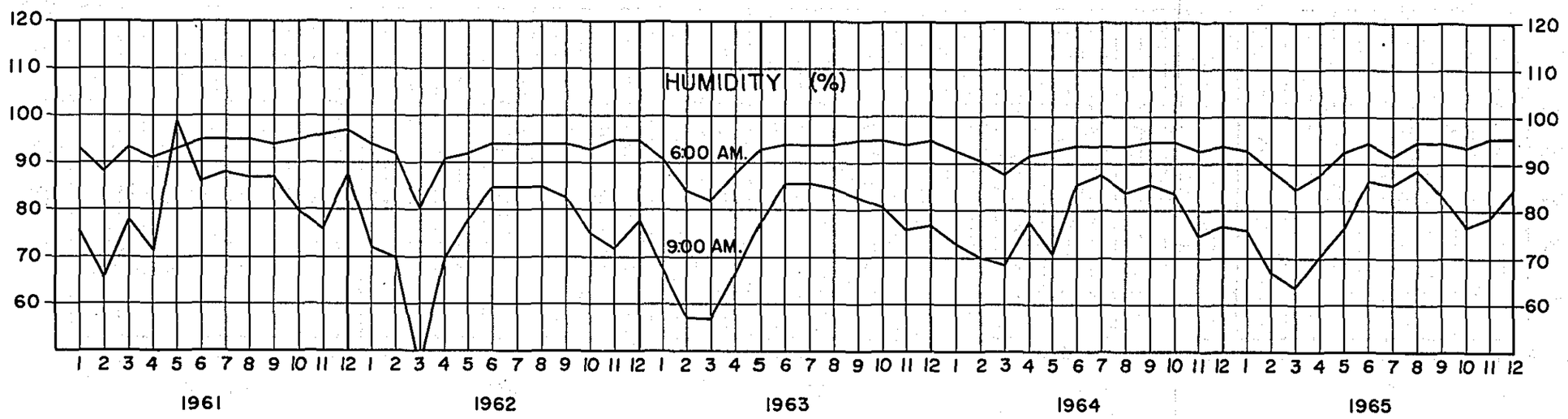
Monthly Rainfall

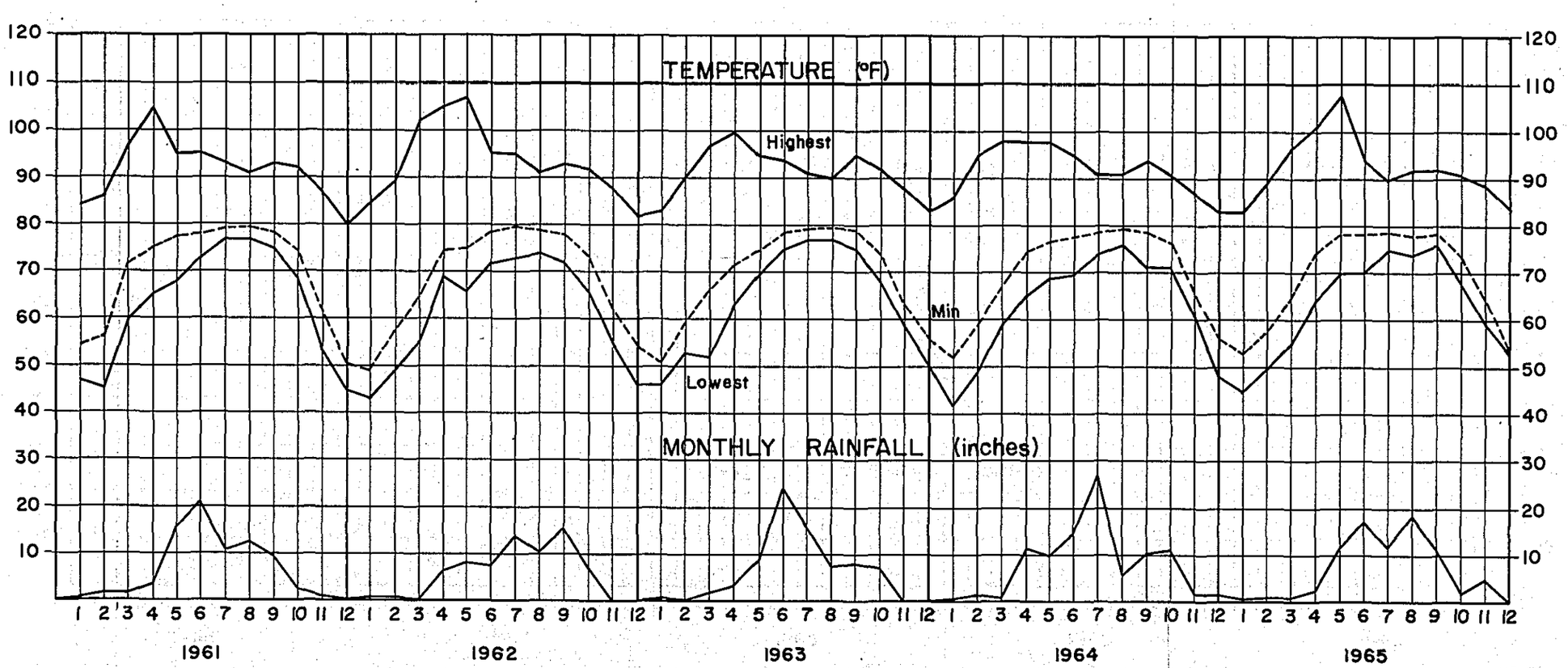
Station: Dacca

(in inches)

Month / Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
1965	0.07	1.08	0.90	2.44	11.95	17.31	11.88	18.80	11.74	2.02	5.11	0.00	83.30
66	0.53	0.00	0.33	1.40	4.94	13.31	11.21	13.47	21.17	9.25	0.56	0.58	76.75
67	0.68	0.03	6.60	2.85	8.40	9.46	14.23	19.94	10.94	2.88	0.02	0.01	76.04
68	0.00	0.20	4.74	3.05	8.35	19.32	18.96	10.02	4.98	2.70	2.64	0.00	74.96
69	0.00	0.05	2.60	3.39	3.72	9.81	11.92	20.95	7.91	4.04	1.28	0.00	65.67
70	0.60	0.30	1.47	1.76	7.55	11.18	19.66	9.97	7.87	18.85	1.24	0.00	80.45
71	0.10	0.46	-	-	14.89	12.33	21.76	21.52	12.50	4.66	4.28	0.00	92.50
72	0.00	0.47	0.49	9.76	13.32	13.88	6.23	14.83	4.38	4.16	0.00	0.00	67.52
73	0.00	0.82	2.19	5.04	24.00	16.23	11.29	10.07	13.76	4.99	2.62	3.39	94.40
74	0.15	0.00	3.92	6.31	9.31	11.10	27.76	13.35	8.89	6.13	0.06	0.00	86.98
75	0.03	1.14	0.51	4.38	10.66	10.63	22.52	8.06	13.36	7.97	1.49	0.00	80.75
76	0.00	0.29	4.57	1.32	13.15	24.62	12.93	15.22	6.48	4.46	0.32	0.00	83.36

DACCA STATION





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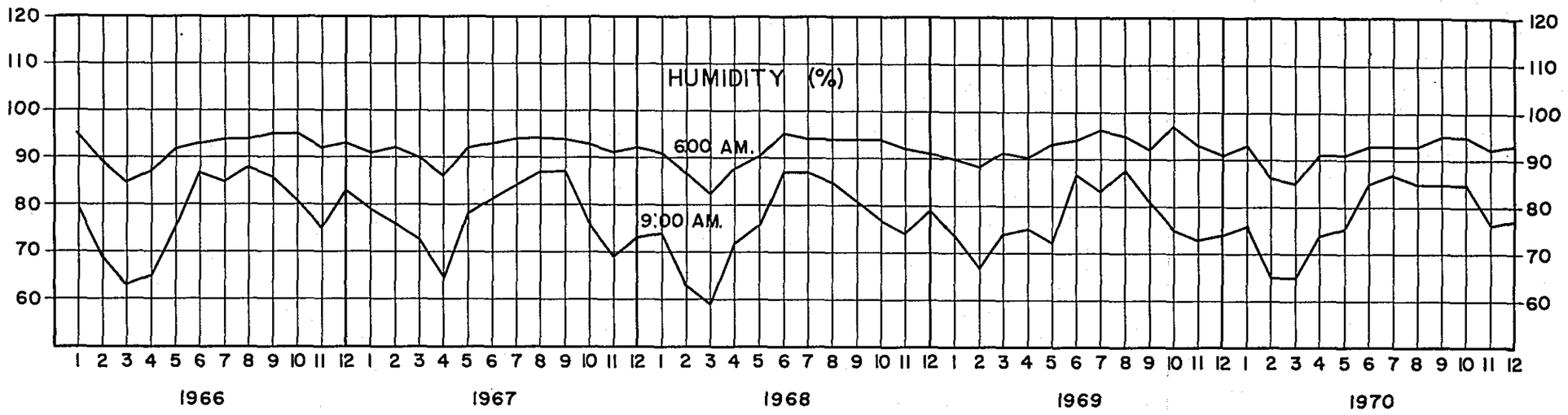
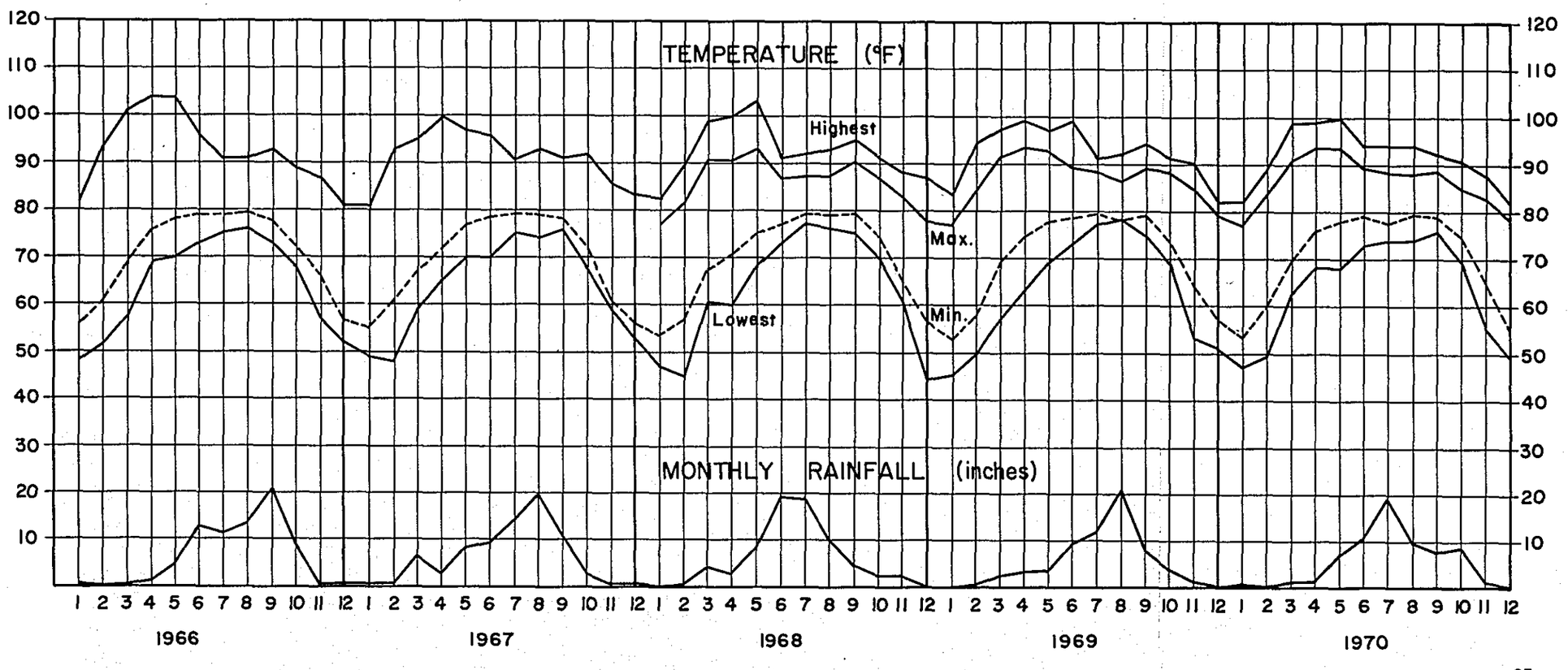




APPENDIX II. SUMMARY OF QUANTITIES

		Field No. 1	Field No. 1	Total	Remarks
Earthwork	Cutting	102,035	230,224	cft 332,259	
	Filling (To use earth cut out)	102,035	(53,657) 227,901	cft (53,657) 329,936	Figure in parentheses indicate quantity of earth for road and irrigation canal fills.
	Filling (To use earth from other sources)	(8,736) 83,473	—	cft (8,736) 83,473	Figure in parentheses indicate quantity of earth for road fills.
Suction tank		1		1	
Discharge tank			1	1	
Irrigation work	Pipeline	1,270		ft 1,270	
	Open canal		1,765.5	ft 1,765.5	
Hydrant box		19		19	
Water distribution facilities	Type A		1	1	
	Type B		1	1	
	Type C		1	1	
Siphon	Type A		1	1	
	Type B		1	1	
	Type C		6	6	
Road construction	Trunk road		561	ft 561	
	Branch road	840	1,124	ft 1,964	

		Field No. 1	Field No. 2	Total	Remarks
Drainage works		794	2,601	cft 3,395	
Culvert	Type A		2	2	
	Type B	3	2	5	
Fence foundation		245	449	694	Cost included in emergency work costs.
Material for cultivation (sand)		33,106	179,249	cft 212,355	
Pump house		1		1	

THE RECORD OF DISCUSSIONS BETWEEN THE JAPANESE SURVEY TEAM FOR TECHNICAL COOPERATION ON CITRUS AND VEGETABLE RESEARCH PROJECT AND THE AUTHORITIES CONCERNED OF THE GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

The Japanese Technical Cooperation Team (hereinafter referred to as the Team) which was organized by Japan International Cooperation Agency (hereinafter referred to as "JICA") and headed by Dr. Masamoto YASUO, visited Bangladesh from September 27 to November 4, 1977 for the purpose of working out the details of the Technical Cooperation between Japan and Bangladesh for Citrus and Vegetable Research Project (hereinafter referred to as the Project) proposed by the Government of Bangladesh and related matters.

During its stay in Bangladesh, the Team had a series of surveys and discussions with the authorities concerned of the Government of Bangladesh concerning the desirable measures to be taken by both Governments for the successful implementation of the Project. As the result of the surveys and discussions, the Team and the Bangladesh authorities concerned agreed to cooperate with each other in the matters referred to in the document attached hereto and/the side letter regarding paragraph 6 (2)(c) of the attached document.

DACCA

November 3, 1977.

A. W. Chowdhuri
Deputy Secretary
for the Government of the
People's Republic of Bangladesh.

Masamoto YASUO
Team Leader
for Japan International
Cooperation Agency.

THE ATTACHED DOCUMENT

RECORD OF DISCUSSIONS BETWEEN THE JAPANESE SURVEY TEAM FOR TECHNICAL COOPERATION ON CITRUS AND VEGETABLE RESEARCH PROJECT AND THE AUTHORITIES CONCERNED OF THE GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

1. (1) Both governments will cooperate with each other in implementing the technical cooperation project on Citrus and Vegetable Research Project (hereinafter referred to as the "Project") for the purpose of increasing citrus and vegetable production in the People's Republic of Bangladesh. The outline of the Project will be as specified in Annex 1, provided that it may be modified by agreement between the authorities concerned of both Governments in order to secure smooth and effective implementation of the Project as a whole.

(2) The Project will be implemented in accordance with an operational work plan to be formulated annually by the "Joint-Committee" referred to in paragraph 8. The operational work plan so formulated shall be approved by the authorities concerned of both Governments.

2. (1) In accordance with the laws and regulations in force in Japan, the Government of Japan will take necessary measures through JICA to provide at its own expense the services of Japanese Experts/officials (hereinafter referred to as "Experts") as listed in Annex II through the normal procedures under the Colombo Plan Technical Cooperation Scheme.

(2) In according with the laws and regulations in force in Bangladesh, the Japanese Experts and their families will be granted in the People's Republic of Bangladesh privileges, exemptions and benefits as listed in Annex III. Such privileges, exemptions and benefits will be no less favourable than those granted to the Japanese Experts of the Central Extention Resources Development Institute (hereinafter referred to as "CERDI")

3. (1) In accordance with the laws and regulations in force in Japan, the Government of Japan will take necessary measures through JICA to provide at its own expense such articles required for the implementation of the Project as listed in Annex IV through the normal procedures under the Colombo Plan Technical Cooperation Scheme.

(2) The articles referred to in (1) above will become the property of the Government of the People's Republic of Bangladesh upon being delivered CIF at any port or airport in the People's Republic of Bangladesh to the authorities concerned of the Government of the People's Republic of Bangladesh.

(3) The articles referred to in (1) above will be utilized exclusively for the implementation of the Project.

4. (1) In accordance with the laws and regulations in force in Japan, the Government of Japan will take necessary measures through JICA to receive Bangladesh officials associated with the Project for technical training or for observation tour in Japan through the normal procedures under the Colombo Plan Technical Cooperation Scheme.

(2) In accordance with the laws and regulations in force in Bangladesh, the Government of the People's Republic of Bangladesh will take necessary measures through the Ministry of Agriculture to ensure that the knowledge and experience acquired by the Bangladesh officials referred to in (1) above will be effectively utilized for the implementation of the Project.

5. In accordance with the laws and regulations in force in Bangladesh, the Government of the People's Republic of Bangladesh undertakes to bear claims, if any arises, against the Japanese Experts engaged in the Project resulting from, occurring in the course of, or otherwise connected with the discharge of their official functions in good faith in the people's Republic of Bangladesh, except for those claims arising from the wilful misconduct of gross negligence of the Japanese Experts.

6. (1) In accordance with the laws and regulations in force in Bangladesh, the Government of the People's Republic of Bangladesh will take necessary measures through the Ministry of Agriculture to ensure the recruitment of Bangladesh counterpart officials and other personnel as listed in Annex V and to provide at its own expense the services of such counterpart officials and personnel.

(2) In accordance with the laws and regulations in force in Bangladesh, the Government of the People's Republic of Bangladesh will take necessary measures through the Ministry of Agriculture to provide at its own expense:

(a) land and buildings as listed in Annex VI as well as incidental facilities;

(b) supply or replacement of facilities, equipment, machinery, vehicles, implements, tools, their spare parts and any other materials necessary for the implementation of the Project other than those provided by the authorities concerned of the Government of Japan under 3(1);

(c) housing accommodation for the Japanese Experts, and facilities for their official travels within the People's Republic of Bangladesh.

7. In accordance with the laws and regulations in force in Bangladesh, the Government of the People's Republic of Bangladesh will take necessary measures through the Ministry of Agriculture to meet:

(1) expenses necessary for construction or improvement of roads, irrigation and drainage facilities and other facilities for the implementation of the Project;

(2) custom duties, internal taxes and other similar charges, if any, imposed in the People's Republic of Bangladesh in respect of the articles referred to in 3(1);

(3) expenses necessary for the transportation of the articles referred to in 3(1) within the People's Republic of Bangladesh as well as for the installation, operation and maintenance thereof;

(4) all running expenses necessary for the implementation of the Project.

8. (1) The Ministry of Agriculture of the Government of the People's Republic of Bangladesh will be responsible for the administration and implementation of the Project, and the Japanese Experts will provide necessary technical guidance and advice for the implementation of the Project.

(2) There will be established a Joint-Committee for the successful implementation of the Project. The composition of the Committee is specified in Annex VII. The Committee will meet regularly.

(3) The Project will be implemented with close cooperation extended by the agricultural agencies and institutions concerned of the People's Republic of Bangladesh.

9. Both the Governments will consult with each other in respect of any matter that may arise from or in connection with this Record of Discussions.

10. The period of the technical cooperation mentioned in this Record of Discussion will be three (3) years from the date of signature of the Record of Discussions and the authorities concerned of both Governments will hold mutual consultations within this period concerning the next stage of the technical cooperation if necessary.

Annex I

The outline of the Project

For the purpose of technical improvement on Citrus and Vegetable production, Main Centre (including experiment fields) will be set up at Joydevpur, and Jaintiapur Research Sub-station, Ishurdi Regional Research Station and Rangpur Research Sub-station will fill their functions as Sub-centres, and the following activities will be implemented.

1. Activities at Main Centre:
   (1) Research for high yielding disease-resistant varieties of citrus and vegetable;
   (2) Development of technical resources for vegetable-seed production and storage;
   (3) Collection of information and exchange of the results of the studies about the above-mentioned matters.

2. Activities at Sub-centres:
   Guidance and advice on the following tests and trials at Sub-centres which may be necessary in connection with activities at Main Centre;

Jaintiapur	Citrus
Rangpur	Vegetable
Ishurdi	Citrus and vegetable

Annex II

The Japanese Experts

Category	Field
1. Team leader	
2. Experts	(1) Citrus (2) Vegetable (3) In such field as may be requested by the Ministry of Agriculture of the Government of Bangladesh
3. Liaison officer/coordinator	

Note:

1) Experts of the above-mentioned fields will be within five (5) persons.
2) Short-term Experts of the above-mentioned fields or others may be dispatched when necessity arises.
3) Japanese Experts usually reside at Main Centre and make their rounds of Sub-centres to provide technical guidance when necessity arises.

Annex III

Privileges, exemptions and benefits

1. Exemption from income tax and charges of any kind imposed on or in connection with the living allowances remitted from abroad;

2. Exemption from providing security and from import and export duties and any other charges imposed in respect of personal and household effects (including one vehicle) which may be brought into the People's Republic of Bangladesh;

3. Free medical and dental services and facilities at Governmental hospitals and health centres;

4. Issue of identification cards to the Japanese Experts, to secure the cooperation of the authorities concerned of the People's Republic of Bangladesh necessary for the performance of the duties of the Japanese Experts, and their families.

Annex IV

The articles to be provided by the Government of Japan

1. Facilities, machinery and implements for laboratory work, and their spare parts;

2. Facilities, machinery and implements for field work, and their spare parts;

3. Facilities, machinery and implements for vegetable-seed production and storage, and their spare parts;

4. Fertilizer, agricultural chemicals and other materials including planting materials;

5. Audio-visual aids and their spare parts;

6. Vehicles and their spare parts;

7. Other necessary equipment, facilities and materials.

Annex V

The Bangladesh counterpart officials and other personnel

Category	Field
1. Project director	
2. Experts	(1) Citrus
	(2) Vegetable
	(3) As may be necessary
3. Clerical and service personnel	
4. Labourers	

Note:

One Japanese Expert will collaborate with at least one counterpart official at Main Centre, and at least one officer in charge of the Project will be posted at each Sub-centre.

Annex VI

The land and buildings

1. Land:

1) Land for buildings and nurseries	2 ha (fixed)
2) Land for citrus experiment field	3 ha (fixed)
3) Land for vegetable experiment field	4 ha (by rotation)

2. Building:

1) Main building
2) Store house for agricultural machinery, facilities, implements and materials
3) Glass house and Screened house
4) Garage
5) Shed for field work

Annex VII

The composition of the Joint-Committee

1. Bangladesh side:

Chairman	Joint Secretary (Research) Ministry of Agriculture
Member	Representative, Agricultural Division, Planning Commission
-do-	Representative, Agriculture Research Council
-do-	Representative, Horticulture Development Board
-do-	Representative, Agriculture Research Institute
-do-	Representative, Faculty of Horticulture, Bangladesh Agriculture University
Member Secretary	Project Director Counterpart

2. Japanese side:

Team Leader
Experts
Liaison officer/coordinator
Team Leader, CERDI
Representative, Japan International Cooperation Agency

Note:

An official of the Embassy of Japan may attend the meeting of the Joint-Committee as an observer.

Dr. M. Yasuo,
Team Leader,
Mission on Horticulture
Research Project,
Japan International Cooperation Agency

November 3, 1977

Dear Mr. A. W. Chowdhuri,

Pertaining to your letter No. D. O. No. TAP/116/Japan/77, I acknowledge the difficulty for the Government of the People's Republic of Bangladesh to provide housing accommodation for the Japanese experts for the period of their stay in Bangladesh as mentioned in the Record of Discussion.

I understand that this letter and your letter form a part of the Record of Discussion.

Yours sincerely,

(M. Yasuo)

Mr. A. W. Chowdhuri,
Deputy Secretary (TAP),
External Resources Division,
Ministry of Planning,
Government of the People's
Republic of Bangladesh,
Dacca.

APPENDIX IV. INTERIM REPORT

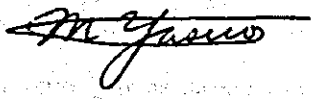
INTERIM REPORT ON THE DETAILED DESIGN
TEAM FOR HORTICULTURE RESEARCH PROJECT
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

Following the result of the survey team for the master plan of this project in the summer of 1976, the Japan International Cooperation Agency (JICA) dispatched seven members headed by Dr. Masamoto Yasuo, Deputy Director, Agricultural and Forestry Planning and Survey Department to Bangladesh from September 27 to November 4, 1977 for the purpose of working out details of the Technical cooperation between Japan and Bangladesh for Citrus and Vegetable Research Project.

During its stay in Bangladesh, the team had the surveys and a serial discussion with the authorities concerned of the Government of Bangladesh. As the result of the survey and discussion the team and Bangladesh authorities concerned agreed to recommend to their respective Government the matters referred to in the attached INTERIM REPORT on the detailed design team the technical cooperation for the Horticulture Research Project in Bangladesh.

During our stay in the People's Republic of Bangladesh we have met many Government officials and authority concerned who have extended their full cooperation with us. We are grateful to them and convey our heartful thanks.

DACCA
November 3, 1977



Masamoto YASUO
Team Leader
for Japan International
Cooperation Agency.

OUTLINE FOR TECHNICAL COOPERATION ON
CITRUS AND VEGETABLE RESEARCH PROJECT
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

I. IMPLEMENTATION AGENCIES

Bangladesh side: Ministry of Agriculture (ARI)
Japanese side : Japan International Cooperation Agency

II. PROJECT STAFF

The Project staff will consist of Japanese experts and counterpart personnels of the People's Republic of Bangladesh, and this project will be carried out mainly by Bangladesh counterpart personnels with assistance of Japanese experts.

III. PROGRAM FOR IMPLEMENTATION

Japanese experts will be assigned in accordance with the schedule as follows.

	1977	1978	1979	1980	1981
Team leader	⊢———	———	———	………	……⊣
Citrus	⊢———	———	———	………	……⊣
Vegetable	⊢———	———	———	………	……⊣
Coordinator	⊢———	———	———	………	……⊣

Notes:

1) Experts of the above-mentioned fields will be within five (5) persons.
2) Short-term experts of the above-mentioned fields or others may be dispatched when necessity arises.
3) Japanese experts usually reside at Main Centre and make their rounds of Sub-centers to provide technical guidance when necessity arises.

IV. TRAINING AND STUDY TOUR IN JAPAN

The training and study tour in Japan for Bangladesh personnels will be carried out along the schedule as follows.

	1977	1978	1979	1980	1981
Study tour	2	2	1	1	1
Citrus	1				
Vegetables	1	3	3	3	3

Note: This training program is subject to changes in accordance with the progress of project and annual country allottment of trainees.

V. EQUIPMENT AND MACHINERY TO BE PROVIDED

The equipment and machinery will be provided in accordance with the provisional list as follows.

(unit: 1 thousand Yen)

	1977	1978	1979	1980	1981	
Budget	40,000	70,000	90,000	70,000	50,000	320,000
Main equipment	vehicles	construc-tion equipment	research equipment	"	"	
	construc-tion equipment	research equipment	agri-culture material	Parts	agri-culture materials	
	Others	Others	Others	Others	Others	

A PLAN OF CO-OPERATIVE WORKS

Horticultural Research Project in Bangladesh

1. Object:

To serve as a strong national Citrus Research Centre through a wide spectrum of applied and adaptive research.

2. Course of action:

(1) To throw the knowledges, experiences and techniques of Japanese Citrus investigators into the project, through Japanese expert in Bangladesh.

(2) To accomplish foreign (Japan) training of technical personnels who are in charge of Citrus.

(3) To refer the actual results on the development of Citrus culture and its study works which have been done in Japan.

3. Methods:

(1) Searching for superior varieties.

(a) Investigations about suitability and productivity of local varieties.

(b) Investigations about suitability and productivity of imported varieties.

(c) To hold an exhibition about Citrus.

(2) Fundamental research works.

(a) Finding out the virus-free plant and breeding up the virus-free mother plant.

(b) Selection of suitable root-stocks and its theoretical studies.

(3) Improvement of cultural techniques.

(a) Establishment standard growing method about nurseries.

(b) Establishment of cultural techniques.

A. Main Centre (Joydevpur):

(Fundamental investigations by equipments and implements would be carried-out principally).

(1) BREEDING:

(a) Searching for good varieties in this country.
(b) Introduction of foreign varieties.
(c) Breeding varieties by seedling.
(d) Breeding virus-free individuals by seedling.
(e) Keeping of method trees.

(2) Mutritional physiology:

(a) Studies on the nutritional diagnosis.
(b) Analysis of components (of abnormal trees).

(3) Diseases:

(a) Diagnosis of virus diseases.
(b) Setting Citrus plants free from virus.
(c) Obtaining plants of virus resistance (by injection of weak toxin)

(4) Insect pests:

(a) Studies on vectors.

B. Citrus Experiment Station (Jointiapur):

(Experimental works on the field would be carried out principally).

(1) BREEDING:

(a) Searching for suitable varieties (contacting with the main centre).
(b) Tests on the suitable of the introduced varieties.
(c) Tests on the adaptability on the selected varieties.
(d) Comparative tests on the seedlings under breeding, (following to main-centre).
(e) Root-stock trials.
(f) Propagation tests (of detoxic and injected varieties which are selected at main-centre).

(g) Distribution of bred nurseries.

(2) Culture:

(a) Tests on the cultural method.

(1) Comparison between several planting methods

(2) Effect of shade trees and selection of suitable kinds.

(3) Treatments of young trees (Training and pruning)

(b) Tests on manure and fertilizers (kinds and amount).

(c) Prevention of erosion, and improvement of soil condition.

(d) Establishment of model farm.

(3) Diseases:

(a) Investigation about frequency of out-break on main diseases.

(b) Central test of main diseases.

(c) Investigation about the conditions of virus disease occurrence. (co-operating with main-centre).

(d) Tests on the evasion of virus diseases. (Using the plant material selected at the main centre and working together with breeding and cultural section of the station).

4. INSECT PESTS:

(a) Investigation about the frequency of main insect pests.

(b) The control tests of main insect pests.

5. Training:

Artificial training of agent and growers.

C. Sub-Centre (Ishurdi, Citrus Division):

(1) Culture.

Tests on the regional adaptability of the Citrus varieties selected.

(2) Exhibition:

Model farm on Citrus cultivation.

(3) Distribution of nurseries.

Distribution of selected Citrus nurseries.

(4) Training:

Technical training of growers.

SUBJECT	1st Plan Period 1977-78	2nd Plan Period 1978-79	1979-80	1980-81
6. TRAINING				
1. Technical training of agents and growers	M.	M.S.	S.	S.
7. DISTRIBUTION				
1. Multiplication of Selected varieties				S.

Note: M. ... Main Centre (Joydevpur)

S. ... Sub-Centre (Jaintiapur, Ishurdi)

-. ... Will extend over a long period time.

ANNUAL PLAN OF RESEARCH SUBJECTS ON THE CITRUS RESEARCH SCHEME (PRELIMINARY)

	SUBJECT	1st Plan Period 1977-78	2nd Plan Period 1978-79	1979-80	1980-81
1.	Breeding				
1.	Collection of local and foreign varieties including root-section	M.	M.S.	M.S.	
2.	Adaptability and profitability of collected varieties.		M.S.	M.S.	M.S.
3.	Breeding varieties by seedling			M.	M.
4.	Finding out virus-free individuals		M.	M.	M.
5.	Maintaining of original plants		M.	M.S.	M.S.
6.	Root-stock trials	M.S.	M.S.	S.	S.
2.	NUTRITIONAL PHYSIOLOGY				
1.	Nutritional analysis of abnormal trees		M.	M.	M.
2.	Diagnosis of nutrient deficiency		M.	M.	M.
3.	DISEASES				
1.	Identification of virus diseases		M.	M.	M.
2.	Setting plants free from virus.			M.	M.
3.	Obtaining virus resistant plants by injection of weak toxin.				M.
4.	Frequency of outbreak on major diseases		M.S.	M.S.	M.S.
5.	Control test of disease		S.	S.	S.
4.	Insect pest				
1.	Studies on vectors			M.	M.
2.	Frequency of major insects and their control		M.S.	M.S.	M.S.
5.	CULTIVATION				
1.	Comparison between several planting methods	M.	S.		
2.	Effect of shade trees and selection of them		S.	S.	S.
3.	Treatments of young trees including training and pruning	M.	M.S.	M.S.	S.
4.	Manures and fertilizers		M.S.	M.S.	M.S.
5.	Improvement of soil condition including prevention of erosion		S.	S.	S.
6.	Establishment of model orchard	M.	M.S.	S.	S.

Horticultural Research Project in Bangladesh

Vegetable (annual planning)

Research Subject	Year 1977 ∿ 1978	1978 ∿ 1979	1979 ∿ 1980	1980 ∿ 1981	Note
6. Breeding					Name of the vegetable crops
a. Collecting materials for breeding					
(1) Introduce and testing cultivation of foreign varieties	o (J)	o (JIR)	o (JIR)		Winter: Cauliflower, Cabbage, Carrot, Knolkhol, Turnip Onion, Garlic, Radish, Chillies, Beet, Lettuce
(2) Collecting local varieties and classification	o (J)	o (JIR)	o (JIR)		Summer: Cucumber, Pumpkin, Water melon, Ginger, Melon, Ladies finger, Gourds
b. Approve the resistance for diseases					
(1) Investigation of disease breakout	o (J)	o (J)			
(2) Inoculation test of disease germ			o (J)	o (J)	
c. Breeding for adaptable varieties					
(1) Approve the adaptability of foreign varieties and select to adaptable varieties			o (JIR)	o (JIR)	
(2) Breeding the superior local fixed varieties			o (JIR)	o (JIR)	

Note: (J) Main Center
(I) Ishurdi Sub-Center
(R) Rangpur Sub-Center

	Research subject	Year 1977 ~ 1978	1978 ~ 1979	1979 ~ 1980	1980 ~ 1981	Note
(3)	Cross breeding between local varieties and breeding superior fixed varieties by selection in posterity (Preliminary test)				o (J)	
(4)	Breeding Fl var.				o (J)	
8.	Improvement of the method of seed production					All kinds of vegetable crops
a.	Regulation of the flowering of vegetables					
(1)	Method of vernilization and method of acclimatization after treatment		o (J)	o (J)	o (J)	
(2)	Development of refriger-		o (J)	o (J)	o (J)	
(3)	Investigation of the flowering habits of vegetables related to environmental and cultural factors			o (J)	o (J)	
(4)	Development of methods of control for making of cross-pollination of varieties of vegetables					
b.	Improvement of cultural procedures for vegetable seed production					
(1)	Investigation of plant characteristics in relation to maturity of crops and harvesting procedure particularly for seed production		o (J)	o (J)	o (J)	

Research subject	Year 1977 ∿ 1978	1978 ∿ 1979	1979 ∿ 1980	1980 ∿ 1981	Note
(2) Irrigation and fertilization practices for seed production	o (J)	o (J)	o (J)	o (J)	
(3) Improvement of systematic methods for seed production	o (J)	o (J)	o (J)	o (J)	
c. Prevent of seed infectious diseases					
(1) Investigation of seed infectious diseases	o (J)	o (JIR)			
(2) Establish the method of seed disinfection		o (J)	o (JIR)	o (JIR)	
C. Improvement of storage method of vegetable seed					All kinds of vegetable crops
a. Development of handy storage method of vegetable seeds		o (J)	o (J)	o (JIR)	
b. Development of processing and wrapping method of vegetable seeds during the dry season and the rainy season			o (JIR)	o (JIR)	
C. Testing the procedure of transportation				o (JIR)	

CONTRIBUTION EXPECTED FROM THE GOVERNMENT OF BANGLADESH CONCERNING LAND CONSOLIDATION

For land consolidation of the Experiment Farm of the Citrus and vegetable Project, the Government of Bangladesh and JICA would make the following contributions:

1. Land consolidation would be taken up by JICA from the early part of 1978, as such work is budgetary endorsed on the Government of Japan;
2. While JICA would complete land consolidation, construct road and irrigation-drainage facilities, suction tank and pump of No. 1 Farm, the Government of Bangladesh should supply duty water ($Q = 0.004\ m^3/s$) and install necessary pipes for the purpose until the suction tank;

Pump of BARI	Suction tank for the Experiment Farm
	Tank for the research center building
Contribution by the Government of Bangladesh	Contribution by JICA

3. Arrangement for the bulldozer necessary for the land consolidation should be made by the Government of Bangladesh;
4. The residential quarters standing in the project area should be removed as soon as possible;
5. The Government of Bangladesh is requested to make necessary arrangement for electrical wiring works between the source of the power supply and the irrigation pump of No. 2 Farm;
6. Fence, gates and store house for farm machinery and equipment would be constructed by the Government of Bangladesh;

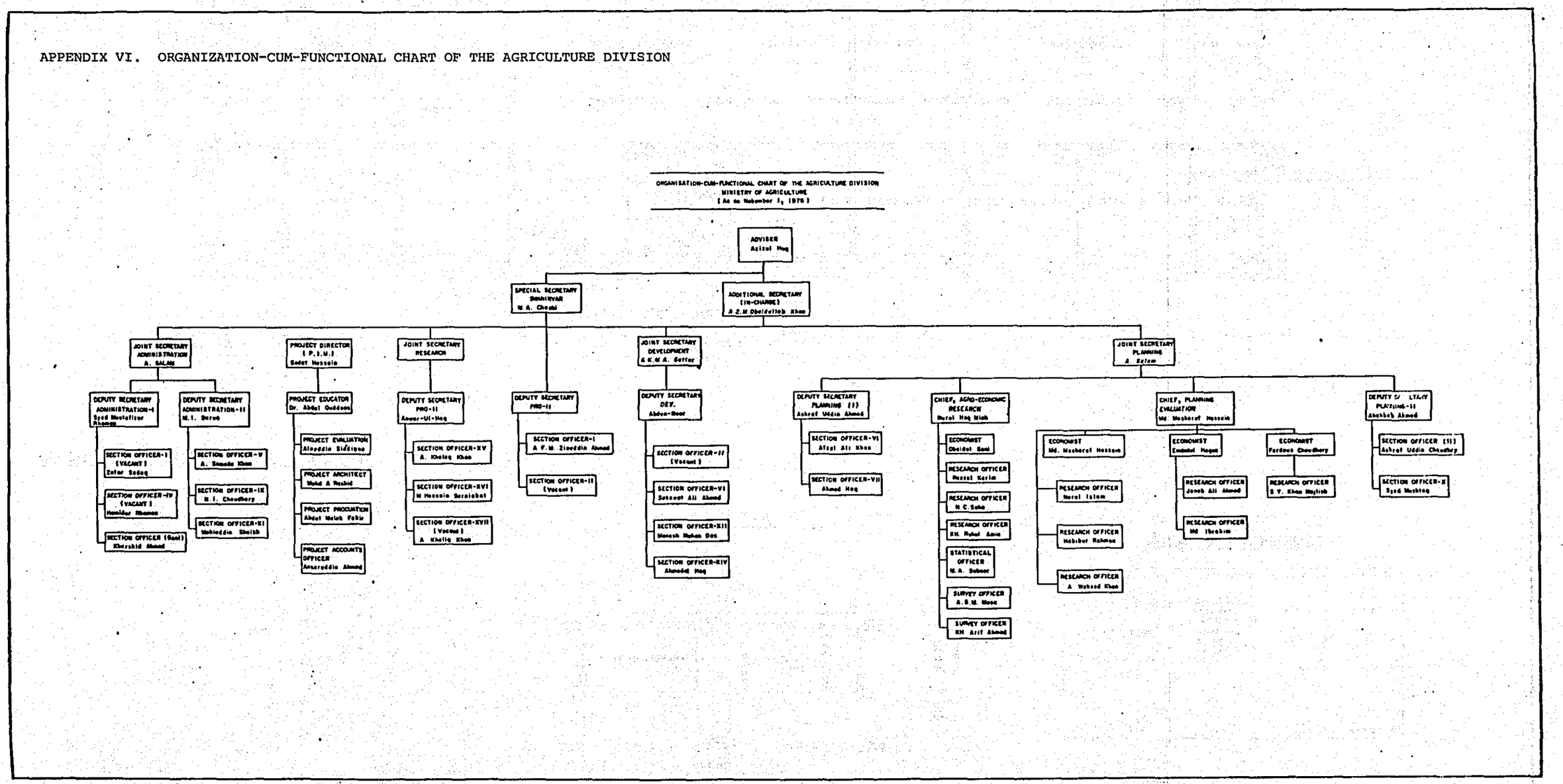
MEMBER LIST OF THE DETAILED DESIGN TEAM FOR HORTICULTURE RESEARCH PROJECT IN BANGLADESH

Team Leader	Dr. Masamoto YASUO	Deputy Director, Agricultural & Forestry Planning & Survey Dept. Japan International Cooperation Agency (JICA)
Member (Vegetable)	Mr. Isamu ABE	Director of Morioka Branch, Vegetable & Ornamental Crops Research Station, Ministry of Agriculture & Forestry
Member (Machinery)	Mr. Masakiyo MORITA	Expert of Agricultural Machinery, (JICA)
Member (Land Consolidation)	Mr. Yoji TAKAHASHI	Chief Irrigation Engineer, Japan Engineering Consultants Co., Ltd.
Member (Field Irrigation)	Mr. Motoo TAKI	Irrigation Engineer, Japan Engineering Consultants Co., Ltd.
Member (Coordinator)	Mr. Keizo EGAWA	Staff of Livestock Development Div., Agricultural Development Cooperation Dept., (JICA)
Member (Coordinator)	Mr. Masatoshi NAGATOMO	Agricultural Technical Cooperation Div., Agricultural Development Cooperation Dept., (JICA)

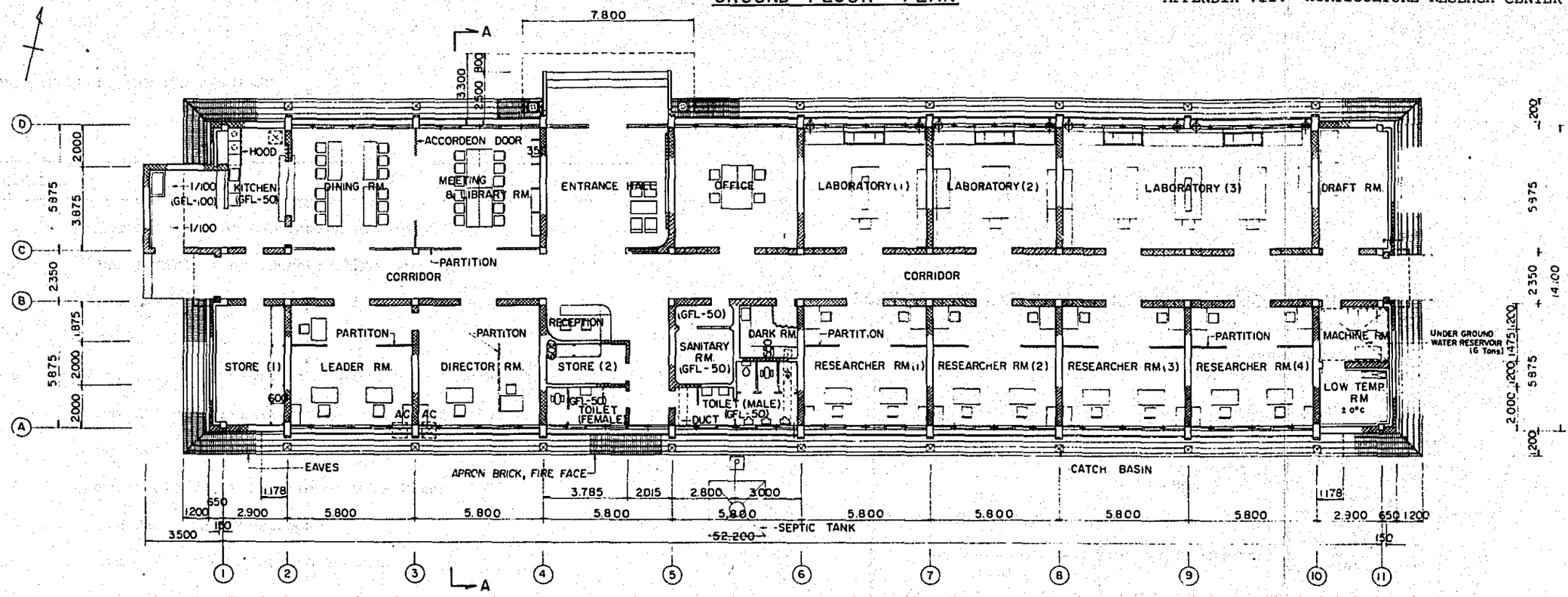
APPENDIX V. PARTICIPANTS' LIST OF THE BANGLADESH GOVERNMENT REGARDING THE HORTICULTURAL RESEARCH COOPERATION PROJECT

No.	Name of Participator	Office's Name and Post
1	Mr. A. Razzaque	P.S.O., Citrus & Vegetable Project, BARI
2	Mr. M. Mafizul Haque	P.S.O., Vegetable Section, BARI
3	Mr. Abul Bashar	F.D.O., Citrus Project, SYLHET
4	Mr. M.R. Talukder	P.S.O., Fruits Section, BARI
5	Mr. M. Islam	D.A.D.A. (Adm.), BARI
6	Mr. S.J. Bhuiya	P.S.O., Special Project, BARI
7	Mr. M.U. Bhuiya	Asst. Professor, Naval Architect, Bangladesh Engineering University
8	Mr. S. Islam	Executive Director, Horticulture Dev. Board
9	Mr. L. Haque	Asst. Director, Agri. Directorate (E&M)
10	Dr. S.D. Chowdhury	Member, Planning Commission
11	Mr. K.U. Ahmad	Project Director (Potato), BARI
12	Dr. Altaf Ali	Chief, Agriculture Section, Planning Section
13	Dr. B. Doza	Director, BARI
14	Mr. Ashrafuddin Ahmad	Joint Secretary, Ministry of Agriculture
15	Mr. A.W. Chowdhury	Deputy Secretary, T.A.P. Section, Planning Ministry
16	Mr. M. Hussain	Associate Director, BARI

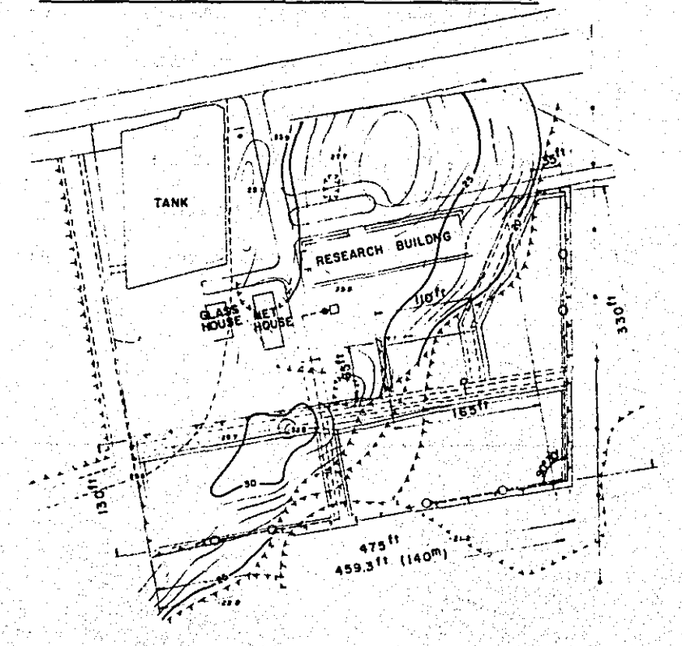
APPENDIX VI. ORGANIZATION-CUM-FUNCTIONAL CHART OF THE AGRICULTURE DIVISION



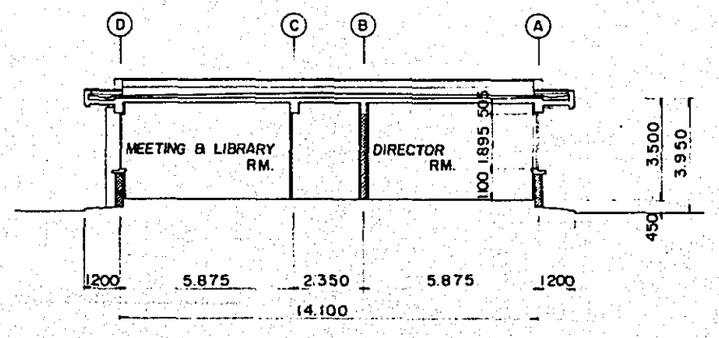
GROUND FLOOR PLAN



PLAN OF HORTICULTURE CENTER



Section A — A



AREA OF BUILDINGS

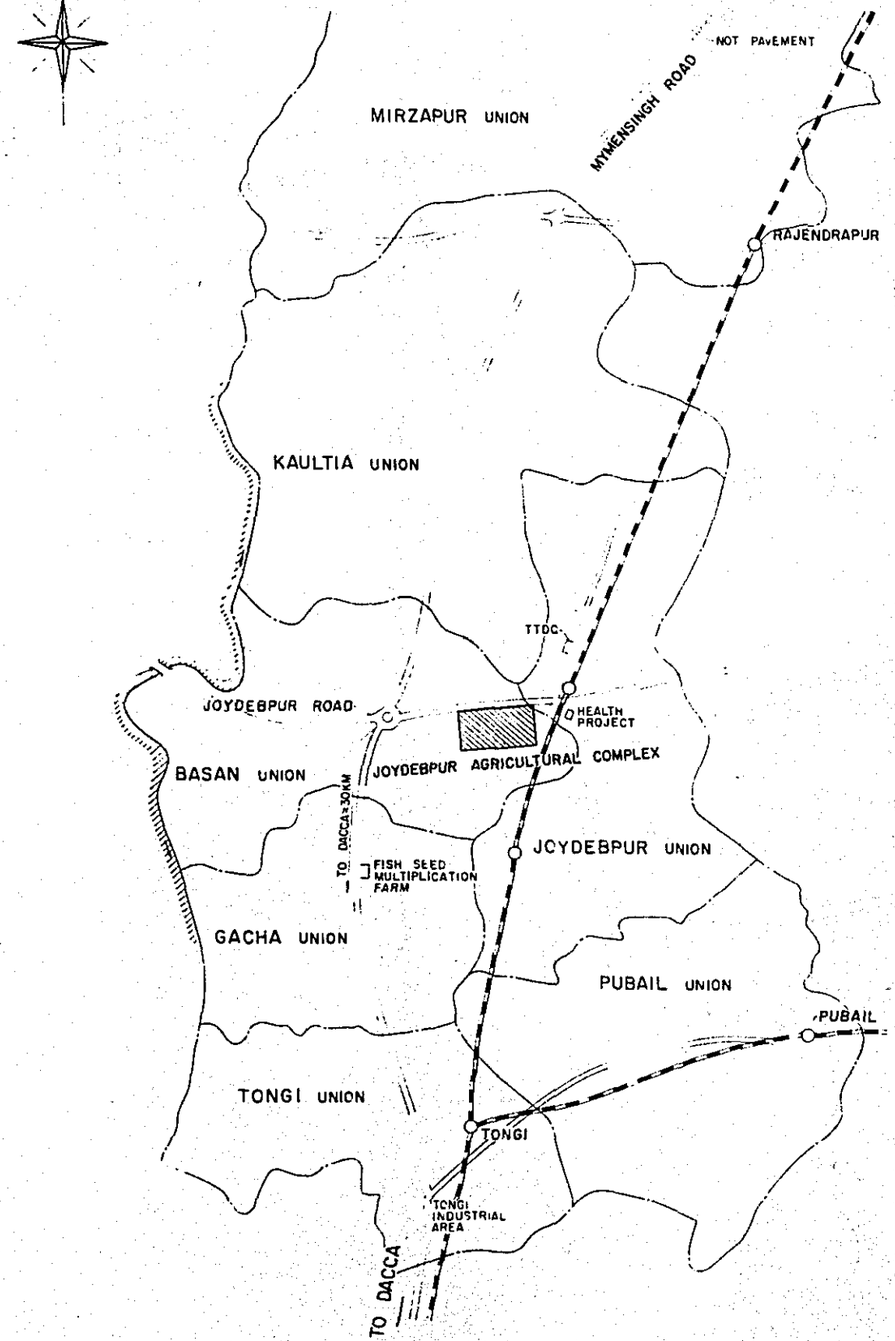
BLDG No	BUILDING NAME	STRUCTURE	BUILDING AREA	FLOOR AREA
①	RESEARCH BUILDING	REINFORCED CONCRETE CONSTRUCTION	161.18 M²	740.25 M²
②	NET HOUSE	ALUMINUM ALLOY CONSTRUCTION	140.40 M²	140.40 M²
③	GLASS HOUSE	DO.	90.00 M²	90.00 M²
	TOTAL		991.58 M²	970.65 M²

CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH

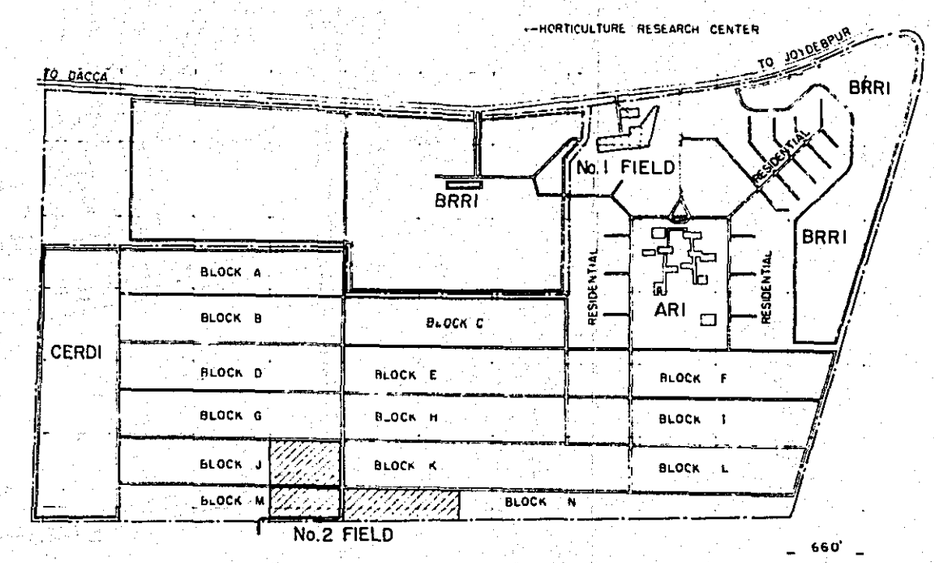
HORTICULTURE RESEACH CENTER BUILDING PLAN & SECTION

Date: D.W.G. No.

LOCATION MAP



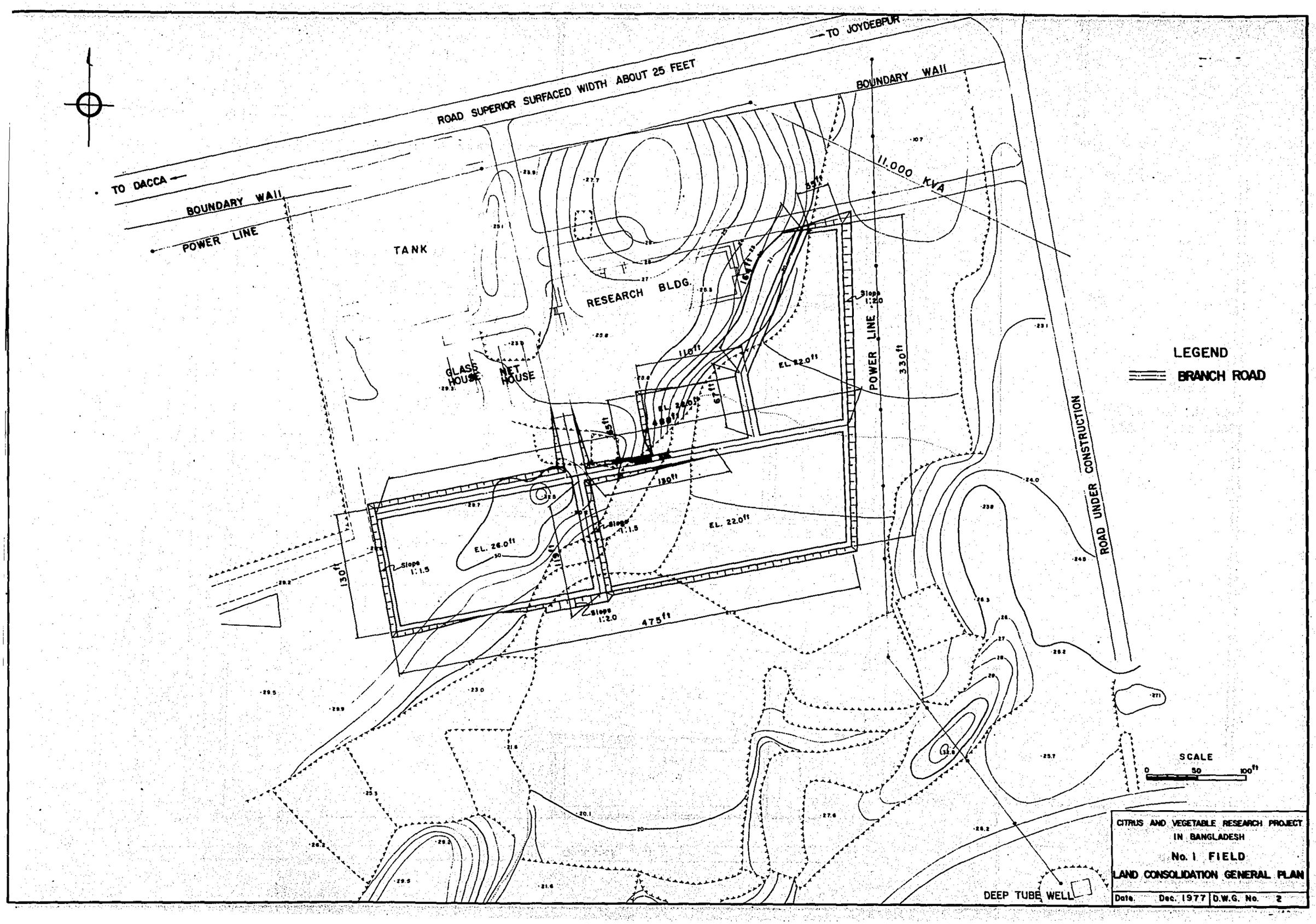
LOCATION OF EXPERIMNT FIELDS IN AGRICULTURAL COMPLEX



CITRUS AND VEGETABLE RESEARCH PROJECT
IN BANGLADESH

LOCATION MAP
OF EXPERIMNT FIELDS

Date. Dec. 1977 | D.W.G. No. 1


TO JOYDEBPUR
ROAD SUPERIOR SURFACED WIDTH ABOUT 25 FEET
TO DACCA
BOUNDARY WALL
BOUNDARY WALL
POWER LINE
TANK
RESEARCH BLDG.
GLASS HOUSE
NET HOUSE
11,000 KVA
POWER LINE
330ft
110ft
EL 32.0ft
EL 24.0ft
67ft
45ft
130ft
EL. 26.0ft
EL. 22.0ft
Slope 1:1.5
Slope 1:1.5
Slope 1:2.0
130ft
475ft
ROAD UNDER CONSTRUCTION
DEEP TUBE WELL
LEGEND
BRANCH ROAD
SCALE
0 50 100ft
CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH
No. I FIELD
LAND CONSOLIDATION GENERAL PLAN
Date. Dec. 1977
D.W.G. No. 2

650 ft

EL. 34.5

Slope 1:1.5

TANK I

222 ft

227 ft

EL. 34.5

EL. 34.5

225 ft

EL. 34.5

371 ft

704 ft

561 ft

106 ft

684 ft

EL. 34.5

100 ft

313 ft

EL. 37.5

158 ft

155 ft

Slope 1:1.5

TANK II

650 ft Boundary Wall

LEGEND

BRANCH ROAD

TRUNK ROAD

SCALE

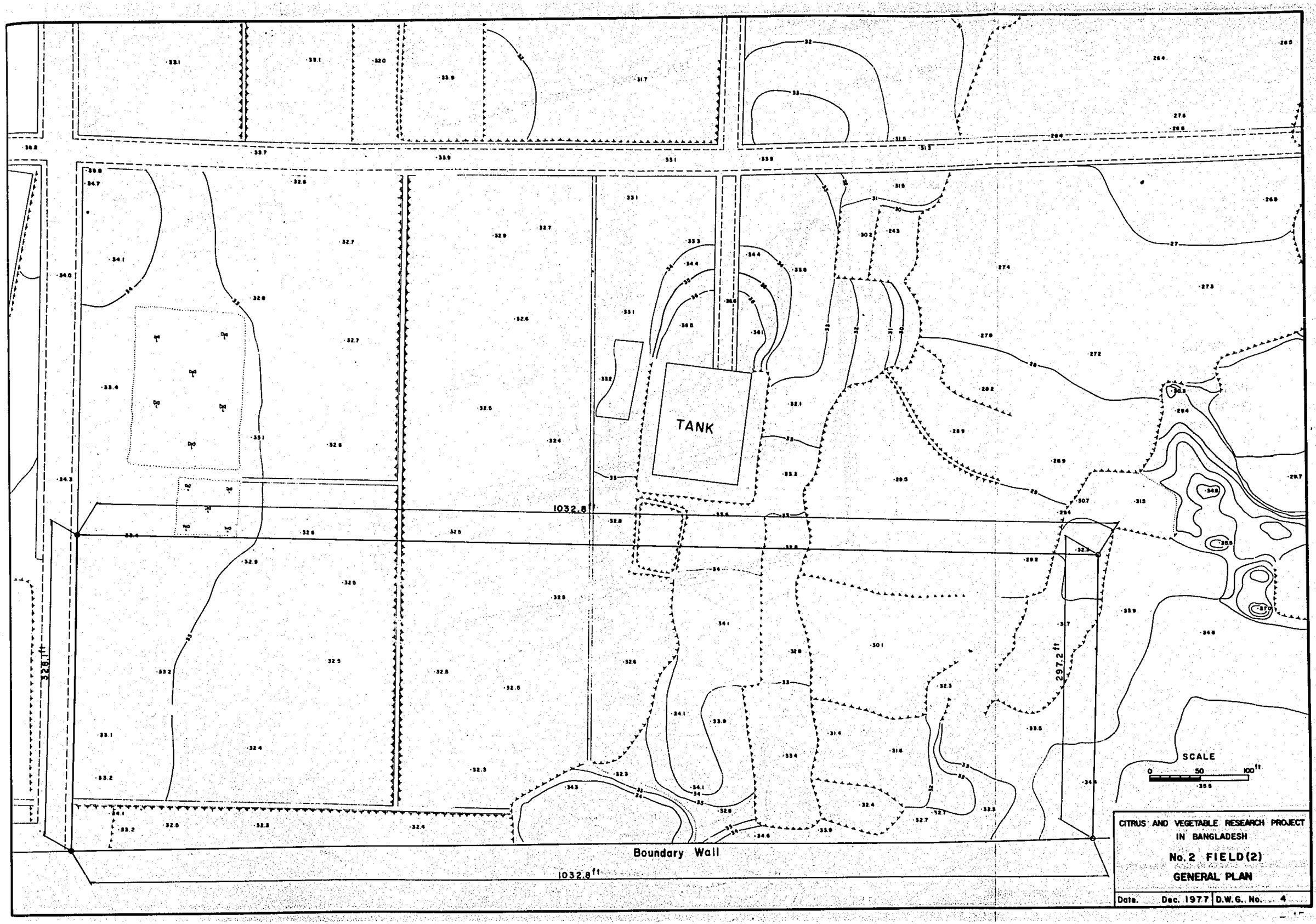
0 50 100 ft

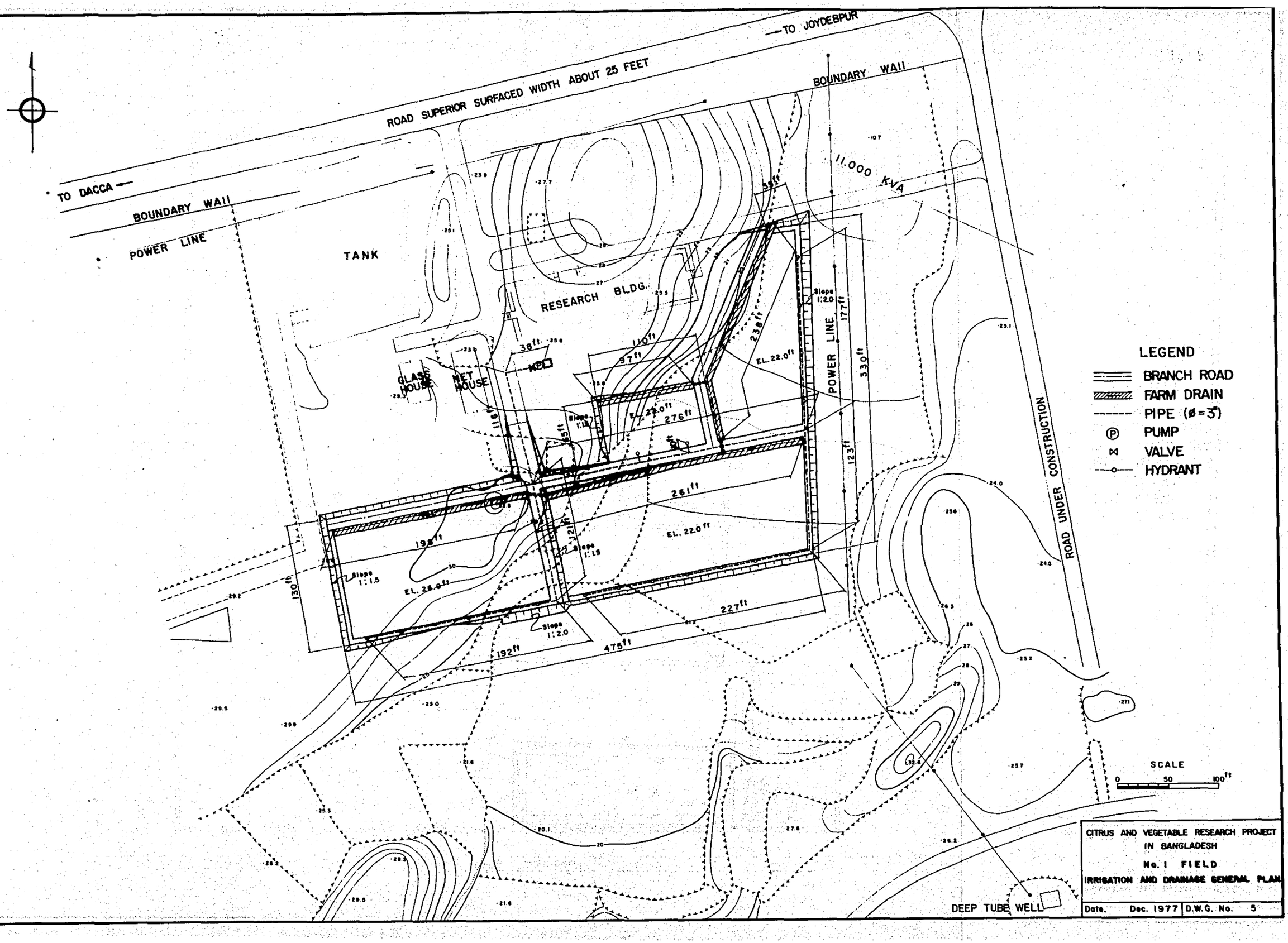
CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH

No. 2 FIELD (I)

LAND CONSOLIDATION GENERAL PLAN

Date. Dec. 1977 | D.W.G. No. 3


TANK
1032.8 ft
Boundary Wall
1032.8 ft
328.2 ft
297.2 ft
SCALE
0 50 100 ft
CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH
No. 2 FIELD (2)
GENERAL PLAN
Date. Dec. 1977
D.W.G. No. 4


TO DACCA
BOUNDARY WALL
POWER LINE
ROAD SUPERIOR SURFACED WIDTH ABOUT 25 FEET
TO JOYDEBPUR
BOUNDARY WALL
TANK
RESEARCH BLDG.
11,000 KVA
GLASS HOUSE
NET HOUSE
38ft
KPL
110ft
97ft
238ft
EL. 22.0ft
Slope 1:2.0
177ft
POWER LINE
330ft
123ft
116ft
Slope 1:1.5
EL. 22.0ft
276ft
261ft
EL. 22.0ft
198ft
121ft
Slope 1:1.5
Slope 1:1.5
EL. 28.0ft
130ft
Slope 1:2.0
227ft
192ft
475ft
ROAD UNDER CONSTRUCTION
DEEP TUBE WELL
LEGEND
BRANCH ROAD
FARM DRAIN
PIPE (ø=3")
PUMP
VALVE
HYDRANT
SCALE
0 50 100ft
CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH
No. 1 FIELD
IRRIGATION AND DRAINAGE GENERAL PLAN
Date. Dec. 1977
D.W.G. No. 5

650 ft

Slope 1:1.5
TANK I

371 ft

205 ft

210 ft

704 ft

533 ft

138.5 ft

280.5 ft

218.5 ft

35 ft

313 ft

684 ft

Slope 1:1.5
TANK II

EL. 40.5

EL. 37.5

PUMP

EL. 37.5

650 ft Boundary Wall

LEGEND

- FARM DITCH
- FARM DRAIN
- BRANCH ROAD
- TRUNK ROAD
- BORDER
- SIPHON
- TURNOUT

SCALE

0 50 100 ft

CITRUS AND VEGETABLE RESEARCH PROJECT
IN BANGLADESH

No. 2 FIELD
IRRIGATION AND DRAINAGE GENERAL PLAN

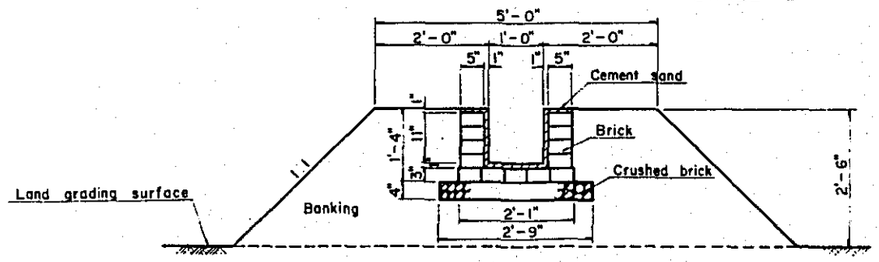
Date.	Dec. 1977	D.W.G. No.	6

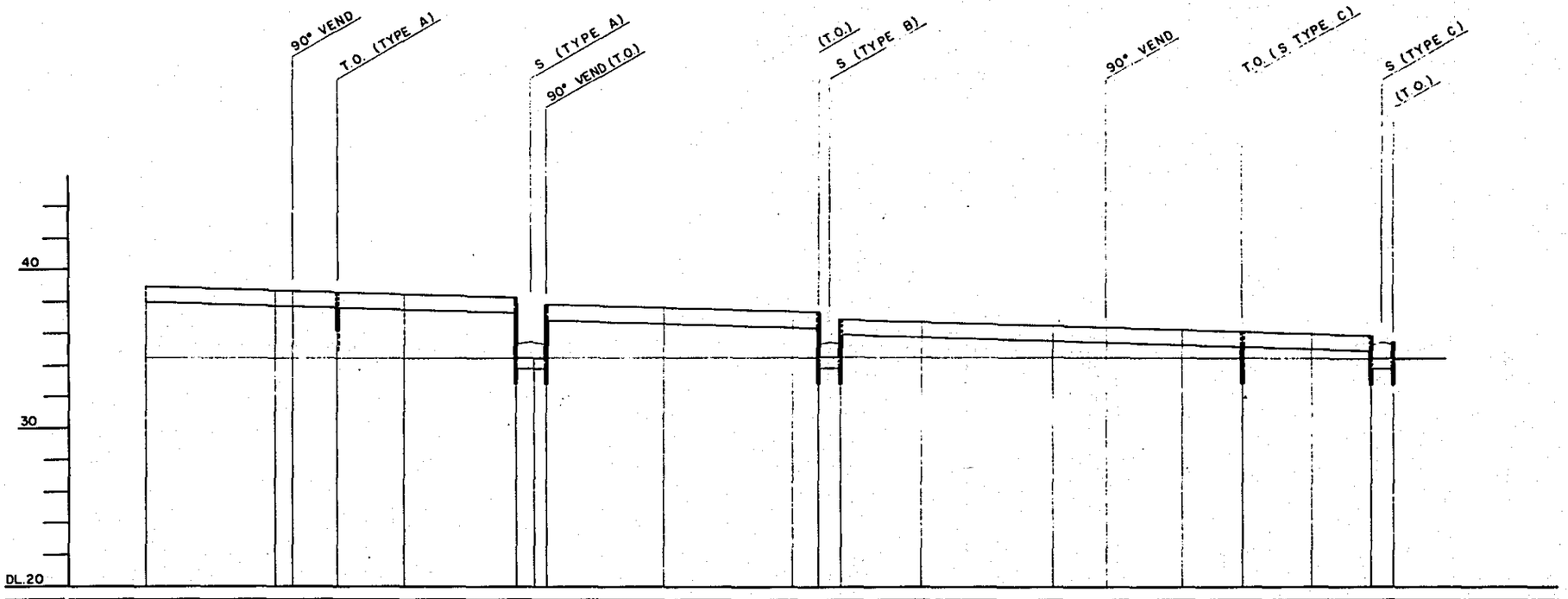
PROFILE OF FARM DITCH (I)

SCALE A

STANDARD CROSS SECTION

SCALE B





Station No.	Dist.	Accum Dist.	Ground Elev.	Bottom of Ditch	Top of Bank	Grade
No. 0	0	0	34.5	38.0	39.0	380
No. 1	100	100.0	34.5	37.8	38.8	
+13.0	13.0	113.0	34.5	37.8	38.8	
+48.0	35.0	148.0	34.5	37.7	38.7	
No. 2	52.0	200.0	34.5	37.5	38.5	
+86.5	86.5	286.5	34.5	37.3	38.3	
No. 3	13.5	300.0	34.5	36.9	37.9	
+ 9.5	9.5	309.5				
No. 4	90.5	400.0	34.5	36.7	37.7	400
No. 5	100.0	500.0	34.5	36.4	37.4	
+19.5	19.5	519.5	34.5	36.4	37.4	
+36.5	17.0	536.5	34.5	36.0	37.0	
No. 6	63.5	600.0	34.5	35.8	36.8	
No. 7	100.0	700.0	34.5	35.5	36.5	
+41.5	41.5	741.5	34.5	35.4	36.4	
No. 8	58.5	800.0	34.5	35.3	36.3	
+46.5	46.5	846.5	34.5	35.2	36.2	
No. 9	53.5	900.0	34.5	35.0	36.0	
+46.5	46.5	946.5	34.5	34.9	35.9	345
+63.5	17.0	963.5	34.5	34.5	35.5	

LEGEND

T.O. Turnout

S Siphon

SCALE A

HORIZONTAL 0 20 100 ft

VERTICAL 0 1 5 ft

SCALE B

0 1 5 ft

CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH

No. 2 FIELD (I)

PROFILE OF FARM DITCH

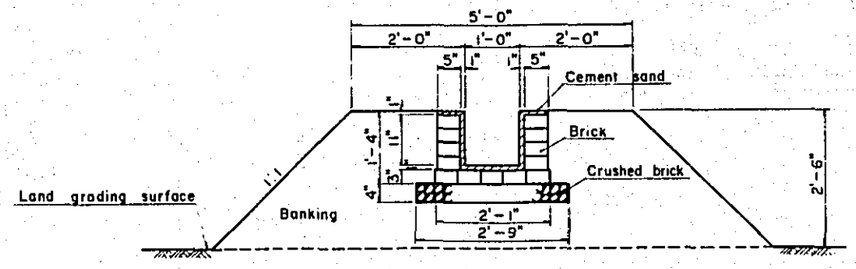
Date. Dec. 1977 | D.W.G. No. 7

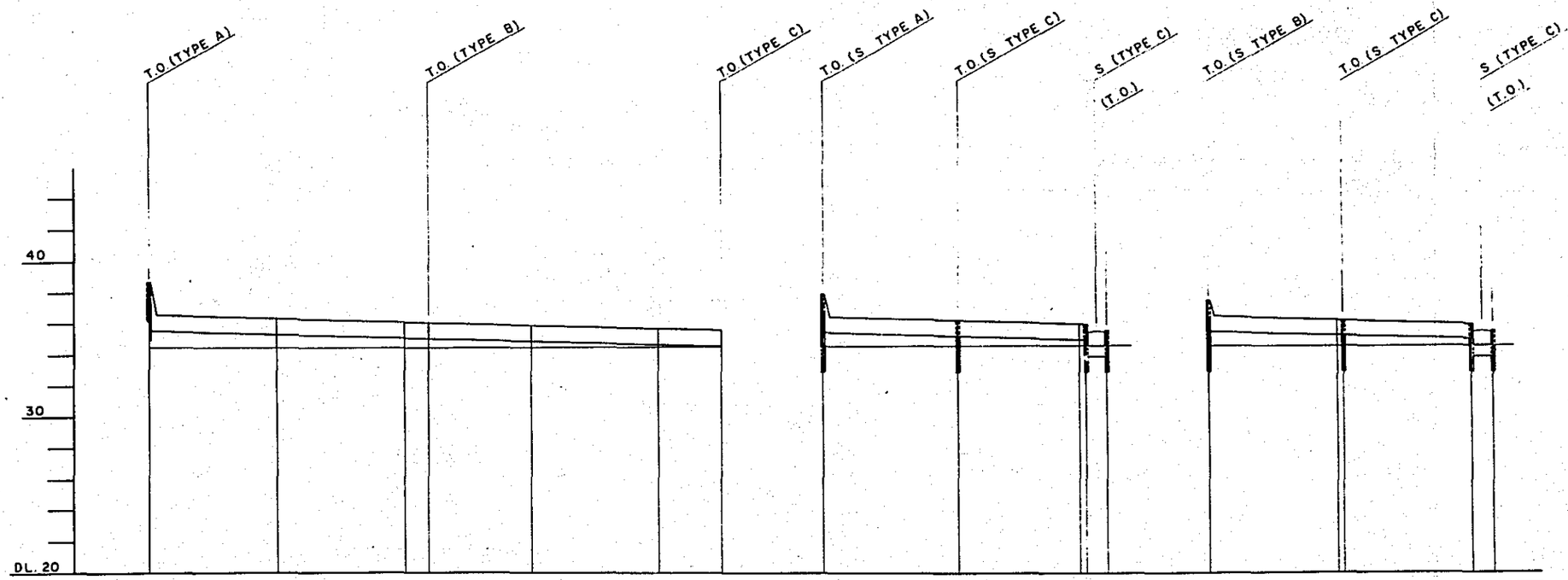
PROFILE OF FARM DITCH (2)

SCALE A

STANDARD CROSS SECTION

SCALE B





Station No.	Dist.	Accum Dist.	Ground Elev.	Bottom of Ditch	Top of Bank	Grade
+ 0 (No. 1+90)	0	0	34.5	37.7 / 35.6	38.7	335
+100.0	100.0	100.0	34.5	35.4	36.4	
+200.0	100.0	200.0	34.5	35.1	36.1	1/400
+218.5	18.5	218.5	34.5	35.1	36.1	
+300.0	81.5	300.0	34.5	34.9	35.9	
+400.0	100.0	400.0	34.5	34.6	35.6	
+449.0	49.0	449.0	34.5	34.5	35.5	345
+ 0 (No. 3+95)	0	0	34.5	36.9 / 35.4	37.9	334
+100.0 / +105.0	100.0 / 5.0	100.0 / 105.0	34.5 / 34.5	35.2 / 35.2	36.2 / 36.2	1/400
+200.0 / +205.0 / +222.0	95.0 / 5.0 / 17.0	200.0 / 205.0 / 222.0	34.5 / 34.5 / 34.5	34.9 / 34.9 / 34.5	35.9 / 35.9 / 35.5	345
+ 0 (No. 5+85)	0	0	34.5	36.4 / 35.4	37.4	334
+100.0 / +105.0	100.0 / 5.0	100.0 / 105.0	34.5 / 34.5	35.2 / 35.2	36.2 / 36.2	1/400
+200.0 / +205.0 / +222.0	95.0 / 5.0 / 17.0	200.0 / 205.0 / 222.0	34.5 / 34.5 / 34.5	34.9 / 34.9 / 34.5	35.9 / 35.9 / 35.5	345

LEGEND

T.O Turnout

S Siphon

SCALE A

HORIZONTAL 0 20 100ft

VERTICAL 0 1 5ft

SCALE B

0 1 5ft

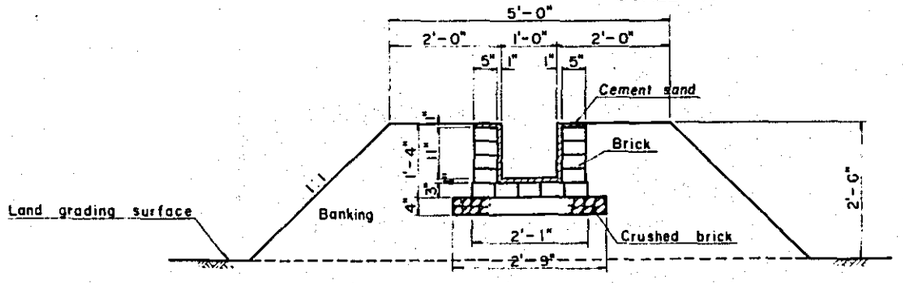
CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH

No. 2 FIELD (2)

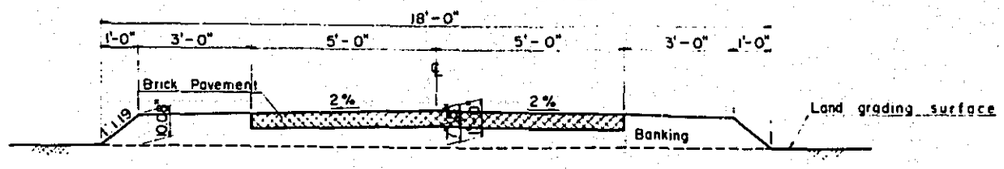
PROFILE OF FARM DITCH

Date. Dec. 1977 D.W.G. No. 8

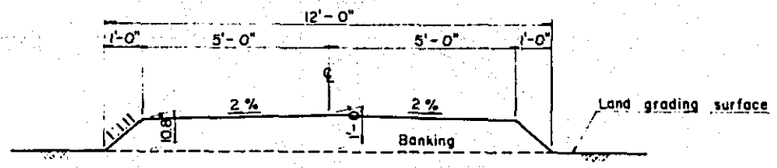
FARM DITCH
SCALE A



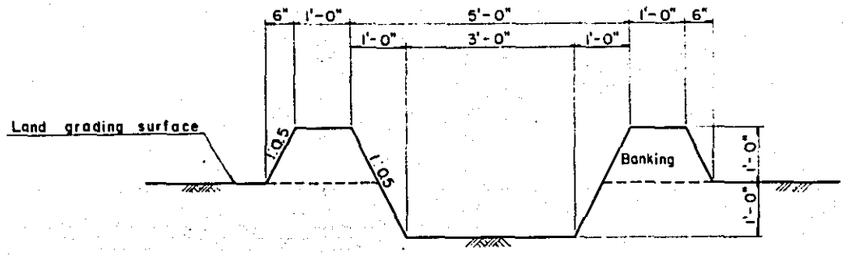
TRUNK ROAD
SCALE B



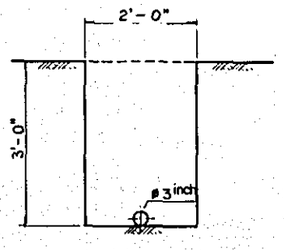
BRANCH ROAD
SCALE B



FARM DRAIN
SCALE A



PIPING
SCALE A



SCALE A 0 — 5 ft

SCALE B 0 — 5 — 10 ft

CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH

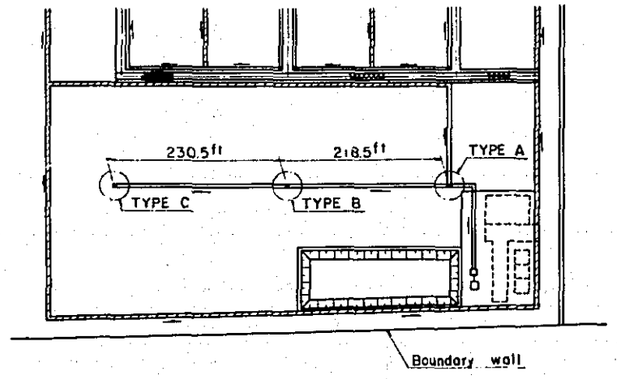
STANDARD CROSS SECTIONS

Date. Dec. 1977 | D.W.G. No. 9

TURNOUT

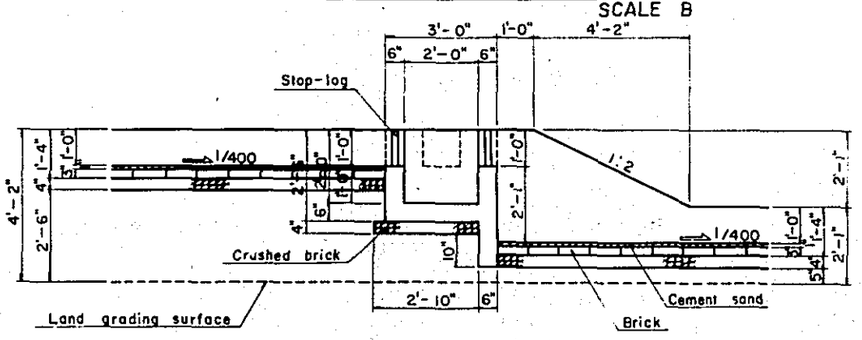
No.2 FIELD General Plan

SCALE A



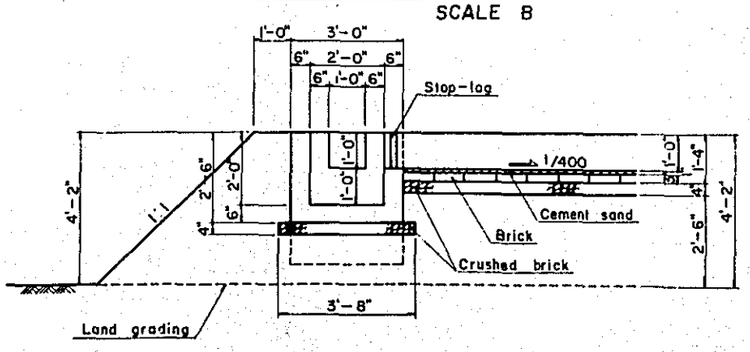
Profile (Section A — A)

SCALE B



Section B — B

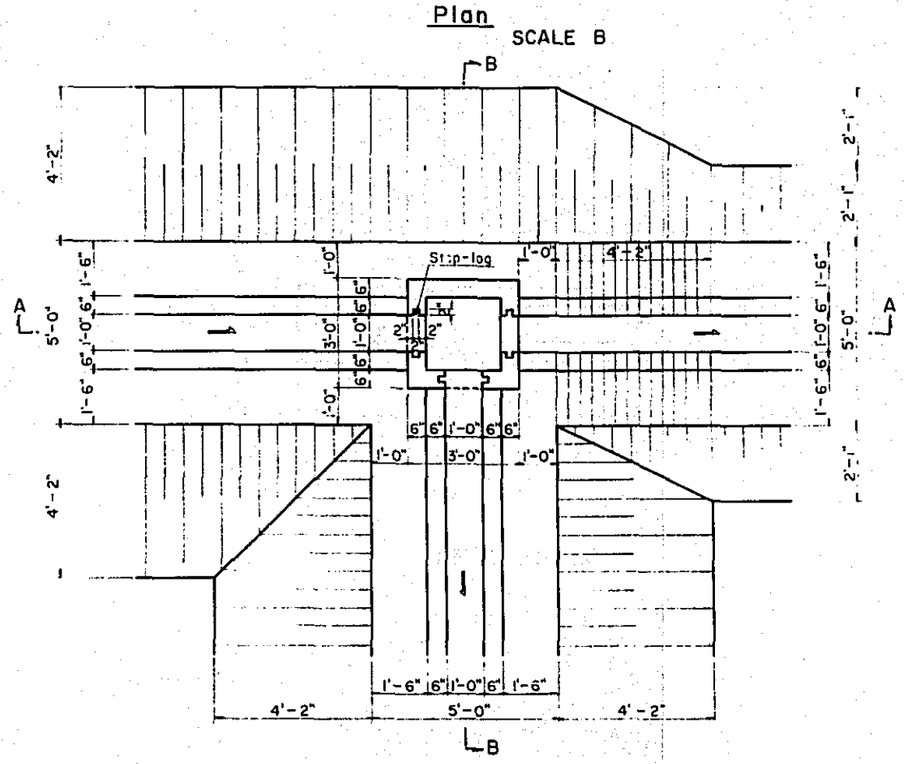
SCALE B



TYPE A

Plan

SCALE B



SCALE A 0 100 200 300 400 500ft

SCALE B 0 5 10ft

CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH

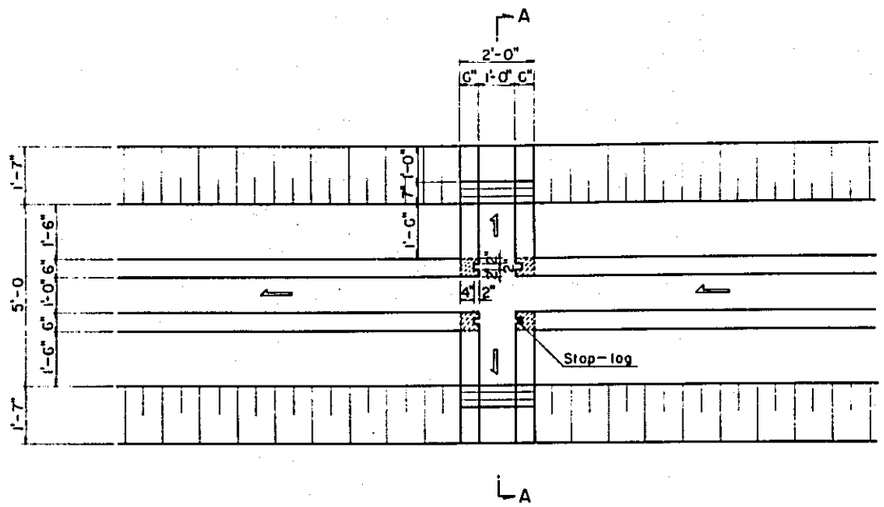
TURNOUT (TYPE A) PLAN & SECTION

Date. Dec. 1977 | D.W.G. No. 10

TURNOUT

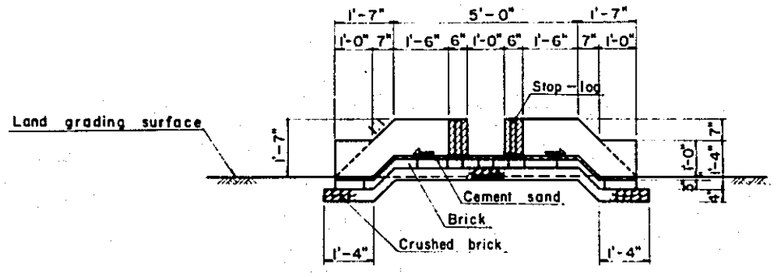
TYPE B

Plan



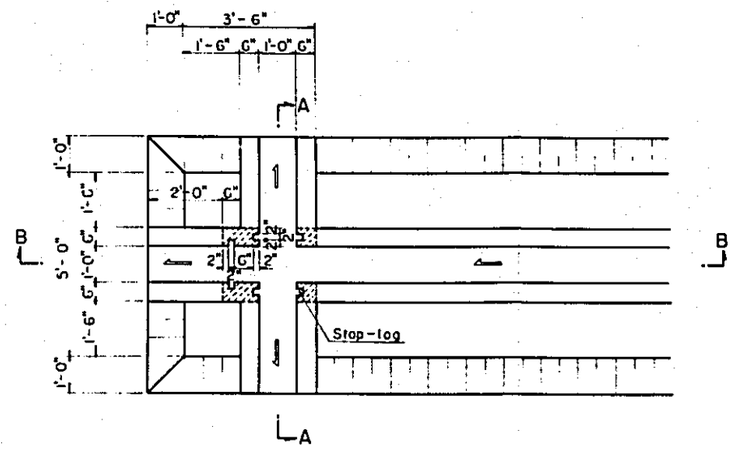
A

Section A — A



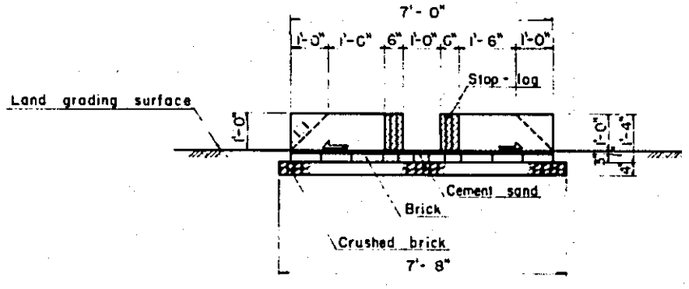
TYPE C

Plan

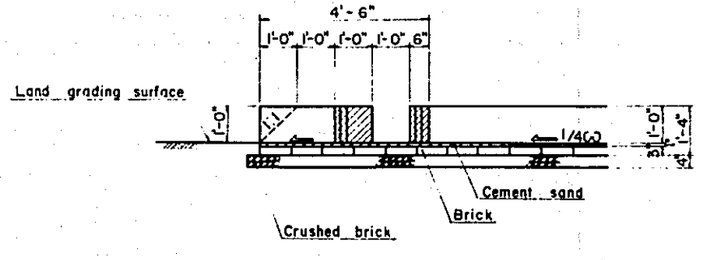


A

Section A — A



Section B — B



SCALE

CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH

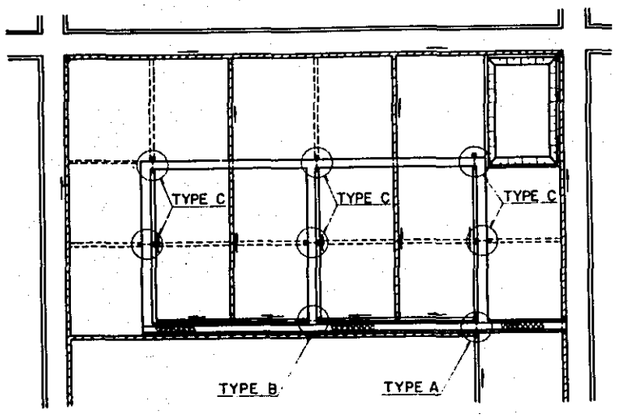
TURNOUT (TYPE B·C) PLAN & SECTION

Date. Dec. 1977	D.W.G. No. 11

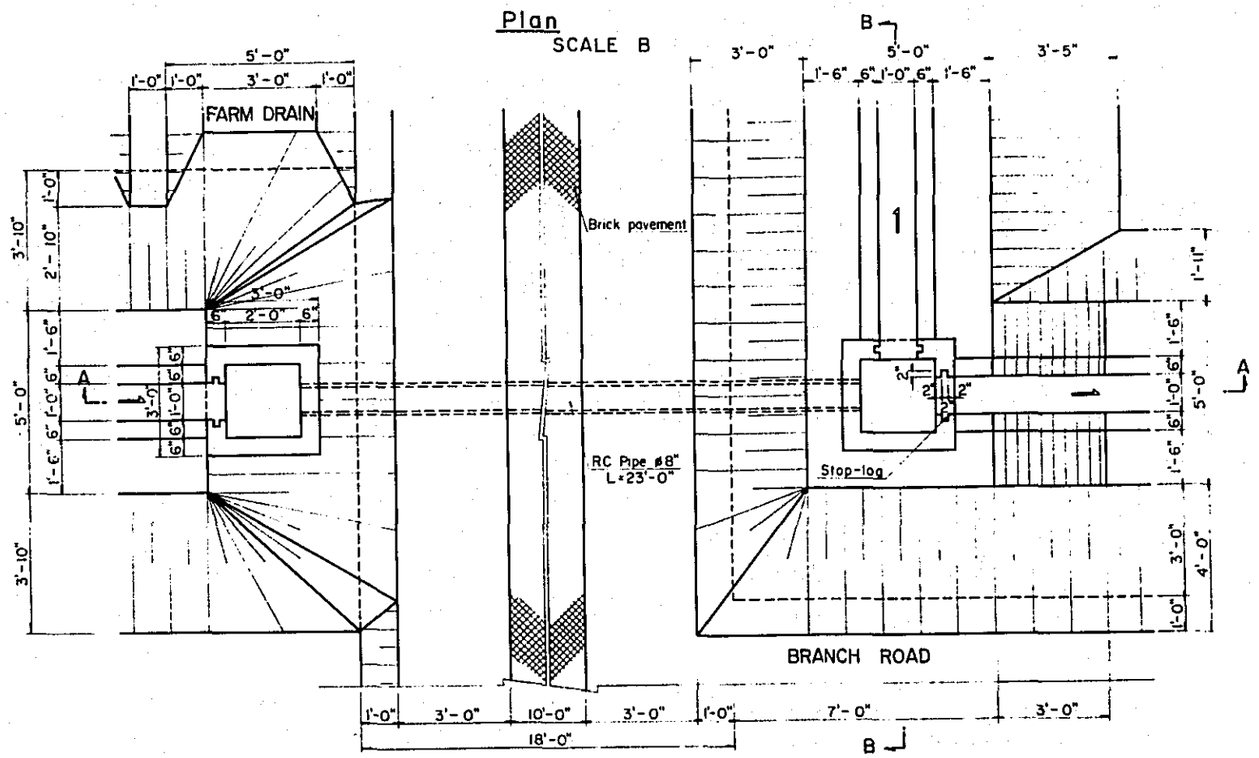
SIPHON

TYPE A

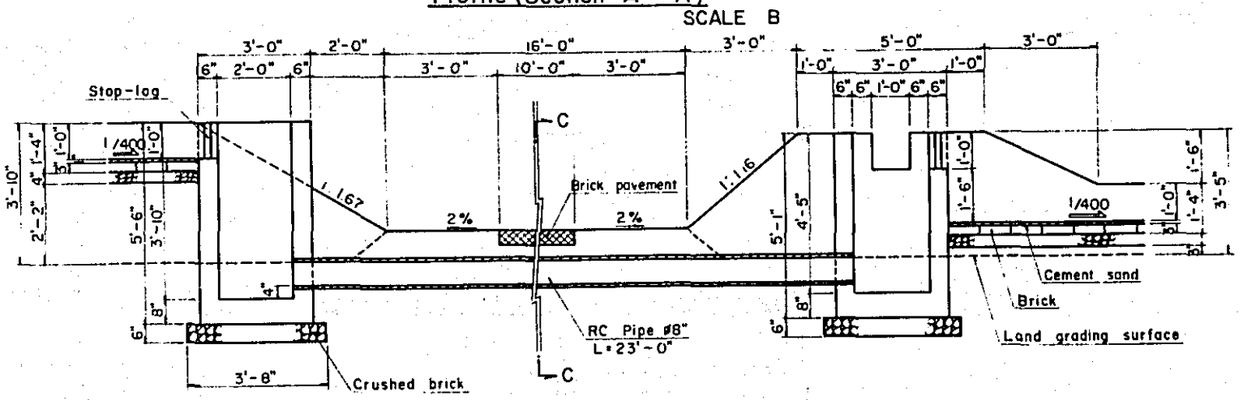
No. 2 FIELD General Plan
SCALE A



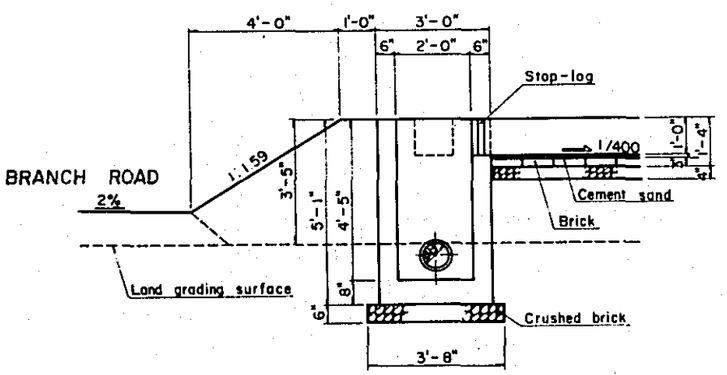
Plan
SCALE B



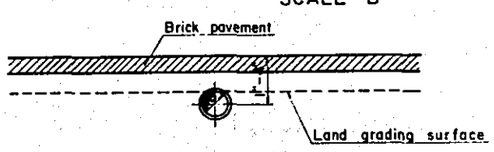
Profile (Section A — A)
SCALE B



Section B — B
SCALE B



Section C—C
SCALE B



SCALE A 0 100 200 300 400 500 ft

SCALE B 0 5 10 ft

CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH

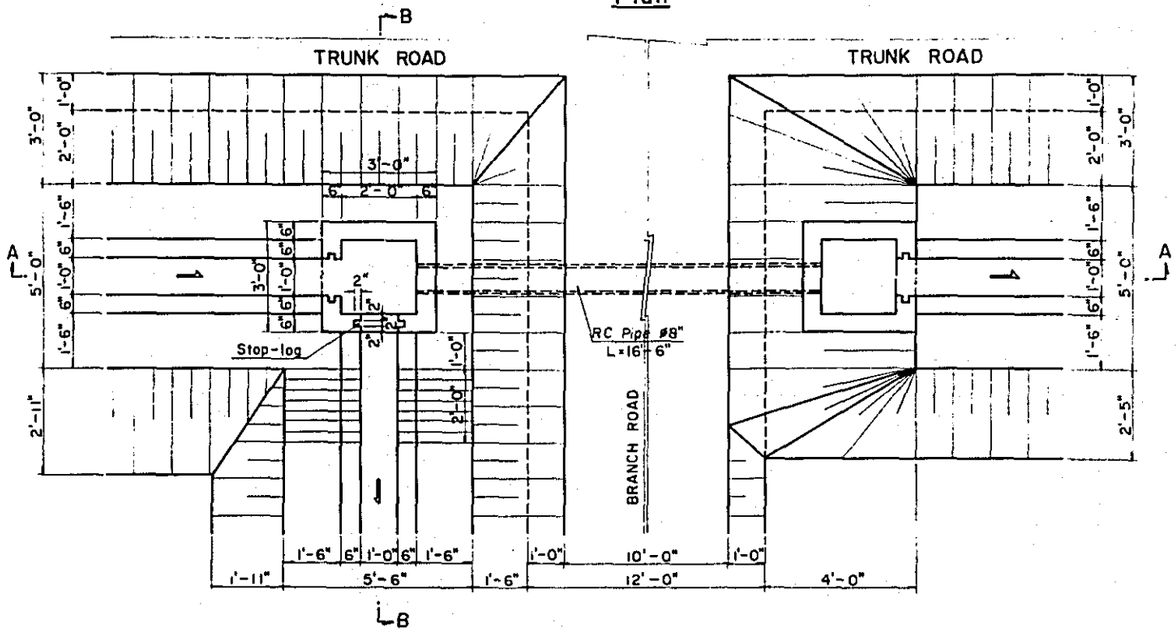
SIPHON (TYPE A) PLAN & SECTION

Date. Dec. 1977 | D.W.G. No. 12

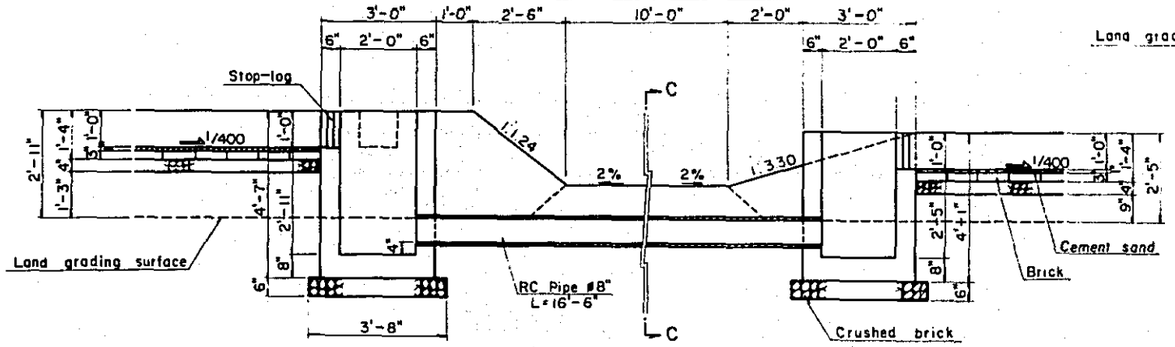
SIPHON

TYPE B

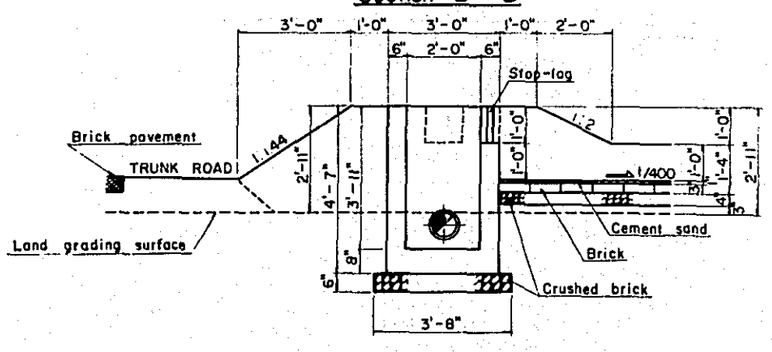
Plan



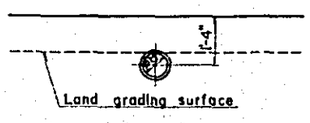
Profile (Section A – A)



Section B – B

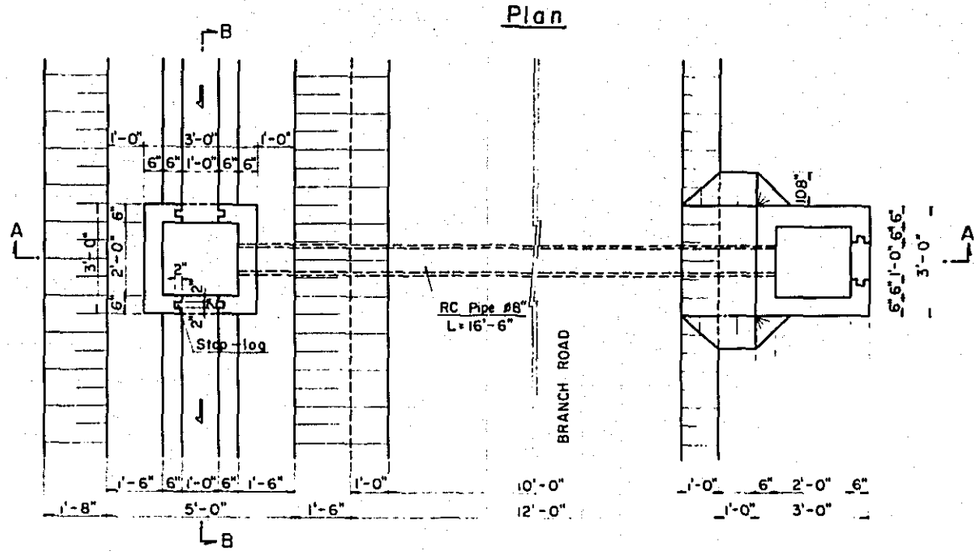


Section C – C

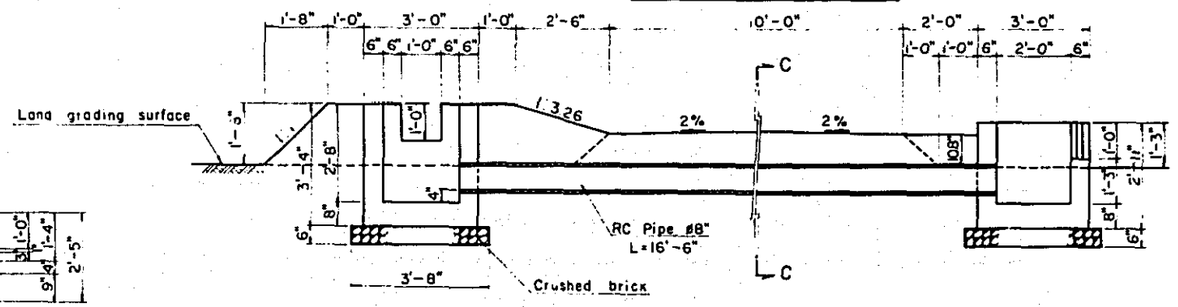


TYPE C

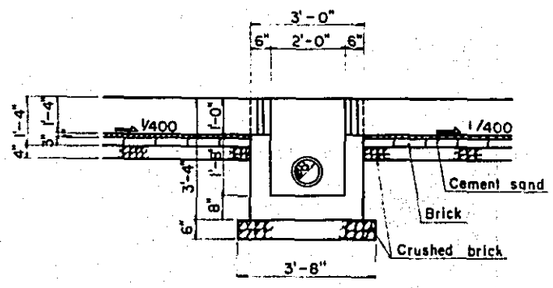
Plan



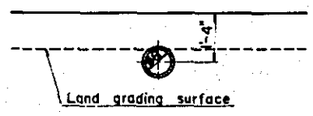
Profile (Section A – A)



Section B – B



Section C – C



SCALE

0 5 10 ft

CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH

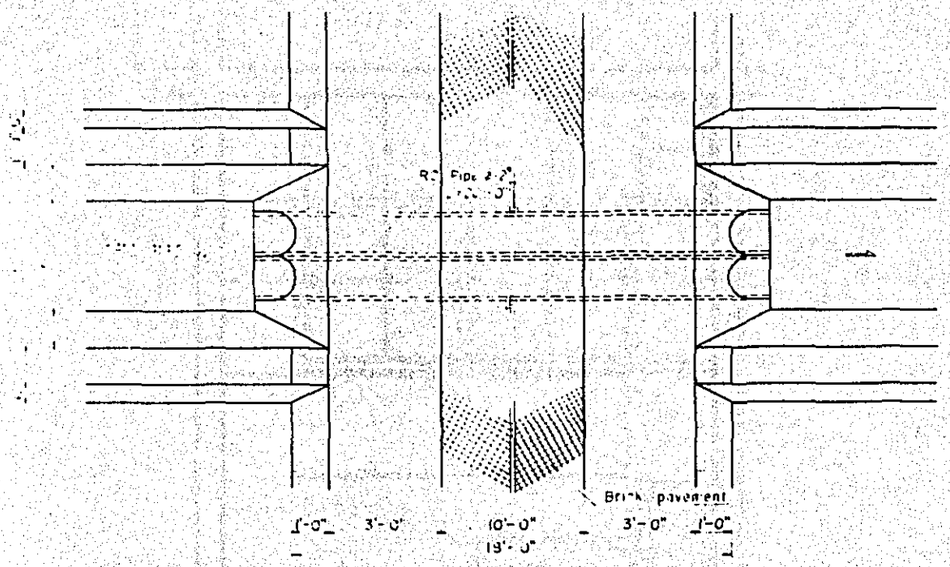
SIPHON (TYPE B·C) PLAN & SECTION

Date. Dec. 1977 | D.W.G. No. 13

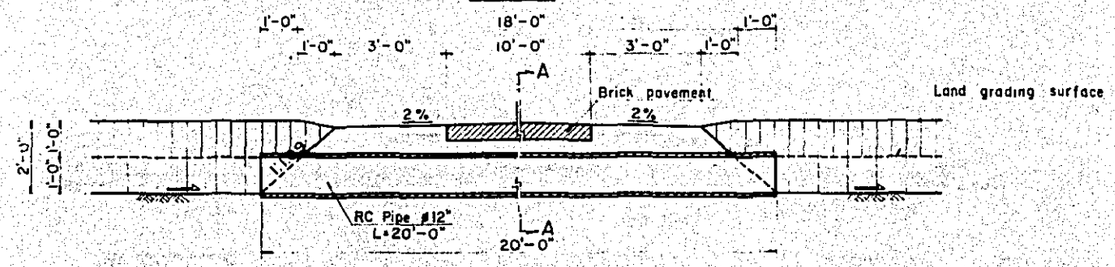
CULVERT

TYPE A

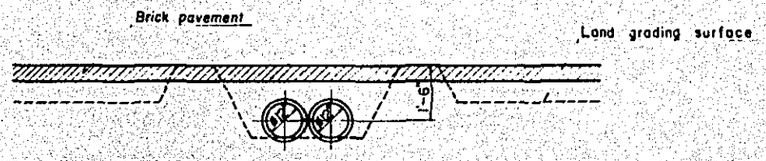
Plan



Profile

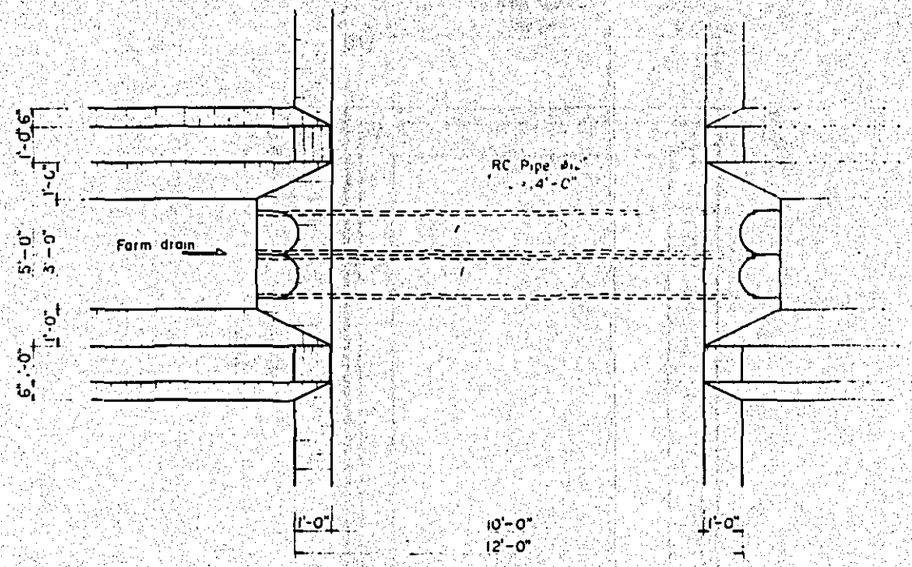


Section A—A

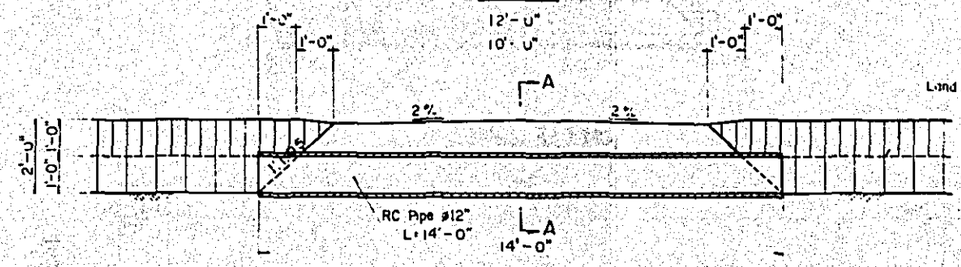


TYPE B

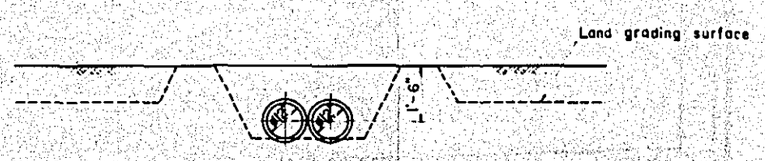
Plan



Profile



Section A—A



SCALE

0 5 10 ft

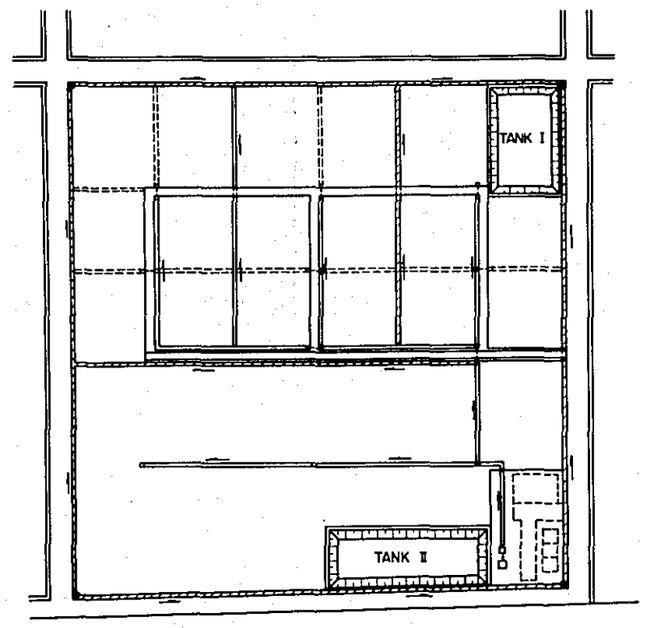
CITRUS AND VEGETABLE RESEARCH PROJECT
IN BANGLADESH

CULVERT
PLAN & SECTION

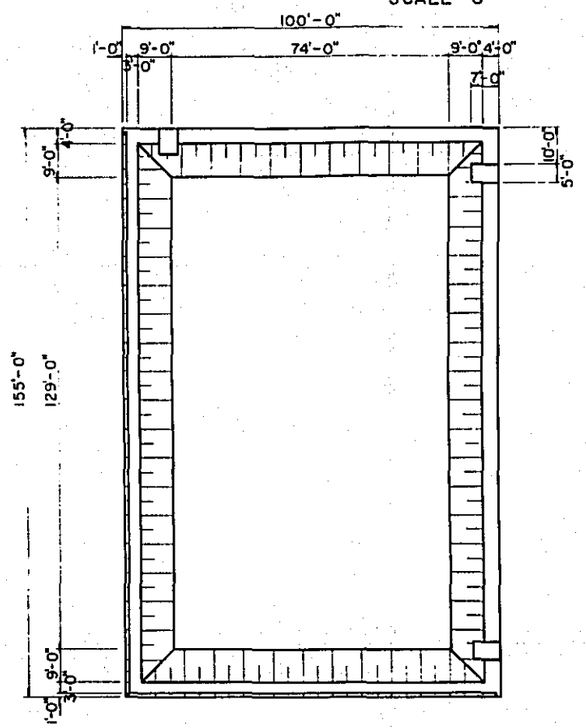
Date. Dec. 1977 | D.W.G. No 14

TANK

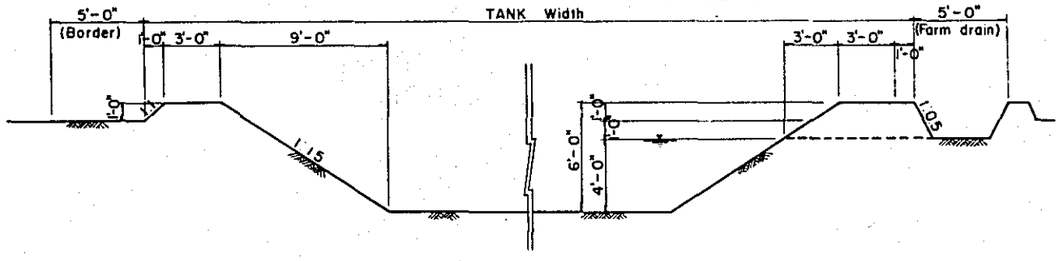
No. 2 FIELD General Plan
SCALE A



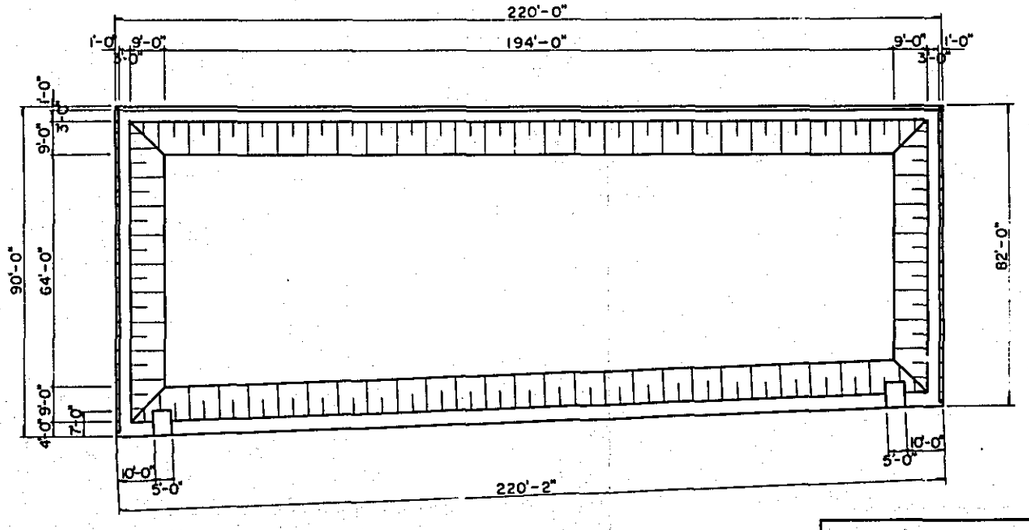
TANK I Plan
SCALE C



TANK Standard Section
SCALE B



TANK II Plan
SCALE C



SCALE A 0 100 200 300 400 500 ft

SCALE B 0 10 20 ft

SCALE C 0 50 100 ft

CITRUS AND VEGETABLE RESEARCH PROJECT
IN BANGLADESH

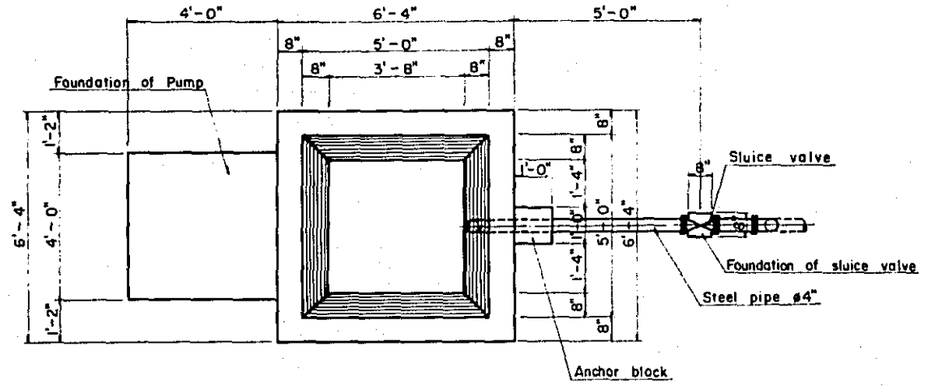
TANK
PLAN & SECTION

Date. Dec. 1977 | D.W.G. No. 15

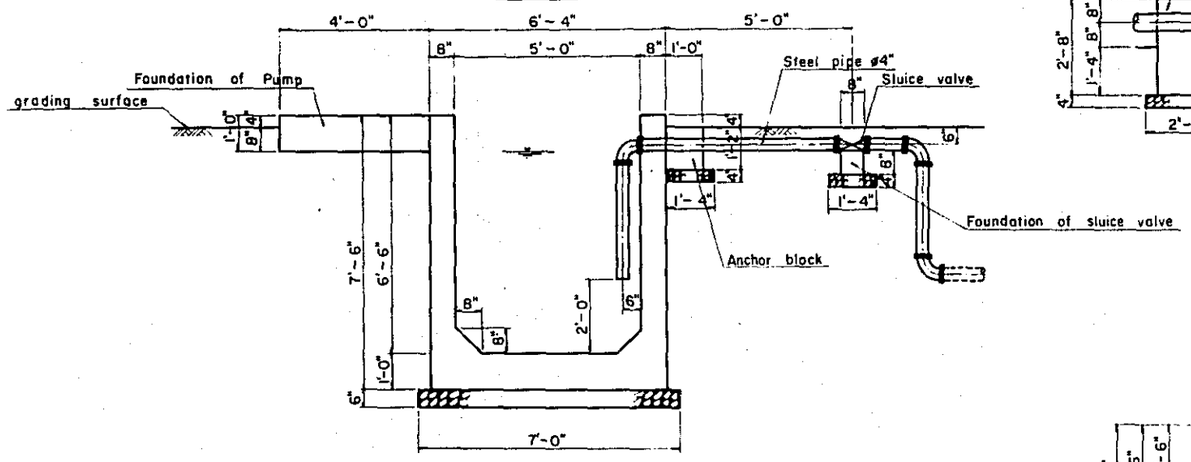
SUCTION TANK FOR No.1 FIELD

SCALE A

Plan



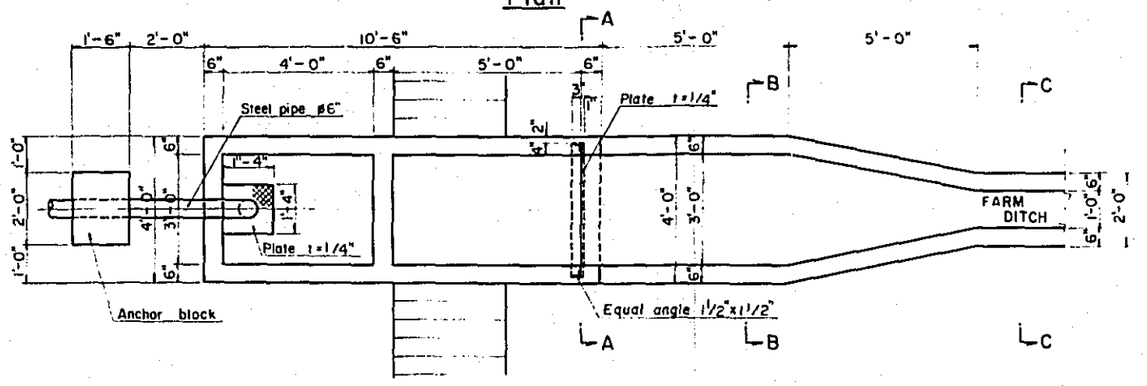
Profile



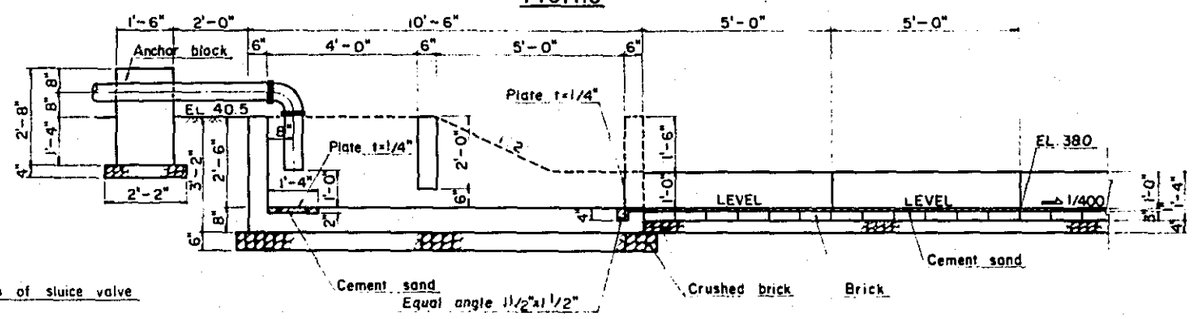
DISCHARGE TANK FOR No.2 FIELD

SCALE A

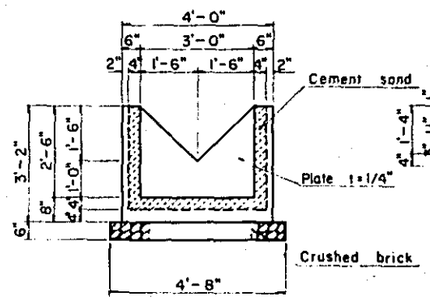
Plan



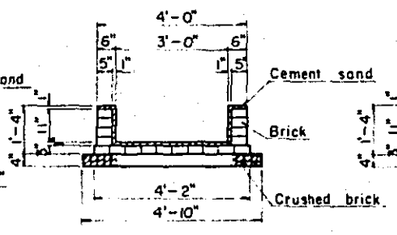
Profile



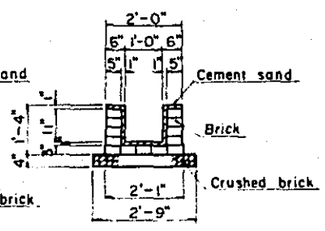
Section A — A



Section B — B



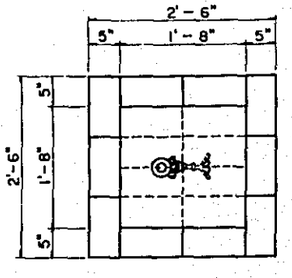
Section C — C



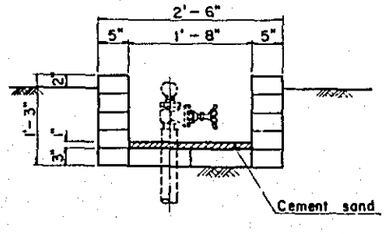
HYDRANT BOX

SCALE B

Plan



Profile



SCALE A 0 5 10 ft

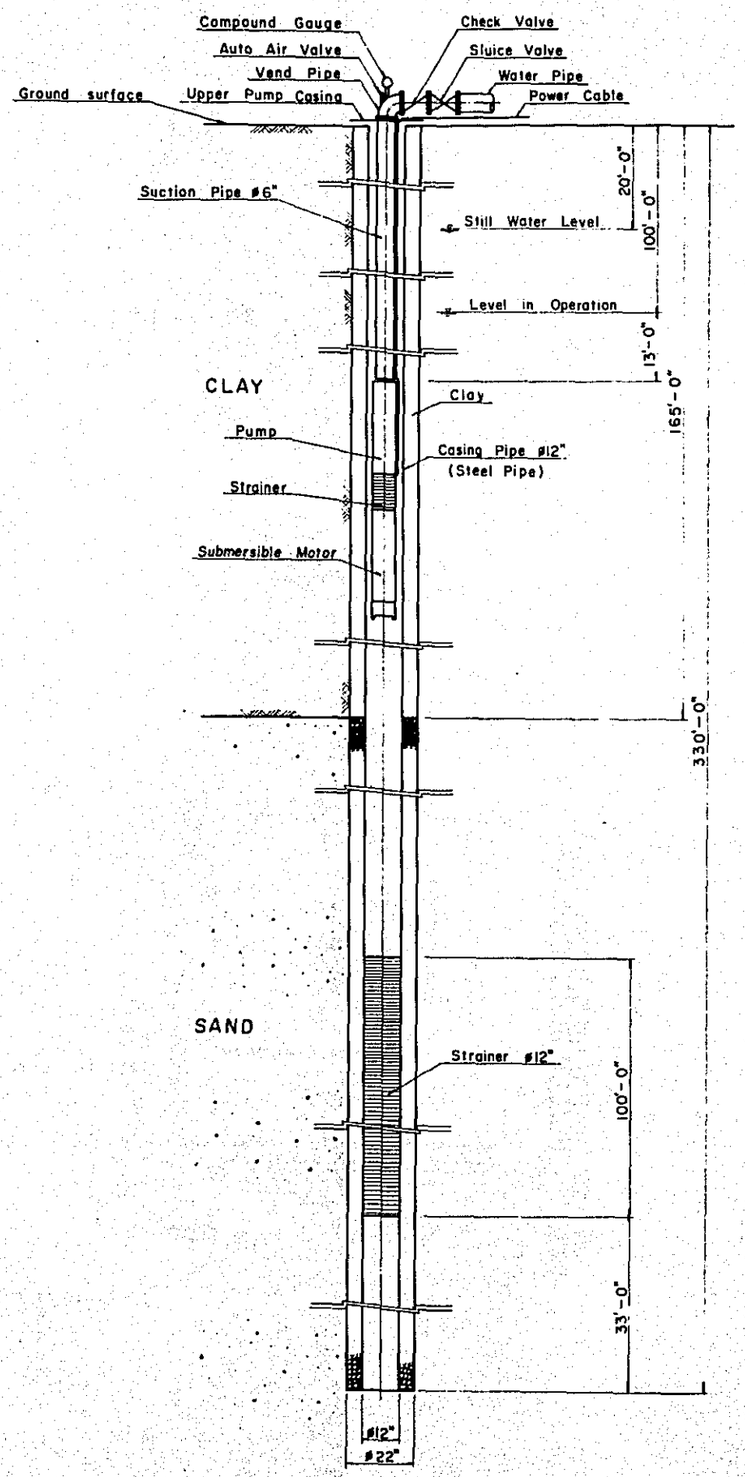
SCALE B 0 1 2 3 4 5 ft

CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH

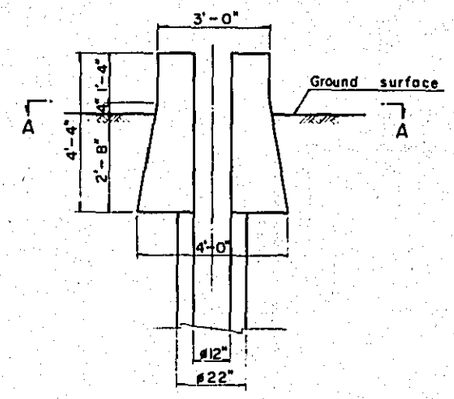
SUCTION · DISCHARGE TANK & HYDRANT BOX

Date. Dec. 1977 | D.W.G. No. 16

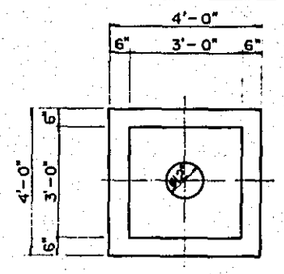
DEEP WELL



FOUNDATION



Section A — A



SCALE

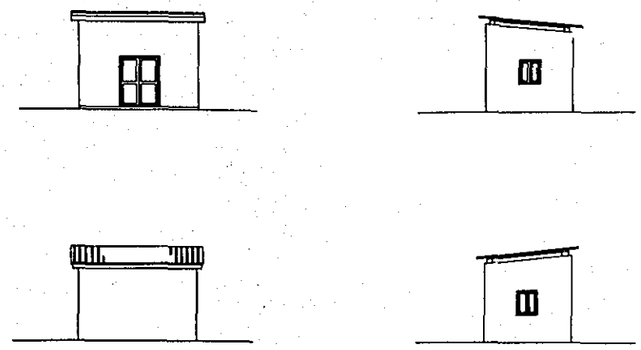
0 5 10 ft

CITRUS AND VEGETABLE RESEARCH PROJECT
IN BANGLADESH

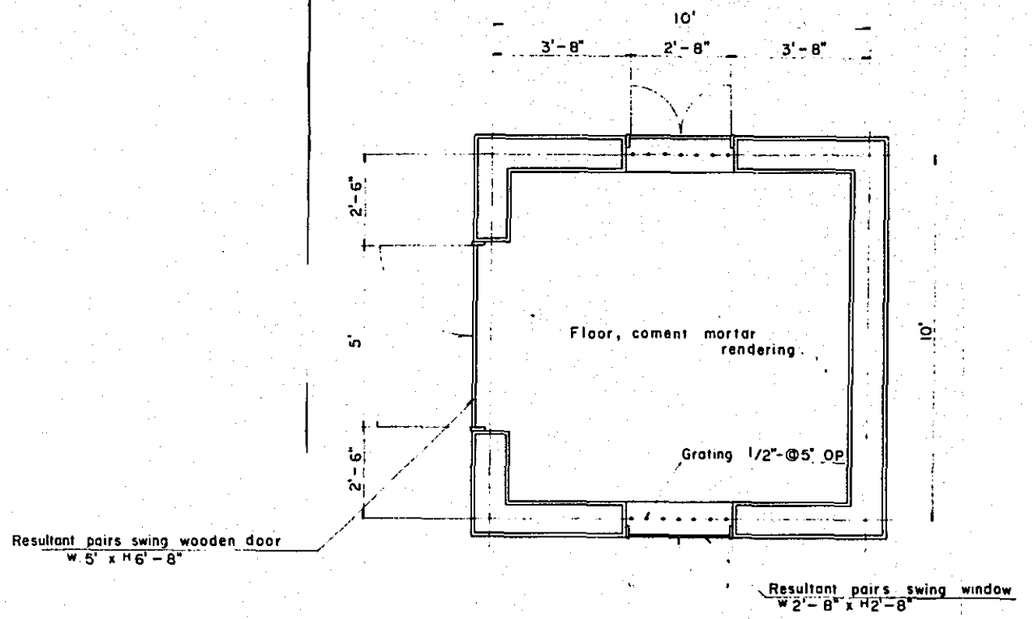
DEEP WELL

Date. Dec. 1977 | D.W.G. No. 17

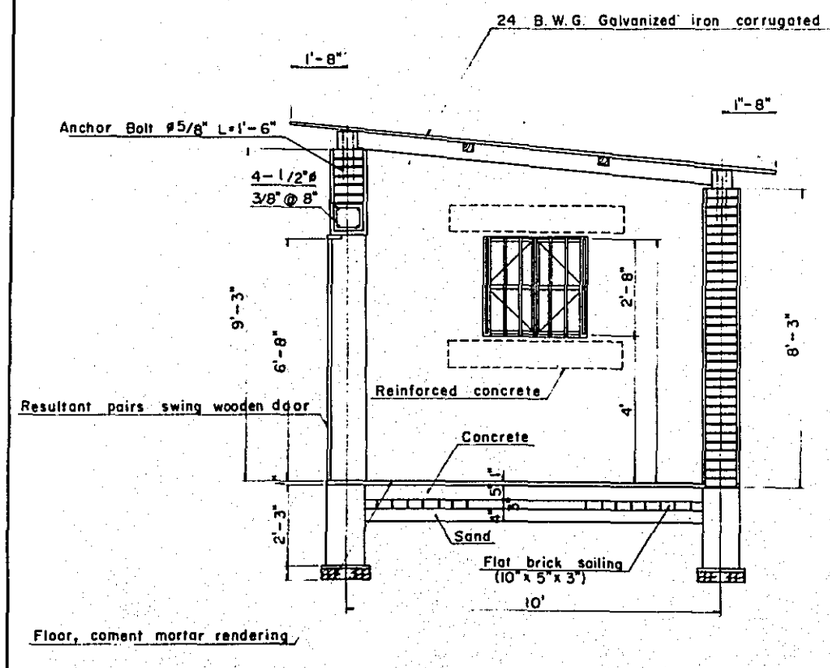
ELEVATION
SCALE A



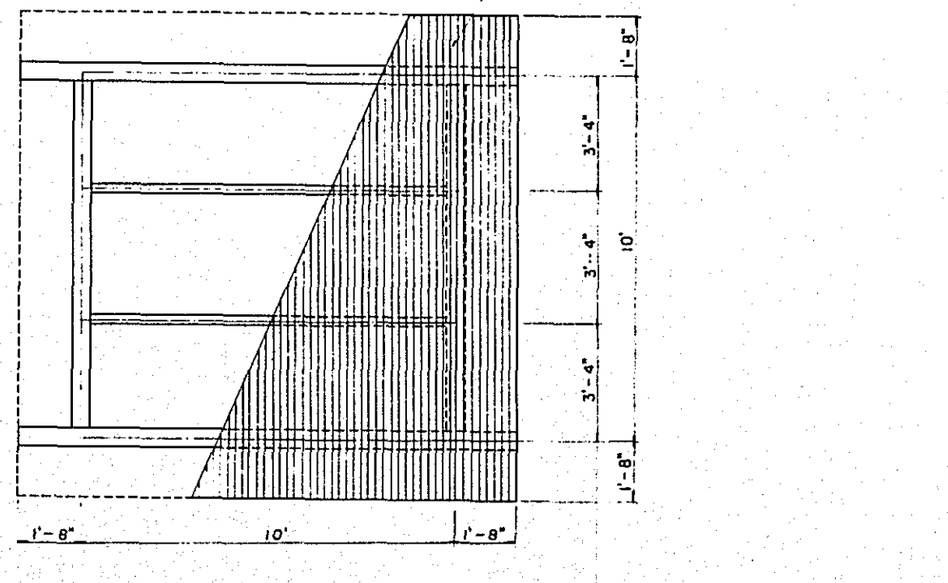
PLAN
SCALE B



SECTION
SCALE B



ROOF PLAN
SCALE B



SCALE A 0 10 20 30 40 50 ft

SCALE B 0 5 10 ft

CITRUS AND VEGETABLE RESEARCH PROJECT IN BANGLADESH

PUMP HOUSE IN No. I FIELD

Date.	Dec. 1977	D.W.G. No.	18