MINISTRY OF HIGHER EDUCATION AND HIGHWAYS
DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

PREPARATORY SURVEY REPORT
ON
THE PROJECT FOR ESTABLISHMENT OF RESEARCH AND TRAINING COMPLEX AT THE FACULTY OF AGRICULTURE, UNIVERSITY OF JAFFNA

MARCH 2016

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS GLOBAL CO., LTD.
EARL CONSULTANTS INCORPORATED

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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to a joint venture consist of Oriental Consultants Global Co., Ltd. and Earl Consultants Incorporated.

The survey team held a series of discussions with the officials concerned of the Government of the Democratic Socialist Republic of Sri Lanka, and conducted a field investigations. As a result of further studies in Japan, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Democratic Socialist Republic of Sri Lanka for their close cooperation extended to the survey team.

March, 2016

Makoto KITANAKA
Director General,
Rural Development Department
Japan International Cooperation Agency

Summary

Summary

1. Overview of Sri Lanka

The Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "Sri Lanka") is an island country in South Asia located south-east of India. The land area is 65,607 km^2 (about 80% the size of Hokkaido, Japan) and has many mountains in the south, whereas in the north the area is mostly flat, including Kilinochchi where this project site is located. The population in 2014 was approximately 20.67 million people, of which 1.05 million were in the Northern Province.

Sri Lankan has a tropical monsoon climate, which is hot and humid, with two rainy seasons a year. The country is divided into dry and wet zones. About 70% of the country from the northern to the central area is in the dry zone with relatively low rainfall. The site for the University of Jaffna's (hereinafter referred to as "UOJ") Faculty of Agriculture (hereinafter referred to as "FoAg") in this project is located in this dry zone area.

After 26 years of civil war in Sri Lanka ended in 2009, economic activity and reconstruction work after 2010 contributed to high economic growth (8.3% in 2011, 7.3% in 2014) and decreasing unemployment (4.3% in 2014). Not only was the number of tourists steadily increasing, which reached 1 million tourists in 2012 and continued to increase as of 2014, but exports also rose by 7.1% (2014), exceeding 10 billion USD for the second consecutive year. As a result, the GDP per capita in 2014 was 3,625 USD with GDP growth at 7.4%, and GNI per capita was 3,400 USD.

However, the social infrastructure is still weak and the development of the late developed regions due to the impact of natural disasters and civil war has been a challenge. With a newly elected Government in 2015, further development in the new administration is expected.

In the past, industry in Sri Lanka was an agriculture-dependent economy centered on rice and plantation crops (tea, rubber, coconut). However, along with economic development, manufacturing, wholesale, and retail trade have expanded, with the textile industry becoming the largest export item as of 2014(industrial products, such as textile and clothing, at 74.2%, agricultural at 25.1%).

2. Background, History and Summary of the Project

(1) Current Situation and Issues of Agriculture in Sri Lanka

In the Northern Province, after the civil war ended, although the promotion of IDPs settlement and infrastructure development have been conducted, further efforts to improve resident livelihood is still necessary. In particular, agriculture is a major industry and also a major income source in the northern region. However, because of the lack of proper irrigation systems and proper knowledge, many farmers are engaged in agriculture under susceptible circumstances. Consequently the productivity is not high and improvement of agriculture productivity has become an urgent issue.

The yield of rice (2.3t/ha) in the Northern Province of Sri Lanka is significantly low compared to

the national average of Sri Lanka (3.8t/ha)[1] as well as compared to Japan (6.7 t/ha)[2]. In order to improve this situation, the basic introduction and dissemination of agricultural technology such as the development of appropriate paddies and establishment of fertilization standards are considered necessary.

As FoAg is the only higher education institution in agriculture sector in the northern region, contribution in improving agriculture in this area through education and research activities is expected to fall on FoAg. However, because FoAg had been forced to evacuate to Jaffna for 25 years, experiments and practical training have been conducted with the help of other departments or other universities by borrowing the necessary facilities and equipment. From 2014, although activities at Kilinochchi Campus have been restarted, due to the limitation of facilities and equipment for experiment and practical training, the teaching program tended to be deviated to theory and lecture, and more practical education and research have been required.

(2) Priority Plan

In the Sri Lankan "National Development Framework 2010 (Mahinda Chintana)", towards balanced regional development with diversity, putting emphasis on accelerating reconstruction areas affected by civil war and social integration. In the new administration launched in 2015, "to build a stable nation" was one of the targets with "food security and sustainable agricultural development" as one of the government manifests.

In the policy formulated by the Ministry of Agriculture "National Agriculture Policy (2015)", improvement of agricultural productivity and efficiency, promotion of the agricultural sector towards young people, as well as promotion of agricultural sector education through the development of agricultural technology are listed as goals to achieve. Furthermore, in the "2014 Progress & 2015 Development Programmes" from the Ministry of Agriculture, promoting development of integrated Dry Zone agriculture including the northern region was listed as one of the goals.

In the "National Higher Education Strategic Management Plan of Sri Lanka (2012－2015)", the University of Jaffna is expected to play a role as the centre of higher education in the Northern Province, with a goal to enter a higher place in the international university ranking. Moreover, sector-based student employment rate in FoAg, which was 73% (2011), was targeted to 90% (2015) .

In the UOJ, the Master Plan of Kilinochchi Campus, which includes development of not only FoAg but also the Faculty of Engineering and Sport and Science Unit, was prepared in accordance with the redevelopment plan of the Kilinochchi area. This project which aims to strengthen the education and research in FoAg is consistent with the priority Plan of Sri Lanka.

[1] From FAOSTAT, average value from 2010－2013

[2] From FAOSTAT, average value from 2011－2013

(3) Request Content

Under these circumstances, the Government of Sri Lanka (hereinafter referred to as "GoSL") requested from the Government of Japan (hereinafter referred to as "GOJ") the construction of a Research and Training Complex, and a Research and Training Farm with essential equipment in FoAg, UOJ under Grant Aid. The summary of the request is as follows:

Building and facilities: Research Laboratory Building (research room, lab, etc., 2-storey building, 4,800 ㎡), ICC Building (research room, lodging facility etc., 2-storey building, 2,400 ㎡), Research and Training Farm (grain & horticultural farm, livestock farm, etc., crop 150 acre, livestock 100 acre)

Equipment: Experimental equipment (for agronomy, animal nutrition, reproductive physiology, soil testing and bio fertilizer, food analysis and processing, plant protection and bio control, bio technology and tissue culture, environment and hydro research laboratory), training equipment, meteorology station equipment, farm machinery (agricultural machines, livestock agricultural equipment), a total of 283 items.

3 Survey Result Summary and Project Contents

The preparatory survey team was dispatched to Sri Lanka from May 6th 2015 to June 5th in order to conduct a field survey, data collection and discussions with the counterparts from the Ministry of Higher Education & Highways, UOJ, the External Resource Department, Ministry of National Policies & Economic Affairs, and Department of Fiscal Policy, Ministry of Finance regarding this project. Through the series of discussions, the survey team confirmed and studied the contents of the requests by GoSL, the condition of the site and existing facilities, farms and equipment, the operation and maintenance system of UOJ, and prepared the corresponding facility and equipment plan. After returning to Japan, the survey team conducted analysis of the field survey results and prepared an outline design which is summarized as the Draft Final Report (hereinafter referred to as "DFR"). The survey team was dispatched to Sri Lanka from November 25th to December 5th 2015, to explain the DFR to the counterparts and its content was basically agreed on by the Sri Lanka side.

(1) Design Policy

In this Grant Aid project, in order for FoAg of UOJ, which was returned to Kilinochchi from refuge, to be able to conduct more practical research and education (human resource development), not only construction of a Research Laboratory Complex, Processing Training Building, and Research and Training Farm but also procurement of the necessary equipment, as well as the development of a training handbook to facilitate implementation and soft component. Based on the request from and consultation with GoSL and results of he field survey, planning was conducted based on the following policies:

1) Design Policy of Facility

In designing the facility, it was agreed to develop the necessary facilities for practical education

(human resource development) which can contribute to improve Dry Zone agriculture in the Northern Province, such as a Research Laboratory Building, a Processing Training Building, and a Research and Training Farm. With regard to training and dissemination of activities, it's been decided to set up a multi-purpose training room for carrying out training and education for instructors in the Research Laboratory Building. Also, necessary facilities for farm training and research, such as a Farm Management Building, goat shed, and livestock weighing building shall be built within the Research and Training Farm site.

The Research Laboratory Building mainly has laboratories for the specialized subjects of 3rd and 4th years and rooms for academic staff of each department. The scale of each group in a lab is planned for 24 people (after considering the future number of students and departments).

Moreover, the design incorporates natural ventilation and shading while taking into account the reduction of heat, high humidity, and maintenance costs.

2) Design Policy of Research & Training Farm

Based on the unit integration possibility of the planned cultivation crops, available water consumption, manageable area of operation and maintenance, and support from other donors, the requested farm has been reviewed and the result is to construct 19.15 acres of the Research and Training Farm.

3) Design Policy of Equipment

While referring to the requested equipment list, the candidate equipment list was prepared based on the study of the curriculum, experiment and practical training syllabus, and confirmation of the research theme and existing equipment. From there, the target equipment for this project were selected according to the criteria which are essential equipment for general experiments and practices of students and research activities with high versatility and high frequency of use, and the necessary equipment for general experiments and practices, or prioritized research activities, even though which the versatility and frequency of use are limited. As a base, general-purpose glassware and chemical agents, equipment which are available or inexpensive in Sri Lanka, equipment overlapped with the existing one, as well as equipment which needs high operation and maintenance cost are excluded.

4) Soft Component

Even during the 25 years of evacuation to Jaffna, FoAg has continuously conducted education, research, as well as training to the agricultural extension workers from the Agriculture Department by renting/borrowing facilities and equipment of the other faculties and other universities. The facilities and equipment were very constrained, resulting in limited learning and research activity. Therefore, in order to support the FoAg to effectively utilize the new research and training facilities, equipment, and farms, activities to support academic staff to provide practical lessons that incorporates the experiments and practical training by using the new equipment, to manage laboratory equipment properly, as well as to manage research & training and farms, are planned as

Soft Component.

(2) Content and Scale

1) Facilities

Table 1 Overview of Target Facilities

Complex / Building	Department / Facility	Room Name	Total Floor Area () incl. outdoor
Research & Training Complex	Dept. of Agronomy	Crop Science Laboratory, staff rooms	280.5 ㎡
	Dept. of Animal Science	Animal Nutrition Lab, staff rooms Reproductive Physiology Lab	501.9 ㎡
	Dept. of Agricultural Chemistry	Soil Testing & Bio Fertilizer Lab, staff rooms Food Analysis & Processing Lab, staff rooms	560.8 ㎡
	Dept. of Agricultural Biology	Plant Protection & Bio Control Lab, Bio Technology & Tissue Culture Lab	344.6 ㎡
	Dept. of Agricultural Engineering	Environment & Hydro Research Lab, staff rooms	280.4 ㎡
	Dept. of Agricultural Economics	Econometrics Lab, staff rooms	241.2 ㎡
	Common	Freezer room, Water Distillation room, Light microscope room	79.26 ㎡
	ICC Related	Multi-purpose Training Room, exhibition zone	346.8 ㎡
	Lecture rooms	Lecture hall, meeting rooms	205.2 ㎡
	Public area	Corridor, toilet, M&E related facilities	736.1 ㎡
	Sub-total		3,576.8 ㎡ (4,721.6 ㎡)
Processing Training Building		Meat Processing Unit , Dairy processing unit, Food processing unit, Preparation room, Changing rooms	324.0 ㎡
Research and Training Farm Building		Office, Farm lecture room, Demonstration room, Primary sample preparation room, Crop post harvest unit, Farm machinery storage, Farm machinery workshop, Washing area	535.1 ㎡ (576.0 ㎡)
Goat shed		Goat shed, storage	48.0 ㎡
Livestock Weighing Building		Measuring chamber, digestive measurement room	22.5 ㎡
Total Floor Area			4,506.4 ㎡ (5,692.1 ㎡)

Source: JICA Study Team

2) Research and Training Farm

Table 2 Research and training farm construction area

Unit Name	Areas planned (acres)	Shape of farms	Contents of construction works
1. Plant propagation unit	0.26	16.0 x 67.0m	Fruit crops, field crops, floriculture crops, vegetable crops, plantation, cut-foliage crops
2. Protected agriculture unit	0.74	45.0 x 67.0m	Cole crops, floriculture crops, vegetable propagated fruit plant, cut-foliage crops, shared field by the department
3. Fruit crops germ-plasm collection unit (1)	1.60	53.0 x 123.0m	Fruit crops, grapes
Fruit crops germ-plasm collection unit (2)	2.60	91.0 x 116.0m	
4. Field crops experimental unit (1)	1.00	54.0 x 75.0m	Cereal crops, oil crops, tuber crops, spices and condiments, pulses, fiber crops, vegetable crops
Field crops experimental unit (2)	0.60	41.0 x 60.0m	
5. Plantation & agro-forestry unit	4.20	123.0 x 139.0m	Silviculture crops, plants for fence, valuable crops, plantation crops, fruit crops
6. Agr. Management unit	0.72	25.0 x 116.0m	
7. Model home garden unit	1.00	54.0 x 75.0m	Fruit crops, vegetable crops, floriculture crops, field crops, medical plants, spices and condiments, export crops, plantation crops
8. Agro-tourism unit	2.00	67.0 x 123.0m	Plantation crops, spices and condiments, fruit crops, vine crops, medical plants
9. Goat rearing unit	5.00	112.0 x 185m	CO3 and CO4, fodder trees, pasture grass
Total	19.72		

Source: JICA Study Team

3) Equipment

Table 3 Major equipment list and its applications

Building	Department	Equipment	Application	Quantity
Research & Training Complex	Dept. of Agronomy	Plant growth chamber	To encourage or inhibit plant growth by controlling the growing environment (temperature, humidity, and light intensity)	1 unit
	Dept. of Animal Science	Digestion chamber	To hold animals for measuring coefficient of feed digestibility	1 unit
	Dept. of Agricultural Chemistry	Fume hood (draft chamber)	To exhaust harmful gas generated from chemical experiments	3 units
	Dept. of Agricultural Biology	Laminar flow cabinet	To carry out experiment under aseptic condition (to avoid contamination from dust and microscope)	1 unit
	Dept. of Agricultural Engineering	Cut models	To display visual image of engine, gear box, break unit etc to help the students to understand better	1 unit
	Dept. of Agricultural Economics	Computer	To perform calculations required for the econometric analysis	6 units
	Common	GC (Gas chromatography)	To identify and measure tiny amount of compounds (inorganic gas, carbon oxide, pesticide, etc)	1 unit
Processing Training Building	Food processing	Twin screw extruder	To mix, blend, mush and shape food materials	1 unit
	Dairy processing	Milk pasteurizer tank set	To homogenize, sterilize, and store milk	1 unit
	Meat processing	Smoke chamber	To process ham & bacon	1 unit
Research and Training Farm Building		4-wheel tractor & attachment	To plough, level, weed, seed, and fertilize the farm by pulling and operating the attachment	1 unit

Source: JICA Study Team

4) Soft Component

Table 4 Output and Activities of proposed Soft Components

Outputs	Results	Activities
(1) Classes that incorporate experiments and practical training will be given.	1) Reference books shall be made for experiments and practical training 2) Teaching staff shall learn experiments and practical training methods	■ Confirm the experiment & training implementation status of each department and the knowledge of teaching staff. ■ Introduce experiment and practical training based on the syllabus and create implementation objectives. ■ Make a list of experiments & training that require reference books. ■ Create reference and handbooks together with the teaching staff of each department, and provide training based on them.
(2) A system to properly manage the laboratory's equipment, tools and materials shall be built.	1) Equipment and tools shall be properly stored and managed.	■ Explain in detail the method of cleaning, organizing, and managing the equipment ■ Create and use the equipment's organized check list. ■ Create equipment's management manual together with the person in charge
	2) Inventory management shall be properly conducted.	■ Explain the management method. ■ Confirm the inventory. ■ Teach how to fill the inventory management list.
(3) The Training and Research farm shall be properly managed.	1) Farm management plan shall be created. 2) The farm management implementation system shall be completed	■ Develop an annual plan regarding crop acreage and pumping management together with the farm administrator and farm users (Faculty of Agriculture). ■ Establish "Farm training committee (tentative)" ■ Put together a handbook on how to manage the farm along with farm administrator and farm users (both used and unused). ■ Calculate the necessary farm management annual cost following the farm manager. ■ Prepare a plan for agricultural machine maintenance, including organization and maintenance method along with farm administrator and farm users.

Source: JICA Study Team

4. Construction period and cost estimation of the project

After signing of the consultant's agreement, Detailed Design and Tender-Related Work 1 (up to preparing tender documents and approval) is planned for about four months, then will proceed to Tender-Related Work 2 (tender notice, distribution of tender documents, tender, tender evaluation, contract suppliers) for about 3.5 months. The duration of construction of the facilities, farm, and equipment procurement, transportation, and installation are planned to be 17 months in total.

The entire cost associated with the implementation of this project is estimated to be 1,786 million Yen (Japan: 1,714 million Yen, Sri Lanka: 71.55 million Yen).

5. Project Evaluation

(1) Relevance

This project aims to contribute in improving the efficiency and effectivity of research and human resource development of the agricultural and livestock sector in the northern Dry Zone, as well as the productivity of the agricultural and livestock sector in the same region by developing a research building, a processing training building and a farm field for research and training in the Faculty of Agriculture, University of Jaffna, so that the priority goal of activating the local economy in the Northern Province through agriculture can be achieved. Thus, the beneficiary of this project is all of the residents in the Northern Province (about 1.05 million people).

Furthermore, the implementation of this project is confirmed to corresponding to the priority areas of 'Development of Emerging Regions' described in "Country Assistance Policy to Sri Lanka" by the Japanese Government, and also expected to contribute to the improvement of Dry Zone agriculture based on 'Livelihood Improvement Support in the Conflict-affected Areas' in "Promotion of Regional Development in Emerging Regions Program".

Moreover, from the environmental and social points of view, there is no negative impact in the implementation of this project. It is considered possible to conduct this project using Japan's Grant Aid.

Based on the above argument, the implementation of this project is considered valid.

(2) Effectiveness

The quantitative and qualitative effects expected by the implementation of this project, which also explains this project's effectiveness, are summarized below.

1) Quantitative Effect

Table 5 Verifiable Indicators for Quantitative Effect

Indicators	Base (Actual value in 2014)	Target (2021) (3years post-project completion)
Number of undergraduate students and graduate students of the Faculty of Agriculture	Undergraduate students：280 Graduate students：14	Undergraduate students：480 Graduate students：30
Number of teachers in the Faculty of Agriculture	24	43
Number of research papers related to improvement in productivity on Dry Zone agriculture of the northern region, by students and teachers of the Faculty of Agriculture. (referred, papers/year)	12	24
Hours of practical training on the Training Farm for students. (hours/year)	0	105
Number of training programs for people outside the university (officers at the agricultural organization, agricultural extension workers and private relations in the Agricultural sector) (times/year)	2	6

Source: JICA Study Team

2) Qualitative Effect

- Students acquire practical knowledge and skills.
- Implementation of practical research activities that can contribute to increased productivity in agriculture and animal husbandry on Dry Zone in the Northern region through the enhancement of the research capability of teachers.
- Productivity of agriculture and animal husbandry on Dry Zone in the Northern region is improved through training provided by the FOA to enhance the expert knowledge of officers in agriculture organizations, agricultural extension workers and private sectors trained by the Faculty of Agriculture.

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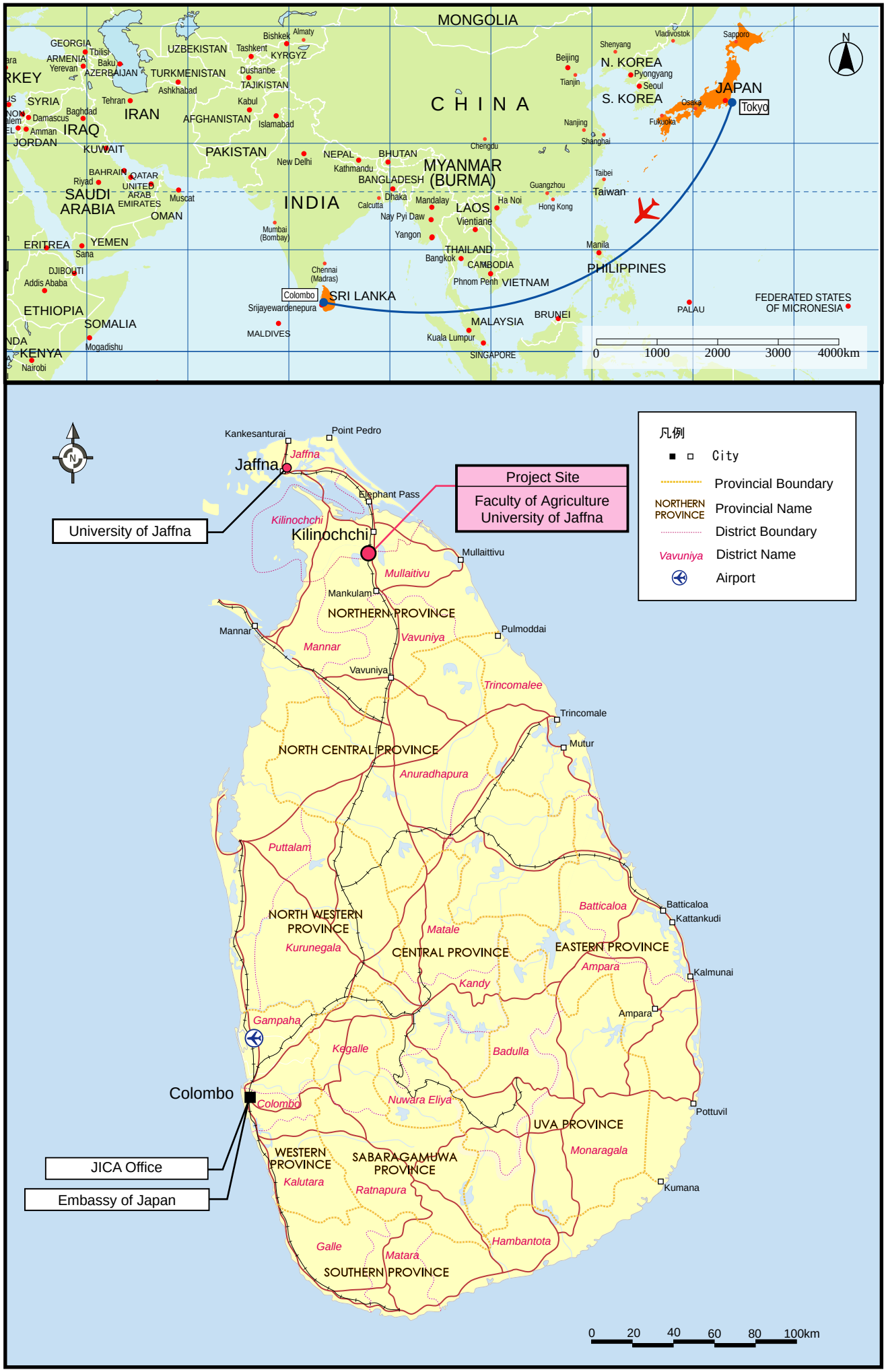
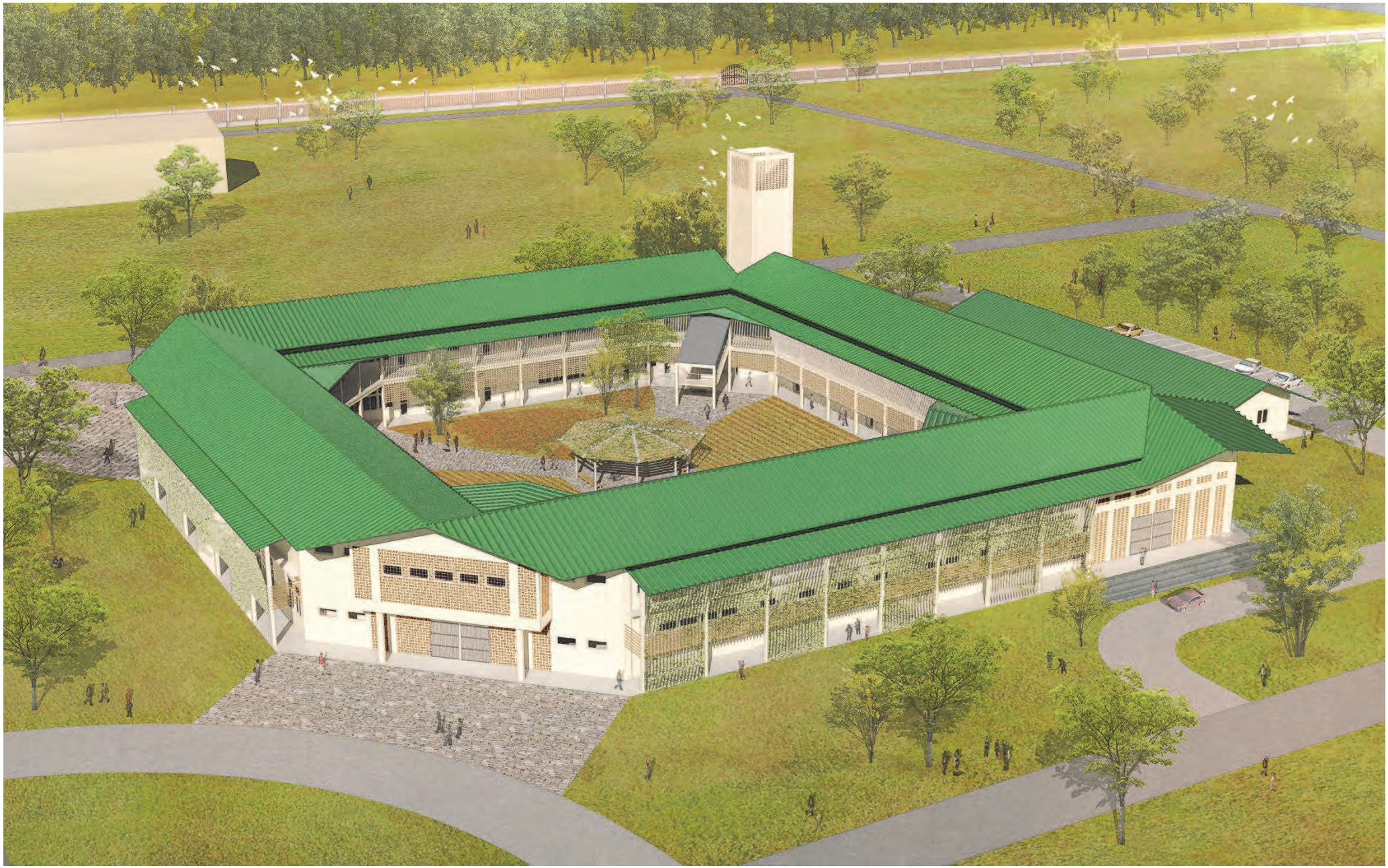


Location Map

Perspective view of the Research and Training Complex



Perspective view of the Research Laboratory Building and the Processing Training Building

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ABBREVIATIONS

ADSL	Asymmetric Digital Subscriber Line
AEP	Acrylic Emulsion Paint
A/P	Authorization to Pay
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	American Society for Testing and Materials
AVR	Automatic Voltage Regulator
B/A	Banking Arrangement
BOD	Biochemical Oxygen Demand
BS	British Standards
BSc	Bachelor of Science
CAD	Computer Aided Design system
CEB	Ceylon Electricity Board
DD	Detail Design
E/N	Exchange of Notes
FAO	Food and Agriculture Organization
FRP	Fiber Reinforced Plastics
G/A	Grant Agreement
GB	GIGABYTE
GC	Gas Chromatography
GL	Ground Level
GPS	Global Positioning System
HPLC	High Performance Liquid Chromatography
ICC	Information and Communications Center
ICT	Information and Communications Technology
ILO	International Labor Organization
IP	Internet Protocol
JASS	Japanese Architectural Standard Specification
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
LEARN	Lanka Education And Research Network
LAN	Local Area Network
LED	Light-emitting Diode
LKR	Sri Lanka Rupee
LPG	Liquefied Petroleum Gas
LTTE	Liberation Tigers of Tamil Eelam
MSc	Master of Science
MOHEH	Ministry of Higher Education and Highways
NBT	National Building Tax
NCT	National Certificate in Technology

NGO	Non-Government Organization
NWSDB	National Water Supply and Drainage Board
PAL	Port and Airport Levies
PC	Personal Computer
PCR	Polymerase Chain Reaction
PhD	Doctor of Philosophy
RBC	Red Blood Cell
SLT	Sri Lanka Telecom
UGC	University Grants Commission
UNDP	United Nations Development Programme
UNWFP	United Nations World Food Programme
UOJ	University of Jaffna
UPS	Uninterruptible Power-supply System
UXO	Unexploded Ordnance
VAT	Value Added Tax
VoIP	Voice over Internet Protocol
VPN	Virtual Private Network
WB	World Bank
WBC	White Blood Cell

Chapter 1 Background of the Project

Chapter 1 Background of the Project

1.1 Background of the Project

1.1.1 Current situation and problems

Since the end of the civil war in 2009, the government of Sri Lanka (GoSL) and international organizations have addressed policies to reconstruct the conflict-affected areas in the Northern and Eastern Provinces. These policies include promoting the return and settlement of IDPs (internally displaced persons) and restoring destroyed infrastructure. However, further efforts are needed to improve the livelihoods of residents in the area, especially in the agricultural sector, which is a major source of income in the region.

Agriculture in the Northern province of Sri Lanka is vulnerable to several biotic and abiotic stresses, such as drought, which significantly reduces the productivity of food crops in the region. To improve the livelihood of the people in the northern province, agricultural productivity in the region urgently needs to be improved.

The yield of paddy rice in the northern provinces is 2.3 t/ha, which is much lower than average yields overall in Sri Lanka (3.8 t/ha)[1] or Japan (6.7 t/ha)[2]. Introduction of basic agricultural technologies such as improved maintenance of paddy fields, development of appropriately designed paddy fields, and optimization of fertilizer use will help to improve the productivity of paddy rice as well as other major crops cultivated in the region.

In the ”National Agricultural Policy 2015”, improvement of agricultural productivity and efficiency, promotion of the agricultural sector towards young people, as well as the promotion of agricultural sector education are listed as goals to be achieved from the development of agricultural technology.

In the “Medium-term Higher Education Management Strategy（2012 - 2015）”, the University of Jaffna is expected to play a role as the centre of higher education in the Northern Province, with a goal to enter a higher place in the international university ranking.

In the Master Plan of Kilinochchi Campus, the University of Jaffna was developed in accordance with the redevelopment plan of the Kilinochchi District, and the campus is expected to be a core of the development of the south side of the city.

As FoAg is the only higher education institution in agriculture in the northern area, contribution in regional capacity building and improving agricultural productivity of the region by education and research activities for the Northern Province is expected. For example, FoAg could contribute to improving the agricultural productivity by improving processing techniques for palm products, or enhancing the preservation and

[1] FAOSTAT, average of data 2010-2013

[2] FAOSTAT, average of data 2010-2013

utilization of jackfruit and mango, which are grown in Sri Lanka in only the northern provinces.

However, FoAg was forced to evacuate to Jaffna for 25 years, during which experiments and practical training have been conducted with the help of other departments or other universities by borrowing the necessary facilities and equipment.

From the end of 2014, although activities at Kilinochchi Campus have been restarted, the necessary facilities and equipment for experiment and practical training was limited. Even though FoAg has same teaching responsibilities as other universities in Sri Lanka, the practical classes that are very important in agricultural education are difficult to conduct in the current facilities at UOJ, and most of the research conducted by undergraduate and graduate students is currently carried out at the facilities of the Faculty of Medical Science of UOJ or at the University of Peradeniya. As a result, the lectures tended to be deviated to theory and a more practical education and research have been required.

Under this circumstances, GoSL requested grant aid assistance from Japan to develop a Research and Training Complex and Research and Training Farms for the Faculty of Agriculture, University of Jaffna. Upon this request, JICA decided to conduct the Preparatory Survey to verify the feasibility of this project, and the necessity and importance of this project in the increase of Dry Zone agriculture in the Northern region was confirmed.

"Development of Emerging Regions" is one of the priority areas (mid-term target) in the Japanese Government's "Country Assistance Policy to Sri Lanka", and support for recovery of productivity in the conflict affected area is a prioritized area in the JICA Country Analysis Paper. It was confirmed that this project met the policy and analysis.

1.2 Natural Conditions

In order to understand the situation of topography, geology and the soil bearing, water quality and capacity of groundwater, and the weather of the project site, four types of Natural Condition Surveys: topographical survey, geological survey, hydrological survey, and weather data collection survey, were conducted. The purpose, method, and influence on this project of each survey are shown below.

1.2.1 Topographical survey

The project site is about 2ha, on the front block of the Administration Building of the FoAg, in the centre of Kilinochchi Campus. Although there are some trees in the site, it is substantially flat and there are no obstacles for construction. However, when it rains heavily, pools form in hollow places on the ground, therefore it is necessary to consider a drainage system.

Within the farm block across the north road from the building area of the campus, around 43.4 acres are available for the farm field. Among this area, 24.3 acre will be used for the farm field and its administration building including 4.6 acres for roads, which will be developed in this project. Tree

trimming and uprooting will be necessary prior to the construction as there are many trees on the site.

The ground level of the site, the position of existing buildings and structures in the site and surrounding area were confirmed through this topographical survey conducted in this project using the existing benchmark.

1.2.2 Geological survey

In order to develop building plans including a structural plan and its construction method, geological and soil bearing capacity surveys were conducted. Four boring tests were conducted in the site: three within the site of Research and Training Complex, and the other in the Research and Training Farm site.

The depth of the boreholes was 30m, from which a sample of soil was collected and the underground water level was confirmed by N-value from the standard penetrating test.

The result of the survey confirmed that the underground water level was approximately 2.5m from the depth of the hole, thus there should be no problem during the foundation work. Furthermore, it was confirmed that the soil has enough bearing strength for the planned 2-story building based on the confirmed N-value, showing that the current site has no problem as the project site.

1.2.3 Hydrological survey

In the site for Research & Training Complex and Farm, the test wells were dug and a hydrological survey of water quality test and pumping test of groundwater were conducted.

Since it was confirmed that the necessary amount of water for the Research & Training Complex can be secured from Test Well no.1, this Test Well no.1 can be used as the Main Tube Well for the complex. However, because there was an experience of difficulties in using the test well due to external factors prior to the start of the project, a new tube well is planned to be constructed to prevent the same problem this time.

Regarding the farm field, the pumping test result confirmed the insufficiency of the water of the existing well which was predicted to be enough in the beginning, thus an additional Test Well no.2 was dug. The result showed that Test Well no.2 only had half the amount of water available compared to Test Well no.1 which was located within the site for the Research & Training Complex. The unsatisfying results of the pumping test for the existing test well and the additional test well were assumed to be the difference of soil permeability between the research building's soil and the farm field's.

Based on the above result, the test well shall not be used as the main water source, and two 6-inch new tube wells will be constructed to cater to the demand of water.

1.2.4 Weather data collection survey

Since there is no weather data for Kilinochchi, the weather data of a geographically close area, Jaffna, shall be used as a reference. The average annual rainfall amount of the most recent three years, from 2012 to 2014 is 1115 mm/ year. Compared to Japan, it's not necessarily dry, since the average low humidity is 51% - 79%, which is relatively high. Moreover, the monthly average low temperature is 22℃(in January and February), and the average high temperature is 33℃ (in April and July). The weather data of Jaffna in the most recent three years is shown below.

Table 1-1 Weather data of Jaffna (average of most recent 3 years from 2012-2014)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avrg. high temperature (℃)	29	30	32	33	32	32	33	32	32	31	30	29
Avrg. low temperature (℃)	22	22	24	26	28	28	27	27	27	25	24	23
Total rainfall (mm/month)	84	58	42	42	53	2.7	1.4	58	91	246	246	191
Avrg. max rainfall (mm/day)	38	27	26	24	32	3	1	27	43	57	72	73
Rain days (≥5mm/day)	3	2	1	3	2	0	0	2	3	8	9	6
Avrg. hours of sunlight (h/day)	7	8	9	9	8	7	8	7	7	7	5	4
Avrg. high humidity (%)	88	87	87	86	82	82	82	83	81	86	87	87
Avrg. low humidity (%)	74	71	66	68	75	71	69	72	74	77	51	79
Avrg. wind speed (km/day)	137	124	115	156	300	304	262	247	261	154	115	127

Source: Weather Observation Station of Jaffna

1.3 Environmental and social considerations

This project is not applicable as the sector easily influenced as defined in the guidelines "New Environmental and Social Considerations". Because the undesirable effects on the environment and society in this project is considered little, it can be categorized in Category C.

Chapter 2 Contents of the Project

Chapter 2 Concept of the Project

2.1 Basic Concept of the Project

2.1.1 Overall Goal and Project Objectives

Since the end of the civil war in 2009, the Government of Sri Lanka (GoSL) has been addressing policies and working on reconstruction of the conflict-affected areas in the Northern and Eastern provinces, including promoting the return of internally displaced persons (IDPs) and restoring destroyed infrastructure.

However, in the agriculture sector, in which most residents are engaged, many farmers are not receiving enough administrative support for acquiring appropriate knowledge and techniques for agricultural production. This leaves the farmers vulnerable and has caused low productivity. As a consequence, improvement in agricultural productivity is a pressing issue.

Under these circumstances, the goal of this project is to increase agriculture productivity Dry Zone agriculture of northern region.

Towards this goal, the objectives of the project are to provide effective and efficient research and education activities for the dry zone agriculture in the Northern Province at the Faculty of Agriculture (FoAg), University of Jaffna (UOJ), through the establishment of the Research and Training Complex, which includes the Research Laboratory Complex and the Processing Training Building, and the Research and Training Farms with essential equipment.

2.1.2 Outline of the Project

The Project is summarized as follows:

Project Outline

1) Goal of the Project	:	To increase agriculture productivity in Dry Zone agriculture of the northern region.
2) Objectives of the Project	:	To provide effective and efficient research and education activities for the dry zone agriculture in the Northern Province at the Faculty of Agriculture, University of Jaffna.
3) Expected Output	:	Development of the Research and Training Complex, including the Research Laboratory Building and the Processing Training Building, and the Research and Training Farms, with provision of the essential equipment.

4) Activity/Input Plan	:	Building and Facilities:
a) Project Components Requested from GOJ		Research Laboratory Building (including Information & Communication Center: ICC function) Processing Training Building (food processing, dairy processing and meat processing) Farm-related buildings Research and Training Farm (crop farm, livestock farm, etc.) Equipment: Experimental equipment, training equipment, and farm machinery
b) Responsibility of GoSL	:	Development of support infrastructure (electricity, sewage system, approach road, etc.) Tax Exemption Secure budget for operation of the Faculty of Agriculture, UOJ Secure necessary teaching and supporting staff for providing training and supervise experiments Secure budget for operation and maintenance of the facility and equipment
5) Project Site	:	Northern Province, Sri Lanka
6) Direct and Indirect Beneficiaries	:	Direct: Students, teaching staff, and administrative staff in the Faculty of Agriculture, UOJ Indirect: Residents in the Northern Province of Sri Lanka (approximately 1.05 million people)

2-2 Outline Design of the Japanese Assistance

2.2.1 Design Policy

2.2.1.1 Basic Policies for the Function of the Faculty of Agriculture, UOJ

The development of the Research Laboratory Complex, ICC Building, and Research and Training Farm with essential equipment was originally requested by the Government of Sri Lanka from the Government of Japan with the aim of enhancing the research, education, and promotion activities of the FoAg.

However, as a result of the field survey and through a series of discussions with UOJ, the expected roles of FoAg, the only higher education institution on agriculture in the northern area, were concluded as follows:

(1) Education (Human Resource Development):

It was confirmed that the primary role of the FoAg is to educate people who will work in the agriculture and animal production sector and related industries.

(2) Research and Development:

FoAg is largely expected to contribute to finding solutions for specific local issues and approaches to effectively increase productivity through research and development activities.

(3) Promotion and Training:

The Department of Agriculture and the Department of Animal Production and Health under the Northern Provincial Government have been the main providers of promotion and training programs to farmers. FoAg is expected to provide lecturers and to support developing promotion and training materials for those programs.

Base on the above conclusions, it was determined that this project will focus mainly on developing facilities that directly contribute to strengthening education and research activities. Only some facilities, such as the multipurpose training room and exhibition zone, will be developed as a part of the Research and Training Complex for training and promotion activities.

2.2.1.2 Basic Policies for the Targeted Courses / Subjects

Through a strong request from FoAg, this project will target all existing departments under the FoAg: the Department of Agronomy, Department of Animal Science, Department of Agricultural Chemistry, Department of Agricultural Biology, Department of Agricultural Engineering, and Department of Agricultural Economics.

In addition, the plan to split the Department of Agricultural Chemistry into the Department of Soil Science and the Department of Food Science has been accounted for in this project.

In another development, in line with the concept of “Technology Stream”, a new policy of the Ministry of Higher Education and Highways (MOHEH), FoAg has been requested to start a new “Department of Bio-system Technology” and is now planning to prepare curriculums for food production and commercial green farming. This new department will not be covered by this project, since the Government of Sri

Lanka is planning to prepare the budget for the necessary facilities and equipment for this department.

2.2.1.3 Basic Policies for the Capacity of the Buildings

(1) Expected Number of Students

The number of admissions for all universities in Sri Lanka is managed by the University Grant Commission (UGC). Through instructions by the government, the number of students in FoAg has gradually increased, as shown in Table 2-1, with two batches of first-year students being admitted in 2015. As a result, out of a total of 280 undergraduate students, 121 students are in the first year.

Each year consists of two semesters. “Core Courses” are offered in the first five semesters (up to the first semester of the third year) and in part of the first semester of the fourth year, while “Specialized Courses” are offered in the second semester of the third year and in part of the first semester of the fourth year. The second semester of the fourth year is reserved for research projects.

Students in the third and fourth years are divided into groups of 7 to 10 students per department.

Students pursuing master’s and PhD degrees in the Faculty of Graduate Studies conduct research under the supervision of doctoral teaching staff in FoAg, most of whom are deans of departments. In 2014/2015, there were 14 such graduate students in FoAg, with an additional three graduate students from other universities receiving research supervision.

Table 2-1 Number of Students (2014/2015)

	Undergraduate Students					Graduate Students (UOJ)		Graduate Students (Other Universities)	
	1st Year 1st Semester	1st Year 2nd Semester	2nd Year	3rd Year	4th Year	Master	Ph.D.	Master	Ph.D.
Department of Agronomy	-	-	-	8	7	2	0	2	1
Department of Animal Science	-	-	-	8	7	1	0	0	0
Department of Agricultural Chemistry	-	-	-	10	7	4	0	0	0
Department of Agricultural Biology	-	-	-	9	8	3	1	0	0
Department of Agricultural Engineering	-	-	-	8	7	1	0	0	0
Department of Agricultural Economy	-	-	-	7	7	1	1	0	0
Total	56	65	66	50	43	12	2	2	1

Source: Faculty of Agriculture, UOJ

The number of students is set to increase at 200 students per year. Table 2-2 shows the future number of students based on this increase.

Table 2-2 Future Number of Students in the Faculty of Agriculture

Department		2015	2017	2020	2025
Dept. of Agronomy, Dept. of Animal Science, Dept. of Agricultural Chemistry, Dept. of Agricultural Biology, Dept. of Agricultural Engineering, and Dept. of Agricultural Economics		100 pers./year	125 pers./year	150 pers./year	200 pers./year
Dept. of Bio-System Technology	Commercial Green Farming	0	50 pers./year	60 pers./year	75 pers./year
	Food Processing	0	50 pers./year	60 pers./year	75 pers./year
Total (1st Year to 4th Year)*1		**337** pers./year	**596** pers./year	**935** pers./year	**905** pers./year

Source: Faculty of Agriculture, UOJ
Note: Calculated based on the assumption that no students drop out or repeat.

(2) Number of Students and Teaching Staff per Design Unit

The number of departments in the Faculty of Agriculture is planned to increase from six departments to seven in 2020, with the splitting of the Department of Agricultural Chemistry into the Department of Soil Science and the Department of Food Science. The number of students in the specialized courses is expected to be 125 students in 2016, increasing to 150 students in 2020, with the number of students in each department expected to be around 22.

Accordingly, each laboratory will be designed to accommodate from between 20 to 24 students per class, with the recommendation that class sizes be kept within this range and dividing up classes when necessary to avoid exceeding laboratory capacity.

The number of teaching staff differs between departments; however, teaching staff space will be standardized across departments and designed to accommodate the following number of staff members and graduate students: 1 department head, 6 academic staff, 1 laboratory technical officer, 1 laboratory attendant, and 4 demonstrators.

However, the Department of Agricultural Chemistry and the Department of Agricultural Biology will be exceptions to the above specification. The designs for these departments are described in the next section.

(3) Determination of Contents of the Facilities

The contents of the facilities were determined as follows to avoid duplication with existing buildings and ensure proper sizes for the facilities:

- The Research Laboratory Building will contain laboratories, teaching staff rooms, and preparation spaces for all 6 departments.
- Laboratories will be designed with space for future equipment.
- Only two laboratories, the “Plan Protection and Bio-control Laboratory” and “Bio-technology and Tissue Culture Laboratory”, and some staff space will be planned for the Department of Agricultural Biology, since this department already has new laboratories and staff rooms.

- For the Department of Agricultural Chemistry, staff rooms for Soil Science and Food Science will be designed separately with each room having space for 1 department head and 3 academic staff.
- Common research and experimental equipment that are utilized by multiple departments are planned to be allocated in the common analysis rooms, such as the Binocular Room, Freezer Room, Water Distiller Room, etc.
- Because research themes and topics are expected to change in accordance to social needs, temporary partitions will be used to provide flexible space arrangements in laboratories and staff spaces.
- Space for future expansion is planned next to the Research and Training Complex.
- In consideration of the planned greenbelt in the south-eastern area of the project site, as prescribed in the Kilinochchi Premises Campus Master Plan of UOJ, the inner court and external area of the Research & Training Complex will be utilized as demonstration farms.

Table 2-3 List of Necessary Rooms

Complex / Building	Department / Facility	Room Name	Number of Students and/or Staff	Floor Area
Research & Training Complex	Dept. of Agronomy	Crop Science Laboratory	24 pers.	160 m^2
		Staff Rooms	12 pers.	120 m^2
	Dept. of Animal Science	Animal Nutrition Laboratory	24 pers.	181 m^2
		Reproductive Physiology Laboratory	24 pers.	199 m^2
		Staff Rooms	12 pers.	122 m^2
	Dept. of Agricultural Chemistry	Soil Testing & Bio Fertilizer Laboratory	24 pers.	183 m^2
		Staff Rooms	9 pers.	97 m^2
		Food Analysis & Processing Laboratory	24 pers.	183 m^2
		Staff Rooms	10 pers.	97 m^2
	Dept. of Agricultural Biology	Plant Protection & Bio Control Laboratory	24 pers.	209 m^2
		Bio Technology & Tissue Culture Laboratory	24 pers.	136 m^2
		Staff Rooms	5 pers.	28 m^2
	Dept. of Agricultural Engineering	Environment & Hydro Research Laboratory	24 pers.	160 m^2
		Staff Rooms	12 pers.	120 m^2
	Dept. of Agricultural Economics	Econometrics Laboratory	54 pers.	120 m^2
		Staff Rooms	12 pers.	122 m^2
	Common	Analytical Measurement Room	5 pers.	27 m^2
		Lecture Hall	75 pers.	108 m^2
		Common Meeting Room	24 pers.	98 m^2
	ICC Function	Multipurpose Training Room	50 pers.	104 m^2
		Display Zone	-	243 m^2
Processing Training Building		Daily Processing Unit	12 pers.	88 m^2
		Meat Processing Unit	12 pers.	77 m^2
		Food Processing Unit	12 pers.	98 m^2
		Changing Rooms	2 pers.	14 m^2
Research and Training Farm Buildings	Farm Management Building	Primary Sample Preparation Unit	12 pers.	64 m^2
		Crop Postharvest Unit	12 pers.	64 m^2
		Demonstration Space	24 pers.	64 m^2
		Farm Machinery Workshop	12 pers.	96 m^2
		Farm Machinery Storage	-	128 m^2
		Office	2 pers.	16 m^2
	Livestock Buildings	Goat Shed	-	48 m^2
		Animal Measurement Shed	-	23 m^2

Source: JICA Study Team

2.2.1.4 Basic Policy for Design of Building, Farm and Equipment

Buildings, farms, and equipment planned in this project under the Japan Grant Aid Scheme are designed based on the following policies, through close coordination with the relevant authorities.

- Buildings, farms, and equipment are designed by taking into account various local conditions, such as the natural environment, social and cultural aspects, construction and procurement regulations and conditions in the Kilinochchi area, building codes of Sri Lanka, operational capacity of UOJ, etc.
- It is essential that the architectural designs consider harmonization and connectivity with other buildings in the campus and the peripheral environment.
- As the only higher education agricultural institution in the Northern region, consideration shall be given to the design of buildings and equipment to create an appropriate education and research environment with the flexibility to respond to future expansion and enhancements of their activities.
- In order to prevent operation and maintenance costs becoming an excessive burden, and to create a comfortable room environment, louvers for shading, windows for natural lighting and natural ventilation, and the introduction of green walls will be considered.
- An equipment plan has been prepared based on an analysis of the curriculum, syllabus, and research theme, and priority has been given to that equipment deemed essential for general student experiments and exercises based on the equipment's high versatility and frequency of use. Equipment that can be used for research activities by several departments will be provided as common equipment for sharing between departments.
- An equipment procurement plan has been prepared based on a study of unit prices, the availability of suppliers and spare parts in Sri Lanka, and the cost and time for transport.
- The size of the research and training farm has been determined based on the capability for operation and maintenance, availability of water, research and training programs, and the activity plan. Sharing farms among several departments were also considered.
- The layout of the Research and Training Farm has been designed with the concepts of user-friendliness and accessibility from within and from outside of the farm. The layout plan of the farm blocks and water supply system has been designed to realize effective practical use of the farm based on the research and training activity plan.
- The university's schedule and the appropriate time to start using facilities and equipment shall be considered when preparing the implementation schedule of this Japan Grant Aid Project, i.e., the schedule starting with the detailed design and continuing with the tender, commencement of construction, completion of construction, and finally the handover.

2.2.2 Basic Plan: Building, Farm, and Equipment

2.2.2.1 Site Layout Plan

(1) Site Conditions

1) Location and Area of the Project Site

Through a series of discussions with UOJ, the site for the Research Laboratory Building and Processing Training Building was agreed to be located on the east side of the Faculty of Agriculture Administration Building for the following reasons:

- The site is located next to the Administration Building and close to the existing Faculty Building (see Figure 2-1), which is also near the main gate of the Kilinochchi Premises of UOJ.
- It will be convenient for people to move between the site and other buildings (Conference Hall, Sports Center, ICT & Library, and Canteen), which are to be constructed with the support of the Government of India.

It was agreed to place the Farm Management Building on the south side of the Training Farm Area, close to the North Gate of the university.

2) Frontal Road

The project site is located in the middle of the university premises and is surrounded by campus roads. This site will have easy access to the other facilities within the premises.

3) Site Preparation

It is planned that the site preparation, including ground leveling and removal of trees, is going to be carried out by the university. The site for the Research Laboratory Building and the Processing Training Building is relatively flat and has no structures. Clearance of landmines has been confirmed by the Sri Lankan side; however, UXO detection will be conducted to reconfirm the absence of UXOs. If UXOs are found, they will be cleared by the Sri Lankan side.

(2) Site Layout Plan

The circulation of people and vehicles and the spatial connectivity to the other facilities were considered in the layout plan of the Research Laboratory Building and the Processing Training Building in order to achieve unity with other university buildings.

1) Cooperation with Surrounding Buildings

The Research Laboratory Building consists of the four blocks of buildings surrounding the courtyard. This shape was selected to reflect the typical traditional style of buildings in Sri Lanka, and to take into account the connectivity with other buildings and the functions to be contained within the building. Interactions between students, teaching staff, and researchers will also be stimulated through this inner courtyard.

The main entrance located in the northwest corner of the Research Laboratory Building will be an

active connection point between the Administration Building and the Faculty Buildings, which are to be used for core courses.

Also, the entrance in the southwest corner will be an access point to the Conference Hall, ICT & Library, Canteen, and Sports Center.

The entrance in the southeast corner, which is near the main gate of the Kilinochchi premises of UOJ and has easy access from outside the university, is designed for ICC-related facilities.

The corner in the northeast is planned to be a back entrance for staff and for receiving deliveries.

Corridors around the courtyard and those directly outside the building will provide shaded walkways during the day.

2) Consideration of the Surrounding Environment

The new buildings are designed to save energy and to reduce running costs by using natural lighting and ventilation, and to provide benefit from the natural cooling effects of green walls.

Harmony with the Existing Experimental Farms, surrounding greenery, and the green axis (which is included in the Master Plan of the Campus shall be considered.

The planned vertical greens and crop fields in the courtyard can be used as demonstrations of agricultural production.

3) Future Extension

The complex is expected to be expanded to accommodate the increase in the number of students and researchers and the increase in departments. The site for the Future Extension is planned at the northeast side of the complex.

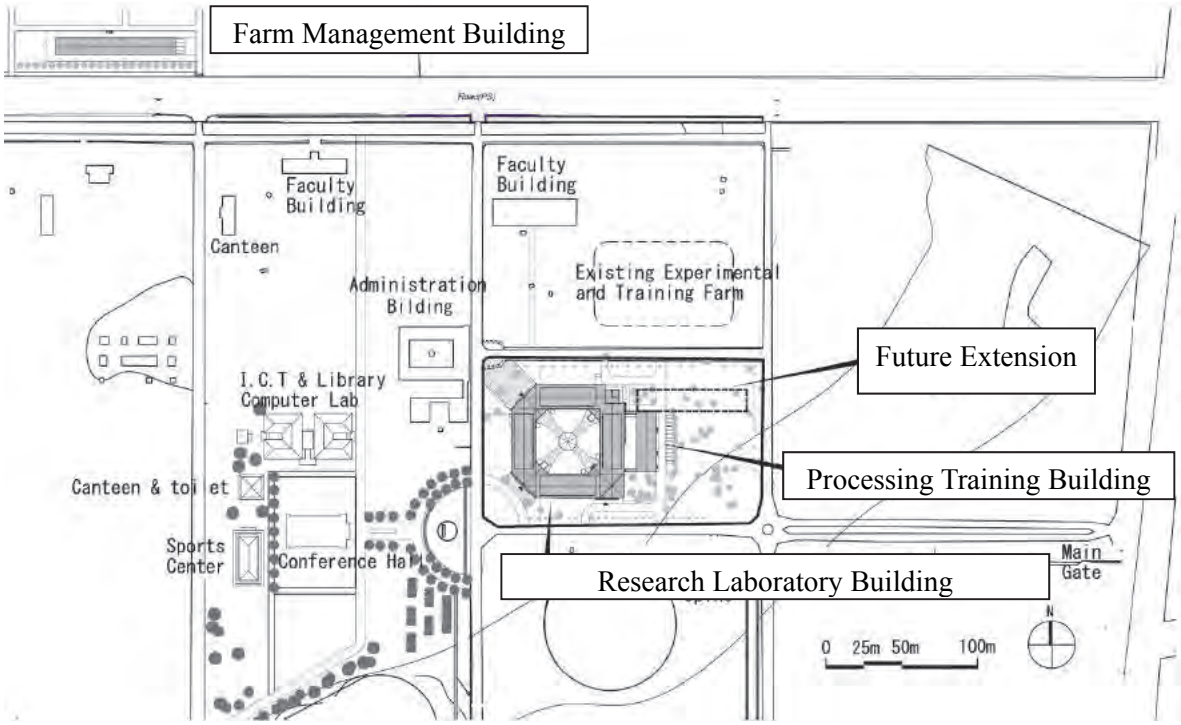


Figure 2-1 Site Layout Plan

2.2.2.2 Architectural Planning

(1) Floor Plan

The main components of the Research Laboratory Building are the laboratories and staff rooms for the 6 departments, along with some general rooms for lectures and a multi-purpose room for ICC activities.

The Processing Training Building, which is a part of the Research & Training Complex, is planned to be located next to the Research Laboratory Building as an independent building, due to the different activities it will host and to better accommodate the transport of materials to the building for processing training.

The Farm Management Building is planned to contain rooms for farm-related exercises and research activities; demonstrations before and after practical exercises on the farm; workshops for farm machinery maintenance; and crop post-processing works. This building will be useful for effective practice in the field. It is planned to be located in the farm, with easy access to the campus site.

(2) Plan for Research Laboratory Building

Based on the characteristics of each laboratory and through requests from the university, the room layout will take into consideration those laboratories that would be better located on the ground floor and those that can be located on the first floor. Laboratories in the same department will be located close to each other.

Analytical Measurement Rooms that contain equipment and/or instruments that can be utilized by multiple departments are to be located in easily accessible areas.

Laboratories are designed have a maximum capacity of 24 students per class. This number is calculated from the future target number of students of FoAg and with the assumption that students will be roughly equally distributed among the departments.

Currently, there are 7 to 10 students per department in the third and fourth years. However, the target for 2017 is to have 125 students per year in six departments with an estimated 20 students per department, and by 2020, to have 150 students per year in seven departments with an estimated 22 students per department.

It was agreed with UOJ to standardize the Preparation Rooms and Staff Rooms for all departments, including rooms for a technical officer, laboratory attendants, 4 demonstrators, and preparation work, along with a staff room for a department head and 6 lecturers. However, the Plant Protection & Bio Control Laboratory, Bio Technology & Tissue Culture Laboratory and Econometrics Laboratory are planned differently.

The plans for laboratories and staff rooms are as follows:

a) Department of Crop Science

- The Crop Science Laboratory has space for 6 tables for 4 people each and 1 table for the lecturer, along with tables for research equipment and counters with sinks along windows for

common use or research activities.

- Preparation spaces for a Technical Officer and research supportive staff are allocated at the entrance of laboratory.
- In the staff space, a room for the department head, individual rooms for staff, one common staff room for lecturers, instrument rooms, and an area for demonstrators are planned. The common area will be used for meetings and activities for graduate students.
- In consideration of the high possibility of changes in research themes and fields in accordance with the change of social needs and the number and type of staff under these circumstances, utilization of variable partitions for the interior of laboratories and staff rooms are planned to adjust to the changes.

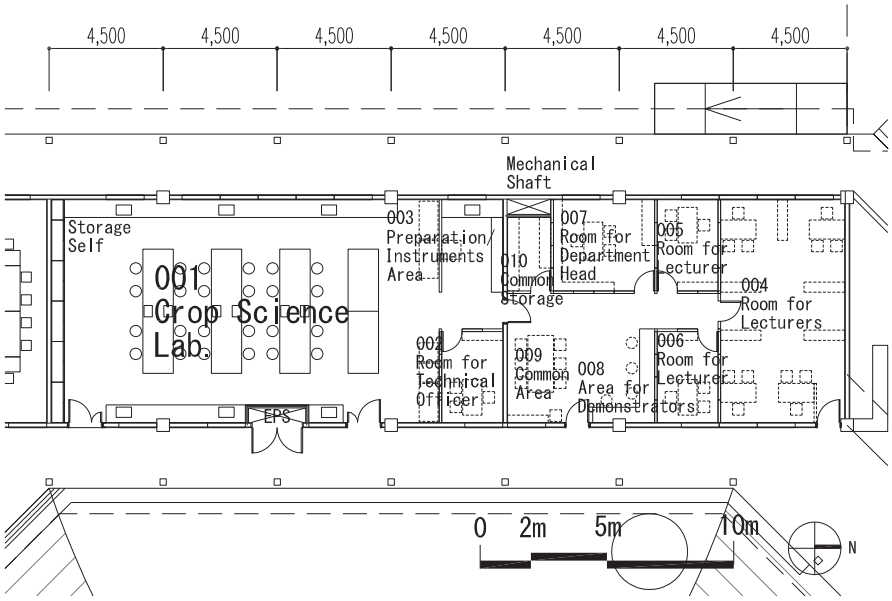


Figure 2-2 Crop Science Laboratory

b) Department of Animal Science

Under the Department of Animal Science, the Animal Nutrition Laboratory (on the first floor), the Reproductive Physiology Laboratory (on the ground floor), the preparation room and the staff room (on the first floor) are planned. The layout plan of laboratories and space for staff is similar to the Crop Science Laboratory. But, some specific rooms, such as rooms for semen and embryo preparation and semen evaluation, are also planned in the Reproductive Physiology Laboratory.

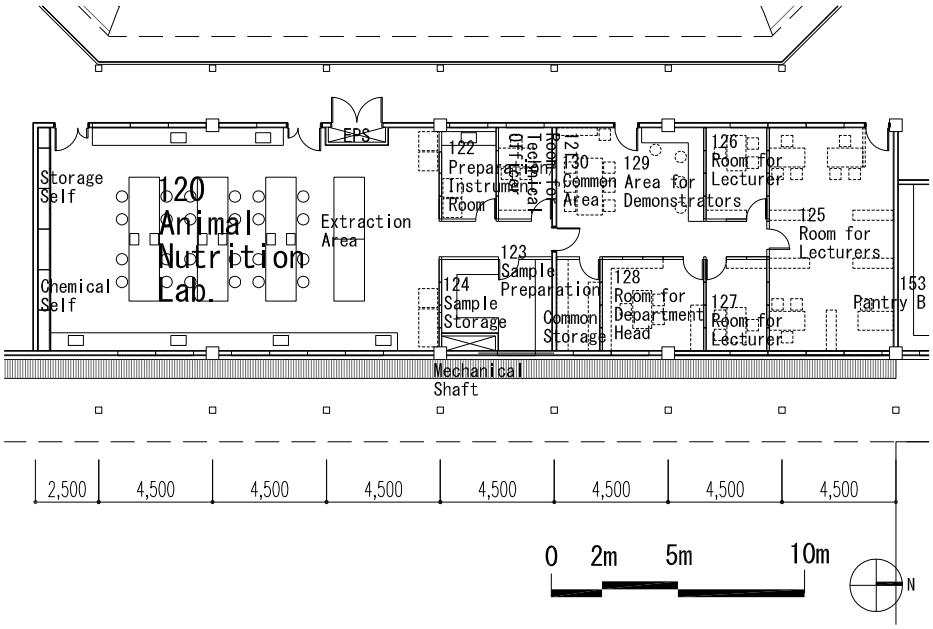


Figure 2-3 Animal Nutrition Laboratory

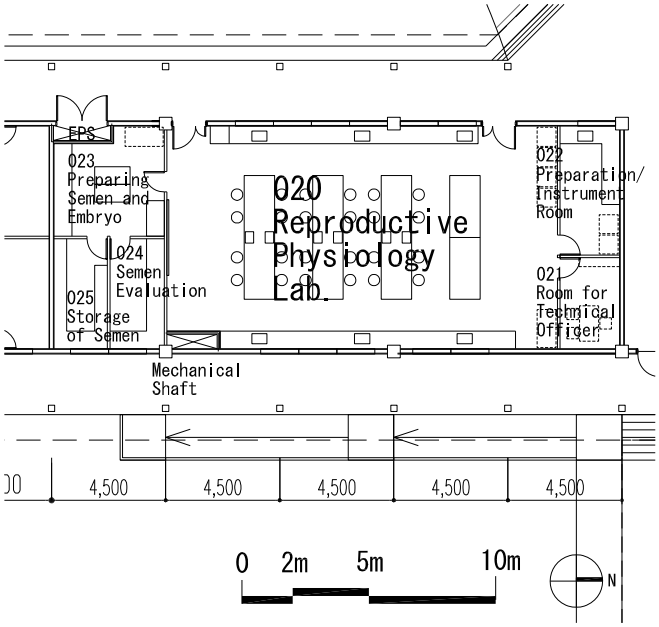


Figure 2-4 Reproductive Physiology Laboratory

c) Department of Agricultural Chemistry

Regarding the Department of Agricultural Chemistry, rooms for a department head, 3 lecturers and 4 demonstrators are placed in each laboratory, considering that the department will be separated into the Department of Soil Science and Department Food Analysis & Processing in the future. Although the layout plan of the laboratory and space for staff is similar to other departments, the size of the space is determined based on the large number of reagents and samples currently in the laboratory.

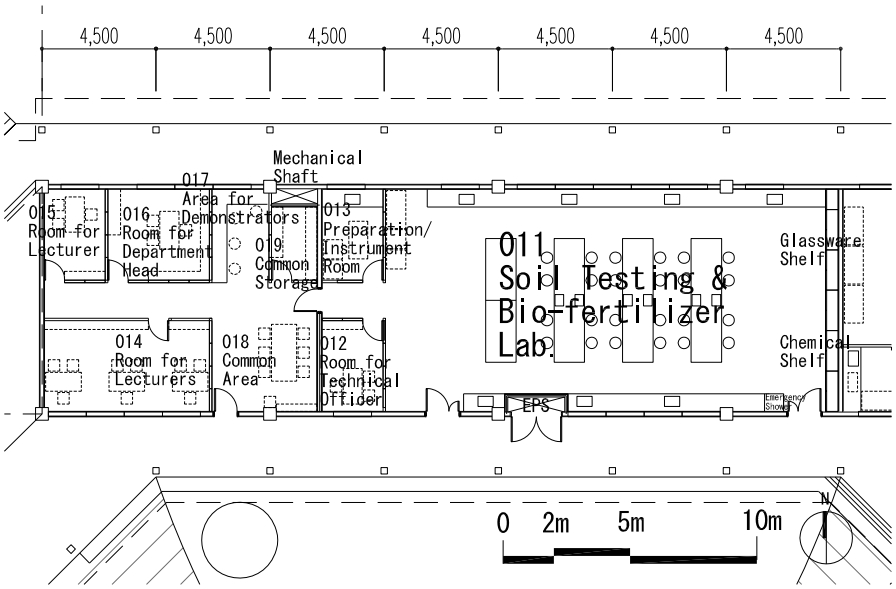


Figure 2-5 Soil Testing & Bio Fertilizer Laboratory

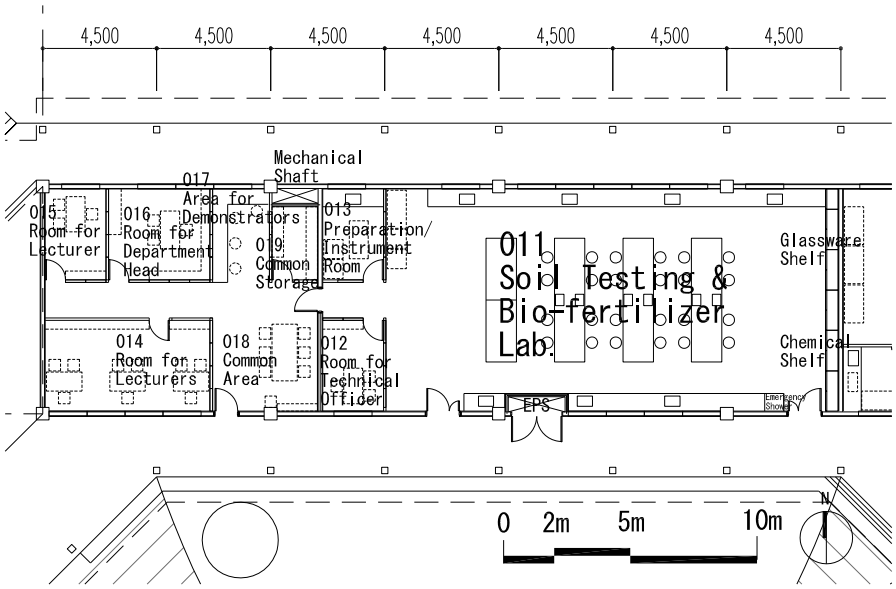


Figure 2-6 Food Analysis & Processing Laboratory

d) Department of Agricultural Biology

In terms of the Department of Agricultural Biology, the Plant Protection & Bio Control Laboratory and the Bio Technology & Tissue Culture Laboratory are planned only in the Research Laboratory Complex since there are already 2 laboratories and a staff room in the existing building. Thus, the Room for the technical officer, the staff area, and the Preparation Room are placed as workspaces for staff.

Staff and students who enter the Tissue Culture Room will be required to change clothes for reasons of hygiene.

The Light Microscope Room is designed to be accessible from the laboratory, with a second access from the corridor, which is intended for use by other department staff and students who

also require use of the light microscope.

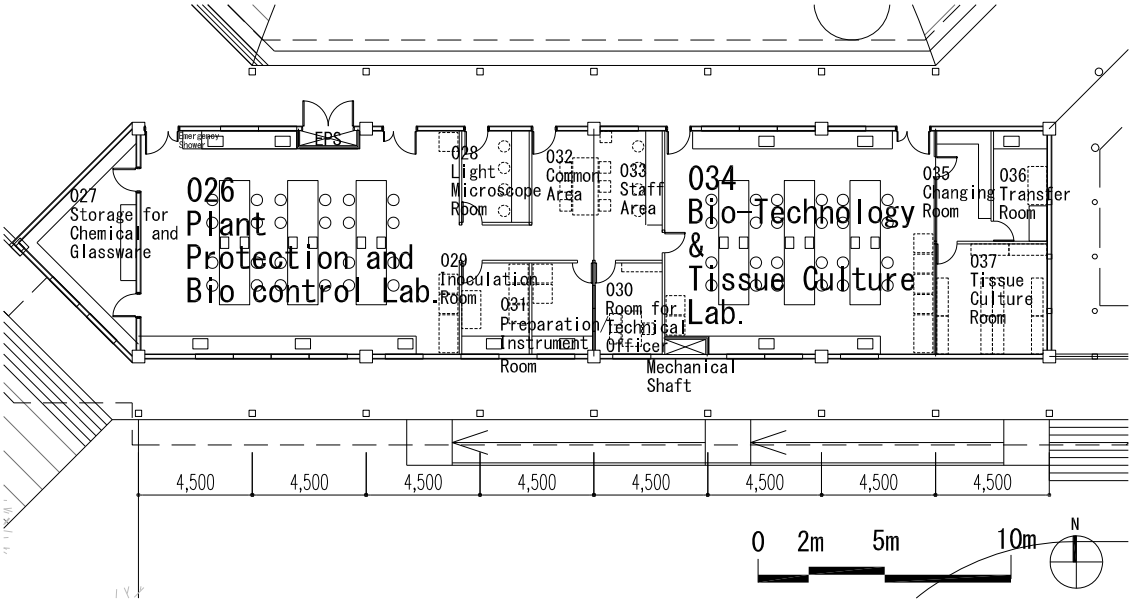


Figure 2-7 Plant Protection & Bio Control Laboratory

e) Department of Agricultural Engineering

In the Department of Agriculture Engineering, the Drafting Room and Workshop in the existing building are kept on the first floor of the Administration Building. Only the Environment & Hydro Research Laboratory and the Staff Room are located in the Research Laboratory Building.

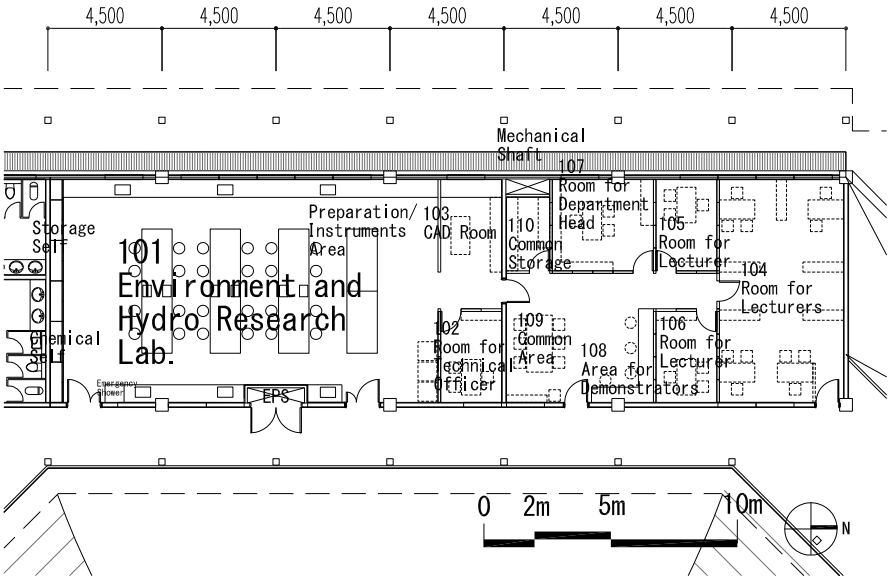


Figure 2-8 Environment & Hydro Research Laboratory

f) Department of Agricultural Economics

The Econometrics Laboratory, the Preparation Room, and the Staff Room are placed in the Department of Agricultural Economics. In the Econometrics Laboratory, the following are included: tables for a seminar; Area for Instruments; Computer Area; and Common Storage. The layout plan of the space for staff is similar to other departments.

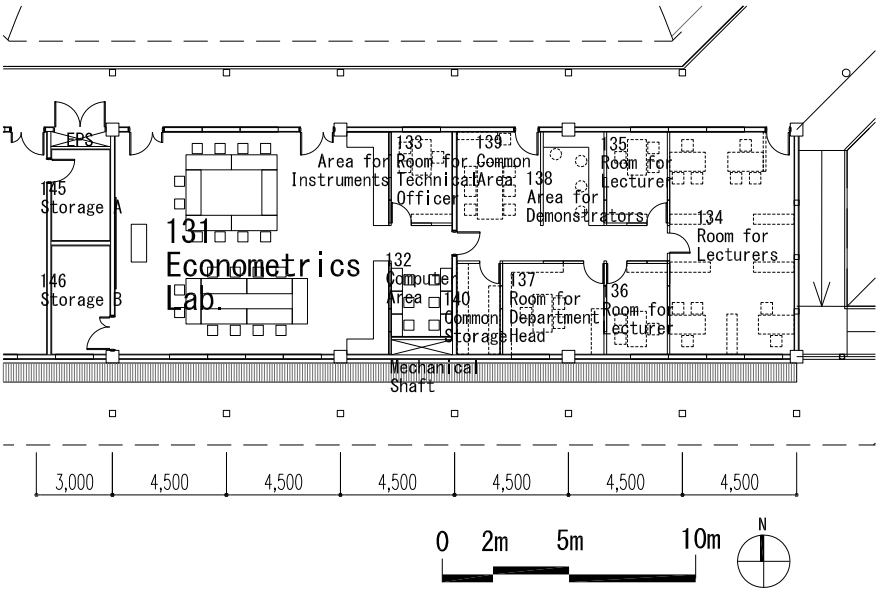


Figure 2-9 Econometrics Laboratory

g) Analytical Measurement Room

The analytical measurement rooms are planned to promote shared use of some equipment/apparatuses. The common rooms, such as the Freezer Room, the Water Distillation Room, and the Light Microscope Room, are placed in easily accessible areas.

h) Lecture Hall

There is one Lecture Hall that has a capacity of 75 people. When the number of students increases to 150 students per grade in the future, students will be divided in to 2 classes for lectures.

i) Meeting Rooms

As most of the staff rooms are planned for the Research Laboratory Building, common meeting rooms, which are available for staff meetings and group works, are included in the plan.

j) ICC Facilities

The entrance at the southeast corner is mainly planned for ICC-related activities, with the demonstration space designed for ICC activities. The area will be used for the exhibition of research and products from each department, or to exhibit promotional materials from visitors outside of the university. The Multipurpose Training Room is planned with a capacity of 50 people, and it is expected that the room will encourage agriculturally-related promotion activities and collaboration between the university and the outside community.

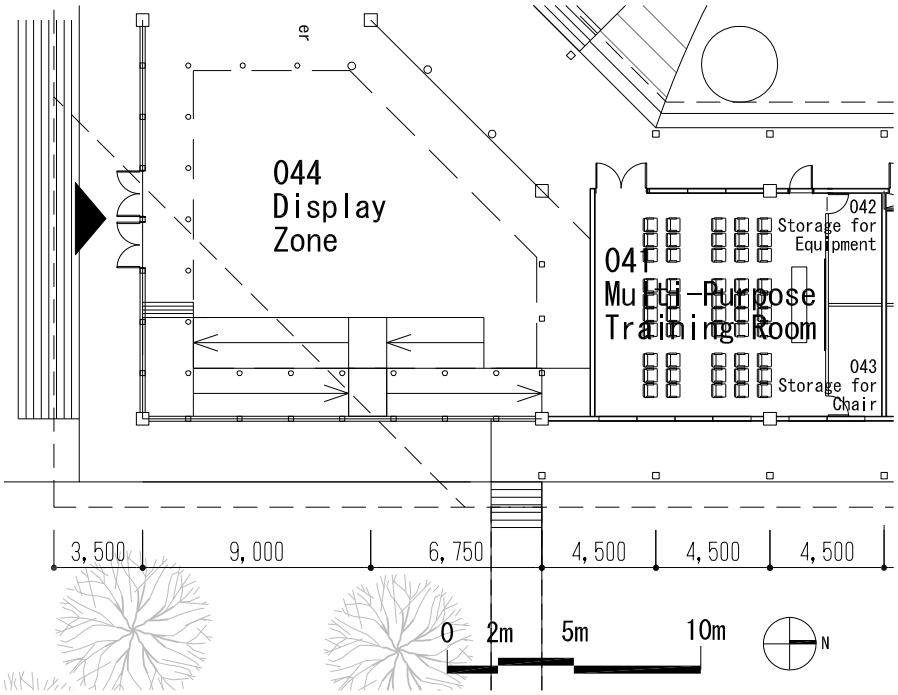


Figure 2-10 ICC Zone

(3) Processing Training Building

Processing Units include the following 3 rooms: the Food Processing Unit belonging to the Department of Agricultural Chemistry, and the Daily Processing and the Meat Processing units, both belonging to the Department of Animal Science.

From the perspective of promoting good hygiene, and for students to learn the importance of sanitation, the training rooms are to be accessed through the Changing Rooms.

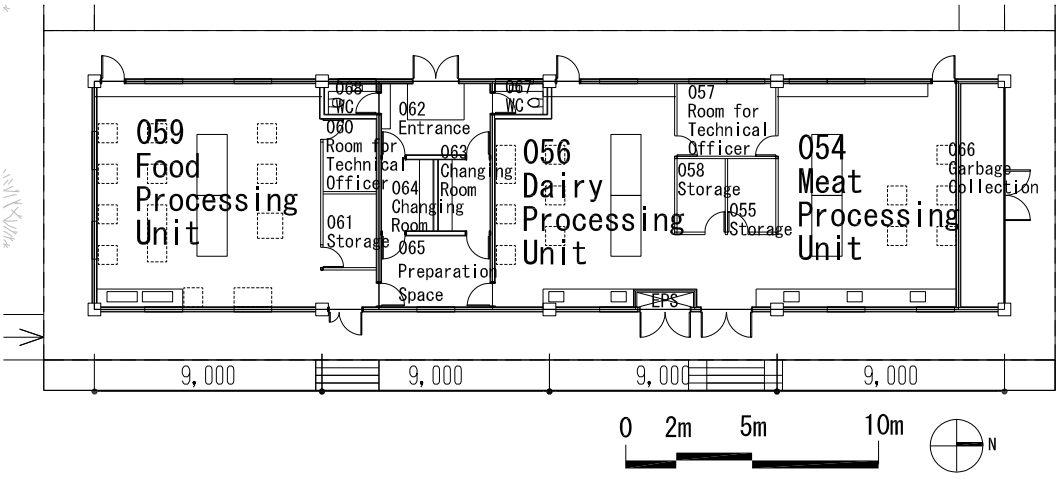


Figure 2-11 Processing Units

(4) Facilities Relating to Training Farm

a) Farm Management Building

The Farm Management Building consists of the following two buildings: the Crop Postharvest Unit (for threshing and milling work), the Primary Sample Preparation Unit (for preparing research samples), the Demonstration Space (for orientation and demonstration before and after the training

class and additional work), the Office, and the Farm Machinery Workshop & Storage Unit (for housing and adjusting tractors and farm equipment).

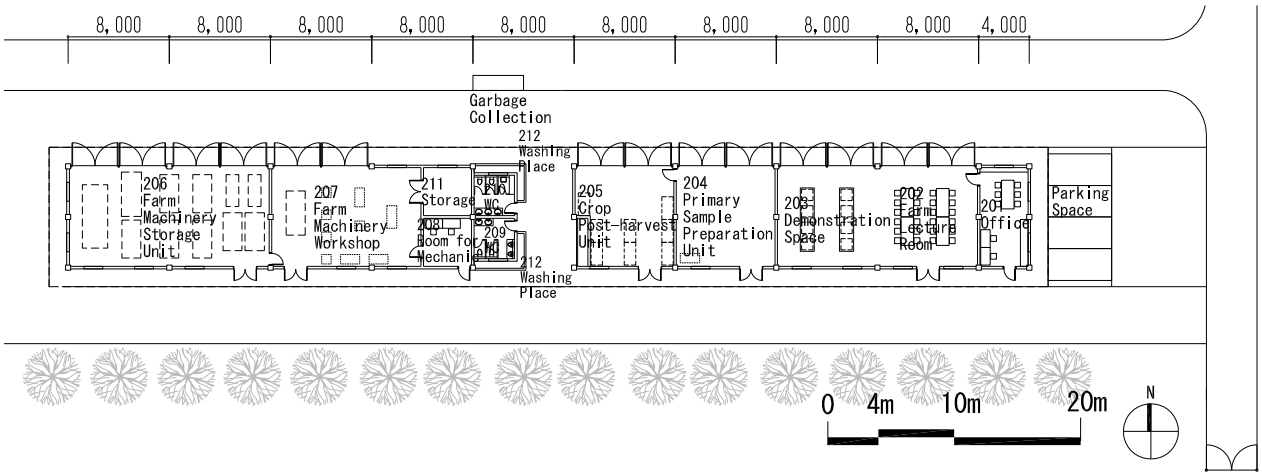


Figure 2-12 Farm Management Building

b) Goat Shed

UOJ is planning to breed 5 types of goat in Sri Lanka (in total 15 goats: a male and two females from each breed). Births are expected twice a year according to UOJ. Therefore, based on the assumption that each breed of goat can have three newborns per year, the shed has been designed to breed 30 goats per year. The floor of the Goat Shed is to be raised above ground level.

Table 2-4 Breed and Number of Goats

Breed	Use	Number of Animals Kept (Female / Male)	Annual Number of Births (Expected Value / Forecast Value)
1. Local	Meat Breed	2 / 1	4 / 3
2. Jamunapari	Meat Breed	2 / 1	4 / 3
3. Kottukachchiya	Meat Breed	2 / 1	4 / 3
4. Boer	Meat Breed	2 / 1	4 / 3
5. Saanen	Dairy Breed	2 / 1	4 / 3
Total		10 / 5	20 /15

Source: FoAg, UOJ

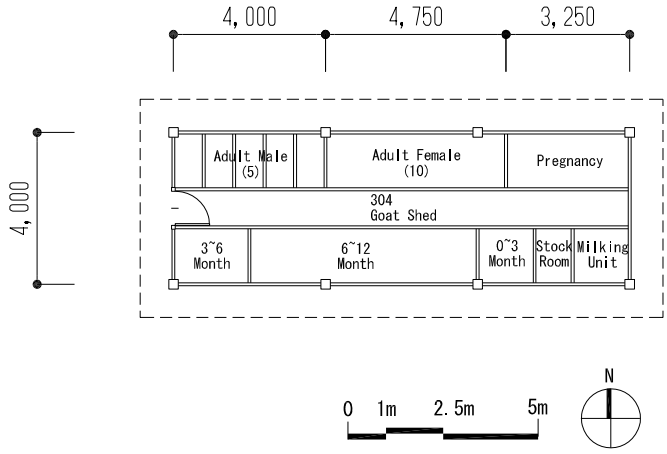


Figure 2-13 Goat Shed

c) Animal Measurement Shed

The Animal Measurement Shed, which is adjacent to the Goat Shed, is to be built in order to weigh animals. The Digestion Chambers for cows and goats are planned separately next to the Animal Measurement Shed.

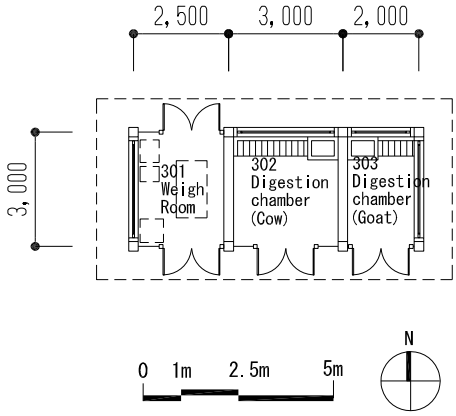


Figure 2-14 Animal Measurement Shed

Table 2-5 Area Table

	Room Name	Area (㎡)	Scale, Grounds for Layout Planning, Remarks
Research & Training Complex GFL	Crop Science Laboratory	160.29	Including Preparation Rooms such as 'Preparation / Instruments Area' and 'Room for Technical Officer'
	Staff Rooms	120.16	Including Lecturer's Room such as 'Room for Department Head', 'Room for Lecturer', 'Area for Demonstrators', 'Common Area', and 'Common Storage'.
	Soil testing and bio fertilizer Laboratory	183.25	Including Preparation Rooms such as 'Preparation / Instruments Area' and 'Room for Technical Officer'
	Staff Rooms	97.14	Including Lecturer's Room such as 'Room for Department Head', 'Room for Lecturer', 'Area for Demonstrators', 'Common Area', and 'Common Storage'.
	Reproductive Physiology Laboratory	199.27	Including Preparation Rooms such as 'Preparation / Instruments Area' and 'Room for Technical Officer'
	Plant Protection and Bio control Laboratory	208.55	Including Preparation Rooms such as 'Preparation / Instruments Area' and 'Room for Technical Officer'
	Bio-Technology and Tissue Culture Laboratory	136.00	Including Preparation Rooms such as 'Preparation / Instruments Area' and 'Room for Technical Officer'
	Freezer Room	27.48	To place common refrigerators and low temperature freezers program freezers
	Water Distillation Room	12.15	To place pure water, distilled water, and super distilled water machines.
	Common Meeting Room A	39.00	Used by students and staffs
	Multi-Purpose Training Room	103.50	50 seats at maximum
	Display Zone	243.30	To place an exhibition space and slopes connected to upstairs
	Entrance Lobby	106.80	To place a reception desk
	Lobby	59.80	
	WC	94.24	WC A、WC B、WC for disabled people、Pantry
	Other Room	139.78	Electrical Room, Mechanical Room, EPS／PS
	Corridor	561.50	Outside Space
	GFL Total (w/o Outside Space)	1,930.71	
	GFL Total (w/ Outside Space)	2,492.21	
Research & Training Complex 1FL	Environment and Hydro Research Laboratory	160.27	Including Preparation Rooms such as 'Preparation / Instruments Area' and 'Room for Technical Officer'
	Staff Rooms	120.16	Including Lecturer's Room such as 'Room for Department Head', 'Room for Lecturer', 'Area for Demonstrators', 'Common Area', and 'Common Storage'.
	Food analysis and processing Laboratory	183.25	Including Preparation Rooms such as 'Preparation / Instruments Area' and 'Room for Technical Officer'
	Staff Rooms	97.14	Including Lecturer's Room such as 'Room for Department Head', 'Room for Lecturer', 'Area for Demonstrators', 'Common Area', and 'Common Storage'.
	Animal Nutrition Laboratory	181.17	Including Preparation Rooms such as 'Preparation / Instruments Area' and 'Room for Technical Officer'
	Staff Rooms	121.50	Including Lecturer's Room such as 'Room for Department Head', 'Room for Lecturer', 'Area for Demonstrators', 'Common Area', and 'Common Storage'.
	Econometrics Laboratory	119.65	Including Preparation Rooms such as 'Preparation / Instruments Area' and 'Room for Technical Officer'
	Staff Rooms	121.50	Including Lecturer's Room such as 'Room for Department Head', 'Room for Lecturer', 'Area for Demonstrators', 'Common Area', and 'Common Storage'.
	Analytical Measurement Room	27.48	To place share instruments
	Water Distillation Room	12.15	To place pure water, distilled water, and super distilled water machines
	Lecture Hall	107.70	Used by all department's students and staffs. (about 75 seats at maximum)
	Common Meeting Room B	58.50	Used by students and staffs
	Storage	46.75	Storage A, B, C, D
	WC	110.27	WC C, WC D, WC for disabled people、Pantry
	Other Room	36.22	Elevated Water Tank Room, EPS / PS
	Stair / Slope	142.36	
	Corridor	583.28	Outside Space
	1FL Total (w/o Outside Space)	1,646.07	
	1FL Total (w/ Outside Space)	2,229.35	
R&TC Total	Total (w/o Outside Space)	3,576.78	
	Total (w/ Outside Space)	4,721.56	
Processing Unit GFL	Meat Processing Unit	76.58	To place processing instruments
	Dairy Processing Unit	84.40	To place processing instruments
	Food Processing Unit	98.10	To place processing instruments
	Entrance of Processing Units	13.50	To place shoeboxes
	Changing Rooms	13.50	To place lockers
	Preparation Space	13.50	Space for Changing Shoes
	Garbage Collection	16.43	Semi Outdoor Space
	WC	6.30	
	EPS	1.70	
	Processing Unit Total	324.01	
Farm Management Building GFL	Office	16.00	Including 'Office Work Space', and 'Meeting Space'
	Farm Lecture Room	64.00	To give orientation before and after training.
	Demonstration Space	64.00	To store cutting samples for agricultural equipment
	Primary Sample Preparation Unit	64.00	Space for Adjusting Crops
	Crop Post-harvest Unit	64.00	Space for Threshing and Milling after Harvest
	Farm Machinery Storage Unit	128.00	To store tractors, attachments for a tractor, and agricultural equipment
	Farm Machinery Workshop	96.00	Space for Maintaining Agricultural Instruments
	WC	23.12	
	Storage	16.00	
	Washing Place	40.88	Outside Space
	Farm Management Building (w/o Outside Space)	535.12	
	Farm Management Building Total (w/ Outside Space)	576.00	
Farm	Weigh Room	7.50	Space for Weighing Cattle, Chickens, and Other Animals
	Digestion Chamber (Cow)	9.00	To check digestive function of cattle
	Digestion Chamber (Goat)	6.00	To check digestive function of goats
	Goat Shed	48.00	Space for Arranging 30 Goats per a Year
	Farm Total	70.50	
Total	Grand Total (w/o Outside Space)	4,506.41	Total Floor Area
	Grand Total (w/ Outside Space)	5,692.07	Total Construction Area

(5) Elevation and Sectional Planning

The FoAg is located in a sub-tropical area with high temperatures and high humidity. It is important to reduce the heat from the strong sunlight and to utilize natural ventilation. The following points are to be considered in the sectional design of the building:

1) The floor level will be carefully designed to take into account the varying elevations of the ground.
2) To counter the effects of the climate, a pitched roof will be used to protect against rain and provide durability, while at the same time the roof's attic space will be effective in reducing heat.
3) Louvers and extended eaves will be placed on both sides of the building to block direct sunlight and heavy rain.
4) Natural lighting and ventilation will be utilized to reduce the running costs of the buildings.
5) Green walls will also be introduced to help cool the building.
6) Instead of escalators, slopes will be installed in the building from the ground floor to the first floor in response to universal design and to reduce running costs.

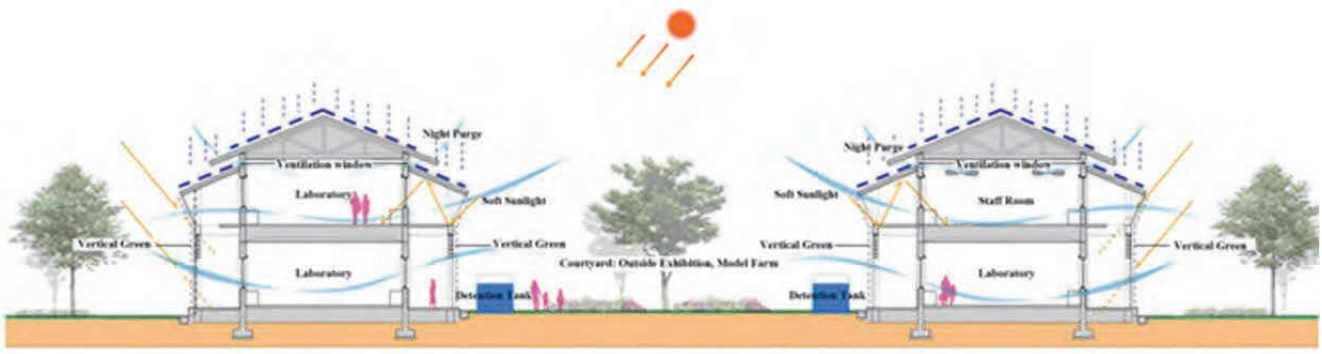


Figure 2-15 Section Concept

2.2.2.3 Structure Plan

(1) Basic Policy

The structural plan for the Project should be formulated after a full review of the existing site conditions and considering the results of the soil investigation. The structure shall be designed to prevent serious defects, such as cracks caused by structural member deflection, ground settlement, etc. Additionally, the building shall have a sufficient factor of safety and have durability against earthquakes, strong winds, etc. Consideration should also be given to local construction methods and materials, and to facilitate maintenance.

(2) Method of Construction

The superstructure is to be reinforced concrete and the walls are of brick, which are economical and widely used in Sri Lanka. Although the walls are based on brick structure, the horizontal rigidity of a building is increased by reinforced concrete walls, which are superficially arranged to provide sufficient lateral stability.

(3) Soil Conditions and Foundation Design

The results of the soil investigations indicate that sub-strata from ground level to a depth of 1.50 meters are solid sand. Soil conditions of this project site are good. In order to design a two-story building, the plan of foundation will use spread footing for foundation, which supports facilitates over sandy clay (N value is 11 or more over) at the depth below.

(4) Design Load

The seismic load is not considered, because there have been no recorded earthquakes in Sri Lanka. The wind load is calculated based on Sri Lankan Standards. Basic wind speed is assumed at 30 m/sec.

(5) Materials

Consideration is given to the following materials:

Table 2-6 Structural Materials

Concrete	From footing to first floor	21 N/mm^2
	Column and Wall: from first floor to second floor	24 N/mm^2
	Column and Wall: from second floor to Roof	24 N/mm^2
Reinforcement	Round steel bar	φ6 - φ9
	Deformed bar SD295	D10 - D14
	Deformed bar SD345	D16 - D25
Steel	Shape steel, Steel plate	SS400
	Light-gauge Steel	SSC400

2.2.2.4 Utility Plan

2.2.2.4.1 Electrical System

(1) Substation System

From the review of the current situation of the power supply system to FoAg, expansion of the existing substation equipment may not be required since the expected maximum power demand in 10 years can be satisfied by the existing transformer.

According to the JICA Grant Aid Scheme, the Sri Lankan side is responsible for primary power supply to the Project and it was confirmed that FoAg will execute trunk line cabling works from the existing Low Voltage Distribution Board to newly planned Main Distribution Board and improvement of existing Low Voltage Power Distribution Board.

1) Expected Power Load Capacity

Expected power load capacities in the Research Laboratory building and Processing Training building are shown in Table 2-7 Expected Power Load Capacity.

Table 2-7 Expected Power Load Capacity

Load Capacity	Load Density (VA/m^2)	Floor Area (m^2)	Load Capacity (kVA)
Lighting & Outlet	35	4,500	157.5
Lab Equipment	65	4,500	292.5
Air-conditioning Equipment	100	2,500	250
Plumbing Equipment	-	-	10
Total			710.0

Total installed capacity is 710 kVA and maximum power demand will be determined as follows, with an assumed demand rate of 25%:

$$710 \text{ kVA} \times 0.25 = 177.5 \text{ kVA, or } 180 \text{ kW}$$

(2) Power Supply Trunk Line System

From the Power Distribution Board in Substation boards, 3-phase, 4-wire 400/230V 50Hz power will be distributed to each demand points in consideration of the division of load and grouping of facilities. Trunk line capacity will be set to meet the installed capacity to be connected under the appropriate voltage drop and allowable current rate. The cable and wiring system will basically be a cable rack system with some conduit piping.

Table 2-8 Outline of the Power Supply Trunk Line

Low voltage power supply	3φ4W 230V/400V
For lighting and outlet sockets	1φ2W 230V
For motors	3φ3W400V

(3) Lightning Protection and Grounding System

In order to prevent damage from abnormal current and voltage intrusions through power and/or telephone lines to the electronic equipment caused by lightning strikes, both the Research Laboratory Building and Processing Training Building will be provided with suitable lightening protection and grounding systems for the entire building structure. The grounding system will be an equipotential grounding system.

(4) Lighting System

Each laboratory, the teaching staff room and other rooms will be provided with LED (Light Emitting Diode) lighting in consideration of maintenance and running costs. Illuminance criteria (standard illumination level) will be planned as follows based on the required average illuminance by international standards and JIS standards, as well as the Sri Lanka domestic standards.

Table 2-9 Planned Illuminance

Room Name	Lux
Laboratory	300 lux
Preparation Room	200 lux
Teaching Staff Room and Administration Room	300 lux
Lecture & Multi-Purpose Room	300 lux
Corridor & Stairs	50 lux
Toilet & Storage	50 lux

Lighting will be controlled in each of the rooms and lighting circuitry will be planned to enable lighting control in every section of the room. A low voltage power supply system for lighting and outlets will be planned to distribute single phase, 2 wires, and 230 V. Evacuation routes such as stairs, corridors, etc., will be planned with emergency exit lighting.

(5) Telephone System

At present the FoAg has 14 direct telephone lines provided by SLT for the Dean's Office, Department Head Office, Computer Unit, and Facility Maintenance Unit.

UOJ has plans to change the exiting telephone system to an IP telephone (VoIP) system, and therefore,

the telephone system for the planned buildings in this project will also be an IP telephone system. In addition, it was confirmed that the network connection with the existing facilities and the communications carrier will be the abovementioned network configuration by the Sri Lankan side.

(6) Campus LAN (Local Area Network)

A virtual private network (VPN) connecting Jaffna, Kilinochchi and Vavuniya campuses via a dedicated line is currently under development by the university. The LEARN (Lanka Education and Research Network) provides a network environment connection to other educational research facilities. The Kilinochchi Premises, consisting of the FoAg and the Faculty of Engineering, will be provided with a core switch housed in the Server Room located between those faculty buildings.

A star-ring topology network is scheduled to be configured with optical fibre cables connecting each building to the network; however, optical fibre cabling to the main switch in FoAg has not been constructed yet. FoAg has a plan to provide a main switch in the Computer Unit Building and to lay optical fibre cables to each facility for establishing the computer network. The above plan has already been agreed to and cables will be laid this year to the Faculty Management Building and the Agricultural Biology Buildings. Currently, the main switch is connected to the Internet through the Sri Lanka Telecom (SLT) ADSL service.

FoAg is considering shifting the existing network to FTTH (fibre to the home, 100 Mbps), which utilizes wideband fibre optic cables.

Since an internal LAN for Research and Food Processing Buildings was requested, with justification, as part of the Agriculture Faculty's LAN, an internal LAN for those buildings is planned. The standards for building the internal LAN will be as follows:

Table 2-10 Standardized LAN System

LAN	Optic Trunk Line: equivalent to 1000BASE-SX UTP Branch Line: 100BASE-TX
Data Transmission Speed	Optic Trunk Line: 1000 Mbps UTP Branch Line: 100 Mbps
Switch	Main Switch L3 Distribution Switch L2

Regarding the connection with the campus network to the Research and Laboratory Building and the Food Processing Building, works to install fibre optic cables between the existing main switch in the Agriculture Faculty and the buildings planned to be constructed in this project scheme were confirmed to be carried out by the Sri Lankan side following the guidelines for the role of allotment (undertakings) in a JICA Grant Aid Project Scheme as shown in Figure 2-16.

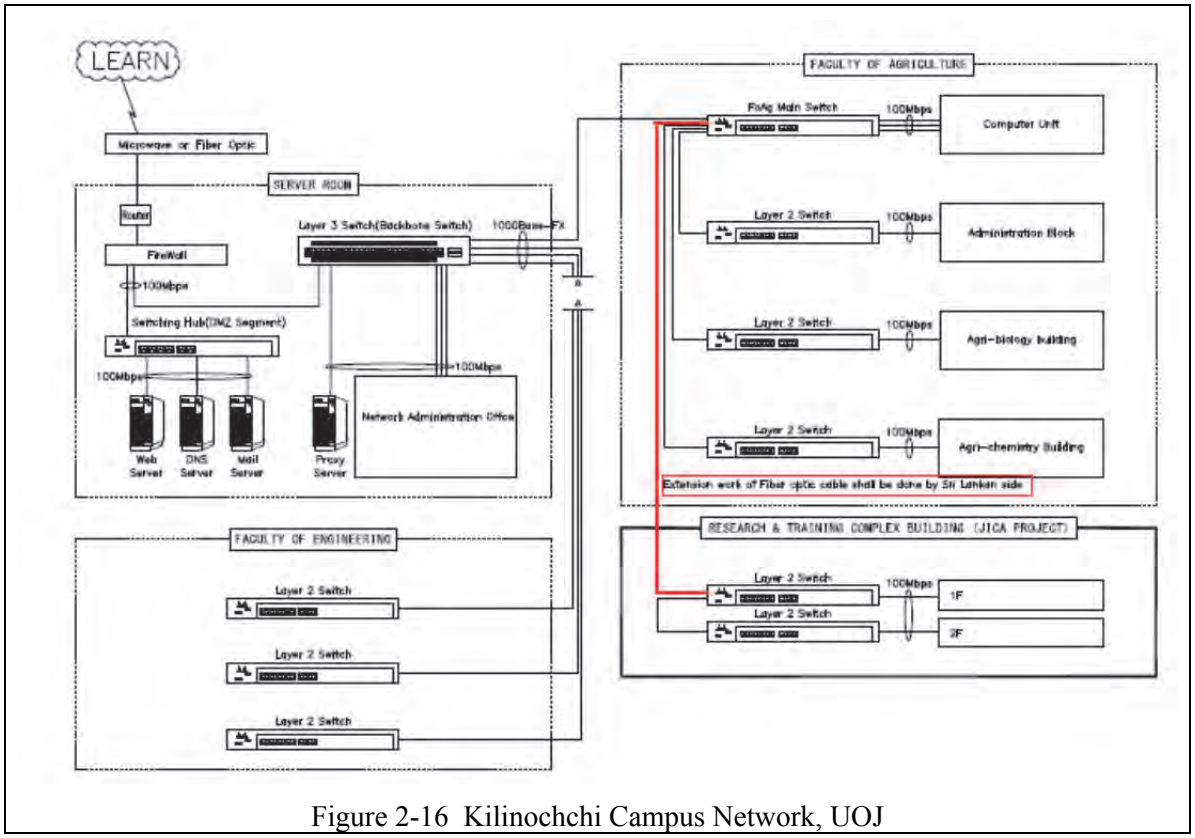


Figure 2-16 Kilinochchi Campus Network, UOJ

(7) Fire Alarm System

A manual fire alarm system will be provided to the Research Laboratory Building and Processing Training Building. The main fire board equipped with an alarm bell, red light, and push-button, will be provided in each of the fire zones on each floor. In addition, a fire alarm panel will be installed near the ground floor entrance of the Research Laboratory Building.

(8) Emergency Generator

Power failures occur frequently in the project site and neighboring areas. In this project, therefore, an emergency generator will be planned to provide a minimum demand load in order to prevent interruption by power outage.

The capacity of the emergency generator will be sufficient for loads covering lighting, outlets, laboratory equipment, and plumbing equipment, but not air-conditioning. General information of the planned emergency generator will be as follows:

Table 2-11 Design outline of the Emergency Generator

Type	Low Noise Air-Cooled Type Indoor Use Packaged Unit
Capacity	3 Phase, 3 Wire, 380 V 50 Hz, 200 KVA
Operation Time	10 Hours（Continuous Duty Operation）
Fuel	Light Oil
Quantity	1

For power-sensitive equipment, like computers, uninterruptible power supplies (UPS) and voltage stabilizers (AVR: Automatic Voltage Regulator) will be procured by the project.

2.2.2.4.2 Plumbing System

(1) Water Supply System

1) Water Source

Since the water supply capacity of the water tower in FoAg cannot accommodate future demand, a new deep well will be required to be bored as a new water source for planned facilities and buildings. For the new deep well, a candidate site will be a location adjacent to the new building, which, according to an engineer of FoAg, may be a good source of underground water.

During the survey, water quality and pumping rate were provisionally confirmed by the test well:

a) Test Well

Casing: 150 mm φ Depth 32 m

Deep Well Pump: 50 mm φ x 100～150 L/min. x 60 m x 3.7 kW

b) Water Quality

Table 2-12 Test Results of Water Quality

Item	Criteria	Result	Evaluation
p H (@25℃)	5.8 - 8.6	6.8	Reasonable
Chloride (Cl mg/l)	-	859	-
Sulfate (SO_4 mg/l)	-	28	-
Total coli (/100ml)	Less than 3	25	Exceeds criteria
Fecal coliform	Not detected	None	Reasonable

From the test results, it is recommended to install chlorine sterilization equipment, since the chloride concentration is quite high and the total of coliform bacteria exceeds the standard rate.

c) Pumping Test Result

As a result of the phased pumping test and continuous pumping test on the test well, the reasonable pumping capacity is assumed to be 100 L/min.

Since the capacity of the above-mentioned deep well has been shown to be suitable for use for the planned buildings, a deep well with a casing diameter of 200 mm will be provided as a new water source for the Research Laboratory Building and the Processing Training Building. In order to supply high quality water to the Research Laboratory Building and the Processing Training Building, the well water will be filtered through sterilization filtration equipment.

2) Assumption of Daily Water Consumption

No. of Users： Research Building and Food Processing Building

Teaching Staff:	75	persons
Students（Undergraduate/Postgraduate）:	315	persons
Total	390	persons

The number of users is estimated at 312 persons, assuming that the occupancy rate is 80%, since it is expected that those users will also utilize other facilities in the Faculty of Agriculture.

Based on the water demand unit rate, maximum daily water consumption will be as follows:

Average Daily Water Consumption per Person: 75 litres/person・day

Thus, the daily water consumption will be as follows:

Research/Food Processing Buildings: 312 persons ×75 litres/person・day

= 23,400 litres/day

Watering (assumed) 25,000 litres/day

Total: 48,400 litres/day or 48 m^3/day

3) Water Supply System and Capacity of Major Equipment

The water supply system to the new two-story Research Laboratory Building and single story Processing Training Building will be planned with an elevated water supply system (elevated tank and lift pump) to ensure a stable water pressure and rate.

The treated well water will be stored in the water reservoir installed in the Pump Room on the ground floor of the Research Laboratory Building, and then lifted up to the elevated tank installed in the penthouse located on the roof floor of the elevated tower, and from there distributed to each water supply point via gravity-flow.

The reservoir and the elevated water tank will be floor-mounted types made of FRP in consideration of hygiene conditions, and these tanks will be double tank types with internal structural partition, making it possible to clean them during operation. The capacity of the reservoir will be equivalent to 50 percent of the daily demand and the capacity of the elevated water tank will be more than the hourly average water supply rate.

Water Reservoir	Required Capacity:	48 m^3/day×50 % = 24 m^3
	Outer Dimensions:	4 m×3 m×2.5 m high
Elevated Tank	Required Capacity :	48 m^3/day × 1/8 = 6 m^3
	Outer Dimensions:	2 m×2 m × 2 m high

(2) Drainage (Wastewater and Sewage)

Currently, a public sewage system has yet not been developed in the project's surrounding area, not even in the city area of Kilinochchi that neighbors the University. Drainage, wastewater, and sewage from each building on campus is to be treated by a infiltration treatment method including an individual septic tank as well as a soak away installed for each building, for treatment and infiltration into the soil.

In this area, on site treatment for wastewater and sewage by septic tank and soak away is generally performed, and the calculation method for the size and structure of the septic tank and soak away are standardized. Therefore, an on-site treatment system will be applied to these proposed buildings for wastewater and sewage treatment.

On the other hand, chemical wastewater from the laboratory equipment, such as laboratory benches and sinks, is drained into and stored in the outdoor laboratory drainage tank separately provided from

the wastewater and sewage system. Through an interview with another university, it was confirmed that chemical wastewater from laboratories is collected by the cement plant and treated by incineration. Thus, this project will also follow this current processing practice.

Capacity of Septic Tank and Soak Away：

Treated Water Quality: BOD 90 ppm or less

Treatment Capacity: 14 m^3/day

Laboratory Drainage Tank:

Tank Capacity: 34 m^3 (amount equivalent to 2 weeks)

(3) Plumbing Equipment

Existing toilets provided in the facility of FoAg are mostly Turkish-style plumbing fixtures with some Western-style fixtures. Similar local facilities in the area are mainly provided with Turkish-style plumbing fixtures for student toilets, and Western-style plumbing fixtures for faculty and staff. However, many of the buildings that were recently completed in Sri Lanka only have Western-style plumbing fixtures.

In this project, student toilets will be a combination of Turkish-style and Western-style plumbing fixtures, and teaching staff toilets will be Western-style plumbing fixtures. In addition, toilets for disabled persons will be provided on the ground and first floors of the Research Laboratory Building.

(4) Gas Supply System

In many of the laboratories planned in the Research Laboratory Building, Bunsen burners are required for experiments. However, some of the experiment equipment, such as clean benches, draft chambers, etc., require Propane Gas (LPG); therefore, an LPG distribution piping system is to be installed.

For safety purposes, an LPG gas cylinder manifold outside the building and an exterior gas piping system for distribution to the above-mentioned laboratories are planned.

(5) Fire Protection System

According to the Urban Development Authority (UDA), which has jurisdiction over building construction, and the chief engineer of the UGC responsible for the university safety and fire prevention standards, the planned buildings are not required to provide special fire-fighting equipment since they are new low-rise buildings of only 2 stories. Therefore, based on the building applications and building scale, the new building will be planned to provide only suitable types of the fire extinguishers effective for primary firefighting.

2.2.2.4.3 Ventilation and Air-Conditioning System

(1) Air-Conditioning System

The project area is located in the City of Kilinochchi, which is situated 6° north of the equator at an altitude of between 5 to 8 meters. The climate is subtropical and is hot and humid throughout the year, with rainy and dry seasons.

The design of air-conditioning systems for Colombo City, the capital of Sri Lanka, are from the "Cooling Only" design schedule in the ASHRAE (America Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.) Guideline Book, which covers all design conditions for major cities in all countries. Although there are no specifications for the Kilinochchi area, the Colombo City air-conditioning design specifications will be applied for this project, as follows:

Outdoor Design Condition： Dry Bulb Temp. ： 32°C,
Wet Bulb Temp. ： 27°C,
Daily Temp. Difference: 8°C

（source：ASHRAE Fundamentals 1997: at Colombo）

In consideration of room applications of laboratories, which house sensitive laboratory equipment and instruments, and the undesirable environment conditions for laboratory equipment, such as hot, humid and dusty, certain air-conditioning systems should be planned for these laboratories.

Particularly, air conditioning is essential for areas with a lot of equipment dissipating heat, such as the Computer Lab, microscopic rooms, and refrigerator rooms.

The Multi-Purpose Room will be provided with an air-conditioning system, because this room will also be used for experiments and training with laboratory instruments.

In consideration of running costs, it was agreed with the Sri Lankan side that air conditioning will not be supplied to some general rooms, such as lecture rooms, meeting rooms, and teaching staff rooms. But, as it is desirable to have air conditioning in order to maintain a suitable indoor environment for efficient training and research activities, a power supply and pipe sleeves will be provided in the project for future installation of air-conditioning equipment by the Sri Lankan side.

Air-conditioning equipment will be split type air-cooled units that can be individually controlled in each room. Meanwhile, other rooms, such as classrooms and general rooms, will be provided with ceiling fans for natural ventilation.

(2) Ventilation System

In order to eliminate odors, heat, and moisture, some of the general rooms will be provided with mechanical ventilation equipment. In reference to the above ASHRAE Standards and Japanese Ministry of Land, Infrastructure and Transport design standards, applicable ventilation design conditions for this project are considered in the tables below.

Table 2-13 Design Conditions for Ventilation System

Room	Ventilation Class	Ventilation Rate	Note
Laboratory	Exhaust Fan & Supply Air Fan with Filter	3 times/hour	For fresh air intake
Multi-Purpose Room	Supply/Exhaust Dual Air Fan	25 m^3/person・hour	For fresh air intake
Storage	Exhaust Air Fan only	5 times/hour	For ventilation
Toilet	Exhaust Air Fan only	10 times/hour	For odors elimination
Water Reservoir under the Mechanical Room	Exhaust Air Fan only	3 times/hour	For ventilation
Electrical Room.	Exhaust Air Fan only	10 times/hour	For removal of heated air
Emergency Generator Room	Supply/Exhaust Dual Air Fan	25 - 30 times/hour	Calorific value removed for combustion air supply and removal of heated air

2.2.2.4.4 Equipment Plan in Farm Field Administration Building

(1) Water Supply and Plumbing System

The Research and Training Farm is located across the road to the FoAg building area. As a water source for watering of the farm field, a shallow well exists in the field along with a submergible pump and water tower. The Sri Lankan side has agreed to lay water supply piping work from the water tower to the Farm Management Building. Sewage from the Farm Management Building will be treated by septic tank and soak away, in the same way as installations for the other buildings.

(2) Ventilation and Air-conditioning System

Air-conditioning equipment will not be required to be provided; however, low voltage supply outlets and pipe sleeves for future installation of the split type air conditioner refrigerant piping will be installed for the Office, Demonstration Room and Maintenance Room. These rooms will also have ceiling fans.

In addition, the toilet will be provided with mechanical ventilation fans for both the supply and exhaust air.

(3) Electrical System

The Research and Training Farm has been planned to be independently tapped with a CEB (Ceylon Electricity Board) distribution line, and it was confirmed that above low voltage line tapping was installed. Low-voltage power supply cabling work to the Farm Management Building will be provided by the Sri Lankan side down to the power distribution panel inside the building.

2.2.2.5 External Work

(1) External Work

- Planning the asphalt pavement on the campus road and the parking lot.
- Planning the interlocking block paving on the pedestrian road in the site.
- Planning the Septic Pit (Research and Training Complex, Processing Unit), Seepage Pit (Research and Training Complex, Processing Unit), and Chemical Waste Water Storage Pit (Research and Training Complex).
- Planning the pergola with wooden louvers on the steel frame in the courtyard of the Research and Training Complex.
- Planning the new deep well as a water source for facilities.

(2) Utility Work

- Planning the conduit, hand hole and buried sheet for the Power Supply Trunk Line System.
- Planning the drainpipe and sewage basin to connect the Septic Pit, Seepage Pit and Chemical Waste Water Storage Pit.
- Planning the pump for the deep well (50φ×100L/min×40m×1.9w), sand separator, pumping pipe and water collecting pipe for deep well.

(3) Garbage Disposal

A government agency of Kilinochchi provides garbage collection service. In this project, garbage

storage space will be provided in the Processing Training Building for sorted collection of general garbage, recyclable refuse, etc.

2.2.2.6 Research and Training Farm Plan

(1) Size and Unit of Farms

Regarding the size of farms planned, the following items are mainly investigated:

- Possibility of integrating units according to similarity of crops;
- Supply capacity of existing intake facility (well) and area of research and training farm;
- Potential to secure a water source other than the existing well;
- Area feasible to handle in terms of operation, maintenance and management;
- Cooperation by other donors.

1) Integrated Crop Research and Training Farm

Since target crops and irrigation methods of the horticultural unit and floricultural unit are the same, they are integrated in the field crop experimental unit and eight units overall, 14.15 acres, were selected as target cooperation units.

Each unit is used mainly for training students and partly for research. As cultivation areas used for training need to be separated from those used for research according to the type of crops cultivated in the same unit, the size of units were confirmed in terms of the use of farms.

2) Integrated Livestock Research and Training Farm

Since the daily cattle rearing unit, layer unit and broiler unit are being constructed under a World Bank project, they are not included in the target unit. Accordingly, the goat-rearing unit, which is prioritized in terms of training and research activities, was selected as the target unit for cooperation in this project. The rabbit unit, piggery, sheep-rearing unit, duck-fish integration unit and waste recycling and fodder conservation unit were excluded from the target scope.

In the goat-rearing unit, there are plans to rear 30 goats annually. The feed consumption per goat per day is around 6 kg, which means 65,700 kg (30 goats x 6 kg/goat/day x 365 days) of feed needed to be cultivated in the meadow year-round.

Two types of feed crops are planned, namely Coimbatore (CO3) and Coimbatore (CO4) and their harvests per unit are 18,000 kg/Ac and 4,400 kg/Ac, respectively. The area of meadow required for 65,700 kg of feed is 5.0 acres (CO3 x 4 Ac and CO4 x 1 Ac).

According to the farm utilization plan and the available water confirmed by the UOJ, the target units and their areas for cooperation are as follows:

Table 2-14 Target Unit for Improvement and Unit Areas

Units	Area (Ac)	Units	Area (Ac)
1. Plant propagation unit	0.25	1. Dairy cattle rearing unit	Excluded from the target
2. Protected agriculture unit	0.45	2. Goat-rearing unit	5.0
3. Fruit crops germ-plasm collection unit	4.20	3. Layer unit	Excluded from the target
4. Field crops experimental unit	1.60	4. Broiler unit	Excluded from the target
5. Plantation & agro-forestry unit	4.20	5. Rabbit unit	Excluded from the target
6. Agri. Management unit	0.45	6. Piggery	Excluded from the target
7. Model home garden unit	1.00	7. Sheep-rearing unit	Excluded from the target
8. Horticultural unit	Integrated in another unit	8. Duck-fish integration unit	Excluded from the target
9. Floricultural unit	Integrated in another unit	9. Waste recycling unit & fodder conservation unit	Excluded from the target
10. Agro-tourism unit	2.00		
Total	14.15	Total	5.0

(2) Irrigation Plan

As shown in Figure 2-17, the university has established a cultivation plan for integrated crop research with training farms in 8 units and the integrated livestock research and training farm in 1 unit. The farms are not used commercially but for training and research of students, and the plan does not consider full-scale use of all farm areas at all times. However, since the area of farm utilization depends on the supply capacity of well water, the aforementioned cultivation plan must be managed by arranging the training and research locations using either rainwater or irrigation water.

In case the quantity of irrigation water falls short against the cultivation plan, a water wagon is available to prepare irrigation water. Accordingly, in this project, irrigation water is calculated to increase the farm utilization rate as much as possible, taking effective rainfall into consideration.

Units	Type of Crops	Area (Ac)	Representative Crops
1. Plant Propagation Unit	1.1 Fruits crops	0.08	Mango nursery
Irrigation Method: Irrigation by Hose pipe	1.2 Field crops	0.04	Chili
	1.3 Floriculture crops	0.04	Rose
	1.4 Vegetable crops	0.03	Cabbage
	1.5 Plantation & export crops	0.04	Coconut
	1.6 Cut-foliage crops	0.02	Aglonema
	Sub-total	**0.25**	
2. Protected Agriculture Unit	2.1 Cole crops	0.09	Crucifers
Irrigation method: Drip- and Basin Irrigation	2.2 Floriculture crops	0.09	Rose
	2.3 Vegetative propagated fruit plant	0.09	Mango(grafted)
	2.4 Cut-foliage	0.09	Aglonema
	2.5 Department sharing	0.09	
	Sub-total	**0.45**	
3. Fruit crops Germ-plasm collection Unit	3.1 Fruit crops	4.00	Orchard
Irrigation method: Basin Irrigation	3.2 Grapes	0.20	Grape
	Sub-total	**4.20**	
4. Field crops experimental Unit	4.1 Cereal crops	0.25	Maize (sweet)
Irrigation method: Basin- and Sprinkler	4.2 Oil crops	0.25	Sunflower
Basin & Sprinkler for Chili (1.0-1.5 height)	4.3 Tuber crops	0.25	Potato
	4.4 Spices and condiments	0.25	onion(dry)
	4.5 Pulses	0.25	Green gram
	4.6 Fiber crops	0.10	cotton
	4.7 Vegetable crops	0.25	brinjal
	Sub-total	**1.60**	
5. Plantation & agro-forestry Unit	5.1 Silviculture crops	3.00	Mahogany
Irrigation method: Basin	5.2 Fencing crops	0.00	Gliricidia
	5.3 Valuable crops	0.20	Satin wood
	5.4 Plantation crops	1.00	Coconut
	5.5 Fruit crops	0.00	Orchard
	5.6 Other crops	0.00	brinjal
	Sub-total	**4.20**	
6. Agri. Management Unit			
Irrigation method: -	**Sub-total**	**0.45**	
7. Model home garden Unit	7.1 Fruit crops	0.20	mango
Irrigation method: Basin	7.2 Vegetable crops	0.10	brinjal
	7.3 Floriculture crops	0.10	Rose
	7.4 Field crops	0.10	ground nut
	7.5 Medicinal plants	0.10	
	7.6 Spices and condiments	0.10	bell pepper
	7.7 Export crops	0.10	Coffee
	7.8 Plantation crops	0.20	Coconut
	Sub-total	**1.00**	
8. Agro-tourism Unit	8.1 Plantation crops	1.00	Coconut
Irrigation method: Basin	8.2 Spices and condiments	0.10	onion(dry)
	8.3 Fruit crops	0.50	Orchard
	8.4 Vine crops	0.20	Grape
	8.5 Medicinal crops	0.20	Aloe Vera
	Sub-total	**2.00**	
Total Area		**14.15**	
9. Goat Rearing Unit	CO3 & CO4	4.00	Sorghum
	Fodder trees (IPIL IPIL 1/4 Ac, GLYRICI	1.00	Pasture grass
	Sub-total	**5.00**	

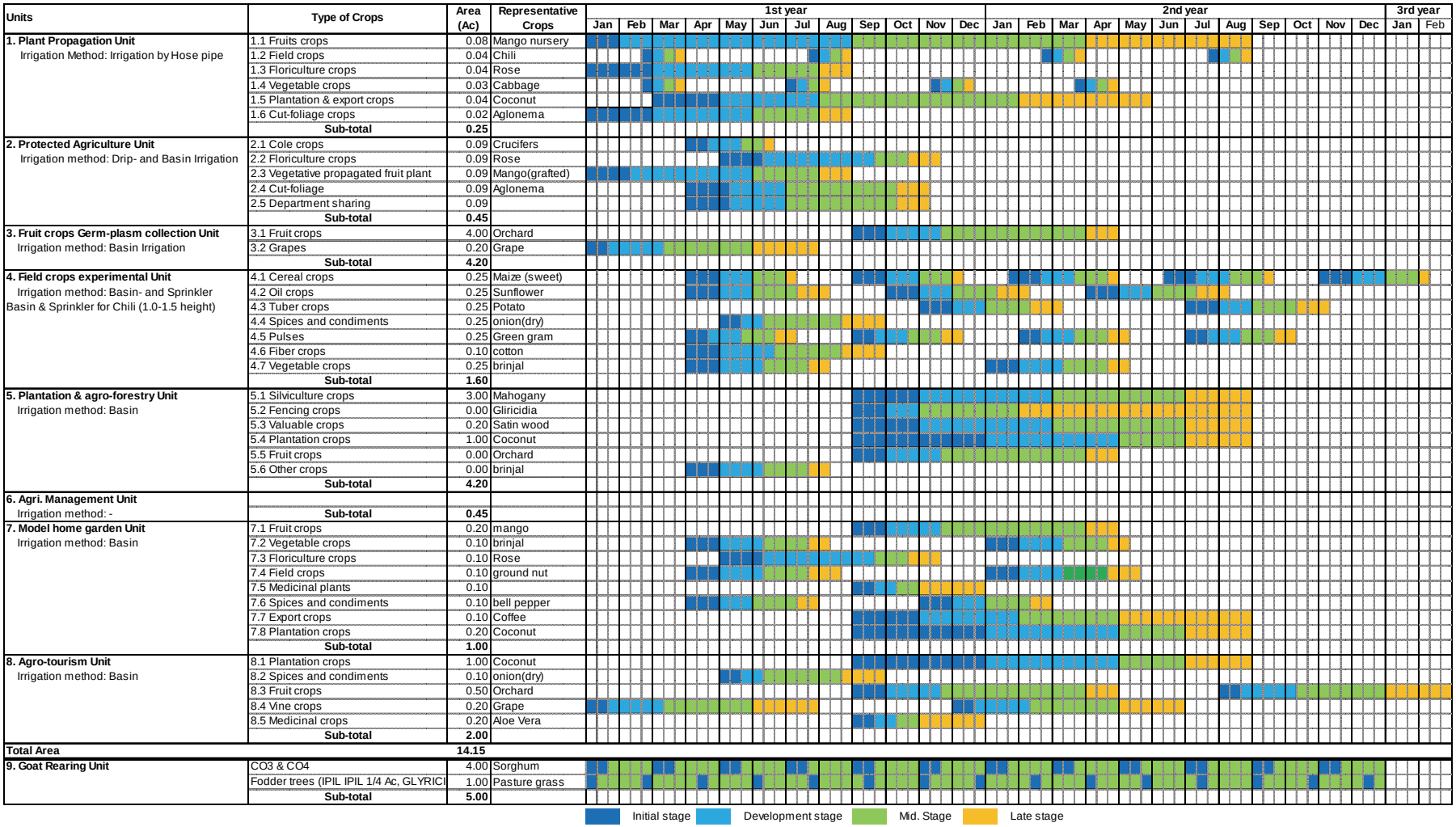


Figure 2-17 Farm Cultivation Plan

1) Calculation of Unit Irrigation Water Requirements

The planned irrigation water requirements are calculated by determining the reference evapotranspiration (ETo) using the FAO Penman-Monteith method based on the meteorological observation data of the Jaffna Meteorological Station and subsequently multiplying the crop coefficient (Kc) to determine the crop water requirements (ETcrop). The net water requirements are determined by subtracting the effective precipitation (Pe) from the crop water requirements (ETcrop), while the gross water requirements are determined by adding irrigation efficiency (e) to the net water requirements.

a) Reference evapotranspiration (ETo)

Reference evapotranspiration (ETo) is calculated using the following formula, based on the guidelines of FAO Irrigation and Drainage Paper 56:

$$\mathrm{ETo} = \frac{0.408 \cdot \Delta \cdot (. \quad - \quad) + \quad \cdot \frac{900}{+273} \cdot \quad _2 \cdot (\quad - \quad)}{\Delta + \quad \cdot (1 + 0.34 \cdot \quad _2)}$$

where, ETo: reference evapotranspiration (mm/day), Rn: net radiation at the crop surface (MJ/m^2/day), G: soil heat flux density (MJ/m^2/day), T: air temperature at 2 m height (oC), u2: wind speed at 2 m height (m/sec), es: saturation vapor pressure (kPa), ea: actual vapor pressure (kPa), ∆: slope vapor pressure curve (kPa/oC), γ: psychrometric constant (kPa/oC)

Meteorological data from 2001 to 2014 was collected from the Jaffna Meteorological Station but the data for each year lacks some calculation items, as shown in Table 2-15. Relative humidity can be forecast from the minimum temperature records so the observation data of 2009 is used for recording the data of each month.

Table 2-15 Meteorological Data (2001 to 2014)

Item	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Max. Temp.	N/A	33.4	33.1	33.1	33.4	33.7	33.5	33.0	33.4	33.7	33.1	33.6	33.2	-
Min. Temp.	N/A	21.9	21.7	21.0	22.0	22.3	21.4	21.7	22.1	21.9	21.8	22.2	22.3	-
Max. R. Humidity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	94.3	92.3	93.9	N/A
Min. R. Humidity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	61.6	59.4	64.0	57.8
Wind Speed	N/A	217.0	219.0	201.0	217.0	225.0	207.0	208.0	198.0	185.0	N/A	N/A	N/A	N/A
Sunshine Hours	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	218.5	219.1	211.4	240.7	221.7	207.0
Rainfall	N/A	1,413.5	1,328.4	1,868.9	1,235.3	926.5	1,168.3	1,811.8	1,270.9	1,496.6	1,470.7	943.2	1,033.3	1,368.6
Hourly Rainfall	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	53.7	25.0

Reference evapotranspiration (ETo) is calculated with a CROPWAT 8.0 of FAO using the meteorological data of 2009.

Table 2-16 Reference Potential Evapotranspiration (2009)

Item	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave.
Max. Temp.	°C	31.5	33.7	34.7	34.2	33.7	32.8	34.5	35.5	33.8	34.1	32.0	30.5	33.4
Min. Temp.	°C	24.8	25.1	25.5	28.5	29.1	28.1	27.8	27.3	27.7	27.6	26.3	25.2	26.9
Relative Humidity	%	3.13	3.19	3.26	3.89	4.03	3.8	3.74	3.63	3.71	3.69	3.42	3.21	3.6
Wind Speed	km/day	136	109	90	181	295	343	283	252	281	161	110	133	197.8
Sunshine Hours	Hour	7.9	10.0	8.5	8.6	7.6	9.1	7.7	8.3	8.7	8.1	5.3	4.4	7.9
Insolation Amount	MJ/m2/day	19.1	23.4	22.3	22.8	20.8	22.6	20.6	22.0	22.6	20.8	15.6	13.8	20.5
ETo	mm/day	4.08	5.08	5.02	5.25	4.84	5.02	5.15	5.66	5.33	4.88	3.58	3.12	4.75
	mm/month	126.55	142.16	155.70	157.40	149.99	150.54	159.69	175.51	159.99	151.31	107.49	96.59	1,732.92
Net Rainfall	mm/month	41.0	24.1	36.8	61.1	36.2	12.4	10.8	41.8	41.8	127.0	158.1	132.6	723.7

b) Crop Coefficient (Kc)

As shown in Figure 2-17, various crops are cultivated in each unit. The crop coefficient for each crop is established by selecting or setting representative crops in each unit and is based on the FAO Irrigation and Drainage Paper 56 (see Table 2-17).

Table 2-17 Type of Crops and Crop Coefficient

Units	Type of Crops	Area (Ac)	Representative Crops	Crops for Kc of FAO	Kc in Stage		
					Initial	Mid	End
1. Plant Propagation Unit Irrigation Method: Irrigation by Hose pipe	1.1 Fruits crops	0.08	Mango nursery	*Evergreen fruit tree	1.00	1.00	1.00
	1.2 Field crops	0.04	Chili	Egg Plant		1.05	0.90
	1.3 Floriculture crops	0.04	Rose	Strawberries	0.40	0.85	0.75
	1.4 Vegetable crops	0.03	Cabbage	Cabbage		1.05	0.95
	1.5 Plantation & export crops	0.04	Coconut	Palm Trees	0.95	1.00	1.00
	1.6 Cut-foliage crops	0.02	Aglonema	*Evergreen fruit tree	1.00	1.00	1.00
	Sub-total	**0.25**					
2. Protected Agriculture Unit Irrigation method: Drip- and Basin Irrigation	2.1 Cole crops	0.09	Crucifers	Cauriflower		1.05	0.95
	2.2 Floriculture crops	0.09	Rose	Strawberries	0.40	0.85	0.75
	2.3 Vegetative propagated fruit plant	0.09	Mango(grafted)	*Evergreen fruit tree	1.00	1.00	1.00
	2.4 Cut-foliage	0.09	Aglonema	*Evergreen fruit tree	1.00	1.00	1.00
	2.5 Department sharing	0.09					
	Sub-total	**0.45**					
3. Fruit crops Germ-plasm collection Unit Irrigation method: Basin Irrigation	3.1 Fruit crops	4.00	Orchard	Almonds, no gound cover	0.40	0.90	0.65
	3.2 Grapes	0.20	Grape	Grapes (Table or Raisin)	0.30	0.85	0.45
	Sub-total	**4.20**					
4. Field crops experimental Unit Irrigation method: Basin- and Sprinkler Basin & Sprinkler for Chili (1.0-1.5 height)	4.1 Coral crops	0.25	Maize (sweet)	Maize, Sweet		1.15	1.05
	4.2 Oil crops	0.25	Sunflower	Sunflower		1.15	0.35
	4.3 Tuber crops	0.25	Potato	Potato		1.15	0.75
	4.4 Spices and condiments	0.25	onion(dry)	Onions - dry		1.05	0.75
	4.5 Pulses	0.25	Green gram	Green Gram & Cowpeas		1.05	0.60
	4.6 Fiber crops	0.10	cotton	Cotton		1.20	0.70
	4.7 Vegetable crops	0.25	brinjal	Egg Plant		1.05	0.90
	Sub-total	**1.60**					
5. Plantation & agro-forestry Unit Irrigation method: Basin	5.1 Silviculture crops	3.00	Mahogany	*Evergreen fruit tree	1.00	1.00	1.00
	5.2 Fencing crops	0.00	Gliricidia	-	-	-	-
	5.3 Valuable crops	0.20	Satin wood	*Evergreen fruit tree	1.00	1.00	1.00
	5.4 Plantation crops	1.00	Coconut	Palm Trees	0.95	1.00	1.00
	5.5 Fruit crops	0.00	Orchard	Almonds, no gound cover	0.40	0.90	0.65
	5.6 Other crops	0.00	brinjal	Egg Plant		1.05	0.90
	Sub-total	**4.20**					
6. Agri. Management Unit Irrigation method: -							
	Sub-total	**0.45**					
7. Model home garden Unit Irrigation method: Basin	7.1 Fruit crops	0.20	mango	*Evergreen fruit tree	1.00	1.00	1.00
	7.2 Vegetable crops	0.10	brinjal	Egg Plant		1.05	0.90
	7.3 Floriculture crops	0.10	Rose	Strawberries	0.40	0.85	0.75
	7.4 Field crops	0.10	ground nut	Ground nut		1.15	0.60
	7.5 Medicinal plants	0.10		Safflower		1.15	0.25
	7.6 Spices and condiments	0.10	bell pepper	Sweet Peppers (bell)		1.05	0.90
	7.7 Export crops	0.10	Coffee	Coffee with weeds	1.05	1.10	1.10
	7.8 Plantation crops	0.20	Coconut	Palm Trees	0.95	1.00	1.00
	Sub-total	**1.00**					
8. Agro-tourism Unit Irrigation method: Basin	8.1 Plantation crops	1.00	Coconut	Palm Trees	0.95	1.00	1.00
	8.2 Spices and condiments	0.10	onion(dry)	Onions - dry		1.05	0.75
	8.3 Fruit crops	0.50	Orchard	Almonds, no gound cover	0.40	0.90	0.65
	8.4 Vine crops	0.20	Grape	Grapes (Table or Raisin)	0.30	0.85	0.45
	8.5 Medicinal crops	0.20	Aloe Vera	Onion Green		1.00	1.00
	Sub-total	**2.00**					
Total Area		**14.15**					
9. Goat Rearing Unit	CO3 & CO4	4.00	Sorghum	Grazing pasture: Extensive grazing	0.30	0.75	0.75
	Fodder trees (IPIL IPIL 1/4 Ac, GLYRICIDIA 1/4 Ac and Pasture grasses	1.00	Pasture grass		0.30	0.75	0.75
	Sub-total	**5.00**					

Note: * The crop coefficients for mango, floriculture crops, mahogany and satin wood are in accordance with those of tea and evergreen fruit (such as loquat) provided in Irrigation Water (Field), Design criteria and plan for land improvement projects, the Ministry of Agriculture, Forestry and Fisheries, Japan

c) Effective Precipitation (Pe)

The probability of effective precipitation is processed based on the observation data of the Jaffna Meteorological Station from 2002 to 2014, whereupon the monthly precipitation in five probable drought years is calculated. The calculation results are shown in Table 2-18.

Table 2-18 Non-excess Probability of Precipitation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	57.2	32.6	50.9	88.9	50.0	16.5	14.3	58.5	58.5	229.7	429.0	247.3
T=1/2	57.2	32.6	50.9	88.9	50.0	16.5	14.3	58.5	58.5	229.7	429.0	247.3
T=1/5	44.1	25.1	39.3	68.6	38.6	12.7	11	45.1	45.1	177.2	330.9	190.8
T=1/10	39.8	22.7	35.4	61.8	34.8	11.5	9.9	40.7	40.7	159.7	298.2	171.9

d) Percolation and Seepage Losses

Percolation and seepage losses per day are determined according to the characteristics of farm soil. As this research and training farm is expected to contain clay-based sandy soil, the percolation and seepage losses in this Project are set at 5 mm/day, the average between heavy clay and sandy soil.

Table 2-19 Amount of Percolation and Seepage Losses

Soil type	Percolation and seepage losses
For heavy clay	2 mm/day = 60 mm/month
For more sandy soil	8 mm/day = 240 mm/month
On average	5 mm/day = 150 mm/month

Source: Irrigation Water Management Training Manual No. 4 Irrigation Schedule, FAO

e) Unit Irrigation Water Requirements per Unit

Based on the cultivation plan shown in Figure 2-17, the unit irrigation water requirements per unit are determined by adding the above effective precipitation (Pe), crop coefficient (Kc) and percolation and seepage losses to reference evapotranspiration (ETo), as shown in Table 2-20. The agricultural management unit and the crops with 0 acres of cultivation area are excluded from the calculation.

Table 2-20 Unit Irrigation Water Requirements per Unit (l/sec/ha)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(a) Eto (mm/day)	4.08	5.08	5.02	5.25	4.84	5.02	5.15	5.66	5.33	4.88	3.58	3.12
(b) Eto (mm/month)	126.55	142.16	155.70	157.40	149.99	150.54	159.69	175.51	159.99	151.31	107.49	96.59
(c) Eff. Rainfall (mm/month)	41.0	24.1	36.8	61.1	36.2	12.4	10.8	41.8	41.8	127.0	158.1	132.6
1 Plant Propagation Unit (l/sec/ha)												
1.1 Fruits crops	0.90	1.07	1.02	0.95	1.00	1.11	1.13	1.08	1.03	0.67	0.38	0.44
1.2 Field crops		0.23	0.90				0.45	0.94				
1.3 Floriculture crops	0.61	0.71	0.74	0.73	0.86	1.02	1.05	0.91				
1.4 Vegetable crops		0.23	0.94				0.86	0.72				
1.5 Plantation & export crops			0.99	0.92	0.98	1.10	1.13	1.08	1.03	0.67	0.38	0.44
1.6 Cut-foliage crops			1.02	0.95	1.00	1.11	1.13	1.08	1.03	0.67	0.38	0.44
2 Protected Agriculture Unit ((l/sec/ha)												
2.1 Cole crops				0.45	0.84	1.09						
2.2 Floriculture crops					0.67	0.81	0.91	0.91	0.90	0.56	-0.03	
2.3 Vegetable propagated fruit plant	0.90	1.07	1.02	0.95	1.00	1.11	1.13	1.08				
2.4 Cut-foliage crops				0.95	1.00	1.11	1.13	1.08	1.03	0.67	-0.84	
3 Fruit crops Germ-plasm collection unit (l/sec/ha)												
3.1 Fruit crops									0.66	0.50	0.31	0.41
3.2 Grapes	0.59	0.85	0.90	0.86	0.92	0.79	0.81					
4 Field crops experimental unit (l/sec/ha)												
4.1 Cereal crops				0.34	0.77	1.20	1.08		0.42	0.43	0.45	-0.58
4.2 Oil crops				0.34	0.77	1.20	0.90	0.32		0.10	0.21	-0.54
4.3 Tuber crops											-0.03	0.29
4.4 Spices and condiments					0.55	0.96	1.16	1.04	0.88			
4.5 Pulses				0.45	0.84	1.05	0.81		0.53	0.51	0.34	-0.74
4.6 Fiber crops				0.34	0.85	1.14	1.25	0.42	0.85			
4.7 Vegetable crops				0.34	0.74	1.04	1.13	0.68				
5 Plantation & agro-forestry unit (l/sec/ha)												
5.1 Silviculture crops									1.03	0.67	0.38	0.44
5.3 Valuable crops									1.03	0.67	0.38	0.44
5.4 Plantation crops									0.66	0.47	0.27	0.41
5.5 Fruit crops									0.66	0.47	0.27	0.41
5.6 Other crops				0.34	0.74	1.04	1.13	0.68				
7 Model home garden unit (l/sec/ha)												
7.1 Fruit crops									1.03	0.67	0.38	0.44
7.2 Vegetable crops				0.34	0.74	1.04	1.13	0.68				
7.3 Floriculture crops					0.67	0.81	0.91	0.91	0.90	0.56	-0.03	0.00
7.4 Field crops				0.34	0.77	1.09	1.10	0.73				
7.5 Medical plants									0.50	0.70	0.07	0.17
7.6 Spices and condiments				0.34	0.74	1.14	1.10				-0.03	0.28
7.7 Export crops									1.07	0.70	0.41	0.47
7.8 Plantation crops									1.00	0.64	0.36	0.43
8 Agro-tourism unit (l/sec/ha)												
8.1 Plantation crops									1.00	0.64	0.36	0.43
8.2 Spices and condiments					0.55	0.96	1.16	1.04	0.88			
8.3 Fruit crops									0.66	0.50	0.28	0.41
8.4 Vine crops	0.59	0.85	0.90	0.86	0.92	0.79	0.81					0.21
8.5 Medical plants									0.62	0.61	0.38	0.44
9 Goat rearing unit (l/sec/ha)												
9.1 CO3 & CO4	0.53	0.92	0.57	0.80	0.57	0.97	0.68	0.91	0.56	0.53	0.06	0.35
9.2 Fodder trees (IPIL IPIL 1/4 Ac, GLYRICIDIA 1/4 Ac and Pasture grasses	0.71	0.84	0.88	0.73	0.78	0.88	0.89	0.91	0.79	0.53	0.22	0.30

2) Calculation of Planned Irrigation Requirements per Unit

The irrigation water requirements are calculated by adding the irrigation hours by unit and irrigation efficiency derived from the irrigation method estimated by the UOJ to the aforementioned unit irrigation water requirements per unit.

a) Irrigation hours and method

While the irrigation hours are basically planned as eight hours from 8:00 to 16:00, the hours are also arranged by unit considering the permissible flow velocity of water piping to each unit.

b) Irrigation efficiency

The cultivation plan of the UOJ applies to surface, sprinkler and drip irrigation methods. Accordingly, the irrigation efficiency is calculated as follows, based on the guidelines of the FAO Irrigation and Drainage Paper 24 Crop Water Requirements as shown in Table 2-21:

Table 2-21 Values of Irrigation Efficiency

Type of Efficiency	Surface irrigation (Basin)	Sprinkler irrigation	Drip irrigation
Conveyance efficiency (Pipeline)	0.95	0.95	0.95
Field application efficiency (Ea)	0.60	0.75	0.90
Irrigation efficiency (Ep)	0.57	0.71	0.86

Source: FAO

c) Irrigation water requirements by unit

Irrigation water requirements are determined by adding irrigation efficiency and hours to net irrigation water requirements and multiplying the unit area. As for trees, however, a 100 cm watering pot in diameter is set in the center of trees to carry out hose pipe irrigation and the unit area cannot be calculated as is. According to the UOJ, one tree is planted per 100 m^2 (10 x 10 m); hence the irrigation area for calculation purpose is determined by calculating the number of trees required from the unit area and multiplying the area of the water pot. Table 2-22 shows the units and target crops with areas changed and unit area determined for calculation purposes.

Table 2-22 Target Crops with Areas Changed for Calculation Purpose

Units and Target Crops	Area of Unit (Ac)		No. of Tree	Basin of Water per tree (m^2)	Total Area of Basin of Water	
	Ac	m^2			m^2	Ac
3. Fruit crops Germ-plasm collection unit						
3.1 Fruit crops	4.0	16,188	162	0.79	127.89	0.03
5. Plantation & agro-forestry unit						
5.1 Silviculture crops	3.0	12,141	121	0.79	95.91	0.02
5.4 Plantation crops	1.0	4,047	40	0.79	31.97	0.01
7. Model home garden unit						
7.1 Fruit crops	0.2	809	8	0.79	6.39	0.00
7.8 Plantation crops	0.2	809	8	0.79	6.39	0.00
8. Agro-tourism unit						
8.1 Plantation crops	1.0	4,047	40	0.79	31.97	0.01
8.3 Fruit crops	0.5	2,024	20	0.79	15.99	0.00

Tables 2-23 and 2-24 show irrigation water requirements by unit and pumping volume by target crops in units calculated from the above. Setting constant irrigation hours by unit, those units requiring a maximum eight hours of irrigation are the fruit crops germ-plasm collection unit, field crops experimental unit and meadow in the goat-rearing unit.

Table 2-23 Irrigation Water Requirements by Unit (l/sec)

	Unit	Area (Ac)	IRR hours	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Plant Propagation Unit	0.25	1.50	1.12	1.12	2.72	1.76	2.08	2.08	2.72	3.04	1.44	1.28	0.32	0.32
2	Protected Agriculture Unit	0.45	3.00	1.12	1.12	1.12	2.00	2.40	2.56	2.56	2.08	0.96	0.56	0.00	0.00
3	Fruit Crops Germ Plasm Collection Unit	0.23	8.00	0.27	0.36	0.36	0.36	0.36	0.33	0.33	0.00	0.06	0.06	0.00	0.00
4	Field Crops Experimental Unit	1.60	8.00	0.00	0.00	0.00	0.78	2.01	3.06	2.82	1.05	1.02	0.54	0.54	0.15
5	Plantation & agro-forestry Unit	0.23	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.77	0.53	0.24	0.34
6	Farm Management Centre	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Model Home Garden Unit	0.60	3.00	0.00	0.00	0.00	0.48	1.60	2.24	2.40	1.36	1.44	1.12	0.32	0.64
8	Agro-tourism Unit	0.51	5.00	0.43	0.58	0.58	0.58	0.77	0.87	0.96	0.34	0.77	0.43	0.24	0.53
9	Goat Rearing Unit	5.00	8.00	6.06	9.69	6.78	8.43	6.57	10.20	7.74	9.75	6.48	5.70	1.02	3.63
	Total														
	Integrated Crop Research and Training Farm			2.94	3.18	4.78	5.96	9.22	11.14	11.79	7.87	6.46	4.52	1.66	1.98
	Integrated Livestock Research and Training Farm			6.06	9.69	6.78	8.43	6.57	10.20	7.74	9.75	6.48	5.70	1.02	3.63
	Total			9.00	12.87	11.56	14.39	15.79	21.34	19.53	17.62	12.94	10.22	2.68	5.61

Table 2-24 Irrigation Water Requirements by Target Crops in Units (l/sec)

	Area (Ac)	Irr. Method	Irr. Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1 Plant Propagation Unit (l/sec/ha)															
1.1 Fruits crops	0.08 Ac	Basin	1.5	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.64	0.32	0.32
1.2 Field crops	0.04 Ac	Basin	1.5		0.00	0.64				0.32	0.64				
1.3 Floriculture crops	0.04 Ac	Basin	1.5	0.32	0.32	0.32	0.32	0.64	0.64	0.64	0.64				
1.4 Vegetable crops	0.03 Ac	Basin	1.5		0.00	0.32				0.32	0.32				
1.5 Plantation & export crops	0.04 Ac	Basin	1.5			0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.32	0.32	0.32
1.6 Cut-foliage crops	0.02 Ac	Basin	1.5			0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.00	0.00
2 Protected Agriculture Unit ((l/sec/ha)															
2.1 Cole crops	0.09 Ac	Basin	3.0				0.32	0.40	0.56						
2.2 Floriculture crops	0.09 Ac	Drip	3.0					0.32	0.32	0.40	0.40	0.40	0.16	0.00	
2.3 Vegetable propagated fruit plant	0.09 Ac	Basin	3.0	0.56	0.56	0.56	0.56	0.56	0.56	0.72	0.56				
2.4 Cut-foliage crops	0.09 Ac	Basin	3.0				0.56	0.56	0.56	0.72	0.56	0.56	0.40	-0.40	
3 Fruit crops Germ-plasm collection unit (l/sec/ha)															
3.1 Fruit crops (4.0 Ac)	0.03 Ac	Basin	8.0									0.06	0.06	0.00	0.00
3.2 Grapes	0.20 Ac	Basin	8.0	0.27	0.36	0.36	0.36	0.36	0.33	0.33					
4 Field crops experimental unit (l/sec/ha)															
4.1 Cereal crops	0.25 Ac	Basin	8.0				0.15	0.42	0.63	0.57		0.21	0.21	0.27	-0.33
4.2 Oil crops	0.25 Ac	Basin	8.0				0.15	0.42	0.63	0.48	0.15		0.06	0.12	-0.27
4.3 Tuber crops	0.25 Ac	Basin	8.0											0.00	0.15
4.4 Spices and condiments	0.25 Ac	Sprinkler	8.0					0.24	0.42	0.51	0.42	0.39			
4.5 Pulses	0.25 Ac	Basin	8.0				0.27	0.42	0.57	0.42		0.27	0.27	0.15	-0.36
4.6 Fiber crops	0.10 Ac	Basin	8.0				0.06	0.15	0.27	0.27	0.12	0.15			
4.7 Vegetable crops	0.25 Ac	Basin	8.0				0.15	0.36	0.54	0.57	0.36				
5 Plantation & agro-forestry unit (l/sec/ha)															
5.1 Silviculture crops (3.0 Ac)	0.02 Ac	Basin	5.0									0.10	0.10	0.00	0.00
5.3 Valuable crops	0.20 Ac	Basin	5.0									0.67	0.43	0.24	0.34
5.4 Plantation crops (1.0 Ac)	0.01 Ac	Basin	5.0									0.00	0.00	0.00	0.00
5.5 Fruit crops	0.00 Ac	Basin	5.0									0.00	0.00	0.00	0.00
5.6 Other crops	0.00 Ac	Basin	5.0				0.00	0.00	0.00	0.00	0.00				
7 Model home garden unit (l/sec/ha)															
7.1 Fruit crops (0.2 Ac)	0.00 Ac	Basin	3.0									0.00	0.00	0.00	0.00
7.2 Vegetable crops	0.10 Ac	Basin	3.0				0.16	0.40	0.56	0.72	0.40				
7.3 Floriculture crops	0.10 Ac	Basin	3.0					0.40	0.40	0.56	0.56	0.56	0.32	0.00	
7.4 Field crops	0.10 Ac	Basin	3.0				0.16	0.40	0.56	0.56	0.40				
7.5 Medical plants	0.10 Ac	Basin	3.0									0.32	0.40	0.00	0.16
7.6 Spices and condiments	0.10 Ac	Basin	3.0				0.16	0.40	0.72	0.56				0.00	0.16
7.7 Export crops	0.10 Ac	Basin	3.0									0.56	0.40	0.32	0.32
7.8 Plantation crops (0.2 Ac)	0.00 Ac	Basin	3.0									0.00	0.00	0.00	0.00
8 Agro-tourism unit (l/sec/ha)															
8.1 Plantation crops (1.0 Ac)	0.01 Ac	Basin	5.0									0.00	0.00	0.00	0.00
8.2 Spices and condiments	0.10 Ac	Basin	5.0					0.19	0.34	0.43	0.34	0.34			
8.3 Fruit crops (0.5 Ac)	0.00 Ac	Basin	5.0									0.00	0.00	0.00	0.00
8.4 Vine crops	0.20 Ac	Basin	5.0	0.43	0.58	0.58	0.58	0.58	0.53	0.53					0.19
8.5 Medical plants	0.20 Ac	Basin	5.0									0.43	0.43	0.24	0.34
9 Goat rearing unit (l/sec/ha)															
9.1 CO3 & CO4	4.00 Ac	Basin	8.0	4.53	7.89	4.89	6.84	4.89	8.31	5.85	7.80	4.80	4.53	0.54	3.00
9.2 Fodder trees (IPIL IPIL 1/4 Ac, GLYRICIDIA 1/4 Ac and Pasture grasses	1.00 Ac	Basin	8.0	1.53	1.80	1.89	1.59	1.68	1.89	1.89	1.95	1.68	1.17	0.48	0.63

a) Available irrigation areas

The irrigation water requirements per day by unit are shown in Table 2-25. Water requirements of the agricultural management unit and goat barns are not considered in this calculation because their usage is small compared to the irrigation water amount and adjustable by irrigation hours.

Calculation of the water amount required in line with the university cultivation plan shows that the maximum volume of irrigation water per day is 470 thousand litres (June). As the amount of supply from well facility is 100 thousand litres per day, 80% of the irrigation water requirements will be lacking during the peak in June.

Considering the irrigation water supply capacity from the well facility, the utilization rate of farms for cultivation is 40% and that of meadows ranges from 10 to around 80%. Although the UOJ does

not plan to irrigate all units based on its cultivation plan, the irrigation water use must be adjusted by changing the crop cultivation density for research and training or integrating similar crops. As one of the purposes of the meadow is to supply feed to livestock, adjustment is needed, such as purchasing feed outside the UOJ and utilizing groundwater on campus.

Table 2-25 Irrigation Water Requirements per Day (l/day)

	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Plant Propagation Unit	6,048.00	6,048.00	14,688.00	9,504.00	11,232.00	11,232.00	14,688.00	16,416.00	7,776.00	6,912.00	1,728.00	1,728.00
2	Protected Agriculture Unit	12,096.00	12,096.00	12,096.00	21,600.00	25,920.00	27,648.00	27,648.00	22,464.00	10,368.00	6,048.00	0.00	0.00
3	Fruit Crops Germ Plasm Collection Unit	7,776.00	10,368.00	10,368.00	10,368.00	10,368.00	9,504.00	9,504.00	0.00	1,728.00	1,728.00	0.00	0.00
4	Field Crops Experimental Unit	0.00	0.00	0.00	22,464.00	57,888.00	88,128.00	81,216.00	30,240.00	29,376.00	15,552.00	15,552.00	4,320.00
5	Plantation & agro-forestry Unit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13,860.00	9,540.00	4,320.00	6,120.00
6	Farm Management Centre	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Model Home Garden Unit	0.00	0.00	0.00	5,184.00	17,280.00	24,192.00	25,920.00	14,688.00	15,552.00	12,096.00	3,456.00	6,912.00
8	Agro-tourism Unit	7,740.00	10,440.00	10,440.00	10,440.00	13,860.00	15,660.00	17,280.00	6,120.00	13,860.00	7,740.00	4,320.00	9,540.00
9	Goat Rearing Unit	174,528.00	279,072.00	195,264.00	242,784.00	189,216.00	293,760.00	222,912.00	280,800.00	186,624.00	164,160.00	29,376.00	104,544.00
	Irrigation Water by Farms (l/day)												
	Integrated Crop Research and Training Farm	33,660.00	38,952.00	47,592.00	79,560.00	136,548.00	176,364.00	176,256.00	89,928.00	92,520.00	59,616.00	29,376.00	28,620.00
	Integrated Livestock Research and Training Farm	174,528.00	279,072.00	195,264.00	242,784.00	189,216.00	293,760.00	222,912.00	280,800.00	186,624.00	164,160.00	29,376.00	104,544.00
	Total	208,188.00	318,024.00	242,856.00	322,344.00	325,764.00	470,124.00	399,168.00	370,728.00	279,144.00	223,776.00	58,752.00	133,164.00
	Utilization Rate of the Farm based on the Capacity of Well Facility and Irrigation Water by Farms (l/day)												
	Integrated Crop Research and Training Farm												
	1) Utilization rate of Farm	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
	2) Irrigation Water	13,464	15,581	19,037	31,824	54,619	70,546	70,502	35,971	37,008	23,846	11,750	11,448
	Integrated Livestock Research and Training Farm												
	1) Utilization rate of Farm	40%	30%	25%	25%	20%	10%	10%	20%	30%	40%	100%	80%
	2) Irrigation Water	69,811	83,722	48,816	60,696	37,843	29,376	22,291	56,160	55,987	65,664	29,376	83,635
	Total	83,276	99,303	67,853	92,520	92,463	99,922	92,794	92,131	92,996	89,511	41,127	95,084

(3) Facility Design

1) Farm Consolidation

a) Unit layout

From the unit area defined by the contour directions and surrounding roads, the fruit crops germ-plasm collection unit and field crop experimental unit are divided into two and placed adjacent to secure continuity and convenience of works. Moreover, the exhibition effects of the agricultural management and agro-tourism units are deemed higher than other units and they are located adjacent to the road between the Faculty of Agriculture and the farms. Since the management level of the plant propagation and model home garden plant propagation units are deemed larger than other units, their location is set near the agricultural management unit. The layout and area of the nine units are as shown in Table 2-26.

b) Base modeling of plowing

Due to the approximately 1.0% slope in each unit, the base is molded with 1.0% of the slope to use the soil volume within units effectively. Soils generated in a unit are basically processed within the same unit but also transported to any unit lacking sufficient soil volume.

Plowing and soil crushing works in units after base molding are implemented except in the fruit crops germ-plasm collection and agricultural management units.

Among the numerous trees in the target units, the UOJ specifies six species to be preserved: Manilhara hexandra (Palu tree), Chlroxylon switenia (Bruta), Deypetus ebonum (Ebony), Azadiracta indica (Neem), Cassia sopp. and Albizzia. The construction plan should take these trees into consideration during the detailed design phase.

Table 2-26 Consolidated Farm Areas and Construction Work Details

Name of the Unit	Areas requested	Areas planned	Shape of farms	Contents of construction works
1. Plant propagation unit	0.25	0.26	16.0 x 67.0 m	①, ②, ③, ④
2. Protected agriculture unit	0.45	0.74	45.0 x 67.0 m	①, ②, ③, ④
3. Fruit crops germ-plasm collection unit (1)	4.20	1.60	53.0 x 123.0 m	①, ②, ③
Fruit crops germ-plasm collection unit (2)		2.60	91.0 x 116.0 m	①, ②, ③
4. Field crops experimental unit (1)	1.60	1.00	54.0 x 75.0 m	①, ②, ③, ④
Field crops experimental unit (2)		0.60	41.0 x 60.0 m	①, ②, ③, ④
5. Plantation & agro-forestry unit	4.20	4.20	123.0 x 139.0 m	①, ②, ③, ④
6. Agr. Management unit	0.45	0.72	25.0 x 116.0 m	①, ②, ③
7. Model home garden unit	1.00	1.00	54.0 x 75.0 m	①, ②, ③, ④
8. Agro-tourism unit	2.00	2.00	67.0 x 123.0 m	①, ②, ③, ④
9. Goat-rearing unit	5.00	5.00	112.0 x 185 m	①, ②, ③, ④, ⑤
Total	19.15	19.72		

Note: ① Weeding ② Base modeling ③ Soil preparation ④ Plowing, solid crushing and removal of miscellaneous objects, ④ Fence work

2) Intake Facilities

a) Water resource plan

The result of the pumping test of the existing well shows that pumping is available from the well but its water level has not recovered. Accordingly, it is judged that the existing well has a problem with groundwater supply and a new well equivalent to the planned yield of the existing well is planned.

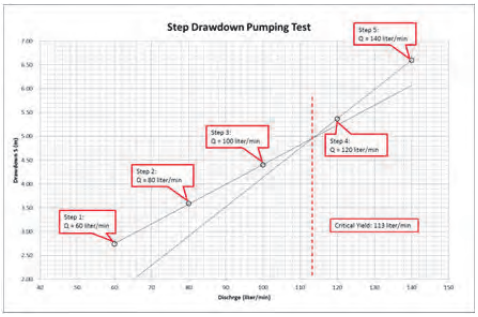


Figure 2-18 The Result of Step Drawdown Pumping Test

The result of the test well pumping test of a new well (6 inches in diameter) shows a maximum well yield of 113 litres/min. Thus, as the water volume available for stable drawing is 80% of the maximum well yield, the volume available for stable pumping is expected to be 90 litres/min.

The UOJ plans to use the existing elevated tank with a capacity of 41,600 litres (width 6.5 x length 4.0 x effective depth 1.6 m) by filling it twice a day, with a planned daily yield of 83,200 litres. Accordingly, two wells (6 inches in diameter), each operating for eight hours, are installed and intended to convey water to the elevated tank.

While it should be confirmed by the UOJ at the time of detailed design, the wells to be installed are located in this Project, including a 50 0m radius of influence to avoid interference caused by any decline in groundwater level following pumping from the well.

b) Intake facilities

① Well facilities

The specifications of the existing deep well are also applied to the new well, which has a PVC

structure, 6 inches in diameter and 40 m depth. Two of these are to be installed in farms.

② Submersible pump for deep wells

The performance of the submersible pump is set by determining the planned pumping volume, total pump head and rated output of the electric motor.

i) Planned pumping volume

Based on the pumping test result, the planned pumping volume per well is 90 litres/min.

ii) Total pump head

The total pump head comprises the height from the water level when declining during pump operation to the elevated tank, head loss of water pipeline and velocity head.

a. Actual pump head: from the result of the step drawdown pumping test, the depth from the ground level to dynamic water level is set to be 7.0 m (140 litres/min at the time of pumping) considering safety, and the height from ground level to the spillway of the elevated tank is set to be 25.0 m. Accordingly, the actual pump head is 32.0 m.

b. Head loss: the head loss of water pipeline is determined by the following Hazen–Williams equation:

$$h = 10.666 \cdot \quad ^{-1.85} \cdot \quad ^{-4.87} \cdot \quad ^{1.85} \cdot$$

where hf: friction head loss (m), C: roughness coefficient (dimensionless)(PVC pipe 150), D : inside pipe diameter (m), Q: quantity rate of flow (m^3/sec), L: total length of pipe run (m)

Pumping system 1 (on the cowshed side of the WB project, pipeline length is 575 m)

$$h = 10.666 \cdot 150^{-1.85} \cdot 0.05^{-4.87} \cdot \left(\frac{0.09}{60}\right)^{1.85} \cdot 575 = 7.5\text{m}$$

Pumping system 2 (on the agricultural management unit side, pipeline length is 425 m)

$$h = 10.666 \cdot 150^{-1.85} \cdot 0.05^{-4.87} \cdot \left(\frac{0.09}{60}\right)^{1.85} \cdot 425 = 5.5\text{m}$$

c. Velocity head: when the diameter of the water pump is 50 mm, the velocity head is determined as 0.038 m by the following formula:

$$\frac{^2}{2} = \frac{(\quad / \quad)^2}{2} = \frac{(0.09/60)/(1/4 \cdot \quad \cdot 0.05^2)}{2 \times 9.8} = 0.038$$

Table 2-27 Total Pump Head of Well Facilities

Item		System 1	System 2
1. Actual pump head	Vertical height from the dynamic water level to the water tank	7.0＋25 = 32 m	7.0＋25 = 32 m
2. Friction loss head	The length of pipeline from the pump to the water tank	7.5 m	5.5 m
3. Velocity head	Velocity head at the time of supplying: 0.09 m^3/sec	0.038 m	0.038 m
4. Total pump head		39.5 m≒40 m	37.5 m≒40 m

d. Calculation of rated output

The rated output is determined by the following formula:

$$P = \frac{0.163 \times \quad \times \quad \times}{} (1 + \quad)$$

where, P: pump hydraulic power outlet (kW), p: fluid density (1.0), Q: flow capacity (0.09 m^3/min), H: total pump head (40 m), fp: pump hydraulic efficiency (0.65), R: allowable coefficient for motor (0.15)

$$P = \frac{0.163 \times 1.0 \times 0.09 \times 40}{0.65} (1 + 0.15) = 1.04$$

The rated output of pump is set as 1.04 kW or higher.

e. Pumping system

The pumping system to supply water to the elevated tank is summarized as follows:

Table 2-28 Pumping System

System	System components
Pumping System 1	Location to be installed: on the side of the WB project Well: 6 inches in diameter, 40 m deep Submersible pump: 90 L/min x 40 m x 1.1 kW Water pipe: PVC φ50 mm; pipe length: 575.0 m
Pumping System 2	Location to be installed: on the side of the agricultural management unit Well: 6 inches in diameter, 40 m deep Submersible pump: 90 L/min x 40 m x 1.1kW Water pipe: PVC φ50 mm; pipe length: 425.0 m

3) Irrigation Pipeline

a) Pipeline system

Since the water resources are currently limited in terms of well facility capacity, it is not possible to irrigate the entire cultivation plan area. However, it is considered that if the UOJ budget for activity increases and the research scope is expanded in the future, well facilities and elevated tanks will be added by the UOJ and additional supply will be realized by connecting other water resources to the pipeline of farms. In this case, although there is concern regarding its function as a system due to the difference in diameter with the pipe to be connected, if pipelines are installed in dendritic status, the piping network system will mitigate such concerns because the water in the pipe is distributed by pressure balance.

Accordingly, the pipe network system is selected in the pipeline allocation plan for the research and training farms.

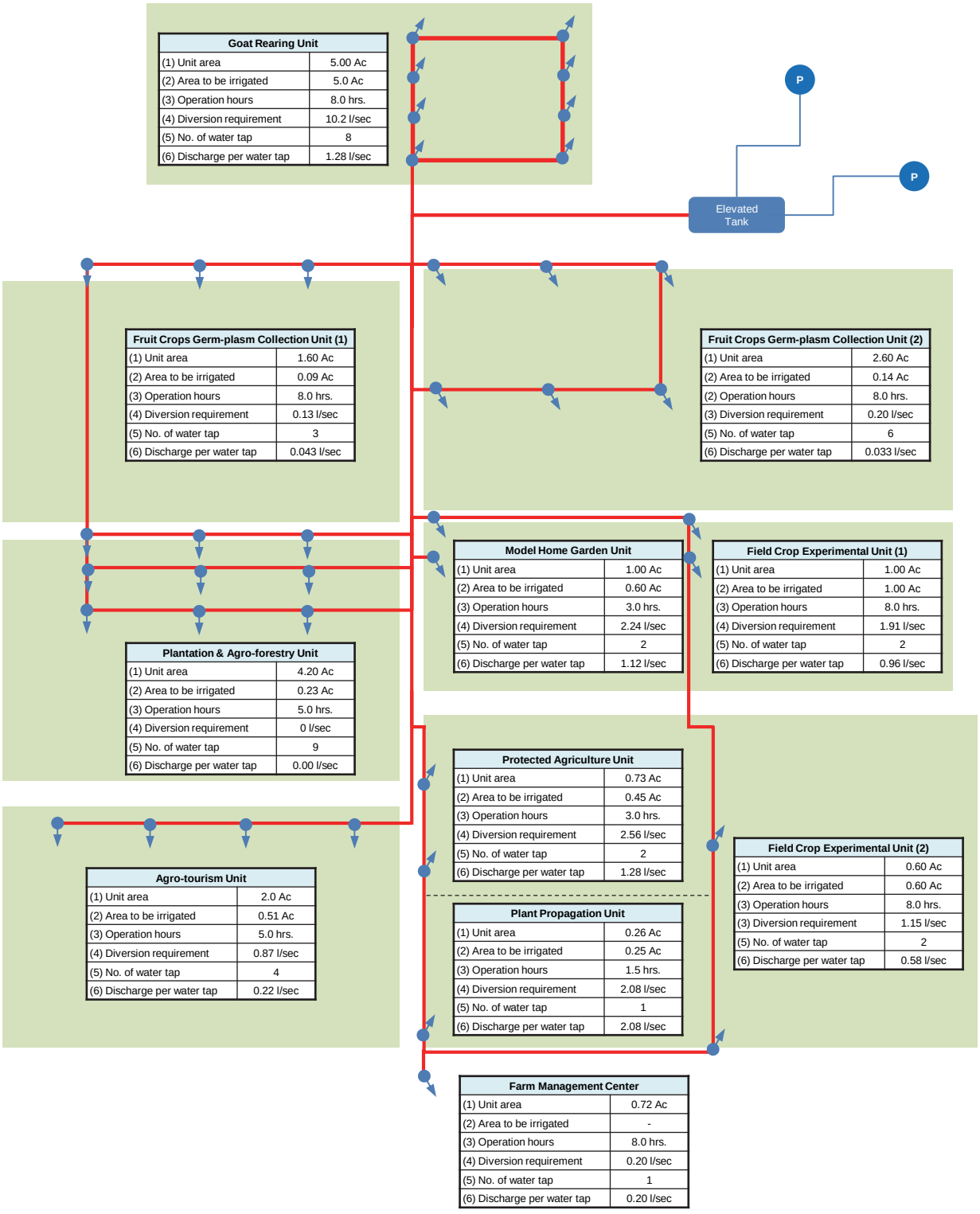
b) Selection of pipe materials and diameter

The irrigation system of the project will be installed utilizing the facilities of existing irrigation system such as elevated tank and a part of pipelines installed. Accordingly, the system water head is decided by the height of the elevated tank. Moreover, the head loss and velocity head at the time of supply are more or less determined, since the pipeline diameters used are between 63 and 160 mm.

The elevated tank is installed at a height of 18.9 m from ground level. The height of the spillway pipe installed in the elevated tank is 1.80 m from the bottom of the tank so that when the thickness of the tank bottom is 20 cm, the effective water level is 1.60 m (20.7 – 19.1) and the effective water head at the elevated tank is 19.1 to 20.5 m.

Hydraulic calculation for selecting the pipe diameter in this system is based on the permissible velocity as shown in Table 2-29. Considering sprinkler and drip irrigation at the end of the system, however, the diameter is selected as large as possible to reduce head loss.

As for the hydraulic condition, the initial water level of the elevated tanks is set at 20.5 m and the maximum flow quantity in the whole unit of June is chosen. During actual operation, adjustment is made by controlling the operation of the water tap. Figure 2-19 shows the irrigation network system.



Goat Rearing Unit	
(1) Unit area	5.00 Ac
(2) Area to be irrigated	5.0 Ac
(3) Operation hours	8.0 hrs.
(4) Diversion requirement	10.2 l/sec
(5) No. of water tap	8
(6) Discharge per water tap	1.28 l/sec

Fruit Crops Germ-plasm Collection Unit (1)	
(1) Unit area	1.60 Ac
(2) Area to be irrigated	0.09 Ac
(3) Operation hours	8.0 hrs.
(4) Diversion requirement	0.13 l/sec
(5) No. of water tap	3
(6) Discharge per water tap	0.043 l/sec

Fruit Crops Germ-plasm Collection Unit (2)	
(1) Unit area	2.60 Ac
(2) Area to be irrigated	0.14 Ac
(2) Operation hours	8.0 hrs.
(3) Diversion requirement	0.20 l/sec
(5) No. of water tap	6
(6) Discharge per water tap	0.033 l/sec

Model Home Garden Unit	
(1) Unit area	1.00 Ac
(2) Area to be irrigated	0.60 Ac
(3) Operation hours	3.0 hrs.
(4) Diversion requirement	2.24 l/sec
(5) No. of water tap	2
(6) Discharge per water tap	1.12 l/sec

Field Crop Experimental Unit (1)	
(1) Unit area	1.00 Ac
(2) Area to be irrigated	1.00 Ac
(3) Operation hours	8.0 hrs.
(4) Diversion requirement	1.91 l/sec
(5) No. of water tap	2
(6) Discharge per water tap	0.96 l/sec

Plantation & Agro-forestry Unit	
(1) Unit area	4.20 Ac
(2) Area to be irrigated	0.23 Ac
(3) Operation hours	5.0 hrs.
(4) Diversion requirement	0 l/sec
(5) No. of water tap	9
(6) Discharge per water tap	0.00 l/sec

Protected Agriculture Unit	
(1) Unit area	0.73 Ac
(2) Area to be irrigated	0.45 Ac
(3) Operation hours	3.0 hrs.
(4) Diversion requirement	2.56 l/sec
(5) No. of water tap	2
(6) Discharge per water tap	1.28 l/sec

Field Crop Experimental Unit (2)	
(1) Unit area	0.60 Ac
(2) Area to be irrigated	0.60 Ac
(3) Operation hours	8.0 hrs.
(3) Diversion requirement	1.15 l/sec
(5) No. of water tap	2
(6) Discharge per water tap	0.58 l/sec

Agro-tourism Unit	
(1) Unit area	2.0 Ac
(2) Area to be irrigated	0.51 Ac
(3) Operation hours	5.0 hrs.
(4) Diversion requirement	0.87 l/sec
(5) No. of water tap	4
(6) Discharge per water tap	0.22 l/sec

Plant Propagation Unit	
(1) Unit area	0.26 Ac
(2) Area to be irrigated	0.25 Ac
(3) Operation hours	1.5 hrs.
(4) Diversion requirement	2.08 l/sec
(5) No. of water tap	1
(6) Discharge per water tap	2.08 l/sec

Farm Management Center	
(1) Unit area	0.72 Ac
(2) Area to be irrigated	-
(3) Operation hours	8.0 hrs.
(4) Diversion requirement	0.20 l/sec
(5) No. of water tap	1
(6) Discharge per water tap	0.20 l/sec

Figure 2-19 Irrigation Network System

Table 2-29 Pipe Diameter

Diameter (mm)	Average velocity (m/sec)
75 - 150	0.7 - 1.0
200 - 400	0.9 - 1.6
450 - 800	1.2 - 1.8
900 - 1,500	1.3 - 2.0
1,600 - 3,000	1.4 - 2.5

Source: Agriculture Engineering Handbook, the Japanese Society of Irrigation, Drainage and Rural Engineering

c) Control facility and safety facility

A sluice valve, air valve and blow-off facilities are installed to operate, maintain and manage the irrigation system taking system contents and geographical conditions, etc. into consideration.

d) Earth covering depth of pipeline

Since pipelines are also installed on farms, they should be buried at a depth not impacting plowing works using tractors, so the height of earth covering the thickness from the field surface to the top of the pipe is set at 1.0 m.

e) Water tap

The water tap is a 63 mm diameter ball valve protected by concrete, which is installed every 0.5 acres (20 a) and the number of water taps per unit is as follows:

Table 2-30 The Number of Water Taps Installed

Unit	No. of Water Taps
1. Plantation propagation unit	1
2. Protected agriculture unit	2
3. Fruit crops germ-plasm collection unit (1)	3
Fruit crops germ-plasm collection unit (2)	6
4. Field crops experimental unit (1)	2
Field crops experimental unit (2)	2
5. Plantation & agro-forestry unit	9
6. Agri. Management unit	1
7. Protected agriculture unit	2
8. Agro-tourism unit	4
9. Goat-rearing unit	8
Total	40

4) Drainage canal (Catch Canal)

a) Drainage canal section

According to the hourly precipitation from 2012 to 2014 as recorded by the Jaffna Meteorological Station, 53.7 mm/h in May 2013 was the maximum figure followed by 25 mm/h (in December 2012 and in October 2014).

Although a cross-section of discharge canal should preferably be included in farms according to hourly precipitation, the slope of farms is 1% and securing a steep slope in the discharge canal installed at the end of farms is difficult. A large cross-section is needed if a cross-section corresponding to hourly precipitation is applied, which occupies the field area. Accordingly, the amount of precipitation is to be discharged from farms over time and the discharge cross-section

applied is equivalent to that in the main discharge canal on campus.

b) Allocation of the drainage canal

The field surface in each unit is consolidated with a 1% slope based on the current landform. Because rainwater that falls onto the field surface is collected by a discharge canal installed on both sides of each unit, the slope of the discharge canal is also 1% (mild slope).

Rainwater collected from both sides of the unit accumulates in a drainage canal installed at the sloping end of the unit and is then discharged outside the unit via a drainage culvert. Such drained rainwater is distributed outside the farms via drainage canals installed in two roads, dividing all the farms into north and south (Routes A and B). The drainage canals installed in each unit are shown in 2.2.3, F-03 and Table 2-31.

c) Drainage crossing works

The drainage crossing is not a culvert type but an over-lid U-flume type, taking maintenance and management into consideration. The number to be installed is combined with agricultural delivery so that they are installed at locations where the road and field surface heights are more or less identical. The locations and number of drainage crossings per unit are shown in 2.2.3, F-03 and Table 2-31.

Table 2-31 Drainage Canal Length and the Number of Drainage Crossings Installed

Unit	Canal length			Crossing No. to be installed
	Both sides of unit	End of unit	Total	
1. Plant propagation unit	0.0	0.0	0.0	0
2. Protected agriculture unit	120.0	67.0	187.0	3
3. Fruit crops germ-plasm collection unit (1)	246.0	53.0	299.0	7
Fruit crops germ-plasm collection unit (2)	232.0	91.0	323.0	7
4. Field crops experimental unit (1)	108.0	75.0	183.0	4
Field crops experimental unit (2)	120.0	41.0	161.0	3
5. Plantation & agro-forestry unit	246.0	139.0	385.0	9
6. Agri. Management unit	116.0	0.0	116.0	1
7. Protected agriculture unit	108.0	75.0	183.0	5
8. Agro-tourism unit	246.0	67.0	313.0	4
9. Goat-rearing unit	377.0	0.0	377.0	1
10. Off-field canal (1) east side	-	499.0	499.0	3
11. Off-field canal (2) west side	-	411.0	411.0	5
Total			3,437.7	52

5) Farm road

The specifications of the farm road are equivalent to those installed improved in the experimental farms of other universities and it is planned as an earth road. Although the road is constructed by filling soils, its materials are those generated by excavation in a research building or purchased.

a) Road surface height

The surface height of the main and branch roads is influenced by the field slope between the successive units, but is set to be identical to the field surface as closely as possible to facilitate the use of machinery.

Multiple approach paths are to be installed in a single unit where the difference between the road

and field surfaces is considerable due to land conditions, where there are no mitigation measures for safety or other reasons, or where the road and farms are isolated due to drainage canals or other facilities. In this project, a drainage crossing is utilized as the approach path (see 2.2.3 F-03 and 2-24).

b) Road surface gradient

The road surface drainage is promoted by raising the center of the road higher than both sides or by road surface cant. As this project applies an earth road, its slope is 3 to 6%.

c) Width

The current road width in the farm is 4.0 m, which is deemed to be the road width considered in this project.

Consolidating farms allows machinery owned by the UOJ to be used for plowing farms in future. The class of riding tractor is 50 HP, which requires 2.3 m of width. Taking a 0.3 m margin width on both sides of the road for traveling into consideration and a 0.5 m shoulder for road protection, the planned road width is set at 4.0 m.

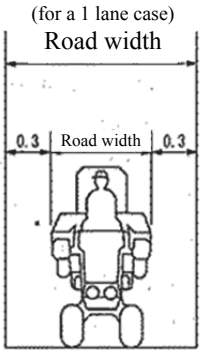


Figure 2-20 Road Width

Table 2-32 Calculation of Road Width

Target vehicle	Width	Margin width (both sides)	Shoulder (both sides)	Width
	①	②	③	④=Σ① - ③
Riding tractor 50 Hp	2.3 m	0.3 m x 2	0.5 m x 2	3.9≒4.0 m

Note: The specifications of each item are based on Farm Roads, Design Criteria and Plan for Land Improvement Projects, the Ministry of Agriculture, Forestry and Fisheries, Japan

d) Corner-cutting

Corner-cutting is installed in the crossing section of road to enhance running convenience.

Taking the 4.0 m planned road width into consideration in this Project, 1.0 m for corner-cutting is to be constructed.

Table 2-33 Crossway and the Length of Cross-cutting

Width of crossway	Length of cross-cut on a side
3－3 m	2.0 m
3－4 m	1.5 m
3－5 m	1.0 m
4－4 m	1.0 m
4－5 m	0.5 m

Source: Land Consolidation (field), Design Criteria and Plan for Land Improvement Projects, the Ministry of Agriculture, Forestry and Fisheries, Japan

6) Farm Equipment

The following items are provided to be installed in the target unit based on the UOJ plan:

Table 2-34 List of Farm Equipment

Item	Location	Specifications	Qty.
1. Vinyl house	Protected agriculture unit	6.0 x 30.0 m	5 sets
2. Net house	Protected agriculture unit	6.0 x 30.0 m	5 sets
3. Sprinkler	Field crops experimental unit	0.25 acre (1,000 m^2) • No. of sprinklers: 36 • No. of laterals: 9 • No. of sprinkler per laterals: 4 • Sprinkler spacing: 5 x 5 m	1 set
4. Drip irrigation equipment	Protected agriculture unit	0.25 acre (1,000 m^2) • No. of plants: 216 • Lateral line used in the system: 16mm in diameter • No. of laterals: 8 (16 mm in diameter) • Spacing between laterals: 8'×8' • Spacing between plants: 6'×6'	1 set

2.2.2.7 Building Material Plan

(1) Basic Policy

The building material plan shall be formulated based on the climatic conditions, the location of the site, the local construction situation, construction period, construction cost, and maintenance and operation costs. The following shall be matters of the Basic Policy:

1) Local procurement of construction materials shall be considered to reduce construction costs and facilitate the construction period.

2) The maintenance and operational costs shall be reduced by considering adaptation to the local climate, resistance against climate and the selection of materials that are easy to maintain and obtain locally.

3) It is important to note that the selection of material should be done to satisfy the essential functions of Research and Laboratory Building of the University and must be considered along with the utility and equipment plans.

4) Selection and determination of the building materials shall be based on the studies on local procurement or application of local construction methods.

(2) Building Material Plan

The local construction situation and construction schedule as well as the method for minimizing operation and maintenance costs should be taken into consideration for the prominent building material plan, referring to the analysis of materials for other similar projects.

Major materials for structural works and finishing works can be procured in Sri Lanka.

The selection of materials for the project will aim at maximizing the adoption of local construction methods and selection of local materials, mainly under the supervision of a Japanese contractor. This policy is intended to reduce the construction cost. In reference to the surveys and studies of materials of existing buildings and similar projects, it is considered that this policy will enable proper selection and procurement of building materials under the scheme of Japan Grant Aid. The results of these considerations are as follows:

1) Structural Materials

In principle, the typical local construction method and material, which is reinforced concrete for main frames with brick walls, will be adopted for this project. Also, for the pitched roof structures, reinforced concrete roof slabs will be adopted to mitigate water leaks and considering the construction schedule and cost reducing factors.

2) Exterior Finishing Materials

a) Exterior Wall

Paint on mortar base will be used as the finishing materials for exterior walls, columns and beams.

b) Roofs

Roofing material will be adopted for the new building taking into consideration the durability from heavy rain and heat absorption from strong sunlight as well as maintenance. Also, the appearance of the roof material (colored galvalume steel sheet) will match the surrounding landscape and be designed in association with current UOJ campus building materials.

c) Windows and Doors

For provision of better durability and air tightness for external openings, such as windows and doors, local available aluminum sashes will be adopted for the new building. Also, steel doors will be used for some openings facing outside. These materials have been used for openings of external walls of existing buildings and similar projects.

d) Louvers

Louvers, which protect the rooms from direct sunlight and intense rainfall and incorporate good ventilation and natural lighting throughout the year, are to be made of steel flat bar with terracotta blocks. A green wall will be grown on these louvers.

3) Interior Finishing Materials

a) Floors

Porcelain tiles, which are generally used in Sri Lanka, will be adopted in the new buildings considering quality and durability. Troweled mortar with dust proof painting will be adopted for the food processing unit, electrical and mechanical rooms.

b) Walls

Paint on mortar base will be used as the finishing materials for interior walls. This is generally used in Sri Lanka and it is currently being used for the existing facilities.

c) Ceilings

Suspended ceilings using rock wool acoustic board and water repellent gypsum board with paint will be used in the new buildings.

Proposed Main Materials

The criteria for building materials have been analyzed and studied. Based on the analysis, the main proposed materials are as follows:

Table 2-35 Main Materials Proposed

		Research and Laboratory Building						Food Processing Unit／Farm Management Building			Goat Shed	Animal Measurement Shed
Structure		Reinforced concrete										
Floor Height		1F：4,500 mm						-				
External Finish	Roof	Pitched roof: Colored Galvalume steel sheet (0.6mm), Flat roof: Mortar setting bed urethane resin waterproofing									steel sheet	
	External Wall	Mortar trowel w/AEP									-	Mortar setting bed w/AEP
	Windows Door	Aluminum sash Aluminum (Anodized) , steel and wooden door						Aluminum sash Aluminum (Anodized) , steel and wooden door			Wooden Louver	Steel Grill
Interior Finish	Room Name	Laboratory	Staff Room	Lecture Room	Main Entrance	Corridor	Toilet	Processing Unit	Demonstration Room	Toilet	Goat Shed	Measurement Room
	Floor	Mortar setting bed porcelain tile 500x500	Mortar setting bed porcelain tile 500x500	Mortar setting bed porcelain tile 500x500	Mortar setting bed porcelain tile 500x500	Mortar setting bed porcelain tile 500x500	Mortar setting bed porcelain tile 300x300	Mortar setting bed w/Dust Proof Paint	Mortar setting bed w/Dust Proof Paint	Mortar setting bed porcelain tile 300x300	Wooden Deck	Mortar Finishing
	Wall	Mortar setting bed w/AEP	Mortar setting bed w/AEP	Mortar setting bed w/AEP	Mortar setting bed w/AEP	Mortar setting bed w/AEP	Mortar setting bed ceramic tile 300x300	Mortar setting bed w/AEP	Mortar setting bed w/AEP	Mortar setting bed ceramic tile 300x300	Wooden Louver	Mortar setting bed w/AEP
	Ceiling	Rockwool acoustic board (T-frame, System ceiling)	Rockwool acoustic board (T-frame, System ceiling)	Rockwool acoustic board (T-frame, System ceiling)	Wooden Ceiling Board	AEP on Concrete	Water repellent Gypsum board w/AEP(T-frame, System ceiling)	AEP on Concrete	AEP on Concrete	Water repellent Gypsum board w/AEP(T-frame, System ceiling)	-	-
Ceiling Height		3,300 3,900 (2F)	3,300 3,900 (2F)	4,700	3,700	2,700	3,860 2,500 (2F)	4,700	4,700	3,000	-	-

2.2.2.8 Equipment Plan

(1) Outline of equipment planning

The Government of Sri Lanka requested the equipment shown in Table 2-36 necessary for laboratory experiment and practical training in the Research Laboratory Complex to be established by the project. The equipment was, therefore, requested based on the assumption that it will be used in specialized courses and research activities of the FoAg.

During a series of discussions, the Faculty of Agriculture requested considering additional equipment necessary for existing laboratories, which will be mainly used for laboratory experiments and practical training in basic courses after establishment of the Research Laboratory Complex. The study team considered that the request was reasonable due to the following reasons.

- Credit components of the FoAg are dominated by subjects in basic courses.
- Some experiments and training in basic courses may be carried out in the Research and Training Complex. In a similar way, some experiments and training in specialized courses will also be

carried out in the existing laboratories, since the education level between basic courses and specialized courses is not much different.

Table 2-36 Outline of Requested Equipment

No	Target Lab. & Facilities	Outline of the Equipment
1	Crop Science Lab.	Equipment for seed inspection, Equipment for photosynthesis measurement, etc. (Total 17 items)
2	Animal Nutrition Lab.	Anatomy models of animals, Equipment for feed quality analysis, Equipment for quality analysis of dairy products, Meat processing equipment, etc. (Total 41 items)
3	Reproductive Physiology Lab.	Microscopes, Equipment for artificial insemination, Equipment for embryo transfer, etc. (Total 22 items)
4	Soil Testing and Bio-fertilizer Lab.	Equipment for soil texture analysis, Equipment for component analysis of soil/plant, etc. (Total 25 items)
5	Food Analysis and Processing Lab.	Equipment for physical & chemical property analysis of foods, etc. (Total 44 items)
6	Plant Protection and Bio-control Lab.	Microscopes, Equipment for insectary, etc. (Total 22 items)
7	Bio-technology and Tissue Culture Lab.	Microscopes, Equipment for tissue/cell culture, Equipment for DNA amplification & analysis, etc. (Total 29 items)
8	Environment and Hydro Research Lab.	Equipment for water quality measurement/analysis, Equipment for soil moisture measurement, Irrigation equipment, Packing equipment for food items, etc. (Total 12 items)
9	Information and Communication Centre (ICC)	Audio-visual equipment, Printing & bookbinding equipment, Communication equipment, Computers, etc. (Total 35 items)
10	Meteorological Station	Meteorological equipment, Station building, etc. (Total 12 items)
11	Farm Machinery	Tractors & attachments for land preparation, Post-harvest equipment, Plant protection equipment, Welding equipment, Cut models of engine (Total 7 items)
12	Livestock Research and Training Farm	Equipment for livestock breeding (cattle/cow, poultry, pigs, goats, sheep, rabbits, etc.), Equipment for fish culture, Milk processing equipment, etc. (Total 17 items)

Source: Request from the Government of Sri Lanka

(2) Procedure of equipment planning

A request letter from the Government of Sri Lanka to the project did not include detailed information about anticipated laboratory experiment and practical training or how they would apply the requested equipment. The explanation of equipment was inadequate, and some items were requested as "a complete set of equipment for doing something" without a detailed description. A lot of general equipment necessary for sample preparation was not included, though a large variety of specific analytical equipment was requested.

For such reasons, the list of requested equipment from the Government of Sri Lanka was referred to only for understanding the project outline at the beginning stage. In order to prepare an accurate equipment plan, the following necessary information from teaching and technical staff of the faculty was collected and analyzed.

- Contents of teaching subjects and syllabus of laboratory experiments and practical training
- Research plan of each department and experimental procedures of the research
- Quantity and condition of existing laboratory and training equipment

A list of candidate equipment for the Research and Training Complex was prepared based on analysis of the above information. The following equipment was excluded from the candidate list and the possibility of sharing or common use of overlapped equipment among two or more departments or

laboratories was considered.

- General glassware and chemical agents
- Simple equipment & tools which can be produced or purchased easily or at low-cost in Sri Lanka
- Equipment that overlaps with existing departments (total numbers of necessary equipment will be considered)
- Equipment that requires a very high O&M cost

Figure 2-21 shows the above-mentioned process.

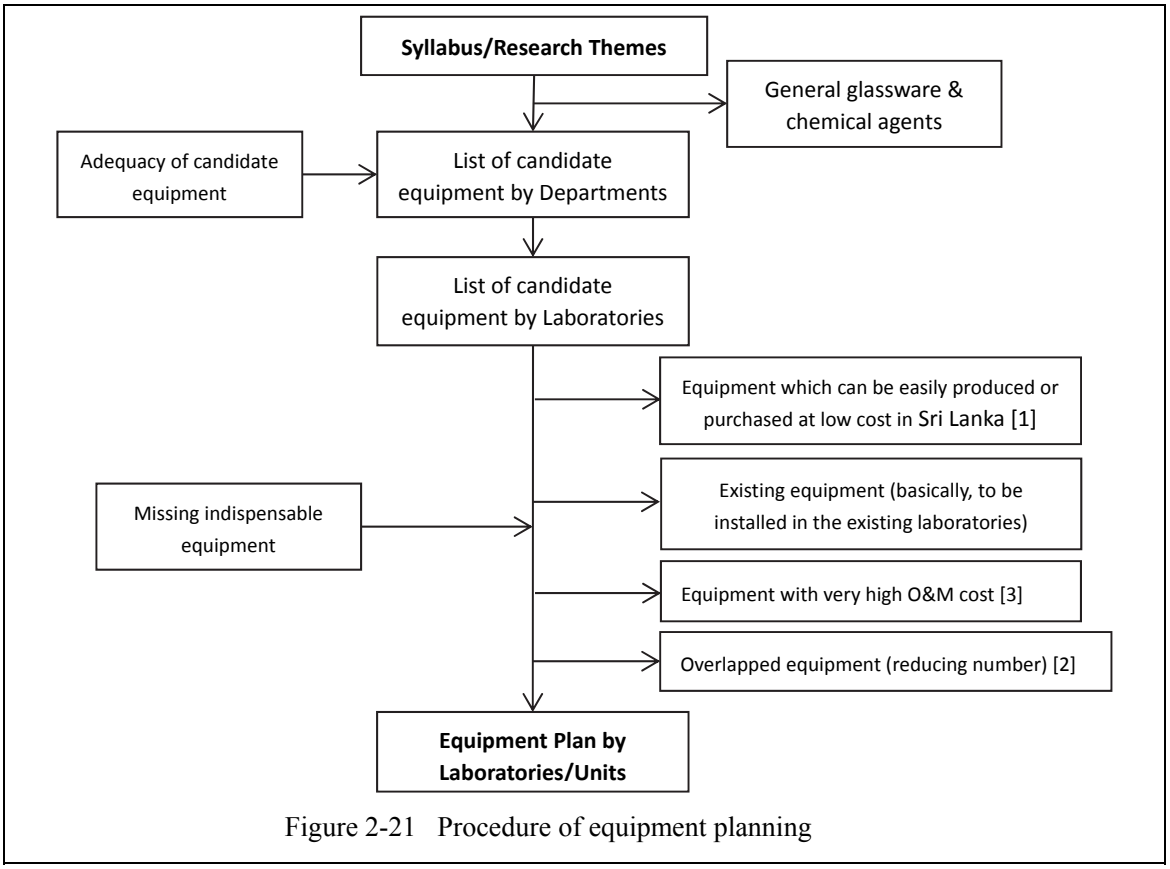


Figure 2-21 Procedure of equipment planning

(3) Selection and examination of candidate equipment

Lists of equipment by laboratory and units after analysis of an inventory of laboratory experiments and practical training and research themes of the departments are shown below. The numbers [1], [2], [3] in the tables correspond with the criteria for selection as shown below, and the equipment applicable to [1], [2], [3] were excluded from the list. General glassware and chemical agents are excluded from the lists.

[1] Simple equipment & tools that can be produced or purchased easily at low-cost in Sri Lanka

[2] Equipment that overlaps with existing departments

[3] Equipment that requires a very high O&M cost

a) Department of Agronomy Lab. (Existing)

Table 2-37 Candidate Equipment for Department of Agronomy Lab.

No	Equipment	Judgment			Remarks
		[1]	[2]	[3]	
1	Stereo microscope				
2	Dissection kit set				
3	Grafting knife	✔			
4	Budding knife	✔			
5	Garden scissors	✔			
6	Measuring tape	✔			

b) Crop Science Lab.

Table 2-38 Candidate Equipment for Crop Science Lab.

No	Equipment	Judgment			Judgment
		[1]	[2]	[3]	
1	Stereo microscope				
2	Dissection kit set				
3	Centrifugal seed dividers				
4	Seed cleaner				
5	Spiral seed separator				
6	Grain moisture meter		✔		
7	Oven				
8	Electronic balance				
9	Weighing balance, small				
10	Weighing balance, large				
11	Seed germination incubator				
12	Hydroponic unit				
13	Plant growth chamber				
14	Polyethylene sealer				
15	pH meter		✔		
16	EC meter				
17	Thermometer		✔		
18	Soil moisture meter				
19	Digital leaf area meter		✔		
20	Green leaf area meter				
21	Chlorophyll meter				
22	Lux meter				
23	CO2 dissolved sensor				
24	Portable photosynthesis analyzer				
25	Nitrogen & Carbon analyzer				
26	Root scanner				
27	Vanier caliper				
28	Clinometer				
29	Diameter tape				
30	Increment borer				
31	GPS				
32	ArcView (ArcGIS)				
33	WinRHIZO				
34	Statistic				
35	Minitab				
36	SPSS				
37	Real Time Landscaping Plus Review				
38	Water bath, with shaker				
39	Magnetic stirrer				
40	Dispenser pipettes				
41	Autoclave				
42	Fume hood (draft chamber)				
43	Refrigerator				
44	Kjeldhal apparatus				Sharing the equipment in Food Analysis and Processing Lab.
45	Fiber analyzer				Sharing the equipment in Food Analysis and Processing Lab.

46	Muffle furnace				Sharing the equipment in Food Analysis and Processing Lab.
47	Membrane filter				Sharing the equipment in Bio-technology and Tissue Culture Lab.
48	Vacuum pump				Sharing the equipment in Bio-technology and Tissue Culture Lab
49	PCR (Thermo-cycler)				Sharing the equipment in Bio-technology and Tissue Culture Lab
50	Laminar flow cabinet				Sharing the equipment in Bio-technology and Tissue Culture Lab
51	Incubator (incubation room)				Sharing the equipment in Bio-technology and Tissue Culture Lab
52	Water deionizer				Sharing with all laboratories

c) Department of Animal Science Lab. (Existing)

Table 2-39 Candidate Equipment for Department of Animal Science Lab.

No	Equipment	Judgment			Remarks
		[1]	[2]	[3]	
1	Animal models of cattle				
2	Animal models of poultry				
3	Animal models of rabbit				
4	Animal models of pig				
5	Animal models for monogastric (pig)				
6	Animal models for ruminants digestive system (cattle)				
7	Animal models for digestive system of poultry				
8	Reproductive system of male and female ruminant models				
9	Reproductive system of male and female pig models				
10	Reproductive system of male and female poultry models				
11	General animal models for nervous system				
12	General animal models for circulatory system				
13	Fish model to illustrate the internal and external anatomy of fish				
14	Poultry vaccine syringe				
15	Cabinet type poultry incubator		✔		
16	Electronic vernier (egg measurement)				
17	Egg candling light				
18	Chick brooder				
19	De-beaker (for poultry)				
20	Yolk color fan (checking egg color)				
21	Sphero meter (measuring egg, internal size)				
22	Fish measuring board				
23	Electronic balance				
24	Water sampler				
25	Sacchi disk (water transparency)				
26	Ekmnman grab sampler				
27	pH meter				
28	EC meter				
29	Thermometer				
30	BOD meter				
31	Salinity meter				
32	Plankton nets				

d) Animal Nutrition Lab.

Table 2-40 Candidate Equipment for Animal Nutrition Lab.

No	Equipment	Judgment			Judgment
		[1]	[2]	[3]	
1	Grass sampler				
2	Digestion chamber				
3	Respiration & metabolic chamber			✔	
4	Animal fistula				
5	Cannula fit				
6	Dissection set (for small animals)				
7	Binocular microscope （x100)		✔		
8	Electric pressurized washer				
9	Weigh bridge for cattle				
10	Animal weighing scale (small animals)				
11	Chicken weighing scale				
12	Electronic balance, small				
13	Electronic balance, large				
14	Analytical balance				
15	Drying cabinet				
16	Autoclave				
17	Centrifuge				
18	pH meter				
19	Feed crushing mill				
20	Grinder				
21	Mixer				
22	Homogenizer				
23	Oven				
24	Water bath, with shaker				
25	Shaker				
26	Voltex mixer				
27	Magnetic stirrer				
28	Vacuum pump (Lab.)				
29	Dispenser pipettes				
30	Fiber analyzer				
31	Micro Kjeldhal apparatus				
32	Macro Kjeldhal apparatus				
33	Soxhlet apparatus				
34	Automatic titrator				
35	Muffle furnace				
36	Bomb calorimeter				
37	Flame photo meter				
38	Fume hood (draft chamber)				
39	Refrigerator				
40	Amino acid analyzer (HPLC)			✔	
41	Gerber centrifuge				Sharing the equipment in Food Analysis and Processing Lab.
42	Milk fat tester				Sharing the equipment in Food Analysis and Processing Lab.
43	Alcohol gun				Sharing the equipment in Food Analysis and Processing Lab.
44	Refractometer				Sharing the equipment in Food Analysis and Processing Lab.
45	Ultrasonic milk analyzer				Sharing the equipment in Food Analysis and Processing Lab.
46	Water deionizer				Sharing with all laboratories
47	Water distiller				Sharing with all laboratories
48	Freezer				Sharing with all laboratories

e) Reproductive Physiology Lab.

Table 2-41 Candidate Equipment for Reproductive Physiology Lab.

No	Equipment	Judgment			Judgment
		[1]	[2]	[3]	
1	Biological microscope				
2	Inverted microscope				
3	Kamar pressure-sensitive mount detector				
4	Electronic mount detectors (Heat detection aid)				
5	Pedometer (Heat detection aid)				
6	Chin ball detector (Heat detection aid)				
7	Dummy cow				
8	Dummy pig				
9	Artificial vagina for cattle				
10	Artificial vagina for goat				
11	Artificial vagina for pig				
12	Red Blood Cell (RBC) counter				
13	White Blood Cell (WBC) counter				
14	Sperm (semen) counting plate				
15	Bovine sperm photometer				
16	Diluter of semen				
17	Single straw filling and sealing machine				
18	Needle pipette for semen dispensing				
19	Thawing device for frozen semen				
20	Vaginal speculum for cow				
21	Vaginal speculum for goat				
22	Vaginal speculum for pig				
23	Semen injector & sheath tube for cow				
24	Semen injector & sheath tube for goat				
25	Semen injector & sheath tube for pig				
26	AI kit for the field				
27	Ultra sound pregnancy detector				
28	Embryo transfer equipment and accessories				
29	Automatic irrigator for embryo flushing				
30	Catheter for removing vagina mucous				
31	Embryo collector				
32	Dilating bougie for cow and heifer, sugie-type				
33	Liquid Nitrogen Gas container				
34	Embryo (cell) transporter				
35	CO2 Incubator				
36	Laminar flow cabinet				
37	Electronic balance				
38	Analytical balance				
39	Drying cabinet				
40	Autoclave				
41	Centrifuge, refrigerated				
42	Micro centrifuge				
43	pH meter				
44	Oven				
45	Water bath, with shaker				
46	Shaker				
47	Voltex mixer				
48	Magnetic stirrer				
49	Dispenser pipettes				
50	Fume hood (draft chamber)				
51	Refrigerator				
52	Phase contrast microscope				Sharing the equipment in Plant Protection and Bio-control Lab.
53	Florescent microscope				Sharing the equipment in Plant Protection and Bio-control Lab
54	PCR (Thermo-cycler)				Sharing the equipment in Bio-technology and Tissue Culture Lab

55	Electrophoresis				Sharing the equipment in Bio-technology and Tissue Culture Lab
56	UV illuminator				Sharing the equipment in Bio-technology and Tissue Culture Lab
57	Water deionizer				Sharing with all laboratories
58	Water distiller				Sharing with all laboratories
59	Ultra-pure water equipment				Sharing with all laboratories
60	Freezer				Sharing with all laboratories
61	Deep freezer				Sharing with all laboratories
62	Ice cube/flake machine				Sharing with all laboratories

f) Department of Agricultural Chemistry Lab. (Existing)

Table 2-42 Candidate Equipment for Department of Agricultural Chemistry Lab.

No	Equipment	Judgment			Judgment
		[1]	[2]	[3]	
1	Fume hood (draft chamber)				

g) Soil Testing and Bio-fertilizer Lab.

Table 2-43 Candidate Equipment for Soil Testing and Bio-fertilizer Lab.

No	Equipment	Judgment			Remarks
		[1]	[2]	[3]	
1	GPS				
2	Soil auger				
3	Soil sieves				
4	pH meter		✔		
5	EC meter		✔		
6	Soil effective volumetric capacity meter				
7	Soil texture analyzer				
8	Pressure plate apparatus				
9	Wet sieving equipment				
10	Soil grinder				
11	Electronic balance				
12	Analytical balance				
13	Drying cabinet				
14	Autoclave				
15	Oven				
16	Centrifuge				
17	Magnetic stirrer				
18	Voltex mixer				
19	Shaker				
20	Water bath, with shaker				
21	Dispenser pipettes				
22	Rotary evaporator				
23	Fume hood (draft chamber)				
24	Macro Kjeldhal apparatus		✔		
25	Micro Kjeldhal apparatus				
26	Soxhlet apparatus				
27	Automatic titrator				
28	Muffle furnace				
29	Flame photo meter				
30	Nitrogen & Carbon analyzer				
31	ArcView (ArcGIS)				
32	Refrigerator				
33	Atomic Absorption spectrometer			✔	
34	Binocular microscope				Sharing the equipment in Plant Protection and Bio-control Lab
35	Spectrophotometer				Sharing with all laboratories
36	Gas chromatography (GC)				Sharing with all laboratories
37	Water deionizer				Sharing with all laboratories
38	Water distiller				Sharing with all laboratories
39	Freezer				Sharing with all laboratories

h) Food Analysis and Processing Lab.

Table 2-44 Candidate Equipment for Food Analysis and Processing Lab.

	Equipment	Judgment			Judgment
		[1]	[2]	[3]	
1	pH meter				
2	EC meter				
3	Weighing balance				
4	Electronic balance				
5	Analytical balance				
6	Drying cabinet				
7	Autoclave				
8	Oven				
9	Centrifuge				
10	Mixer grinder				
11	Homogenizer				
12	Magnetic stirrer				
13	Voltex mixer				
14	Shaker				
15	Water bath, with shaker				
16	Hot plate				
17	Dispenser pipettes				
18	Rotary evaporator				
19	Fume hood (draft chamber)				
20	Macro Kjeldhal apparatus				
21	Micro Kjeldhal apparatus				
22	Soxhlet apparatus				
23	Automatic titrator				
24	Fibre analyzer				
25	Muffle furnace				
26	Flame photo meter				
27	Bomb calorimeter				
28	Water activity measuring meter				
29	Rapid viscosity analyzer				
30	Force gauge				
31	Texture analyzing machine (meat & fish)				
32	Fruit firmness tester (hardness meter)				
33	Gerber centrifuge				
34	Milk fat tester				
35	Alcohol gun				
36	Ultrasonic milk analyzer				
37	Refractometer				
38	Salinity meter				
39	Ebulliometer				
40	Thermometer				
41	Digital moisture meter				
42	Food chronometer				
43	Laminar flow cabinet				Sharing with all laboratories
44	Incubator				Sharing with all laboratories
45	Colony counter				
46	Haemocyto-meter				
47	Stereo microscope				
48	Refrigerator				
49	Binocular microscope				Sharing the equipment in Plant Protection and Bio-control Lab
50	Fluorimeter				Sharing with all laboratories
51	Spectrophotometer				Sharing with all laboratories
52	Water deionizer				Sharing with all laboratories
53	Water distiller				Sharing with all laboratories
54	Freezer				Sharing with all laboratories
55	Deep freezer				Sharing with all laboratories

i) Department of Agricultural Biology Lab. (Existing)

Table 2-45 Candidate Equipment for Department of Agricultural Biology Lab.

No	Equipment	Judgment			Judgment
		[1]	[2]	[3]	
1	Magnifier				
2	Dissection kit set				
3	Ganong's photometer		✔		Need additional number of the equipment

j) Plant Protection and Bio-control Lab.

Table 2-46 Candidate Equipment for Plant Protection and Bio-control Lab.

No	Equipment	Judgment			Remarks
		[1]	[2]	[3]	
1	Stereo microscope		✔		
2	Stereo microscope				with 3 dimension camera attachment & monitor system
3	Inverted microscope				
4	Research binocular microscope with phase contrast lens & florescent filter				
5	Microscope pointer				
6	Dissection kit set				
7	Soil auger				
8	Nematodes sieve				
9	Atomizer				
10	ULV sprayer				
11	Thermo-hygrometer				
12	Electronic balance				
13	Drying cabinet				
14	Oven				
15	Autoclave				
16	pH meter				
17	Grinder				
18	Mortar and pestle				
19	Sample mixer				
20	Homogenizer				
21	Voltex mixer				
22	Magnetic stirrer				
23	Water bath, with shaker				
24	Hot plate				
25	Shaker				
26	Centrifuge, refrigerated				
27	Dispenser pipettes				
28	Rotary evaporator				
29	Fume hood (draft chamber)				
30	Laminar flow cabinet				
31	Inoculation needle				
32	Liquid Nitrogen container				
33	Incubator				
34	Low temp. incubator				
35	Plant growth chamber				
36	Refrigerator		✔		Need additional number of the equipment
37	Gas chromatography				Sharing with all laboratories
38	PCR (Thermo-cycler)				Sharing with all laboratories
39	Electrophoresis				Sharing with all laboratories
40	Trans illuminator				Sharing with all laboratories
41	Water deionizer				Sharing with all laboratories
42	Water distiller				Sharing with all laboratories
43	Ultra-pure water equipment				Sharing with all laboratories
44	Freezer				Sharing with all laboratories
45	Deep freezer				Sharing with all laboratories

k) Bio-technology and Tissue Culture Lab.

Table 2-47 Candidate Equipment for Bio-technology and Tissue Culture Lab.

No	Equipment	Judgment			Remarks
		[1]	[2]	[3]	
1	Stereo microscope				with 3 dimension camera attachment & monitor system
2	Dissection kit set				
3	Electronic balance				
4	Analytical balance				
5	Drying cabinet				
6	Oven				
7	Autoclave				
8	Microwave oven				
9	pH meter				
10	Grinder				
11	Mortar and pestle				
12	Voltex mixer				
13	Magnetic stirrer				
14	Water bath, with shaker				
15	Membrane filter				
16	Centrifuge, refrigerated				
17	Dispenser pipettes				
18	Fume hood (draft chamber)				
19	Laminar flow cabinet				
20	Incubator				
21	Shelves with lighting				
22	Shelves with lighting				
23	Plant growth chamber				Sharing the equipment in Plant Protection and Bio-control Lab
24	Low temp. incubator				Sharing the equipment in Plant Protection and Bio-control Lab
25	Inverted microscope				Sharing the equipment in Plant Protection and Bio-control Lab
26	Research binocular microscope with phase contrast lens & florescent filter				Sharing the equipment in Plant Protection and Bio-control Lab
27	Spectrophotometer				Sharing with all laboratories
28	Electrophoresis				Sharing with all laboratories
29	Trans illuminator				Sharing with all laboratories
30	PCR (Thermo-cycler)				Sharing with all laboratories
31	Water deionizer				Sharing with all laboratories
32	Water distiller				Sharing with all laboratories
33	Ultra-pure water equipment				Sharing with all laboratories
34	Freezer				Sharing with all laboratories

l) Department of Agricultural Engineering Lab. (Existing)

Table 2-48 Candidate Equipment for Department of Agricultural Engineering Lab.

No	Equipment	Judgment			Remarks
		[1]	[2]	[3]	
1	Plane table				
2	Alidade				
3	Dumpy level				
4	Theodolite(transit)				
5	Compass				
6	Tri pod				
7	Leveling staff				
8	Measuring tape				
9	Drafting board and drafter				
10	CAD software				
11	Oven				
12	Seed cleaner				
13	Paddy sample divider				
14	Grain moisture meter				
15	Rice husker		✔		

16	Milling machine				
17	Rice grader				
18	Vanier caliper				
19	Water bath				
20	Water pump				
21	Steamer				
22	Pressure cooker				
23	Electrical rice cooker				
24	Thermometers				
25	Humidifiers				
26	Cur models (six cylinder four stroke diesel engine)				
27	Cut models (four cylinder four stroke petrol engine)				
28	Cut models (synchromesh gear box)				
29	Cut models (sliding mesh gear box)				
30	Cut models (constant mesh gear box)				
31	Cut models (fully floating differential and rear wheel mechanism)				
32	Cut models (hydraulic brake unit-four wheel type)				
33	Cut models (board of fuel supply system of diesel engine)				

m) Environment and Hydro Research Lab.

Table 2-49 Candidate Equipment for Environment and Hydro Research Lab.

No	Equipment	Judgment			Remarks
		[1]	[2]	[3]	
1	CAD System				
2	Staff for water elevation				
3	Water-level gauge				
4	Water-level gauge, sounding type				
5	Current meter, river				
6	Current meter, laboratory				
7	Hydrothermograph logger				
8	Tensiometer				
9	Gypsum block moisture meter				
10	Soil moisture meter				
11	Lysimeter				
12	Water sample collector				
13	Water temperature meter				
14	pH meter		✔		
15	EC meter				
16	DO meter				
17	Turbidity meter				
18	Colorimeter				
19	Refrigerator				

n) Department of Agricultural Economics Lab. (Existing)

None of new equipment shall be procured by the project.

o) Econometrics Lab.

Table 2-50 Candidate Equipment for Econometrics Lab.

No	Equipment	Judgment			Remarks
		[1]	[2]	[3]	
1	Camera				
2	Multimedia projector				
3	Duplex photocopier				
4	Computer				
5	Analytical software				

p) Food Processing Unit

Table 2-51 Candidate Equipment for Food Processing Unit

No	Equipment	Judgment			Remarks
		[1]	[2]	[3]	
1	Fruits pulper				
2	Squeezer				
3	Mixer				
4	Dough mixing machine				
5	Baking oven				
6	Twin screw extruder				
7	Cabinet drier				
8	Freeze dryer				
9	Spray drier				
10	Steam sterilizer				
11	Bag sealing machine				
12	Vacuum packaging machine				
13	Vacuum gas-filling, Packaging equipment				
14	Microwave oven				
15	Refrigerator				
16	Weighing balance, large				
17	Weighing balance, small				
18	Electronic balance				
19	Freezer				Sharing the equipment in Meat Processing Unit

q) Dairy Processing Unit

Table 2-52 Candidate Equipment for Dairy Processing Unit

No	Equipment	Judgment			Remarks
		[1]	[2]	[3]	
1	Homogenizer (for milk)				
2	Incubator for yoghurt making				
3	Butter churner				
4	Cheese presser				
5	Cream separator				
6	Milk pasteurizer				
7	Sterilizing milk processer				
8	Flavored milking machine				
9	Milk packing machine set (for plastic bag & carton package)				
10	Ice cream maker		✔		
11	Refrigerator				
12	Weighing balance				
13	Electronic balance				
14	Freezer				Sharing the equipment in Meat Processing Unit

r) Food Processing Unit

Table 2-53 Candidate Equipment for Food Processing Unit

No	Equipment	Judgment			Remarks
		[1]	[2]	[3]	
1	Shear force test machine				
2	Meat grinder				
3	Bowl chopper				
4	Linking machine				
5	Meat stuffer				
6	Meat tumbler				
7	De boning and butchering knives				
8	Ham & bacon moulding cases				
9	Brine injector				
10	Steamer				
11	Smoke chamber				

12	Meat thermometer				
13	Ice cube/flake machine				
14	Refrigerator				
15	Freezer				
16	Weighing balance, large				
17	Weighing balance, small				
18	Electronic balance				

s) Crop Post-harvest Unit

Table 2-54 Candidate Equipment for Crop Post-harvest Unit

No	Equipment	Judgment			Remarks
		[1]	[2]	[3]	
1	Rice husker		✔		
2	Rice polisher		✔		
3	Engine		✔		
4	Coconut oil extraction machine		✔		

t) Research and Training Farm

Table 2-55 Candidate Equipment for Research and Training Farm

No	Equipment	Judgment			Remarks
		[1]	[2]	[3]	
1	2-wheel tractor		✔		
2	4-wheel tractor		✔		Need additional number of the equipment
3	Mould board plough (attachment of 4W tractor)				
4	Disc plough (attachment of 4W tractor)				
5	Harrow (attachment of 4W tractor)				
6	Rotator cultivator (attachment of 4W tractor)		✔		Need additional number of the equipment
7	Intercultivator (attachment of 4W tractor)				
8	Seed drill (attachment of 4W tractor)				
9	Broadcaster (attachment of 4W tractor)				
10	Flower and leaf plucker (attachment of 4W tractor)				
11	Grass cutters (attachment of 4W tractor)				
12	Grass cutters (shoulder holding)				
13	Grass choppers		✔		
14	Rice transplanter				
15	Reaper				
16	Thresher				
17	Combine harvester				
18	Atomizer		✔		Need additional number of the equipment
19	Power sprayer		✔		
20	Duster				
21	Water pump, large				
22	Water pump, small		✔		
23	Water pump, submersible pump				
24	Refrigerator				
25	Sprinkler unit				Equipped by research and training farm planning
26	Drip irrigation set				Equipped by research and training farm planning
27	Net green house				Equipped by research and training farm planning

u) Farm Machinery Workshop

Table 2-56 Candidate Equipment for Farm Machinery Workshop

No	Equipment	Judgment			Remarks
		[1]	[2]	[3]	
1	Gas welder				
2	Arc welder		✔		
3	Metal cutting machine				
4	Metal grinder		✔		
5	Metal bending machine				
6	Bench vice, small		✔		
7	Bench vice, medium		✔		
8	Bench vice, large				
9	Drilling machine		✔		
10	Lathe machine				
11	Tap & Die set		✔		
12	Wood lathe		✔		
13	Air compressor		✔		
14	Pressure pump		✔		
15	Workshop tool box				
16	Workshop table				

v) Meteorology Station

Table 2-57 Candidate Equipment for Meteorology Station

No	Equipment	Judgment			Remarks
		[1]	[2]	[3]	
1	Maximum and minimum thermometer		✔		
2	Wet & dry bulb thermometer		✔		
3	Hygrometer		✔		
4	Rain-gauge		✔		
5	Barometer		✔		
6	Wind anemometers		✔		
7	Soil thermometer		✔		
8	Sun shine recorder				
9	Evaporimeter		✔		

(4) Equipment plan

The study team made an equipment list for each laboratory and unit of the Research and Training Complex based on the above examination. Equipment plan including basic specifications, necessary quantity was developed, and the prioritization of the equipment is prepared based on the following criteria.

A : Essential equipment for general experiments and practices of students and research activities with high versatility and high frequency use

B : Necessary equipment for general experiments and practices, or prioritized research activities, even though which versatility and frequency of use are limited (e.g. analytical devices)

C : Other equipment (e.g. high-degree analytical devices with limited usage, specific purpose or made to order equipment which can be replaced by other equipment with versatility, accessories less related to the substantial function of the main equipment, software for computer, etc.)

The following lists show the equipment plan by the laboratories and the units including information of major use application of the equipment.

a) Department of Agronomy Lab. (Existing)

Table 2-58 Equipment Plan for Department of Agronomy Lab.

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Stereo microscope (1)	binocular, x45	26	2	24	A	To observe plant body and plant tissue/cells
2	Dissection kit set (2)	7-item set	26	0	26	A	To dissect plant body

b) Crop Science Lab.

Table 2-59 Equipment Plan for Crop Science Lab.

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Stereo microscope (2)	x300	2	0	2	A	To observe plant & plant cells
2	Dissection kit set (3)	7-item set	2	0	2	A	To dissect plant organ
3	Seed dividers	centrifugal type	1	0	1	B	To divide seed samples equally
4	Seed cleaner (1)	air jet flow	1	0	1	B	To clean seed samples
5	Spiral seed separator	double spiral	1	0	1	B	To separate mature seeds
6	Oven (1)	160lit, 10-250℃	1	0	1	A	To dry samples & glassware
7	Electronic balance (1)	200g, 0.1mg	1	0	1	A	To weigh samples & chemicals
8	Weighing balance (1)	3kg, 0.001g	1	0	1	A	To weigh samples
9	Weighing balance (2)	12kg, 0.1g	1	0	1	A	To weigh samples
10	Seed germination incubator	170lit, 5-50℃	2	0	2	A	To encourage germination of seed samples
11	Hydroponic unit		6	0	6	C	To grow plants by liquid solution
12	Plant growth chamber	400 lit., temp & humid & light control	1	0	1	A	To encourage or inhibit plant growth by controlling growing environment
13	Polyethylene sealer	W:5mm, L:350mm	1	0	1	B	To making pots for raising seedlings
14	EC meter (1)	desk top, EC: 0-199.9S/m	1	0	1	A	To measure electric conductivity of medium solution & sample soil
15	Soil moisture meter	portable, 0-40%	1	0	1	A	To measure moisture content of soil samples
16	Green leaf area meter	portable, Max W: 100mm, Max L: 1m	1	0	1	B	To measure leaf area of plant samples
17	Chlorophyll meter	portable, double wave length	1	0	1	B	To measure leaf area of plant samples
18	Lux meter	portable, 0-199,999Lux	1	0	1	B	To measure amount of sunlight upper/under sample plants
19	CO2 dissolved sensor	10 - 1000mbar CO2	1	0	1	B	To measure CO2 gas concentration
20	Portable photosynthesis analyzer		1	0	1	C	To measure photosynthesis of sample plants
21	Nitrogen & Carbon analyzer		1	0	1	C	To measure % of all nitrogen and all carbon
22	Root scanner		1	0	1	C	To measure root length of sample plants
23	Vernier caliper	150, 200, 300mm (3-item set)	1	0	1	A	To measure stem diameter of sample plants
24	Clinometer	Graduation: 0-90°	1	0	1	A	To measure strike and slope of geological stratum
25	Diameter tape	10 m	1	0	1	B	To measure diameter of wood samples
26	Increment borer	50cm length	1	0	1	B	To collect wood samples for counting annual growth ring

27	GPS	handheld, color LCD, 240x400 pixel	1	0	1	A	To determine latitude, longitude and altitude
28	ArcView (ArcGIS)		1	0	1	C	To integrate map information (software)
29	WinRHIZO		1	0	1	C	To analyze photo images of plant root (software)
30	Statistica		1	0	1	C	To make a statistical analysis (software)
31	Minitab		1	0	1	C	To make a statistical analysis (software)
32	SPSS		1	0	1	C	To make a statistical analysis (software)
33	Real Time Landscaping Plus Review		1	0	1	C	To make a landscaping plan (software)
34	Water bath, with shaker	23 lit., 10-80℃, horizon-reciprocated	1	0	1	A	To heat samples under constant temp. condition
35	Magnetic stirrer	50-1200rpm, 5-300℃	2	0	2	A	To stir water solution
36	Dispenser pipettes	5 viable steps, with syringe	6	0	6	A	To dispense water solution
37	Autoclave	76 lit., 45～135℃, Max: 0.25MPa	1	0	1	A	To sterilize glassware, tools and samples by high temp. & pressure
38	Fume hood (draft chamber)	1,500(W) x 750-800(D) x 1,950-2,700(H)mm	1	0	1	A	To exhaust toxic gas occurred during experiment
39	Refrigerator (1)	340lit., 2-14℃	1	0	1	A	To store samples and chemicals under low temp. condition

c) Department of Animal Science Lab. (Existing)

Table 2-60 Equipment Plan for Department of Animal Science Lab.

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Animal models of cattle	2,800x1,500x500mm	1	0	1	B	To display visual images
2	Animal models of poultry	450x260x490mm	1	0	1	B	To display visual images
3	Animal models of rabbit	520x200x330mm	1	0	1	B	To display visual images
4	Animal models of pig	1020x260x480mm	1	0	1	B	To display visual images
5	Animal models for monogastric (pig)	210x180x390mm	1	0	1	B	To display visual images
6	Animal models for ruminants digestive system (cattle)	280x180x350mm	1	0	1	B	To display visual images
7	Animal models for digestive system of poultry		1	0	1	C	To display visual images
8	Reproductive system of male and female ruminant models	700x650x1,500mm	1	0	1	B	To display visual images
9	Reproductive system of male and female pig models	600x70x370mm	1	0	1	B	To display visual images
10	Reproductive system of male and female poultry models		1	0	1	C	To display visual images
11	General animal models for nervous system		1	0	1	C	To display visual images
12	General animal models for circulatory system		1	0	1	C	To display visual images
13	Fish model to illustrate the internal and external anatomy of fish	490x150x350mm	1	0	1	B	To display visual images
14	Poultry vaccine syringe	automatic, 0.2-1.0ml	1	0	1	B	To give vaccination to poultry
15	Electronic vernier	Egg measurement	1	0	1	B	To measure dimensions of poultry egg
16	Egg candling light	LED white light, 45lm	1	0	1	B	To inspect sperm eggs and development of chicks
17	Chick brooder	2,600x750x800mm	1	0	1	B	To rear chicks after hatching
18	De-beaker (for poultry)		1	0	1	B	To cut chick-beak
19	Yolk color fan (checking egg color)	10 charts set	1	0	1	B	To check color of egg yolk

20	Sphero meter (measuring egg, internal size)	Accuracy: 1/100mm	1	0	1	B	To measure height of dense albumen
21	Fish measuring board	1,200x250x25mm, gauge unit: 1cm	1	0	1	B	To measure size of fish
22	Electronic balance (2)	600g, 0.1g	1	0	1	A	To weigh samples & chemicals
23	Water sampler	2 lit., with 30m rope	1	0	1	B	To collect water samples
24	Sacchi disk (water transparency)	30cm diameter	1	0	1	B	To measure water color and transparency
25	Ekmnman grab sampler	stainless, 240x210x350mm	1	0	1	B	To collect soil samples from bottom of a water body
26	pH meter (1)	portable, pH0.00-14.00	1	0	1	A	To measure pH of water solution
27	EC meter (2)	portable, EC:0.00-19.9mS/cm	1	0	1	A	To measure electric conductivity of water solution
28	Thermometer (1)	portable, dual channel: -100-1300℃ & -100-1000℃	1	0	1	A	To measure temp. of samples
29	BOD meter	portable, 0-20ppm,	1	0	1	A	To measure water quality by BOD
30	Salinity meter	portable, 0.0-7.0%(g/100g)	1	0	1	A	To measure salinity of water solution
31	Plankton nets	φ200x500mm	1	0	1	B	To collect plankton

d) Animal Nutrition Lab.

Table 2-61 Equipment Plan for Animal Nutrition Lab.

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Grass sampler	stainless, 300-1200rpm	1	0	1	B	To collect grass (feed) samples
2	Digestion chamber	Goat:1,260x760x1,550mm Cattle:1,300x2,120x1,900mm	1	0	1	B	To hold animals for measuring coefficient of feed digestibility
3	Animal fistula	Goat:φ35/150x50mm Cattle:φ100/270x75mm	1	0	1	B	To observe a digestive function of animals
4	Cannula fit	gastric juice collection	1	0	1	B	To shut an animal fistula
5	Dissection set (for small animals)	18-item set	1	0	1	A	To dissect animal body/organ
6	Electric pressurized washer	27lit/hr, 6.5MPa	1	0	1	A	To cattle house and cattle body
7	Weigh bridge for cattle	3000kg, 0.2kg, 1100x2000mm	1	0	1	B	To measure cattle weight
8	Animal weighing scale (small animals)	table type	1	0	1	B	To measure weight of small animals
9	Chicken weighing scale	4kg	1	0	1	B	To measure weight of chicken
10	Electronic balance (1)	200g, 0.1mg	2	0	2	A	To weigh samples & chemicals
11	Weighing balance (3)	2000g, 0.1g	1	0	1	A	To weigh samples & chemicals
12	Analytical balance	200g, 0.01mg, with hood	1	0	1	A	To weigh samples & chemicals
13	Drying cabinet	300 lit, 10-35℃	1	0	1	A	To dry glassware and tools
14	Autoclave	76 lit., 45～135℃, Max: 0.25MPa	1	0	1	A	To sterilize glassware, tools and samples by high temp. & pressure
15	Centrifuge	300-6000rpm, Max: 1000ml	1	0	1	A	To separate substance from water solution
16	pH meter (2)	desk-top, pH0.000-14.000	1	0	1	A	To measure pH of water solution
17	Feed crushing mill	500-800kg/hr	1	0	1	A	To pulverize feed samples
18	Grinder	20000rpm or more, 150ml	1	0	1	A	To pulverize samples
19	Mixer (1)	1000ml, 20000rpm	1	0	1	A	To mix samples
20	Homogenizer	5000-10000rpm, 0.25ml-10lit.	1	0	1	A	To atomize and disperse substance in water solution
21	Oven (2)	97 lit., 10-250℃	1	0	1	A	To dry samples & glassware
22	Water bath, with shaker	23 lit., 10-80℃, horizon-reciprocated	1	0	1	A	To heat samples under constant temp. condition
23	Shaker	20-200rmp	1	0	1	A	To mix and agitate water solution
24	Voltex mixer	600-3000rpm	2	0	2	A	To mix water solution in tube
25	Magnetic stirrer	50-1200rpm, 5-300℃	1	0	1	A	To stir water solution
26	Vacuum pump (Lab.)	12lit/sec, 6.65Pa or more	1	0	1	A	To aspirate air for accelerating filtration time
27	Dispenser pipettes	5 viable steps, with syringe	6	0	6	A	To dispense water solution
28	Fiber analyzer	NDF, CF, ADF, ADL, Sample size: 0.5-1.0g	1	0	1	B	To make quantitative analysis of plant fiber content of samples

29	Micro Kjeldhal apparatus	6 flasks	1	0	1	A	To make quantitative analysis of nitrogen and protein content of samples (small quantity)
30	Macro Kjeldhal apparatus	0.1-200mgN, sample tube: 100-300ml	1	0	1	A	To make quantitative analysis of nitrogen and protein content of samples
31	Soxhlet apparatus	150-250ml x 4 holes	1	0	1	B	To extract subsistence with solvents from solid samples
32	Automatic titrator		1	0	1	C	To make quantitative analysis with titration automatically
33	Muffle furnace	11 lit., 100-1150℃	1	0	1	A	To burn or dry samples
34	Bomb calorimeter	Max:33500 joule	1	0	1	B	To measure calorific value of solid/liquid samples
35	Flame photo meter	Na, K, Li: up to 199ppm Ca: 10-199ppm	1	0	1	A	To make quantitative analysis by emission from samples
36	Fume hood (draft chamber)	1,500(W) x 750-800(D) x 1,950-2,700(H)mm	1	0	1	A	To exhaust toxic gas occurred during experiment
37	Refrigerator (2)	150 lit., 2-14℃	2	0	2	A	To store samples and chemicals under low temp. condition

e) Reproductive Physiology Lab.

Table 2-62 Equipment Plan for Reproductive Physiology Lab.

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Biological microscope	binocular, x400, with micro-warm plate	1	0	1	A	To observe sperms
2	Inverted microscope	x400, phase-contrast, mechanical stage, camera adopter	1	0	1	A	To observe viable cells (eggs)
3	Kamar pressure-sensitive mount detector	Double-stick tape, 400pcs set	1	0	1	B	To detect the time of estrus (cattle)
4	Electronic mount detectors (Heat detection aid)		1	0	1	C	To detect the time of estrus (cattle)
5	Pedometer (Heat detection aid)		1	0	1	C	To detect the time of estrus (cattle)
6	Chin ball detector (Heat detection aid)		1	0	1	C	To detect the time of estrus (cattle)
7	Dummy cow	manual height adjustment	1	0	1	B	To collect sperm from cattle
8	Dummy pig		1	0	1	C	To collect sperm from pig
9	Artificial vagina for cattle	Plastic, L:385mm	1	0	1	B	To collect sperm from cattle
10	Artificial vagina for goat	Plastic, L:200mm	1	0	1	B	To collect sperm from goat
11	Artificial vagina for pig		1	0	1	C	To collect sperm from pig
12	Blood Cell counter	Thoma type	2	0	2	B	To measure number of blood cells
13	Sperm (semen) counting plate	Thoma type	1	0	1	B	To count number of sperms
14	Bovine sperm photometer		1	0	1	C	To measure sperm density
15	Diluter of semen		1	0	1	C	To dilute sperm
16	Single straw filling and sealing machine		1	0	1	C	To fill and seal sperm into straw tube for preservation
17	Needle pipette for semen dispensing	φ1.25x100mm, 10pcs set	1	0	1	B	To dispense sperm
18	Thawing device for frozen semen	φ20x150mm, room temp.-65℃	1	0	1	B	To thaw frozen sperm
19	Vaginal speculum for cow	horizon open type, L:300mm	1	0	1	B	To examine vagina and uterus, and injecting sperm (cattle)
20	Vaginal speculum for goat	horizon open type, L:90mm	1	0	1	B	To examine vagina and uterus, and injecting sperm (goat)
21	Vaginal speculum for pig		1	0	1	C	To examine vagina and uterus, and injecting sperm (pig)
22	Semen injector & sheath tube for cow	φ4x450mm	1	0	1	B	To inject sperm (AI of cattle)
23	Semen injector & sheath tube for goat	L: 230mm	1	0	1	B	To inject sperm (AI of goat)

24	Semen injector & sheath tube for pig		1	0	1	C	To inject sperm (AI of pig)
25	AI kit for the field	AI kit, LN2 tank, Freezer for cattle semen	1	0	1	B	To carry out AI on site (cattle)
26	Ultra sound pregnancy detector	portable, 60-240mm	1	0	1	B	To diagnose pregnancy and condition of baby in the womb (animals)
27	Embryo transfer equipment and accessories	Injector & sheath tube, thawing device, dilating bougie, LN2 tank	1	0	1	B	To carry out embryo transfer of cattle
28	Automatic irrigator for embryo flushing	Room temp. - +50℃	1	0	1	B	To collect fertilized egg from cows
29	Catheter for removing vagina mucous	φ6x400mm, 30pcs set	1	0	1	B	To collect mucus in the cervix for measuring pH (cattle)
30	Embryo collector	φ80x53mm, 100pcs set	1	0	1	B	To collect fertilized egg from cows (separation of egg from mucus)
31	Dilating bougie for cow and heifer, sugie-type	Sugie-type	1	0	1	B	To carry out embryo transfer of cattle
32	Liquid Nitrogen Gas container	30 lit.	2	0	2	B	To preserve sperm and eggs
33	Embryo (cell) transporter	0.25ml x 20pcs, 37-38.5℃	1	0	1	B	To transport fertilized eggs
34	CO2 Incubator	165lit., CO2:0-20%, Temp.5-50℃	1	0	1	B	To incubate fertilized eggs and mammalian cells
35	Laminar flow cabinet	Class100, 1,300(W) x 750-800(D) x 1,700-2,100(H)mm	1	0	1	A	To carry out experiment under aseptic condition (to avoid contamination from dust and microbes)
36	Electronic balance (1)	200g, 0.1mg	2	0	2	A	To weigh samples & chemicals
37	Analytical balance	200g, 0.01mg, with hood	1	0	1	A	To weigh samples & chemicals
38	Drying cabinet	300 lit, 10-35℃	1	0	1	A	To dry glassware and tools
39	Autoclave	76 lit., 45-135℃, Max: 0.25MPa	1	0	1	A	To sterilize glassware, tools and samples by high temp. & pressure
40	Centrifuge, refrigerated (1)	Max: 21000rpm, -9 - +35℃	1	0	1	A	To separate substance from water solution under low temp. condition
41	Micro centrifuge	Max:13500rpm, refrigerated	1	0	1	B	To separate substance from small quantity of water solution
42	pH meter (2)	desk-top, pH0.000-14.000	1	0	1	A	To measure pH of water solution
43	Oven (2)	97 lit., 10-250℃	1	0	1	A	To dry samples & glassware
44	Water bath, with shaker	23 lit., 10-80℃, horizon-reciprocated	1	0	1	A	To heat samples under constant temp. condition
45	Shaker	20-200rmp	1	0	1	A	To mix and agitate water solution
46	Voltex mixer	600-3000rpm	2	0	2	A	To mix water solution in tube
47	Magnetic stirrer	50-1200rpm, 5-300℃	1	0	1	A	To stir water solution
48	Dispenser pipettes	5 viable steps, with syringe	6	0	6	A	To dispense water solution
49	Fume hood (draft chamber)	1,500(W) x 750-800(D) x 1,950-2,700(H)mm	1	0	1	A	To exhaust toxic gas occurred during experiment
50	Refrigerator (2)	150 lit., 2-14℃	2	0	2	A	To store samples and chemicals under low temp. condition

f) Department of Agricultural Chemistry Lab. (Existing)

Table 2-63 Equipment Plan for Department of Agricultural Chemistry Lab.

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Fume hood (draft chamber)	1,500(W) x 750-800(D) x 1,950-2,700(H)mm	1	0	1	A	To exhaust toxic gas occurred during experiment

g) Soil Testing and Bio-fertilizer Lab.

Table 2-64 Equipment Plan for Soil Testing and Bio-fertilizer Lab.

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	GPS	handheld, color LCD, 240x400 pixel	1	0	1	A	To determine latitude, longitude and altitude
2	Soil auger (1)	L:600mm (handle), 8-auger edge set	1	0	1	A	To collect soil samples
3	Soil sieves	φ200x45mm (4 sieve sizes), φ150x45mm (4 sieve sizes), φ100x45mm (4 sieve sizes)	1	0	1	A	To separate different particle sizes of soil
4	Soil effective volumetric capacity meter	0-100ml, 0.01ml	1	0	1	B	To measure cubic volume of sample soil
5	Soil texture analyzer	vertical movement: 30 times/min., amplitude: 38mm	1	0	1	B	To analyze soil texture
6	Pressure plate apparatus	pressure: 5 bar	1	0	1	B	To measure water retention capacity of soil
7	Wet sieving equipment	sieveφ: 200 - 360mm	1	0	1	B	To assess stability of soil aggregated structure
8	Soil grinder	500-1000ml, 100rpm	1	0	1	B	To crush soil samples
9	Electronic balance (1)	200g, 0.1mg	2	0	2	A	To weigh samples & chemicals
10	Analytical balance	200g, 0.01mg, with hood	1	0	1	A	To weigh samples & chemicals
11	Drying cabinet	300 lit, 10-350℃	1	0	1	A	To dry glassware and tools
12	Autoclave	76 lit., 45-135℃, Max: 0.25MPa	1	0	1	A	To sterilize glassware, tools and samples by high temp. & pressure
13	Oven (2)	97 lit., 10-250℃	1	0	1	A	To dry samples & glassware
14	Centrifuge	300-6000rpm, Max: 1000ml	1	0	1	A	To separate substance from water solution
15	Magnetic stirrer	50-1200rpm, 5-300℃	1	0	1	A	To stir water solution
16	Voltex mixer	600-3000rpm	2	0	2	A	To mix water solution in tube
17	Shaker	20-200rpm	1	0	1	A	To mix and agitate water solution, and to incubate microorganisms
18	Water bath, with shaker	23 lit., 10-80℃, horizon-reciprocated	1	0	1	A	To heat samples under constant temp. condition
19	Dispenser pipettes	5 viable steps, with syringe	6	0	6	A	To dispense water solution
20	Muffle furnace	11 lit., 100-1150℃	1	0	1	A	To burn or dry samples
21	Rotary evaporator	20-180rpm, 1 lit. flask	1	0	1	A	To evaporate solvent
22	Fume hood (draft chamber)	1,500(W) x 750-800(D) x 1,950-2,700(H)mm	1	0	1	A	To exhaust toxic gas occurred during experiment
23	Micro Kjeldhal apparatus	6 flasks	1	0	1	A	To make quantitative analysis of nitrogen and protein content of samples (small quantity)
24	Soxhlet apparatus	150-250ml x 4 holes	1	0	1	A	To extract subsistence with solvents from solid samples
25	Automatic titrator		1	0	1	C	To make quantitative analysis with titration automatically
26	Flame photo meter	Na, K, Li: up to 199ppm Ca: 10-199ppm	1	0	1	A	To make quantitative analysis by emission from samples
27	Nitrogen & Carbon analyzer		1	0	1	C	To measure % of all nitrogen and all carbon
28	ArcView (ArcGIS)		1	0	1	C	To integrate map information (software)
29	Refrigerator (2)	150 lit., 2-14℃	2	0	2	A	To store samples and chemicals under low temp. condition

h) Food Analysis and Processing Lab.

Table 2-65 Equipment Plan for Food Analysis and Processing Lab.

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	pH meter (2)	desk-top, pH0.000-14.000	1	0	1	A	To measure pH of water solution
2	EC meter (1)	desk top, EC: 0-199.9S/m	1	0	1	A	To measure electric conductivity of medium solution & sample soil
3	Weighing balance (3)	2000g, 0.1g	1	0	1	A	To weigh samples
4	Electronic balance (1)	200g, 0.1mg	2	0	2	A	To weigh samples & chemicals
5	Analytical balance	200g, 0.01mg, with hood	1	0	1	A	To weigh samples & chemicals
6	Drying cabinet	300 lit, 10-35℃	1	0	1	A	To dry glassware and tools
7	Autoclave	76 lit., 45-135℃, Max: 0.25MPa	1	0	1	A	To sterilize glassware, tools and samples by high temp. & pressure
8	Oven (2)	97 lit., 10-250℃	1	0	1	A	To dry samples & glassware
9	Centrifuge	300-6000rpm, Max;1000ml	1	0	1	A	To separate substance from water solution
10	Grinder	20000rpmor more, 150ml	1	0	1	A	To crush food samples
11	Homogenizer	5000-10000rpm, 0.25ml-10lit.	1	0	1	A	To atomize and disperse substance in water solution
12	Magnetic stirrer	50-1200rpm, 5-300℃	1	0	1	A	To stir water solution
13	Voltex mixer	600-3000rpm	2	0	2	A	To mix water solution in tube
14	Shaker	20-200rpm	1	0	1	A	To mix and agitate water solution, and to incubate microorganisms
15	Water bath, with shaker	23 lit., 10-80℃, horizon-reciprocated	1	0	1	A	To heat samples under constant temp. condition
16	Hot plate	250℃, 400 x 300mm	1	0	1	A	To heat solution
17	Dispenser pipettes	5 viable steps, with syringe	6	0	6	A	To dispense water solution
18	Rotary evaporator	20-180rpm, 1 lit. flask	1	0	1	A	To evaporate solvent
19	Fume hood (draft chamber)	1,500(W) x 750-800(D) x 1,950-2,700(H)mm	1	0	1	A	To exhaust toxic gas occurred during experiment
20	Macro Kjeldhal apparatus	0.1-200mgN, sample tube: 100-300ml	1	0	1	A	To make quantitative analysis of nitrogen and protein content of samples (small quantity)
21	Micro Kjeldhal apparatus	6 flasks	1	0	1	A	To make quantitative analysis of nitrogen and protein content of samples
22	Soxhlet apparatus	150-250ml x 4 holes	1	0	1	A	To extract subsistence with solvents from solid samples
23	Automatic titrator		1	0	1	C	To make quantitative analysis with titration automatically
24	Fibre analyzer	NDF, CF, ADF, ADL Sample size: 0.5-1.0g	1	0	1	B	To make quantitative analysis of plant fiber content of samples
25	Muffle furnace	11 lit., 100-1150℃	1	0	1	A	To burn or dry samples
26	Flame photo meter	Na, K, Li: up to 199ppm Ca: 10-199ppm	1	0	1	A	To make quantitative analysis by emission from samples 析
27	Bomb calorimeter	Max:33500joule	1	0	1	B	To measure calorific value of solid/liquid samples
28	Water activity measuring meter	Aw:0.10-0.98	1	0	1	B	To measure free water in food samples
29	Rapid viscosity analyzer	0-100Pa·s, sample volume: 2-10ml	1	0	1	B	To measure starch gelatinization
30	Force gauge	500N	1	0	1	B	To measure hardness of food samples
31	Texture analyzing machine (meat & fish)	100N	1	0	1	B	To measure texture (hardness, solidity, elasticity, etc.) of meat and fish meat
32	Fruit firmness tester (hardness meter)	0-13kg, 0.5kg	1	0	1	B	To measure hardness of fruits
33	Gerber centrifuge	1130rpm, room temp.- +65℃	1	0	1	B	To separate butterfat from raw milk
34	Milk fat tester	0-100%, sample 1.0-2.0g	1	0	1	B	To measure butterfat content in milk
35	Alcohol gun	For milk inspection	1	0	1	B	To judge freshness of milk

36	Ultrasonic milk analyzer	sample 20ml, with printer	1	0	1	B	To analyze milk quality, e.g. fat amount, non-fat solid, density, protein content, moisture, etc.
37	Refractometer	portable, Brix 0-33%	1	0	1	B	To measure sugar content of fruits juice and beverage
38	Salinity meter	portable, 0.0-7.0%(g/100g)	1	0	1	B	To measure salinity of water solution
39	Ebulliometer	0-17%	1	0	1	B	To measure alcohol content of water solution
40	Thermometer (2)	bimetal type, 0-100℃	1	0	1	A	To measure temp. of water solution
41	Digital moisture meter	～100%	1	0	1	A	To measure moisture content of food samples
42	Food chromometer	410-660nm, LED lamp, Min sample: 1.0ml	1	0	1	B	To measure color and concentrations of food samples
43	Colony counter	x2-3	1	0	1	A	To count number of colonies of bacteria
44	Haemocyto-meter	Thoma type	1	0	1	A	To count number of cells
45	Stereo microscope (3)	x115, camera adopter	1	0	1	A	To observe microorganisms
46	Refrigerator (2)	150 lit., 2-14℃	2	0	2	A	To store samples and chemicals under low temp. condition

i) Department of Agricultural Biology Lab. (Existing)

Table 2-66 Equipment Plan for Department of Agricultural Biology Lab.

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Magnifier	x10, φ90mm, LED light	26	0	26	A	To observe insect body
2	Dissection kit set (5)	8-item set	26	0	26	A	To dissect insect body
3	Ganong's potometer	1mm gauge	26	1	25	B	To measure transpiration

j) Plant Protection and Bio-control Lab.

Table 2-67 Equipment for Plant Protection and Bio-control Lab.

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Stereo microscope (4)	x115, 3 digital camera system, CCD camera	1	0	1	A	To observe insect body and nematode
2	Inverted microscope	x400, phase-contrast, mechanical stage, camera adopter	1	0	1	A	To observe microorganisms and cells
3	Research binocular microscope	x1000, with phase contrast lens & florescent filter, digital camera system	1	0	1	A	To observe microorganisms and cells
4	Microscope pointer		1	0	1	C	To display microscope image
5	Dissection kit set (1)	9-item set	1	0	1	A	To dissect insect body
6	Soil auger (2)	Hole auger: φ10mm (1m deep) Auger: φ4cmx50cm	1	0	1	A	To collect soil samples
7	Nematodes sieve	33-item set	1	0	1	A	To collect nematode from soil
8	Sprayer (1)	laboratory portable type, 4 lit	1	0	1	B	To spray insecticides
9	ULV sprayer	14 lit., 10-20μ particle	1	0	1	B	To spray ULV insecticides
10	Thermo-hygrometer	Temp.:-5 - +45℃ Humid:20-95%	1	0	1	A	To measure atmosphere temp. & humidity
11	Electronic balance (1)	200g, 0.1mg	2	0	2	A	To weigh samples & chemicals
12	Drying cabinet	300 lit, 10-35℃	1	0	1	A	To dry glassware and tools
13	Oven (2)	97 lit., 10-250℃	1	0	1	A	To dry samples & glassware
14	Autoclave	76 lit., 45-135℃, Max: 0.25MPa	1	0	1	A	To sterilize glassware, tools and samples by high temp. & pressure
15	pH meter (2)	desk-top, pH0.000-14.000	1	0	1	A	To measure pH of water solution
16	Grinder	20000rpm or more, 150ml	1	0	1	A	To crush samples
17	Mortar and pestle	φ150mm	1	0	1	A	To crush and mix samples
18	Mixer (1)	1000ml, 20000rpm	1	0	1	A	To mix samples

19	Homogenizer	5000-10000rpm, 0.25ml-10lit	1	0	1	A	To atomize and disperse substance in water solution
20	Voltex mixer	600-3000rpm	2	0	2	A	To mix water solution in tube
21	Magnetic stirrer	50-1200rpm, 5-300℃	1	0	1	A	To stir water solution
22	Water bath, with shaker	23 lit., 10-80℃, horizon-reciprocated	1	0	1	A	To heat samples under constant temp. condition
23	Hot plate	250℃, 400 x 300mm	1	0	1	A	To heat solution
24	Shaker	20-200rpm	1	0	1	A	To mix and agitate water solution, and to incubate microorganisms
25	Centrifuge, refrigerated (2)	300-15000rpm, -9 - +35℃, Max: 1000ml	1	0	1	A	To separate substance from water solution under low temp. condition
26	Dispenser pipettes	5 viable steps, with syringe	6	0	6	A	To dispense water solution
27	Rotary evaporator	20-180rpm, 1 lit. flask	1	0	1	A	To evaporate solvent
28	Fume hood (draft chamber)	1,500(W) x 750-800(D) x 1,950-2,700(H)mm	1	0	1	A	To exhaust toxic gas occurred during experiment
29	Laminar flow cabinet	Class100, 1,300(W) x 750-800(D) x 1,700-2,100(H)mm	1	0	1	A	To carry out experiment under aseptic condition (to avoid contamination from dust and microbes)
30	Inoculation needle	Loopφ3mm, handle 150mm, 24 gauge	1	0	1	A	To transplant cultivated bacteria to petri-dishes
31	Liquid Nitrogen container	30 lit.	2	0	2	A	To preserve bacteria
32	Incubator	150 lit., room temp. +5 - +60℃	1	0	1	A	To incubate insects and bacteria
33	Low temp. incubator	140 lit., -10 - +50℃	1	0	1	B	To incubate insects and bacteria
34	Plant growth chamber	400 lit., temp & humid & light control	1	0	1	A	To encourage or inhibit plant growth by controlling growing environment
35	Refrigerator (1)	340lit., 2-14℃	2	1	1	A	To store samples and chemicals under low temp. condition

k) Bio-technology and Tissue Culture Lab.

Table 2-68 Equipment Plan for Bio-technology and Tissue Culture Lab.

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Stereo microscope (4)	x115, digital camera syatem, CCD camera	1	0	1	A	To observe plant body and plant tissue/cells
2	Dissection kit set (4)	13-item set	1	0	1	A	To dissect plant body
3	Electronic balance (1)	200g, 0.1mg	2	0	2	A	To weigh samples & chemicals
4	Analytical balance	220g, 0.01mg, with hood	1	0	1	A	To weigh samples & chemicals
5	Drying cabinet	300 lit, 10-35℃	1	0	1	A	To dry glassware and tools
6	Oven (2)	97 lit., 10-250℃	1	0	1	A	To dry samples & glassware
7	Autoclave	76 lit., 45-135℃, Max: 0.25MPa	1	0	1	A	To sterilize glassware, tools and samples by high temp. & pressure
8	Microwave oven	2.8kW, 420x470x340mm	1	0	1	A	To fuse culture medium by heating
9	pH meter (2)	desk-top, pH0.000-14.000	1	0	1	A	To measure pH of water solution
10	Grinder	20000rpm or more, 150ml	1	0	1	A	To crush samples
11	Mortar and pestle	φ150mm	1	0	1	A	To crush and mix samples
12	Voltex mixer	600-3000rpm	2	0	2	A	To mix water solution in tube
13	Magnetic stirrer	50-1200rpm, 5-300℃	1	0	1	A	To stir water solution
14	Water bath, with shaker	23 lit., 10-80℃, horizon-reciprocated	1	0	1	A	To heat samples under constant temp. condition
15	Membrane filter	With funnel and decompression flask + suction device	1	0	1	A	To eliminate microorganisms in water solution by filtration
16	Centrifuge, refrigerated (2)	300-15000rpm, -9 - +35℃, Max: 1000ml	1	0	1	A	To dispense water solution
17	Dispenser pipettes	5 viable steps, with syringe	6	0	6	A	To evaporate solvent
18	Fume hood (draft chamber)	1,500(W) x 750-800(D) x 1,950-2,700(H)mm	1	0	1	A	To exhaust toxic gas occurred during experiment

19	Laminar flow cabinet	Class100, 1,300(W) x 750-800(D) x 1,700-2,100(H)mm	1	0	1	A	To carry out experiment under aseptic condition (to avoid contamination from dust and microbes)
20	Incubator	150 lit. room temp. +5 - +60℃	1	0	1	A	To incubate plant tissue/cells
21	Shelves with lighting	stainless, 5 shelves, 900x450x1800mm	10	0	10	B	To cultivate plant tissue in incubation room
22	Refrigerator (1)	340lit., 2-14℃	2	0	2	A	To store samples and chemicals under low temp. condition

l) Department of Agricultural Engineering Lab. (Existing)

Table 2-69 Equipment Plan for Department of Agricultural Engineering Lab.

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Plane table	A2 size	6	0	6	B	To carry out plane-table survey
2	Alidade		6	0	6	B	To find direction on the plane table
3	Dumpy level	X32-34, view: 1° 20'	6	0	6	B	To take a level (surveying)
4	Theodolite(transit)	x30, view: 1° 20' - 1° 30'	6	0	6	B	To measure angle between two objectives (surveying)
5	Compass	5' gauge (horizontal)	6	0	6	A	To find direction (surveying)
6	Tri pod	Aluminum	6	0	6	B	To fix plane table and other instruments during surveying
7	Leveling staff	5m (5 steps)	6	0	6	B	To measure distance (surveying)
8	Measuring tape	50 m	6	0	6	A	To measure distance
9	Drafting board and drafter	A1 size, with chair	6	0	6	A	To make drawings
10	CAD software		1	0	1	C	To make computer-aided drawing (software)
11	Oven (2)	97 lit., 10-250℃	1	0	1	A	To dry sample grains
12	Seed cleaner (2)	Winnowing of cereal seeds, laboratory-type	1	0	1	B	To clean sample grains
13	Paddy sample divider	36 divisions, Max sample: 5kg	1	0	1	B	To divide sample grains equally
14	Grain moisture meter	portable, MC: 11-30% (paddy)	1	0	1	B	To measure moisture content of sample grains
15	Milling machine	laboratory-type, friction type + abrasive type (set)	1	0	1	B	To mill sample rice
16	Rice grader	laboratory-type, indent cylinder	1	0	1	B	To separate milled sample rice for grading
17	Vernier caliper	150, 200, 300mm (3-item set)	1	0	1	A	To measure dimension of sample grains
18	Water bath	room temp. +10 - +200℃, 13 lit.	1	0	1	A	To soak paddy grain in parboil processing (with constant temp.)
19	Water pump (1)	2", centrifugal, with engine, 0.40 ㎥/min.	1	0	1	A	To explain working principle pf single cylinder 4-stroke engine
20	Steamer	drawer type, gas boiler	1	0	1	B	To steam soaked paddy grain in parboil processing
21	Pressure cooker	2.4 lit.	1	0	1	B	To cook paddy grain in parboil processing
22	Electrical rice cooker		1	0	1	C	To cook milled rice
23	Thermometers (3)	thermistor -20 - +250℃	1	0	1	A	To measure storage temp.
24	Humidifiers	1200ml/hr	1	0	1	A	To measure storage humid.
25	Cut models (six cylinder four stroke diesel engine)	5200cc	1	0	1	B	To display visual images
26	Cut models (four cylinder four stroke petrol engine)	1000 – 1300cc	1	0	1	B	To display visual images
27	Cut models (synchromesh gear box)	Front 4-5 speeds Rear 1 speed	1	0	1	B	To display visual images
28	Cut models (sliding mesh gear box)		1	0	1	B	To display visual images
29	Cut models (constant mesh gear box)	Multistage clutch	1	0	1	B	To display visual images

30	Cut models (fully floating differential and rear wheel mechanism)	Large-scaled truck type	1	0	1	B	To display visual images
31	Cut models (hydraulic brake unit-four wheel type)	Wall-hanging panel type	1	0	1	B	To display visual images
32	Cut models (board of fuel supply system of diesel engine)		1	0	1	B	To display visual images

m) Environment and Hydro Research Lab.

Table 2-70 Equipment Plan for Environment and Hydro Research Lab.

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	CAD System	PC, digitizer, scanner, A1 plotter	1	0	1	A	To make computer-aided drawing
2	Staff for water elevation	5m, 5 steps	2	0	2	B	To measure water level of canals/rivers
3	Water-level gauge (1)	self-recording, 10 m	1	0	1	B	To measure water level of canals/rivers
4	Water-level gauge (2)	throw-in type, 0-12 m	2	0	2	B	To measure water level of canals/rivers
5	Current meter (1)	filed type, 0-3m/sec.	1	0	1	B	To measure current speed of canals/rivers
6	Current meter (2)	laboratory type, about 200cm/sec.	2	0	2	B	To measure current speed of experimental canal/river models
7	Hydrothermograph logger	Temp.: -15 - +65℃ Humid.: 10-99%	1	0	1	B	To measure and record temp. & humid. with a certain interval
8	Tensiometer	pF0-2.7, self-recording	2	0	2	B	To measure soil moisture content
9	Gypsum block moisture meter	Measurement: 1-100%	2	0	2	B	To measure soil moisture content
10	Soil moisture meter	0-40%, TDR method	1	0	1	B	To measure soil moisture content
11	Lysimeter	For examining evapotranspiration of plants, 2000cm2, with data logger	1	0	1	B	To make simulation on soil environment
12	Water sample collector	2 lit., with 30 m rope	1	0	1	B	To collect water samples
13	Water temperature meter	portable, 0-40℃, with 50m cable	1	0	1	A	To measure temp. of water samples
14	EC meter (2)	portable, EC:0.00-19.9mS/cm	1	0	1	A	To measure electric conductivity of water solution
15	DO meter	portable, DO:0-19.9mg/lit	1	0	1	B	To measure dissolved oxygen of water samples
16	Turbidity meter	0-3000FNU, with data logger	1	0	1	B	To measure turbidity of water samples
17	Colorimeter	Portable	1	0	1	A	To analyze water quality (absorptiometer)
18	Refrigerator (2)	150 lit., 2-14℃	1	0	1	A	To store samples and chemicals under low temp. condition

n) Econometrics Lab.

Table 2-71 Equipment Plan for Econometrics Lab.

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Camera		1	0	1	C	To record picture images
2	Multimedia projector		1	0	1	C	To project picture/movie images on screen
3	Duplex photocopier		1	0	1	C	To duplicate written materials
4	Computer	OS: Microsoft, i7 or more, with 19 inch color monitor & keyboard	6	0	6	A	To analyze result of rural survey and market research and practice methods of analysis
5	Analytical software		1	1	1	C	To process vast amount of data (software)

o) Common Rooms

Table 2-72 Equipment Plan for Common Rooms

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
<Pure Water Room>							
1	Water deionizer	Max: 1 lit./min.	2	0	2	A	To produce deionized water
2	Water distiller	About 20 lit./hr.	2	0	2	A	To produce distilled water
3	Ultra-pure water equipment	Max: 0.65 lit./min.	1	0	1	A	To produce ultra-pure water
<Freezer Room>							
1	Freezer (1)	-14 - -30℃, 270 lit.	2	0	2	A	To preserve samples and chemicals under very low temp. condition
2	Deep freezer	-70 - -80℃, 380 lit.	1	0	1	A	To preserve samples and chemicals under extremely low temp. condition
3	Ultra-deep freezer	-70 - -80℃, 330 lit.	1	0	1	A	To preserve samples and chemicals under ultra-low temp. condition
4	Freezer, programmable	-40 - +30℃, 3.3 lit.	1	0	1	B	To make soft freezing of tissue cells
5	Ice flake machine	180kg/day	1	0	1	A	To produce ice flake
<Analytical Measurement Room>							
1	Fluorimeter	200-900nm	1	0	1	B	To analyze vitamin and microelements
2	UV Visible Spectrophotometer	190-1100nm	1	0	1	A	To analyze DNA, protein and cell density of samples
3	Spectrophotometer	Min. sample: 1-2μL	1	0	1	B	To make quantitative analysis of various substance & DNA/RNA in samples
4	PCR (Tnermo-cycler)	4-99℃, 96x0.2ml tubes	1	0	1	B	To amplify DNA
5	Electrophoresis	Horizontal	1	0	1	A	To separate DNA and protein
6	Trans illuminator	UV: 300nm, UV lamp:90w	1	0	1	B	To analyze DNA band after electrophoresis operation
7	GC (Gas chromatography)	Temp.: room +5 - +450℃, No. of injectors: 3, Inflection volume: 0-1200ml/min.	1	0	1	B	To identify and measure tiny amount of compounds (inorganic gas, carbon hydrides, pesticides, etc.)
<Microbial Analysis Room>							
1	Laminar flow cabinet	Class100, 1,300(W) x 750-800(D) x 1,700-2,100(H)mm	1	0	1	A	To carry out experiment under aseptic condition (to avoid contamination from dust and microbes)
2	Incubator	150lit., room temp.+5 - +60℃	1	0	1	A	To incubate food microbes

p) Food Processing Unit

Table 2-73 Equipment Plan for Food Processing Unit

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Fruits pulper	0.2 - 0.3 ton/hr.	1	0	1	B	To remove fruit pulp
2	Squeezer	Oil press, press tank cap.: 40 lit. (φ350x400mm)	1	0	1	B	To squeeze juice from fruit
3	Mixer (2)	6.7 lit.	1	0	1	B	To crush and mix vegetables & fruits
4	Dough mixing machine	30 lit.	1	0	1	B	To mix up dough
5	Baking oven	900x840x370mm	1	0	1	B	To bake bread
6	Twin screw extruder	1-180rmp, 5Nm/screw, 300℃, manual feeding	1	0	1	B	To mix, blend, mush and shape food materials
7	Cabinet drier	For food drying, 3 trays	1	0	1	B	To dry food materials
8	Freeze dryer	-45℃, 1.5 lit.	1	0	1	B	To make freeze-dried foods
9	Spray drier	250℃, 3kg/hr.(evaporation volume)	1	0	1	B	To make dried powder from liquid mixture
10	Autoclave	79 lit. 45～135℃, 0.25MPa	1	0	1	B	To sterilize spices by heating

11	Bag sealing machine	Foot pedal operation	1	0	1	B	To seal plastic film bags
12	Vacuum packaging machine	2-3 cycle/min.	1	0	1	B	To seal plastic bags after vacuuming
13	Vacuum gas-filling, Packaging equipment	Vacuum pump: 167lit./min.	1	0	1	B	To seal plastic bags after filling nitrogen gas
14	Microwave oven	2.8kW, 420x470x340mm	1	0	1	A	To fuse culture medium by heating
15	Refrigerator (3)	1000 lit., -5-10℃	1	0	1	A	To store food materials under low temp. condition
16	Weighing balance (2)	12kg, 0.1g	1	0	1	A	To weigh food materials
17	Weighing balance (3)	2000g, 0.1g	1	0	1	A	To weigh food materials
18	Electronic balance (1)	200g, 0.1mg	1	0	1	A	To weigh seasonings and additives

q) Dairy Processing Unit

Table 2-74 Equipment Plan for Dairy Processing Unit

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Homogenizer (for milk)	100 lit/hr., 19.6MPa	1	0	1	B	To homogenize raw milk to prevent from fat separating
2	Yoghurt incubator	About 40lit.	1	0	1	B	To produce yoghurt
3	Butter churner	Processing capacity: 4-10 lit., stainless	1	0	1	B	To produce butter by churning
4	Cheese presser	stainless, plate:300x300mm	1	0	1	B	To produce cheese by pressing curd
5	Cream separator	125lit. /hr.	1	0	1	B	To separate cream from milk
6	Milk pasteurizer tank set	150 lit.x2, stainless	1	0	1	B	To store milk with low temp. and to blend milk and flavor materials, e.g. coffee, fruits juice essence, etc.
7	Sterilizing milk processor	150 lit., stainless	1	0	1	B	To sterilize milk with high temp.
8	Milk packing machine set (for plastic bag & carton package)		1	0	1	C	To pack milk after processing
9	Refrigerator (3)	1000 lit., -5-10℃	1	0	1	A	To store milk and dairy products under low temp. condition
10	Weighing balance (3)	2000g, 0.1g	1	0	1	A	To weigh seasonings and additives
11	Electronic balance (1)	200g, 0.1mg	1	0	1	A	To weigh seasonings and additives

r) Meat Processing Unit

Table 2-75 Equipment Plan for Meat Processing Unit

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Shear force test machine	single column, Max. load 2kN	1	0	1	B	To measure tenderness of meat
2	Meat grinder	100-150kg/hr., table-top	1	0	1	B	To make minced meat
3	Bowl chopper	5 lit., table-top	1	0	1	B	To chop meat
4	Linking machine	Max: 2000kg/hr.	1	0	1	B	To make sausage (linking)
5	Meat stuffer	Manual operation	1	0	1	B	To stuff meat into sausage casing
6	Meat tumbler	6.8kg, table-top	1	0	1	B	To cut connective tissue of meat (tenderization)
7	De boning and butchering knives	8-item set	1	0	1	B	To debone and cut meat
8	Ham & bacon moulding cases	2-item set	1	0	1	B	To hold ham & bacon for smoking
9	Brine injector	table-top, pump injection	1	0	1	B	To inject brine to meat (for making ham & bacon)
10	Steamer	drawer type, gas boiler	1	0	1	B	To process ham
11	Smoke chamber	20-100℃, stainless, Cap.:40kg of meat	1	0	1	B	To process ham& bacon
12	Meat thermometer	0-100℃	1	0	1	B	To measure temp. of meat
13	Ice flake machine	180kg/day	1	0	1	A	To produce ice flake
14	Refrigerator (3)	1000 lit., -5-10℃	1	0	1	A	To store meat and meat products under low temp. condition
15	Freezer (2)	220lit., -30℃	1	0	1	A	To preserve foods and meat materials under very low temp.

16	Weighing balance (2)	12kg, 0.1g	1	0	1	A	To weigh meat
17	Weighing balance (3)	2000g, 0.1g	1	0	1	A	To weigh meat
18	Electronic balance (1)	200g, 0.1mg	1	0	1	A	To weigh seasonings and additives

s) Research and Training Farm

Table 2-76 Equipment Plan for Research and Training Farm

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	4-wheel tractor	45hp	2	1	1	A	To pull and operate attached farm equipment
2	Mould board plough (attachment of 4W tractor)	2 boards	1	0	1	A	To plow field
3	Disc plough (attachment of 4W tractor)	2 discs	1	0	1	A	To plow field
4	Harrow (attachment of 4W tractor)	14 harrow discs	1	0	1	A	To crush soil after plowing
5	Rotator cultivator (attachment of 4W tractor)	1700mm width	2	1	1	A	To crush soil and level field
6	Intercultivator (attachment of 4W tractor)		1	0	1	B	To inter-till and weed out field
7	Seed drill (attachment of 4W tractor)	8 rows	1	0	1	B	To seed in line or dot with fertilizers
8	Broadcaster (attachment of 4W tractor)	450kg capacity	1	0	1	B	To broadcast compost, fertilizers and crop seeds
9	Flower and leaf plucker (attachment of 4W tractor)		1	0	1	C	To pluck plant leaves and flowers
10	Grass cutters (attachment of 4W tractor)	1200mm width	1	0	1	A	To cut weeds in and surroundings of filed
11	Grass cutters (shoulder holding)	engine operation	2	0	2	A	To cut weeds in and surroundings of filed
12	Rice transplanter		1	0	1	C	To transplant paddy seedlings
13	Reaper		1	0	1	C	To harvest paddy & wheat
14	Thresher		1	0	1	C	To thresh grains, e.g. paddy, wheat, beans, etc.
15	Combine harvester		1	0	1	C	To harvest and thresh grains, e.g. paddy, wheat, beans, etc.
16	Sprayer (2)	24 lit. with engine	2	1	1	A	To spray pesticides, etc. (liquid)
17	Duster	26 lit. with engine	1	0	1	A	To blow pesticides, etc. (powder)
18	Water pump (1)	2", centrifugal, with engine, 0.40m3/min.	1	0	1	A	To lift water for irrigation
19	Water pump (2)	0.08-0.15m3/min, submersible	1	0	1	A	To lift water for irrigation
20	Refrigerator (3)	1000 lit., -5-10℃	1	0	1	A	To store products under low temp. condition

t) Farm Machinery Workshop

Table 2-77 Equipment Plan for Farm Machinery Workshop

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Gas welder		1	0	1	A	To joint metal materials
2	Metal cutting machine	manual operation	1	0	1	A	To cut metal materials
3	Metal bending machine	manual operation	1	0	1	A	To bend metal materials
4	Bench vice	Opening: about 200mm	1	0	1	A	To fix materials (metals & woods) for processing
5	Lathe machine	Table-top type, between centers: about 200mm, 2000rpm	1	0	1	A	To process (machining) metal parts
6	Workshop tool box	52 tool item set	1	0	1	A	To adjust and maintain farm machinery in good condition
7	Workshop table	1800x900x740mm	1	0	1	A	To do various processing works

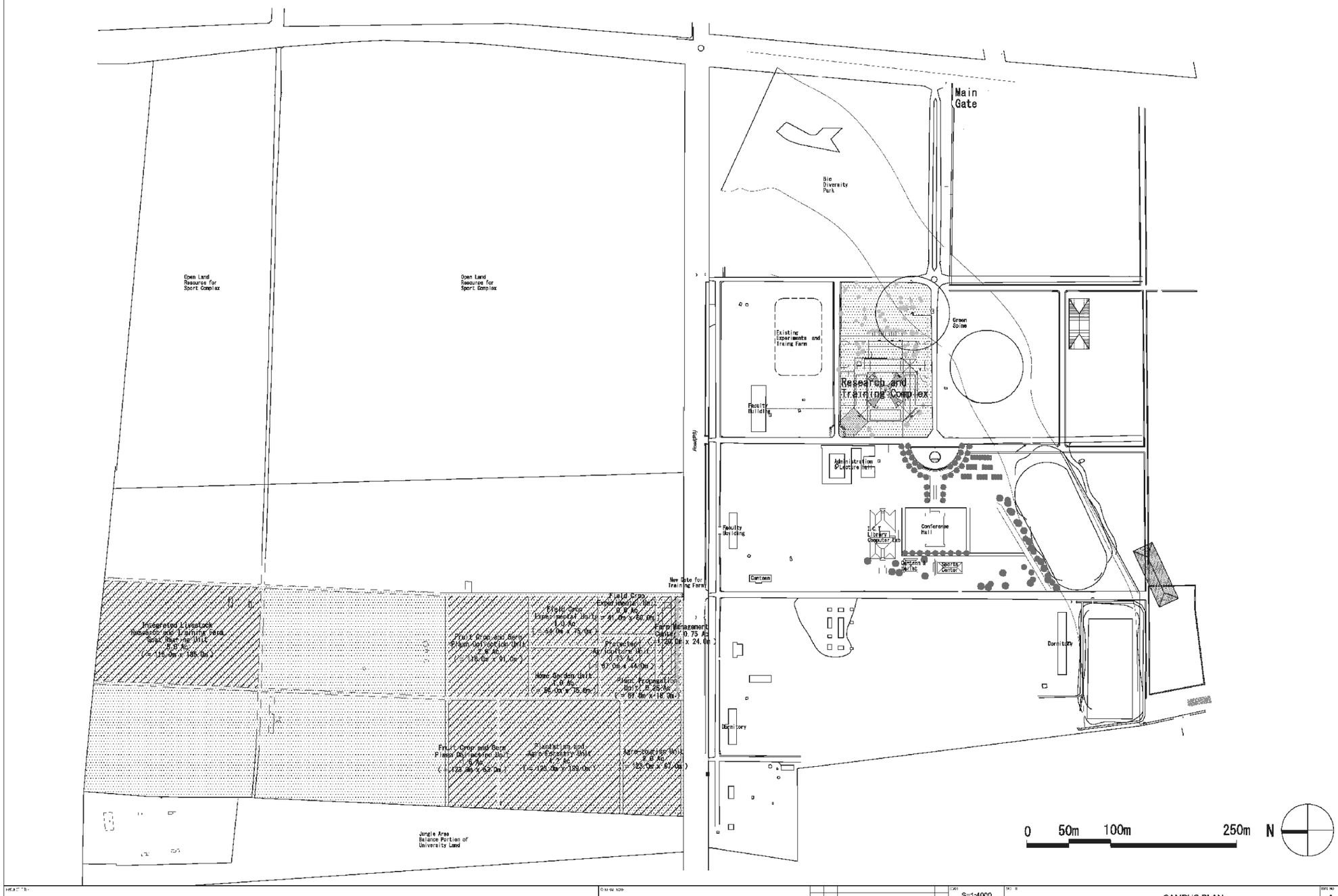
u) Meteorology Station

Table 2-78 Equipment Plan for Meteorology Station

No	Equipment	Basic Specifications	Q'ty			Priority	Use Application
			Need	Exist	Plan		
1	Sun shine recorder	300-2800nm, self-recording	1	0	1	B	To measure and record sunshine hours

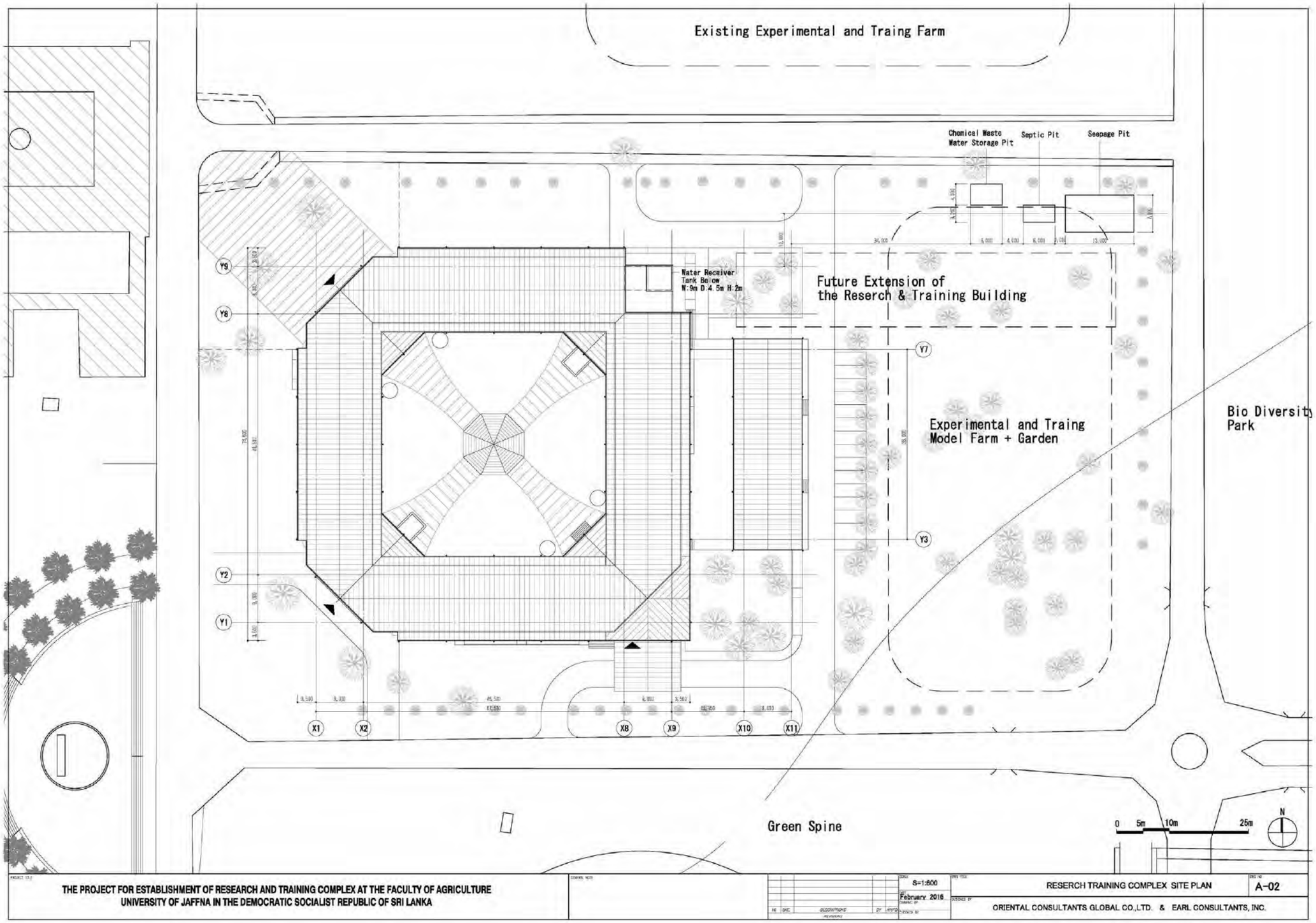
2.2.3 Outline Design Drawing

Drawing No.	Drawing
A-01	Campus Plan
A-02	Research Training Complex Site Plan
A-03	Research Training Complex GFL Plan
A-04	Research Training Complex 1FL Plan
A-05	RFL Plan
A-06	Elevations Sections
A-07	Farm Management Building Plans
A-08	Farm Management Building Elevations Sections
A-09	Goat Shed
A-10	Animal Measurement Shed
F-01	Layout of Research and Training Farm
F-02	Layout of Drainage Canal System
F-03	Layout of Drainage Canal System
F-04	Farm Road Network



THE PROJECT FOR ESTABLISHMENT OF RESEARCH AND TRAINING COMPLEX AT THE FACULTY OF AGRICULTURE
UNIVERSITY OF JAFFNA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

SCALE	S=1:4000	CAMPUS PLAN	DRAWING NO. A-01
DATE	February 2016		
DRAWN BY			
CHECKED BY		ORIENTAL CONSULTANTS GLOBAL CO.,LTD. & EARL CONSULTANTS, INC.	


Existing Experimental and Traing Farm
Chomical Waste
Water Storage Pit
Septic Pit
Seepage Pit
Water Receiver
Tank Below
W:9m D:4.5m H:2m
Future Extension of
the Reserch & Training Building
Experimental and Traing
Model Farm + Garden
Bio Diversity
Park
Green Spine
Y9
Y8
Y7
Y3
Y2
Y1
X1
X2
X8
X9
X10
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0 5m 10m 25m
N
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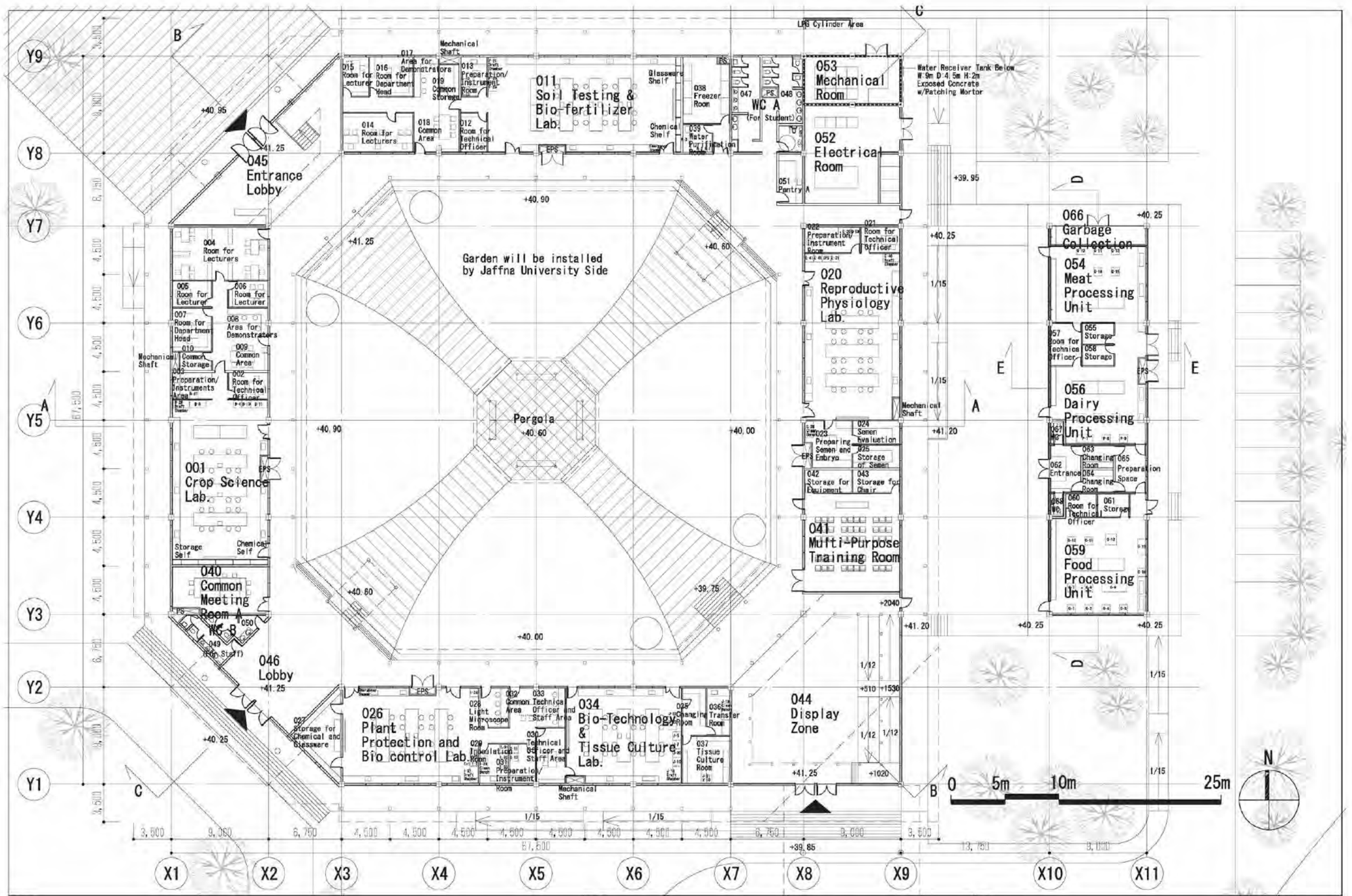
UNIVERSITY OF JAFFNA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
S=1:600
February 2016
RESERCH TRAINING COMPLEX SITE PLAN
A-02
ORIENTAL CONSULTANTS GLOBAL CO.,LTD. & EARL CONSULTANTS, INC.



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February 2016

RESEARCH TRAINING COMPLEX GFL PLAN

A-03

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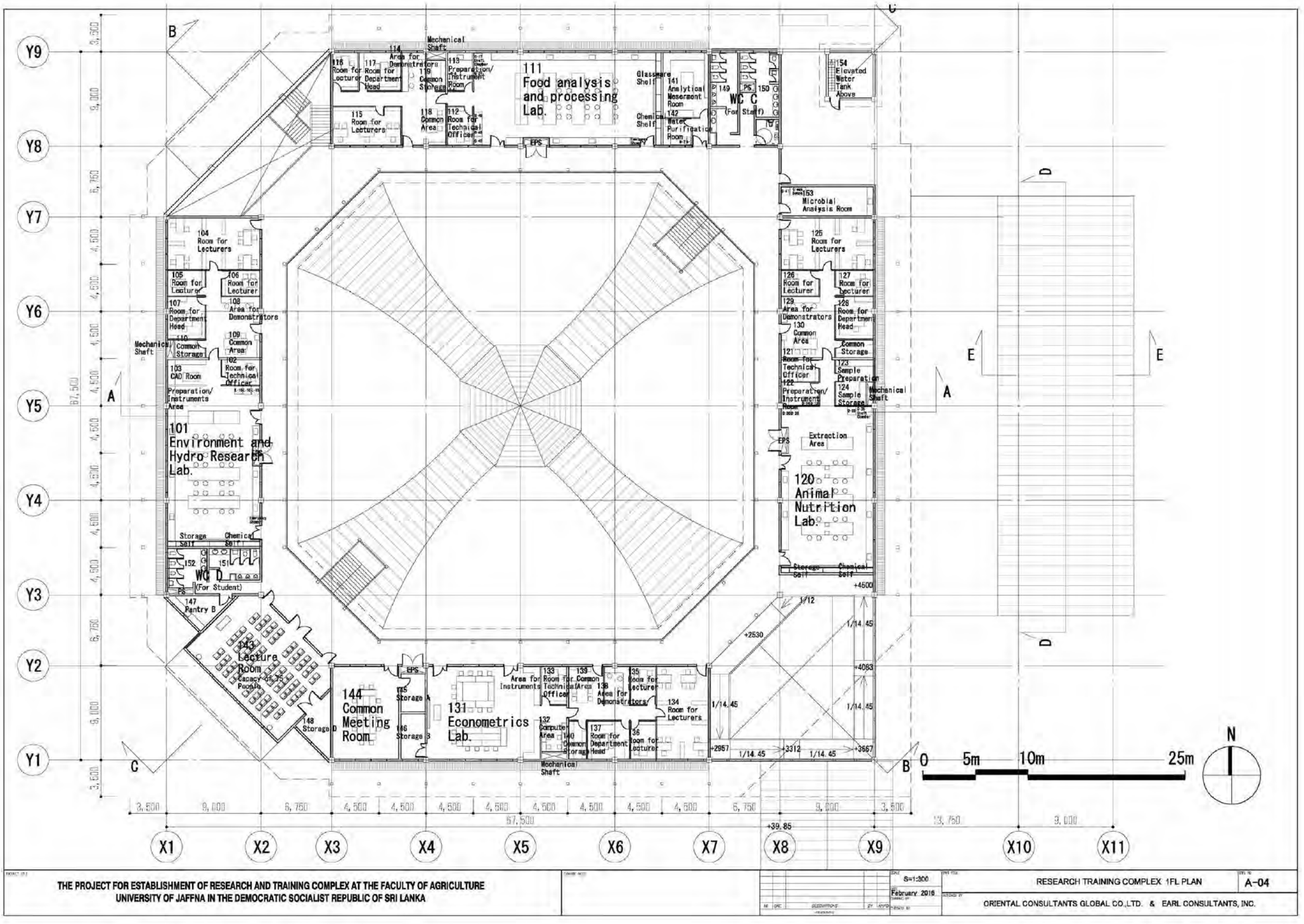

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RESEARCH TRAINING COMPLEX 1FL PLAN

A-04

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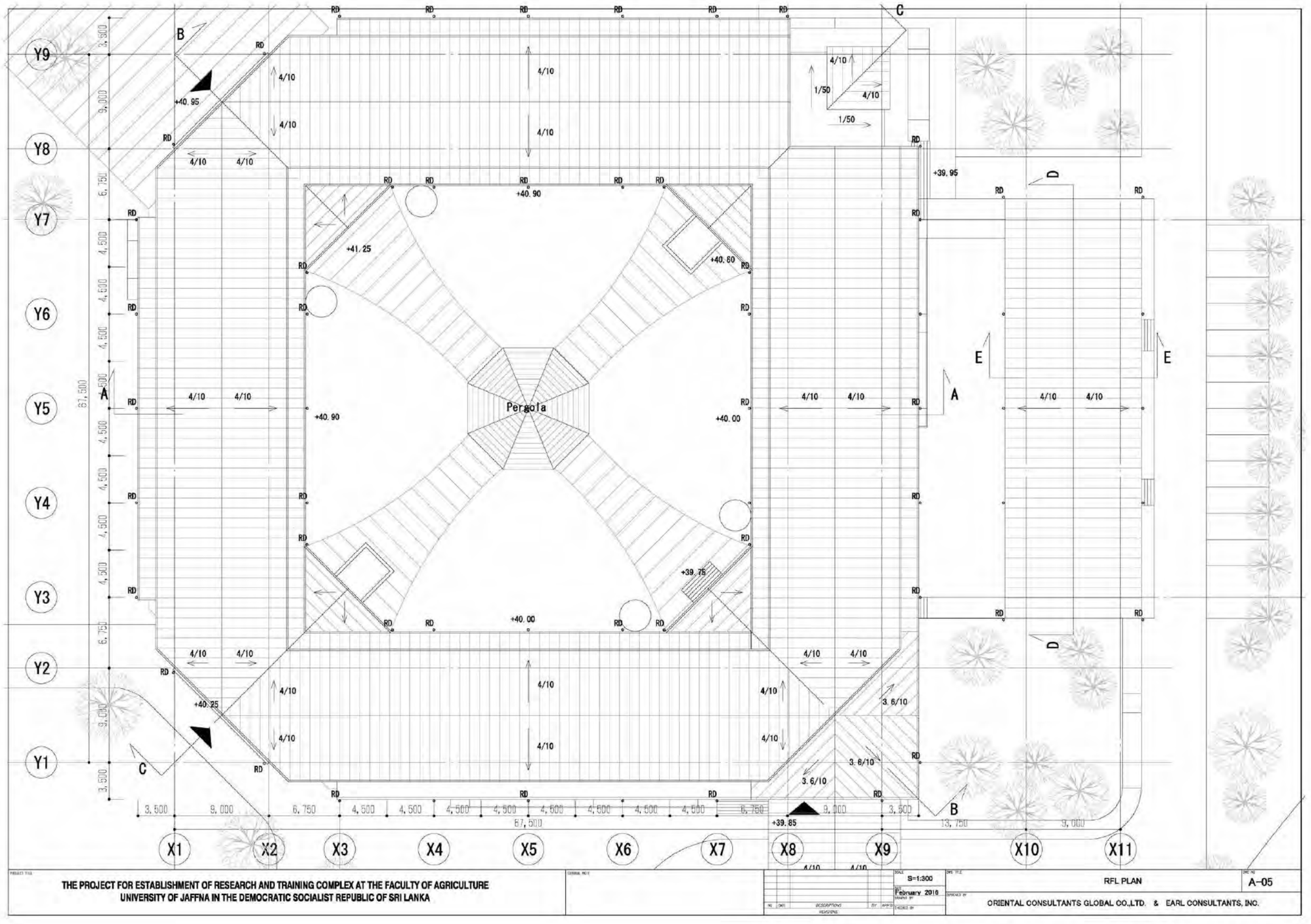
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X8
X9
X10
X11
A
B
C
D
E
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+40.90
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+40.80
+40.00
+39.75
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+39.85
+39.95
4/10
1/50
3.6/10
RD
3,500
9,000
6,750
4,500
67,500
13,750
THE PROJECT FOR ESTABLISHMENT OF RESEARCH AND TRAINING COMPLEX AT THE FACULTY OF AGRICULTURE
UNIVERSITY OF JAFFNA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
S=1:300
February 2016
RFL PLAN
A-05
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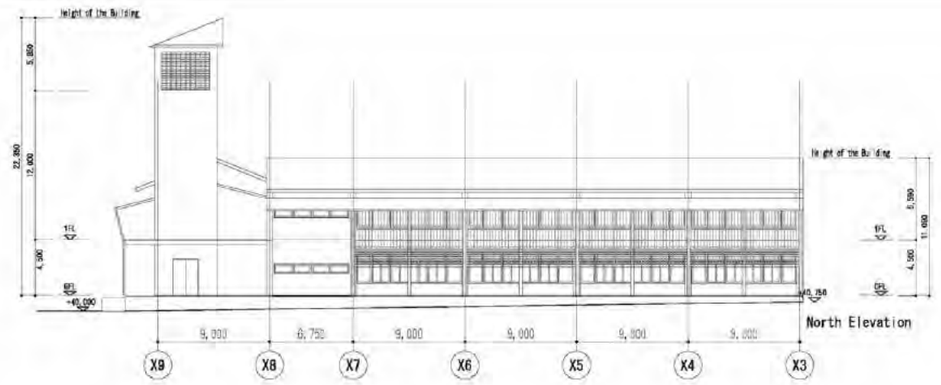
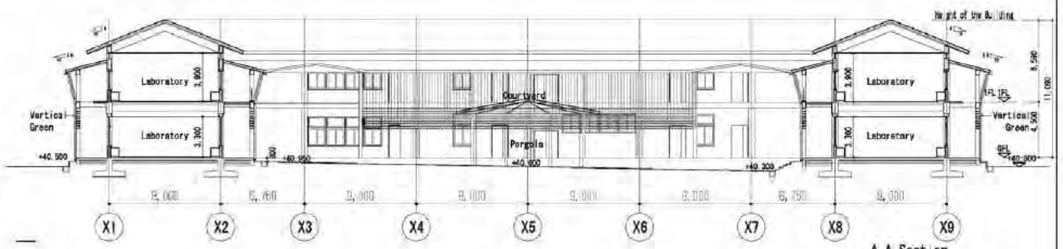
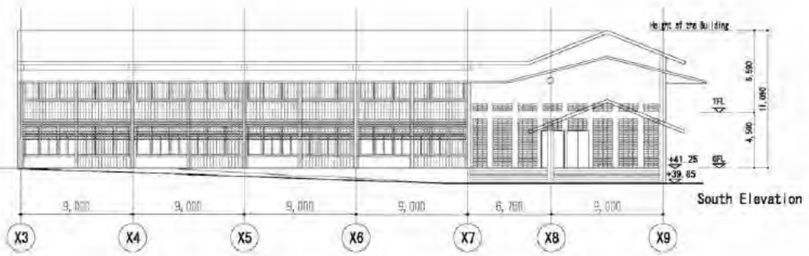
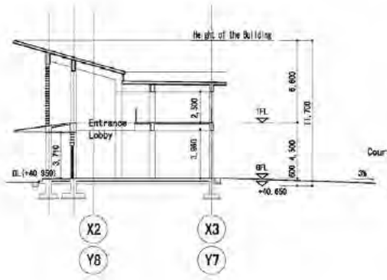
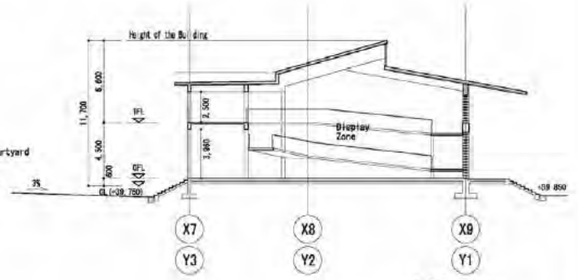
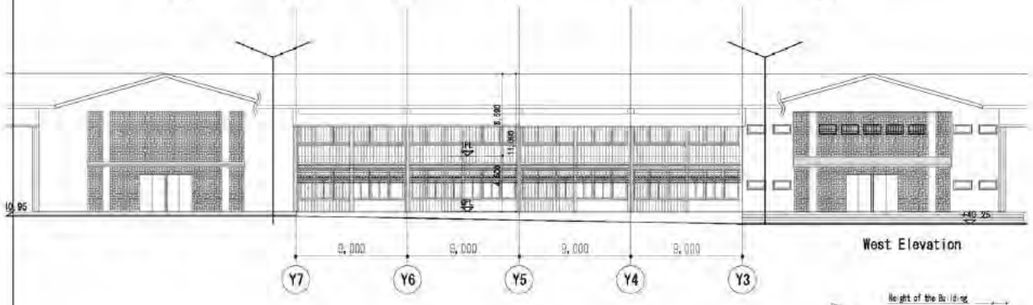


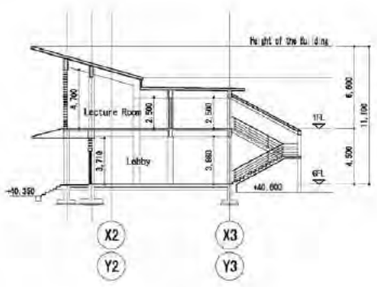


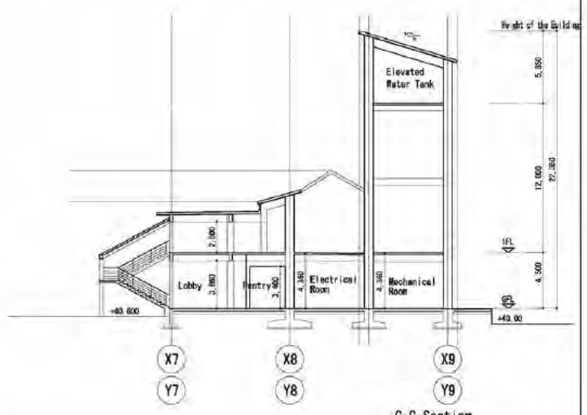


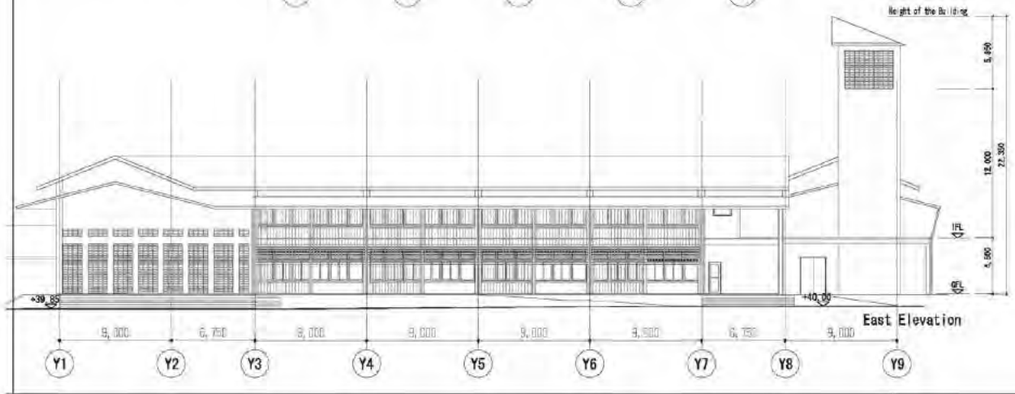


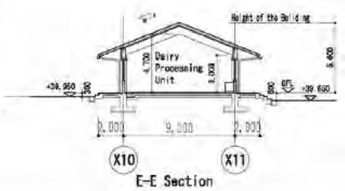


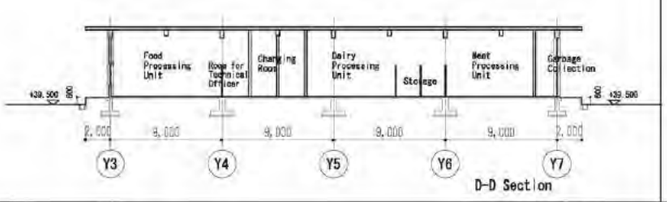












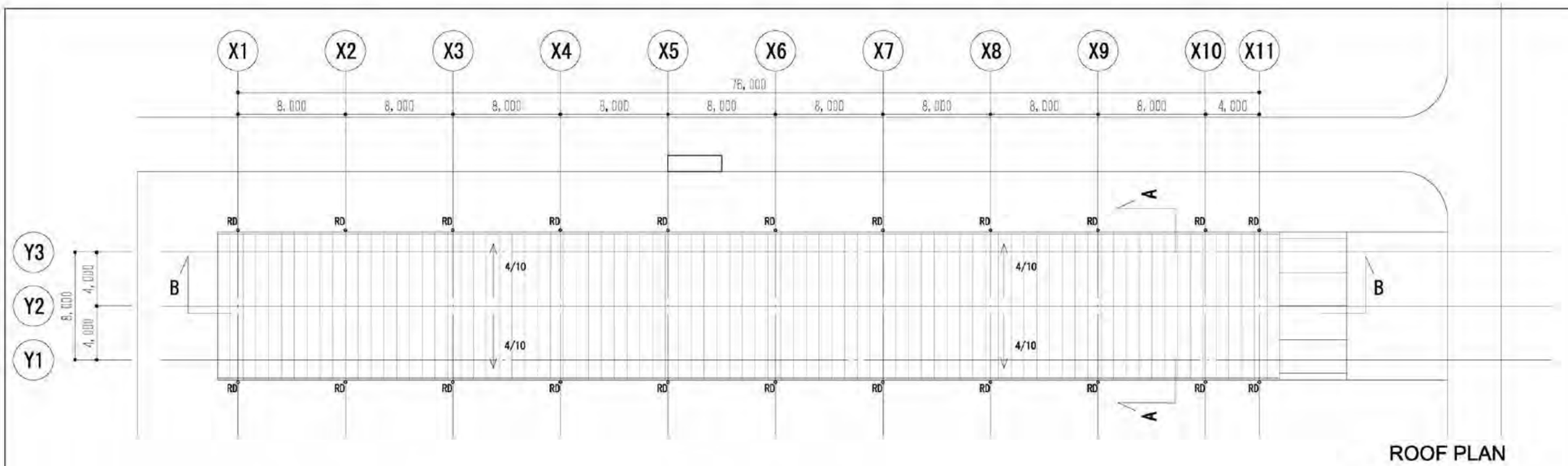
THE PROJECT FOR ESTABLISHMENT OF RESEARCH AND TRAINING COMPLEX AT THE FACULTY OF AGRICULTURE
UNIVERSITY OF JAFFNA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

S=1:400
February 2016

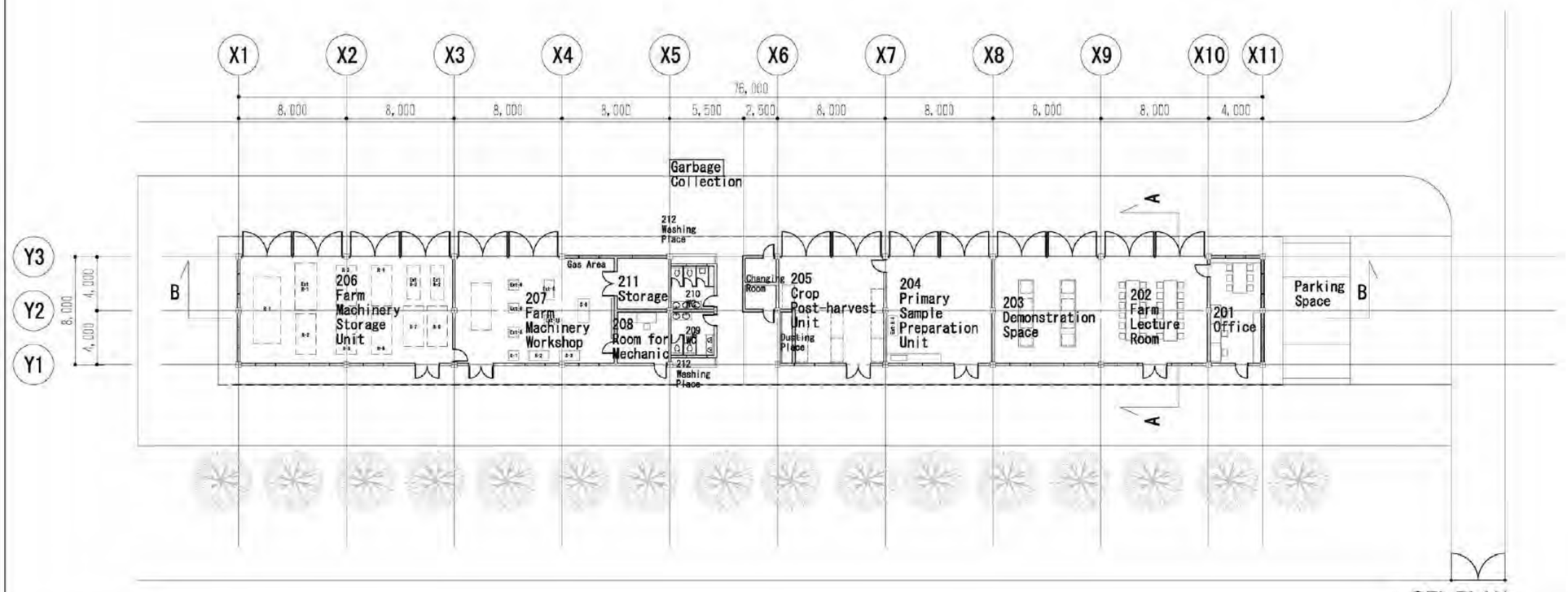
ELEVATIONS SECTIONS

A-06

ORIENTAL CONSULTANTS GLOBAL CO.,LTD. & EARL CONSULTANTS, INC.



ROOF PLAN



GFL PLAN

THE PROJECT FOR ESTABLISHMENT OF RESEARCH AND TRAINING COMPLEX AT THE FACULTY OF AGRICULTURE
UNIVERSITY OF JAFFNA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

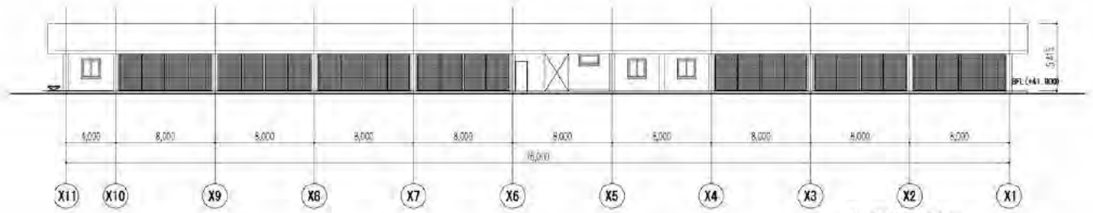
S=1:300

February 2016

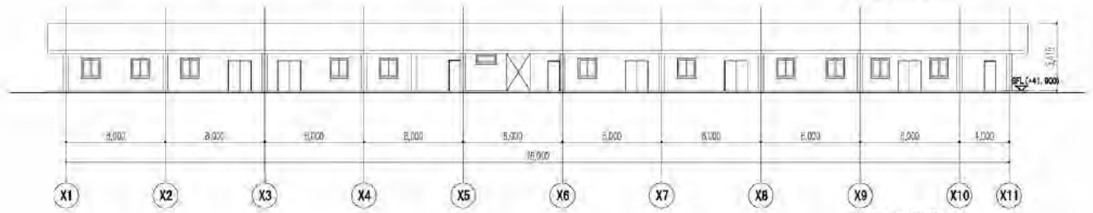
FARM MANAGEMENT BUILDING PLANS

A-07

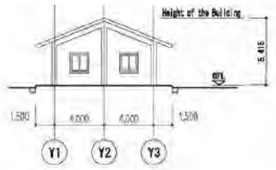
ORIENTAL CONSULTANTS GLOBAL CO.,LTD. & EARL CONSULTANTS, INC.



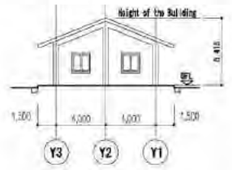
North Elevation



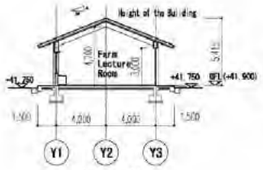
South Elevation



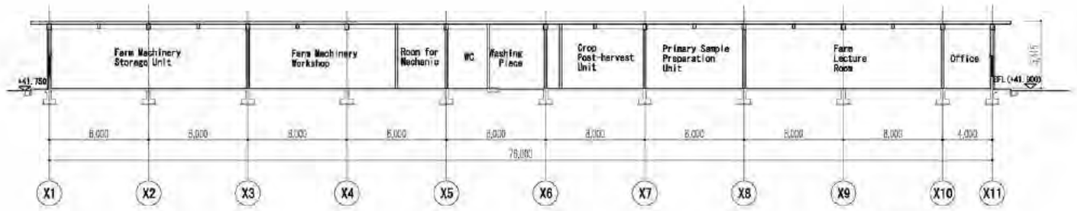
East Elevation



West Elevation

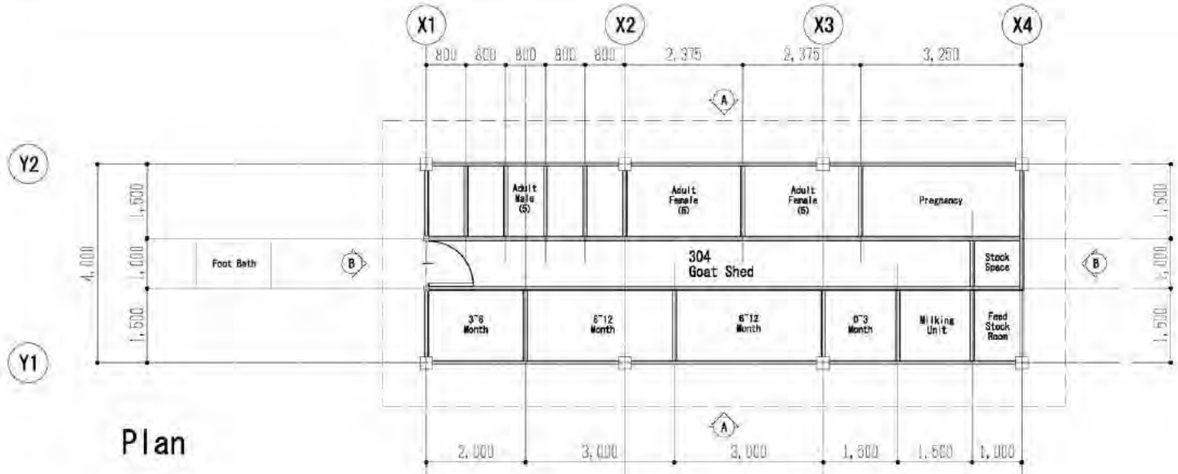


A-A Section

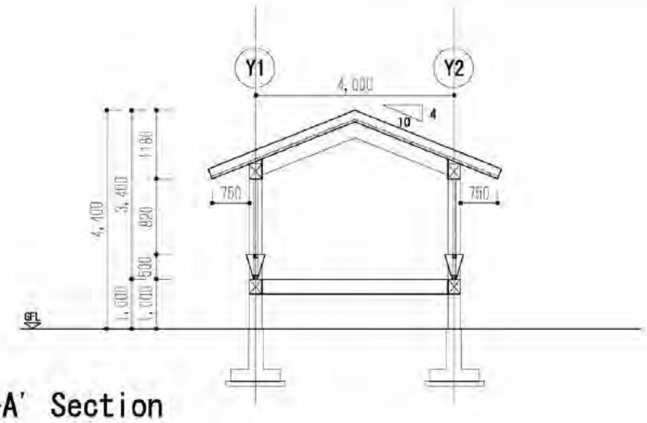


B-B Section

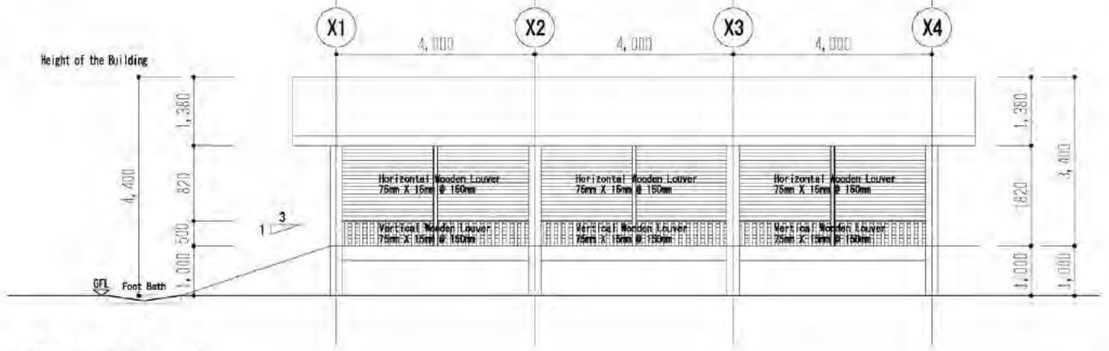
THE PROJECT FOR ESTABLISHMENT OF RESEARCH AND TRAINING COMPLEX AT THE FACULTY OF AGRICULTURE UNIVERSITY OF JAFFNA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA			SCALE S=1:400 DATE February 2016	FARM MANAGEMENT BUILDING ELEVATIONS SECTIONS / A-08
				ORIENTAL CONSULTANTS GLOBAL CO.,LTD. & EARL CONSULTANTS, INC.



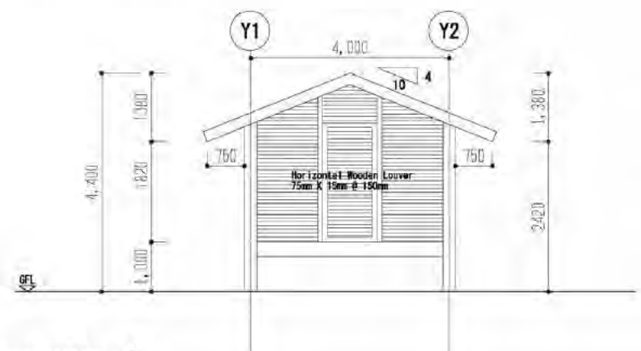
Plan



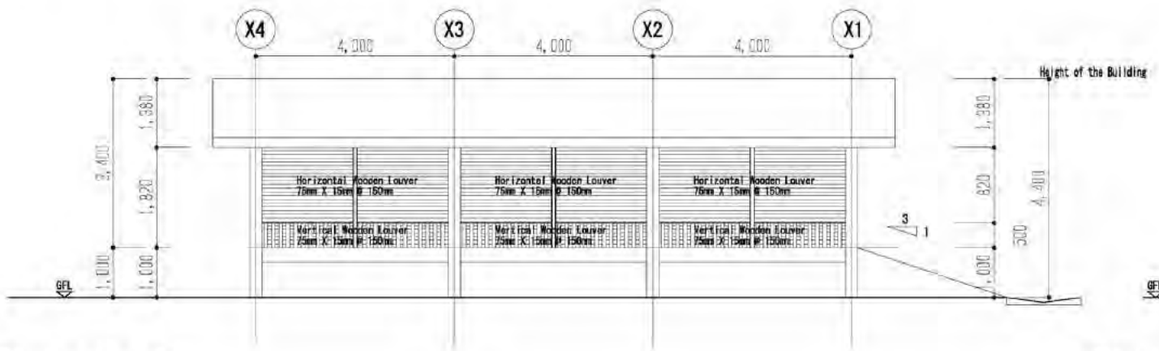
A-A' Section



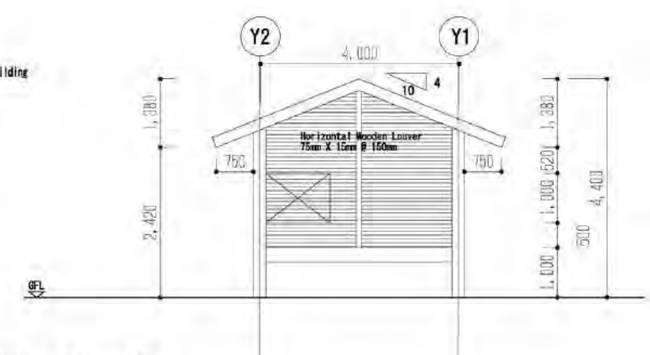
Elevation A



Elevation B

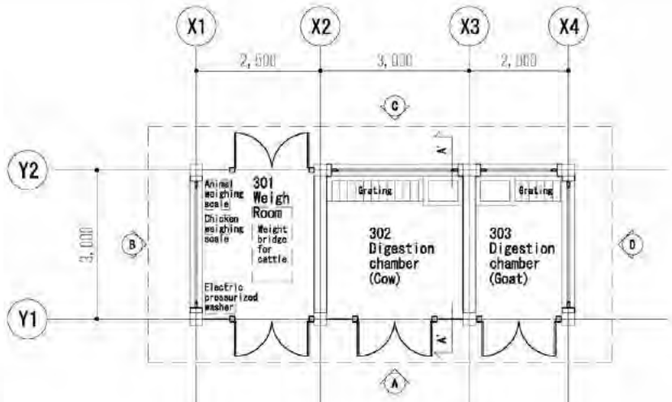


Elevation C

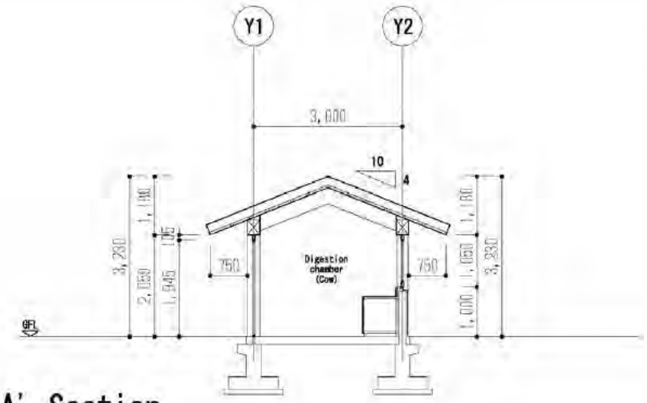


Elevation D

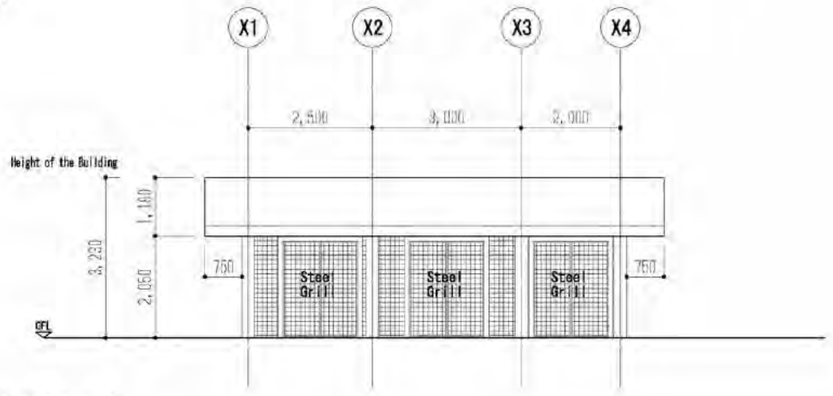
THE PROJECT FOR ESTABLISHMENT OF RESEARCH AND TRAINING COMPLEX AT THE FACULTY OF AGRICULTURE UNIVERSITY OF JAFFNA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA		S=1:100 February 2016	GOAT SHED / A-09
			ORIENTAL CONSULTANTS GLOBAL CO.,LTD. & EARL CONSULTANTS, INC.



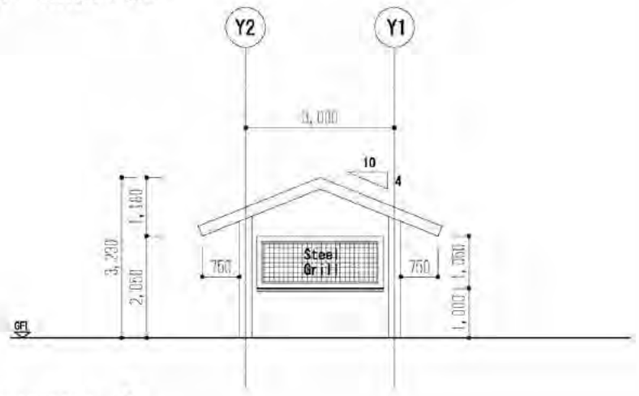
Plan



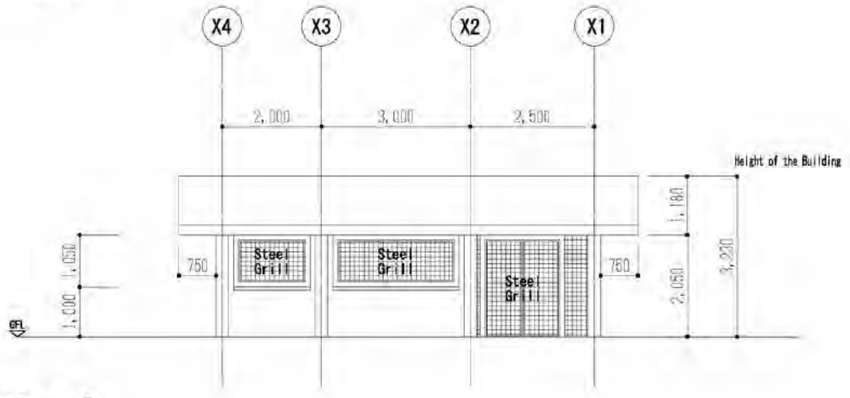
A-A' Section



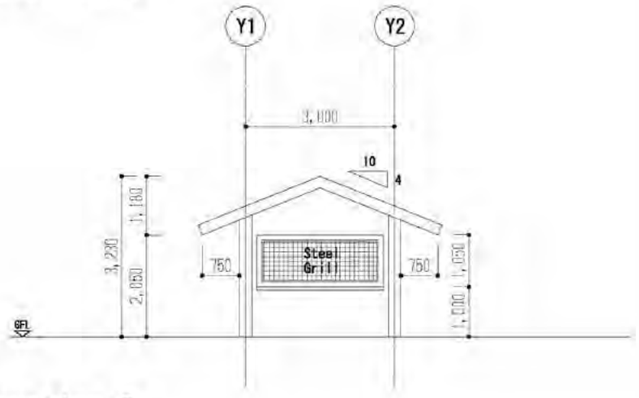
Elevation A



Elevation B

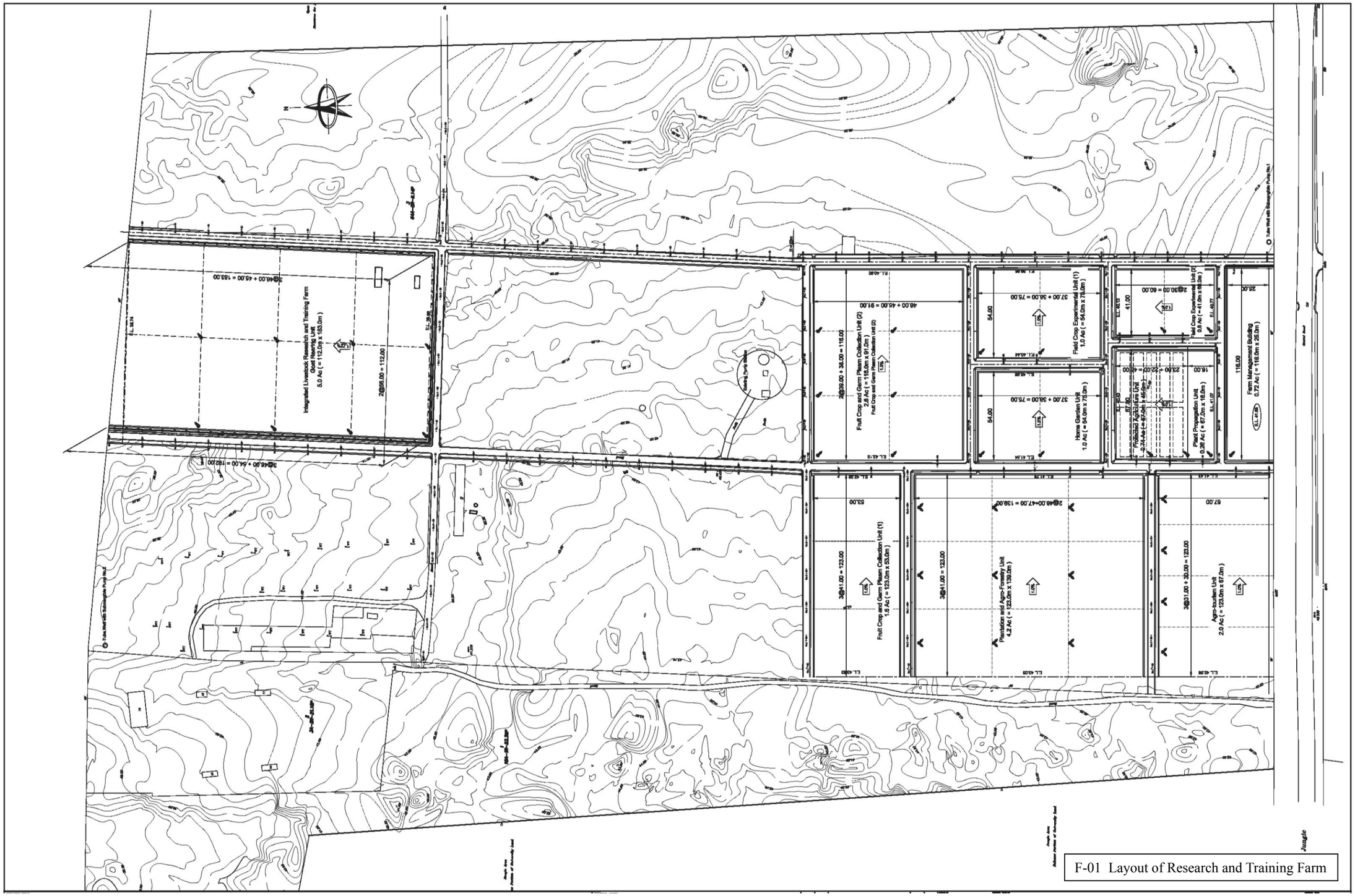


Elevation C

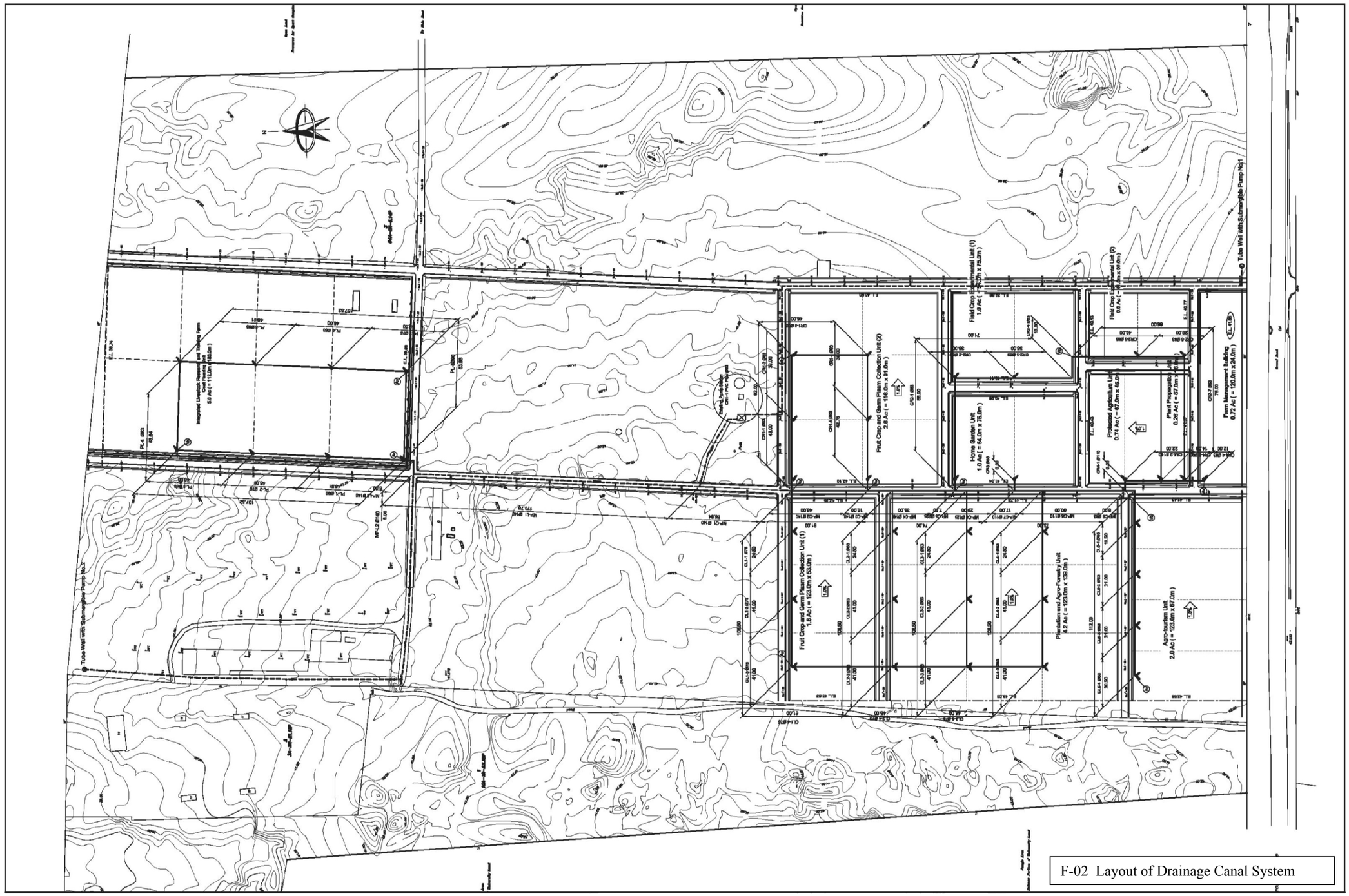


Elevation D

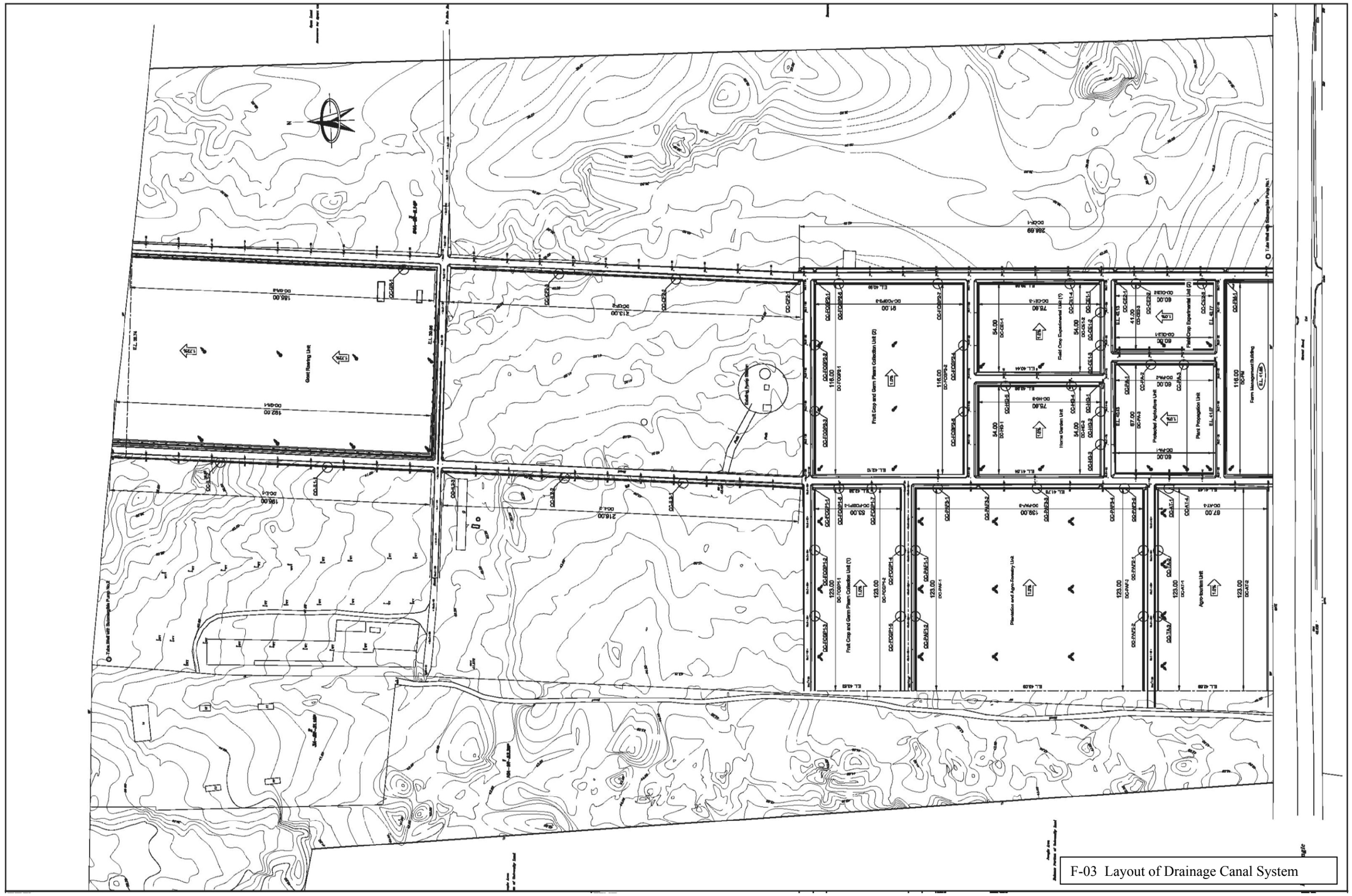
THE PROJECT FOR ESTABLISHMENT OF RESEARCH AND TRAINING COMPLEX AT THE FACULTY OF AGRICULTURE UNIVERSITY OF JAFFNA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA		S=1:100 February 2016	ANIMAL MESUREMENT SHED A-10
			ORIENTAL CONSULTANTS GLOBAL CO.,LTD. & EARL CONSULTANTS, INC.



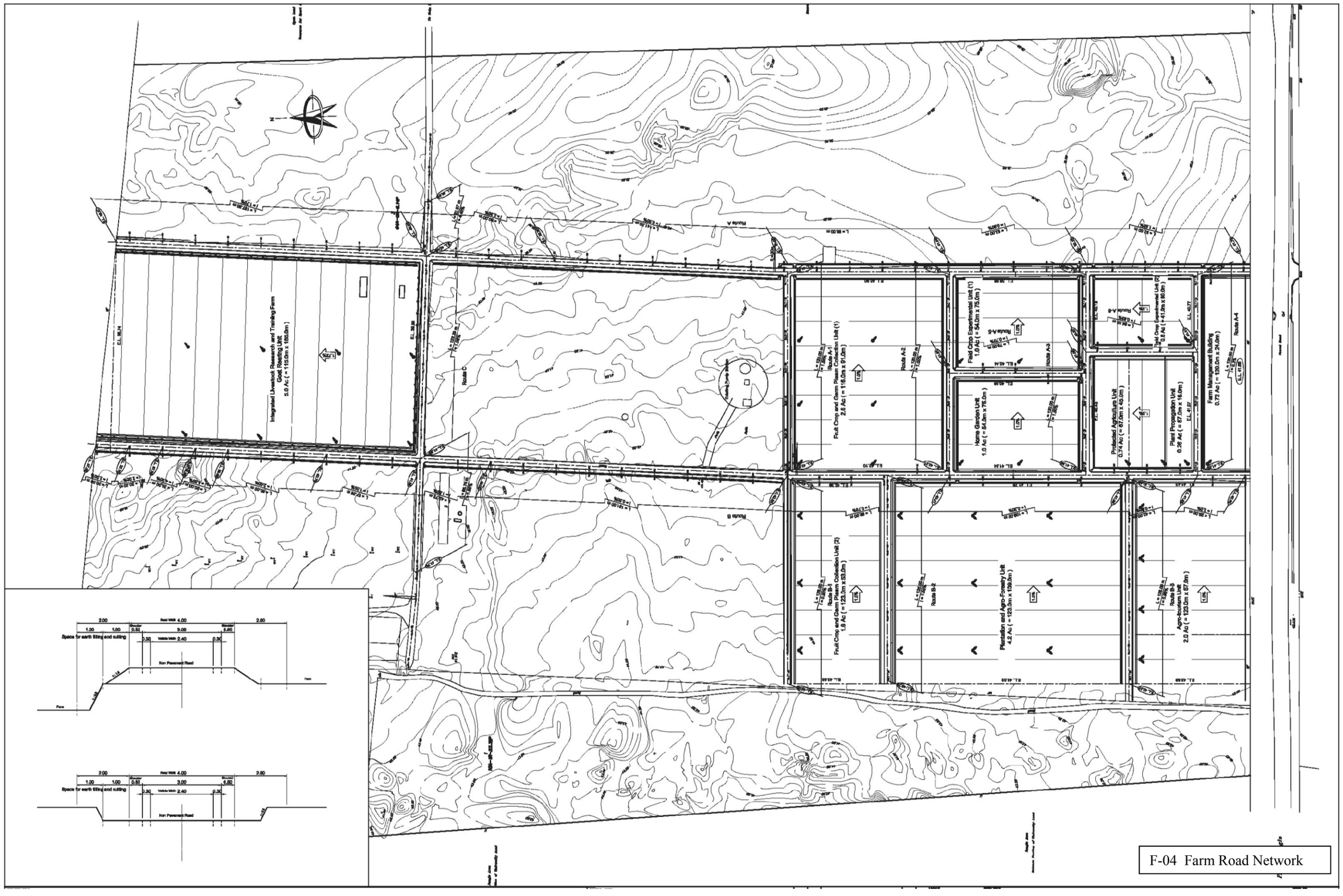
F-01 Layout of Research and Training Farm



F-02 Layout of Drainage Canal System



F-03 Layout of Drainage Canal System



F-04 Farm Road Network

2.2.4 Implementation Plan

2.2.4.1 Implementation Policy

(1) General

1) The Exchange of Notes (E/N) for the Grant Aid Project shall be concluded between the Government of Japan and the Government of Sri Lanka after the cabinet meeting and decision by the Government of Japan.
2) With the approval of the Government of Japan, Exchange of Notes (E/N) shall be entered into between the Government of Japan and Government of Sri Lanka. Continuously, the Grant Agreement (G/A) shall be entered into between JICA and the Government of Sri Lanka in order for the project to be formally committed and implemented.
3) Following the conclusion of the G/A, consultants of Japanese nationality and the Government of Sri Lanka will conclude an execution design and supervision contract, and immediately start detailed design work.

(2) Detailed Design Stage

1) For the Detailed Design, full details of facilities and equipment in the Outline Design should be carefully confirmed and discussed with the implementing agency.
2) The consultant shall discuss the technical issues through meetings with the relevant authorities in Japan and Sri Lanka during the detailed design stage.
3) It is believed that the design period will require approximately 3 months.

(3) Tender

1) Tendering will be conducted in line with the Preparatory Survey Design and Integration Manual (trial version) “Complete Version (Construction sector)” (March 2009) relating to financial aid provided by JICA.
2) It is thought that the tendering method will be either a consortium between Japanese construction companies and trading companies that combines facility construction and equipment, or a stand-alone method dividing facilities and equipment. Coordinating facility and equipment construction work schedules for the project is important, so it is considered that choosing the former method would be desirable to avoid disagreements.
3) The party executing the tender will be the implementing agency, but it is necessary for consultants to cooperate sufficiently while taking instructions from JICA.

(4) Construction

1) According to the result of the Preparatory Survey, local building materials, which are acceptable in quality and supply in Sri Lanka, should be used for the project as much as possible. However, ensuring and maintaining quality are the most important factors to be considered.
2) For the planning of labor supply, it is important that a Japanese contractor, as the prime contractor, supervises and manages the local contractor and his laborers to maintain the quality assurance required for the project.

(5) Implementation Organization

The organizations involved in this project are as shown below:

The organization responsible for the project is the Ministry of Higher Education and Highways (MOHEH) and the executing organization is University of Jaffna (UOJ). The following diagram shows the relationship between the executing organization, the Japanese consultant and contractor.

The Ministry of Finance is responsible for procedures of this Japanese Grant Aid project, such as E/N and G/A.

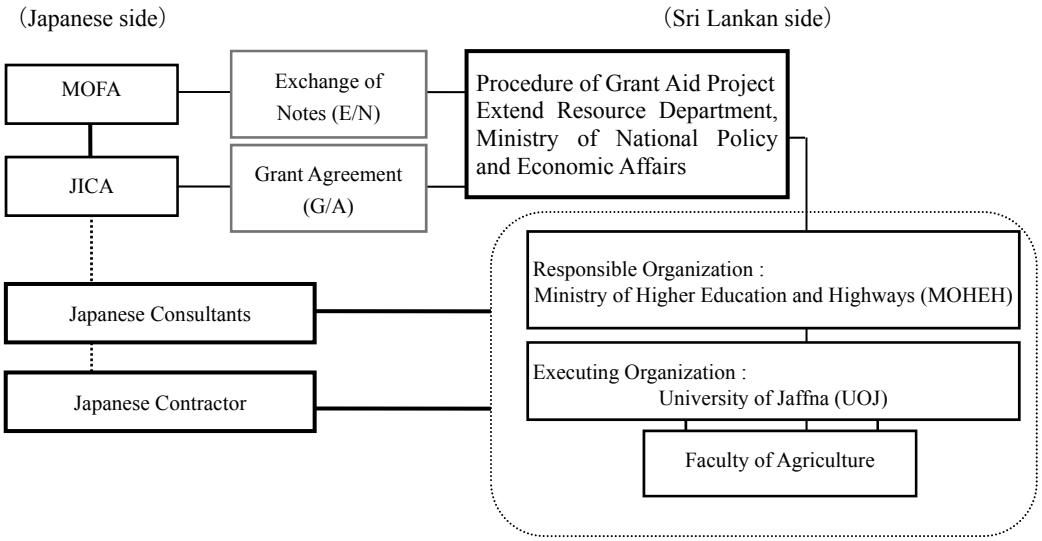


Figure 2-22 Implementation Organization

2.2.4.2 Implementation Conditions

1) October to January is the rainy season in the northern area of Sri Lanka. For construction planning, the earthworks, substructure and superstructure works should consider the season and be scheduled and completed before or after the rainy season.
2) Sri Lankan laws, codes and standards and Japanese standards should be followed. However, American Society for Testing and Materials (ASTM), British Standards (BS), etc., may also be applied considering the local conditions.
3) Close and detailed monitoring and coordination of schedules is required particularly between the facilities construction work and the period of installation of the equipment.
4) As the project site is located within the campus of UOJ, consideration of the surrounding environment during construction is required as shown below.
   a) The construction method that has the minimum influence on the adjacent UOJ facilities should be adopted. Construction methods to minimize noise and air pollution should also be adopted.
   b) Safety measures against construction vehicles that carry construction materials are required. Also, damage to the existing road should be prevented.
   c) A temporary yard and temporary buildings for the construction work will be planned within

the site. Therefore, safety measures must be taken to avoid exposing the UOJ staff and students to any danger during the construction.

5) MoHEH, the responsible agency of this project, shall bear the direct tax, such as PAYE Tax and Corporate Tax, levied on implementation of this Japan's Grant Aid project. MOHEH shall request the necessary budget to the Department of Fiscal Policy (DFP), Ministry of Finance, after signing of E/N and G/A.

6) Indirect Taxes and levies related to the project implementation including, but not limited to VAT (Value Added Tax), NBT (Nation Building Tax), PAL (Port and Airport Levies), CID, CESS, Excise Special Provision, and Construction Industry Guarantee Fund Levy, shall be exempted and /or borned by GoSL by categorizing the project as the project as the Specialized Project. MOHEH will prepare application documents and will apply to DFP.

2.2.4.3 Scope of Works

The responsibilities of the Japanese side and the Sri Lankan side for the implementation of this Japan Grant Aid Project are shown in the table below.

Table 2-79 Extent of Works

Japanese side	Sri Lankan side
(1) Building Works a) Structure works, finishing works b) Parking lot c) Access road within the site (2) Farm Works a) Land leveling works b) Irrigation and drainage system c) Farm road d) Related structure works (3) Electrical Works a) Low voltage power supply system within the Project site including installation of distribution panels, cables, conduit pipes and outlets b) Emergency power supply system providing a diesel engine generator c) Lighting system within the Project site including installation of lighting fixtures, cables, conduit pipes and switches d) Local Area Network System within the Project site including installation of switches, cables and LAN outlets e) Telecommunications system applying VoIP within the Project site f) Lightning Protection System g) Manual Fire Alarm System (4) Mechanical Works a) Installation of a new deep well b) Water Supply system within the Project site including installation of Elevated tank, reserve tank, pumps, piping and fixtures c) Sewerage system including piping works within the Project site d) Wastewater treatment facility (Septic tanks and soaked pits) e) Storm drainage piping to the existing open	(1) Site Preparation a) Pre-construction works ・ In case an UXO is found, GoSL shall promptly clear it. . b) Ground-preparation works: ・ Demolition of unnecessary existing buildings, utilities. ・ Removal of unnecessary existing trees. ・ Leveling and reclaiming the site for the building c) Preparation of temporary stock yard for construction period d) Temporary access road for the construction. ・ Separate gate from students/staff access. (2) External Works and Approach Roads ・ Landscaping, planting, etc., within the site ・ Fencing around the site ・ Permanent road works around the site (3) Utilities and Facilities a) Electrical Works ・ Cabling works from the existing low voltage distribution panel to the distribution panel at the Research & Training Complex and Farm Management building provided by the Project b) Network and Telecommunication Works ・ Installation work of fibre optic cable from the existing main switch located in the Computer Unit to the switch provided by the Project c) Storm drainage from outside (4) Others (before implementing project) a) Commissions to the Japanese foreign exchange bank for its banking services based upon the Banking Arrangement (B/A) namely the advising commission of the Authorization to Pay (A/P) and payment commission. b) Smooth customs clearance, tax exemptions,

ditch inside the Project site f) Fire extinguishing facility (Fire extinguishers) g) Air conditioning system and Mechanical Ventilation system (5) External Work for the Building Road, path and parking lots within the site (6) Equipment Equipment for research, experiments and practical training (7) Technical assistance for experiments and practical training	and prompt internal transportation for the imported construction materials and equipment. c) Governmental works including the application and obtaining of governmental approvals and permissions (5) Tax exemptions and necessary preferential treatment for the construction staff from Japan or a third country (6) Smooth entry, re-entry, and departure of DRC for the Japanese technical members (7) All the expenses, other than those to be born by Japan Grant Aid within the scope of the Project (8) Participation to the explanation on the operation and maintenance method. (9) Issue the Completion certificate (10) After the Construction : Management, operation and maintenance cost for the new building and facilities

2.2.4.4 Consultant Supervision

(1) Basic Policy

A consultant supervisor (a professional in the field of architecture) is dispatched to coordinate the architectural, mechanical and electrical works. Also, technical engineers are dispatched to supervise the important stages of structural, electrical and mechanical works, etc. A resident engineer is dispatched to supervise and inspect during important stages such as beginning of construction, the structure works, the completion and final inspection.

Table 2-80 Plan of Personnel Necessary for Supervision

Supervisor	Period (Months)
Supervisor (Architecture)	Approx. 17.00
Project Manager/Resident Engineer (Architecture)	Approx. 1.50
Building construction (Architectural Engineer)	Approx. 0.73
Building construction (Structural Engineer)	Approx. 0.50
Building construction (Electrical Engineer)	Approx. 1.00
Building construction (Mechanical Engineer)	Approx. 1.00
Farm construction (Farm Engineer)	Approx. 1.50

The supervision works are to control the construction schedule monitoring and supervising construction method, the number of laborers, and procurement of construction materials and equipment. At the same time, quality of materials and construction work, control of construction cost and security for workers shall be included. If the construction work being carried out by the Sri Lankan side is delayed, the consultant may urge acceleration of the construction work. Furthermore, a suitable construction schedule will be planned in consideration of the construction and procurement arrangement as mentioned in 2.2.4.9.

(2) Contents of Consultant Assignment in Sri Lanka and Japan

The scope of the works for the supervisor at the project site is to check and approve the construction plans and drawings. In addition, the construction schedule will be managed to monitor the building construction, procurement equipment and installation of equipment. The scope of the works for the

supervisor in Japan is quality control for building construction methods, materials and design through reports by the supervisor at the project site, reporting progress of the construction work to JICA, and inspection of equipment procured from Japan in factories before shipment.

(3) Issuance of Certificates

The certificates on export of construction materials and equipment, the payment for construction, practical completion and final completion, etc., are issued.

(4) Submission of Reports, etc.

Monthly progress reports, completion documents and photos of works from the contractor shall be checked and approved and submitted to the Government of Sri Lanka and JICA. The completion report shall be prepared and submitted to JICA in accordance with the Grant Aid guidelines.

(5) Others

Monitoring and expediting the schedule of works to achieve smooth operation of related works executed by the Government of Sri Lanka, shall be done as necessary.

2.2.4.5 Quality Control Plan

(1) Basic Policy

The Detailed Design drawings shall be developed based on the studies analyzed from actual circumstances in Sri Lanka, maintenance cost, use of local materials and local construction methods. The specifications should comply with Sri Lankan construction standards, Japanese Regulations such as Japanese Architectural Standard Specification (JASS), British Standards (BS) and American Society for Testing and Materials (ASTM) to ensure the quality of buildings, utilities and equipment. The construction plan, implementation schedule and shop-drawings, which are to be submitted by the contractor during the construction period, shall be examined and approved by the Consultant.

(2) Quality Examination (Building and Farm Construction)

The Consultant shall examine the implementation plan submitted by the Contractor prior to the commencement of each stage of the works, and approve it if the construction materials and the execution methods conform to specifications. The Consultant should inspect necessary portions of work based on the implementation plan and specifications.

Quality assurance inspections of the materials for approval or the execution of work are essential. The manufacturers' warranty on the products shall be sufficient to keep the quality required in the specifications which comply to codes and regulations related to developed nations as mentioned above.

1) Earthwork

According to the soil investigation report, which was made in the Preparatory Survey, the ground condition of the project site is satisfactory. The progress schedule should be examined to include the rainy season in order to assure safety and schedule delays.

2) Reinforcing Bar Work

The Mill-Sheet, etc., showing re-bar content submitted by the Contractor, should be confirmed by

the Consultant. Also, bar quality and strength should be inspected to match yield strength in the specifications.

3) Concrete Work

There are 3 ready mixed concrete plants in Kilinochchi and Jaffna. They are located a maximum of one and a half hours by car from the project site. The production capacity, storage condition and quality control are acceptable. Therefore, ready mixed concrete shall be adopted for the strength categories required by this report under structural design. The important items for the supervision works are as follows:

a) Items to be inspected for concrete material

Material	Item to be inspected	Method of inspection
Cement	Hydration Heat	Dissolution Heat
Sand/ Gravel/ Crushed Stone	Grading	Sieve analysis
	Absolute dry specific gravity	Specific gravity & ratio of water absorption
	Alkali aggregate reaction	Alkali aggregate reaction test
Water	Organic impurities	Quality test of water
Cement	Hydration Heat	Dissolution Heat

b) Items to be inspected for the mixing test

Item to be inspected	Method of inspection
Estimate test for structural concrete	Compression test machine
Slump	Slump cone
Concrete humidity	Hygrometer
Air content	Manometer
Chloride volume	Measuring instrument for salt

c) Items to be inspected for the concrete placing

Item to be inspected	Method of inspection
Time from mixing to completion of concrete placing	Check time of completion of concrete placing (one hr. or less)
Slump	Slump cone
Concrete humidity	Hygrometer
Air content	Manometer
Chloride volume	Measuring instrument for salt

d) Items to be inspected in the progress schedule (Inspection for the accuracy of concrete placing)

Item to be inspected	Method of inspection
Estimate test for structural concrete	Compression test machine
Accuracy for the openings of door & windows	Measurement
Accuracy for horizontal level of concrete slab	Spirit level & measurement
Status of Finishing	Visual inspection

(3) Quality inspection for equipment

The Consultant shall hold a detailed discussion with the Sri Lankan side and the equipment supplier on the work period, scope of work, and dispositioning plan to devise a procurement plan that is most suitable for this particular project at the time of equipment procurement and installation management. In addition, the consultant shall ensure the smooth progress of all areas of our operation while adjusting differences of opinion with the facility plan after the decision of equipment to be procured. Considerations for the procurement management are pointed out as follows.

- The Consultant will confirm with consultant for the facility and engineers in charge of M & E Plan, the person in charge of the facility plan for the Sri Lankan side, and equipment supplier

contents of equipment procurement, installation plan, country of origin, procurement, and utility soon after conclusion of the supply contract.

- The Consultant will carry out an inspection before shipment in such a way that the Consultant consigns a third party to inspect the products shipped from Japan.
- On the occasion of the installation work by the equipment supplier, the Consultant shall dispatch a procurement management engineer to perform the adjustment with facility construction work based on a disposition plan of the equipment.
- The Consultant shall confirm the number of items specified in the supply contract, presence of disagreements, required specifications and functions and performance of the explanation of instruction manuals and complete the equipment hand-over work.

2.2.4.6 Procurement Plan

(1) Procurement Plan

Local materials shall be used as much as possible, and the basic policy shall be to reduce cost and to select materials that have the best quality with low maintenance costs.

The division of procurement of construction materials is as shown in the following Table 2-82. As shown, most of the materials can be obtained in Sri Lanka. However, some materials for mechanical works such as well water treatment equipment, supply fan units, emergency shower units, chemical faucets, LPG units, etc. will be procured from Japan. Thus, it should be confirmed that there are no problems with respect to material quality and production quantity from the locality of procurement.

In principle, the medical equipment of this project will be procured from either Japan or Sri Lanka. However, procurement from additional countries should be also considered to avoid cases in which limiting procurement to Japanese or Sri Lankan products would hinder fair competition in tendering. Therefore, procurement from the additional countries will be considered for the following items of equipment.

1) Items that are not manufactured in Japan, or for which manufacturers are limited in number
   Feed fiber analyzer, Ultrasonic milk analyzer, Ganong's potometer, etc.
2) Items that need after-sales services by local agents in terms of operation and maintenance services after procurement
   GC (Gas chromatography), twin screw extruder, spectrophotometer, etc.

The procurement countries of major items are shown in Table 2-81.

Table 2-81 Procurement Situation of Construction Materials

Name of material	Procurement Country		Remarks
	Sri Lanka	Japan	
Portland Cement	○		
Sand	○		
Gravel	○		
Re-bar	○		
Steel frames	○		
Form	○		

Name of material	Procurement Country		Remarks
	Sri Lanka	Japan	
Concrete Blocks	○		
Timber	○		
Metal Fittings	○		
Aluminum sash	○		
Glass	○		
Paint	○		
Waterproof material	○		
Distribution Panel	○		
Wire, Cable	○		
Wiring Devices (Switch, Outlets)	○		
Conduit Pipe	○		
Lighting Fixtures	○		
Air Conditioning Units (Split Type)	○		
Ventilating Fans	○		
Water reserving tank	○		
Sanitary Fixtures	○		
Pipe (uPVC, SGP)	○		
Valve	○		
Well water treatment equipment		○	
Supply fan unit		○	
Emergency shower unit		○	
Chemical faucet		○	
LPG Unit		○	
Generator	○		
Construction Machinery	○		
Furniture	○		

Table 2-82 Procurement Plan of Various Items of Equipment

Descriptions	Procurement Countries		
	Sri Lanka	Japan	Third countries
Oven, Centrifuge, CO_2 incubator, Laminar flow cabinet, Refrigerators, Low Temp. Incubator, Sterilizing milk processor, etc.		○	
Bomb calorimeter, Flame photometer, Texture analyzing machine (meat & fish), Stereo microscope, Freezer, programmable Fluorimeter, Spectrophotometer, GC (Gas chromatography), Linking machine, Shear force test machine, 4-wheel tractor, etc.		○	○
Green leaf area meter, CO_2 dissolved sensor, Animal models, Macro Kjeldhal, Soxhlet apparatus, Feed fiber analyzer, Ganong's potometer, Ultrasonic milk analyzer. Twin screw extruder, etc.			○

2.2.4.7 Plans for Initial Operational Guidance and Operational Guidance

It is desirable for precision items such as GC (Gas chromatography) to conduct technical guidance by technicians and/or engineers of manufacturers or local agents specialized in the planned equipment.

The initial guidance on equipment operation should be provided to all the users on all the items by technicians and/or engineers sent from the supplier at the time of delivery and installation. The guidance for equipment to be installed should consist of the operation method, precautions during handling, daily inspection, troubleshooting, and regular maintenance control. It is important to train the users sufficiently

on inspection procedures conducted before and after operation of the equipment to keep the equipment in a good working condition for a long period.

2.2.4.8 Soft Component (Technical Assistance) Plan

During 25 years of evacuation to Jaffna, FoAg has been conducting education and research activities continuously, as well as promotion activities through collaboration with Department of Agriculture, even though they were stationed in temporary private houses or renting laboratories of other faculties, UOJ.

However, due to the limitation of facilities and equipment, the research activities, experiments and training that they could organize and implement were very limited. Also, facilities and equipment that FoAg has been managing were also limited.

It will be useful and effective to provide the following types of assistance for FoAg to maximize their use of facilities and equipment that will be provided under this project.

Table 2-83 Output and Activities of proposed Soft Components

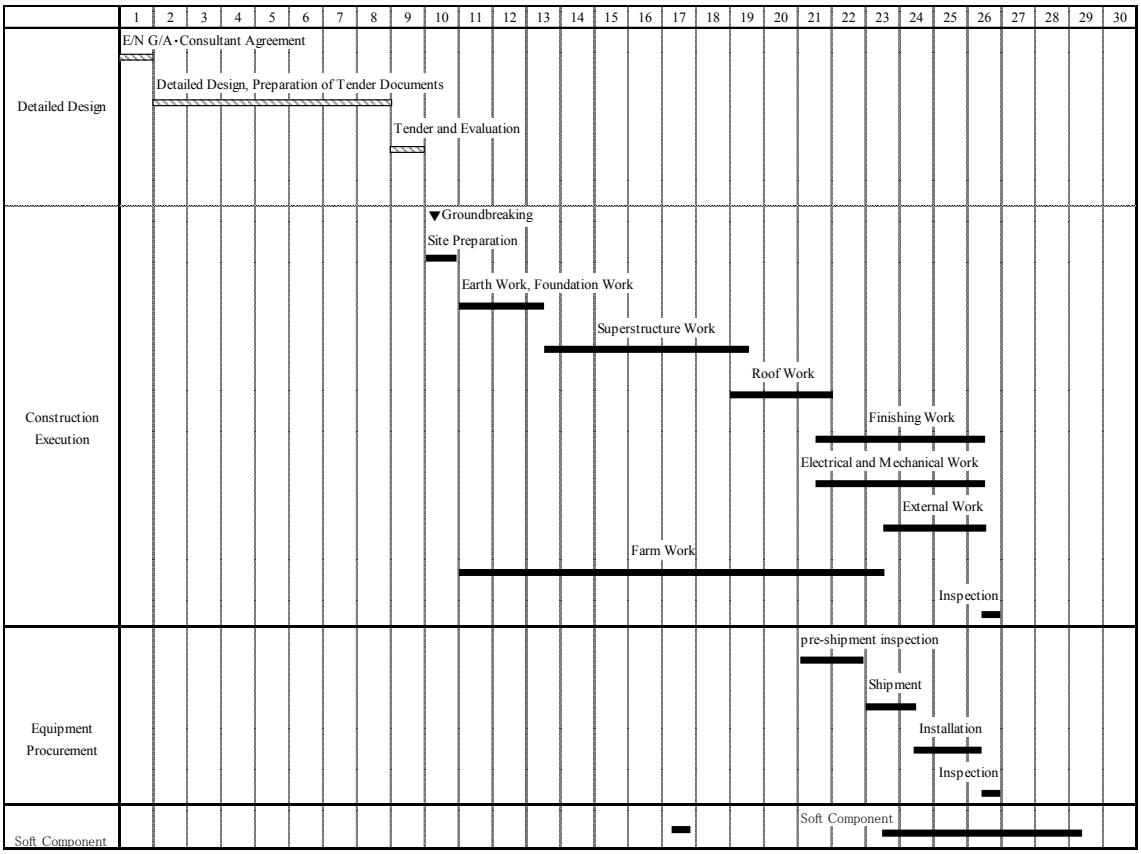
Outputs	Results	Activities
(1) Classes that incorporate experiments and practical training will be given.	(1) Reference books shall be made for experiments and practical training (2) Teaching staff shall learn experiments and practical training methods	■ Confirm the experiment & training implementation status of each department and the knowledge of teaching staff. ■ Introduce experiment and practical training based on the syllabus and create implementation objectives. ■ Make a list of experiments & training that require reference books. ■ Create reference and handbooks together with the teaching staff of each department, and provide training based on them.
(2) A system to properly manage the laboratory equipment, tools and materials shall be built.	(1) Equipment and tools shall be properly stored and managed. (2) Inventory management shall be properly conducted.	■ Explain in detail the method of cleaning, organizing, and managing the equipment. ■ Create and use the equipment's organized checklist. ■ Create equipment management manuals together with the person in charge ■ Explain the management method. ■ Confirm the inventory. ■ Teach how to fill the inventory management list.
(3) The Training and Research farm shall be properly managed.	Farm management plan shall be created. The farm management implementation system shall be completed	■ Develop an annual plan regarding crop acreage and pumping management together with the farm administrator and farm users (Faculty of Agriculture). ■ Establish "Farm training committee (tentative)" ■ Put together a handbook on how to manage the farm along with farm administrator and farm users (both used and unused). ■ Calculate the necessary farm management annual cost following the farm manager. ■ Prepare a plan for agricultural machine maintenance, including organization and maintenance method along with farm administrator and farm users.

For the implementation of the above-mentioned activities, it is proposed to dispatch eight experts to Sri Lanka several times between the middle of construction and a few months after the completion of construction.

2.2.4.9 Implementation Schedule

The tentative implementation schedule for the project is expected as shown in Table 2-84.

Table 2-84 Tentative General Project Schedule



2.3 Obligations of the Sri Lankan side

2.3.1 Responsibilities of the Sri Lankan side

In the case this project is implemented, the Sri Lankan side will carry out the following scope of works, and it has been confirmed that the Sri Lankan side agrees to execute their scope of works during the Preparatory Survey.

(1) Responsibilities of the Sri Lankan side

1) Tax Exemption

a) Under the Japan Grant Aid Scheme, the equipment and materials purchased for the project shall be tax free.

b) Based on the contract that was verified, the equipment and services provided, and the Japanese who are involved in this Project shall be exempt from custom tariffs, income tax and other domestic taxes.

2) Assistance with Entry Permit and Visa

a) Based on the verified contract, assistance with entry permits and visas will be provided by Sri Lanka to Japanese nationals who will be involved in this project.

2.3.2 Portions by the Sri Lankan Side

The portions by Sri Lankan side are shown Table 2-79 Extent of works. The major items by the Sri Lankan side are noted as follows:

(1) Before Implementation of the Project

1) Detection of landmines and UXO, and remove them if necessary.
2) Clearing the site, such as demolishing and removing trees and roots, existing facilities and base, garden and back-filling and leveling of the site before the construction starts.
3) Extending the approach road for the access road to the project site during construction as necessary.
4) Providing temporary power and water supply for construction.

(2) During Implementation of the Project

1) To issue permissions and licenses, etc., necessary for the implementation of the project, without delay.
2) Construct cabling or piping work for main feeder wiring, water supply and telephone line, etc., to the site.
3) Landscaping and planting, etc., in the site.
4) To purchase and install furniture, curtains and carpets, etc., for the new buildings, if necessary.

(3) After Implementation of the Project

1) Securing the expense for the operation and maintenance of the facility should be ensured before completion of the Project.

In order to carry out the project smoothly for the portions by the Sri Lankan side, the contents, schedule, etc., should be sufficiently explained. The budget for the portions by the Sri Lankan side should be

prepared with the budget of UOJ. In order to facilitate completion of construction in accordance with the schedule, the Sri Lankan side must complete their scope of works on schedule and coordinate their works with the Japanese side. The Preparatory Survey Team has also explained this importance. It is necessary for the Japanese side to monitor the progress in regard to this matter.

2.4 Project Operation Plan

2.4.1 Operation and Management Plan of the Buildings

(1) Securing budget necessary for operation and maintenance

The necessary budget for operation of FoAg will be distributed by UOJ, considering the balance with other faculties. According to past records, the amount of budget has been increased, but the share of FoAg in the total budget of UOJ was kept at approximately 8%. It is around the mean among the faculties, but much lower than the Faculty of Medicine (17%), Faculty of Science (18%) and Faculty of Art (26%).

It is obviously required to increase the budget for the FoAg after the completion of this project.

Table 2-85 Budget for the University of Jaffna

	2013		2014	
	UOJ	FoAg.	UOJ	FoAg.
1) Personal Emoluments	697,024,683.20	46,731,589.39	826,170,151.53	56,647,614.44
2) Traveling Expenses	3,661,463.35	448,729.15	3,492,780.67	382,300.64
3) Supplies	28,478,687.41	4,307,964.10	32,904,002.33	4,771,191.34
4) Minor Repairs and Maintenance	10,551,778.99	465,921.20	14,283,453.81	1,467,124.38
5) Contractual Services	62,435,707.95	13,137,937.84	92,044,175.38	17,956,584.12
6) Others	34,310,801.15	4,214,954.61	44,996,528.89	4,253,468.10
Total	836,463,122.05	69,307,096.29	1,013,891,092.61	85,478,313.02

Source: Final Accounts 2014 and Final Accounts 2013, UOJ Unit: LKR

Table 2-86 Budget for Operation and Maintenance

	2013			2014		
	UOI	FoAg	FoAg Share %	UOI	FoAg	FoAg Share %
Supplies	28,478,687	4,307,964	15%	32,904,002	4,771,191	15%
1304I Mechanical & Electrical Goods	245,972	-	0%	91,570	5,700	6%
1304II Chemical & Glassware	10,125,149	1,691,727	17%	11,186,761	1,395,767	12%
Others	18,107,566	2,616,237	14%	21,625,671	3,369,725	16%
Minor Repairs & Maintenance	10,551,779	465,921	4%	14,283,454	1,467,124	10%
1401 Minor Repairs & Maintenance (Vehicles, Plant & Machinery)	4,809,862	295,465	6%	3,466,978	547,061	16%
1402 Minor Repairs & Maintenance (Buildings, Furniture, etc.)	5,741,917	170,456	3%	10,816,476	920,064	9%

Source: Final Accounts 2014 and Final Accounts 2013, UOJ Unit: LKR

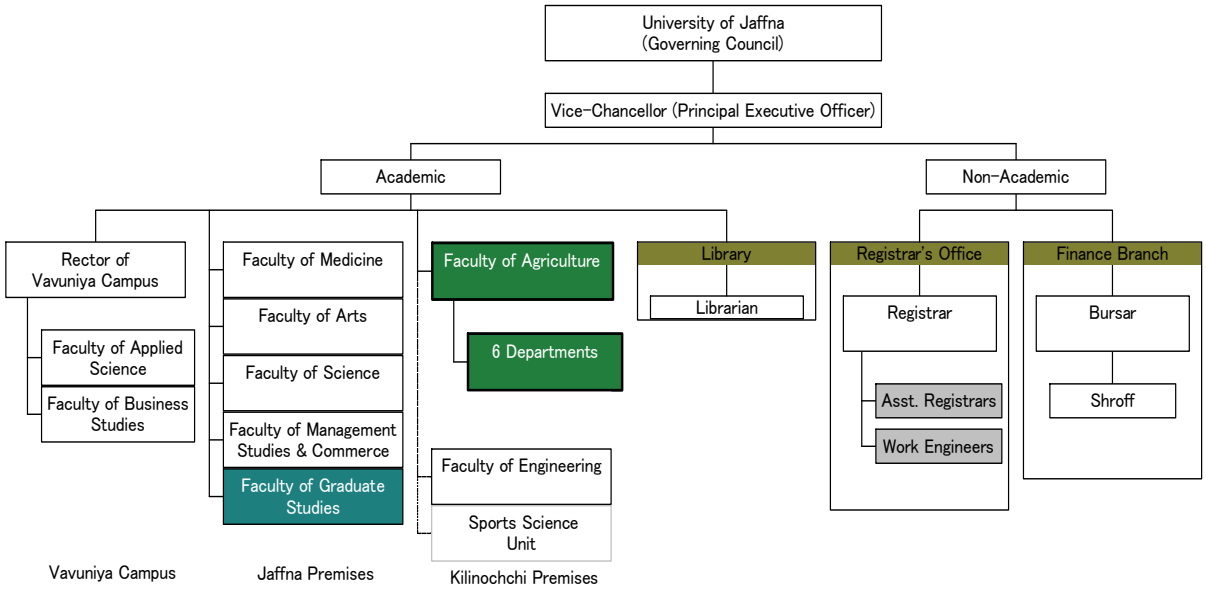
In addition to the budget from the government, it is necessary for each of the academic staff to apply for some research funds to cover the operation cost of equipment and consumables required for the research activities, as observed in Peradeniya University.

(2) Organization and staff for operation and maintenance

Organization structure of the UOJ is as shown in Figure 2-23 below. UOJ has 9 faculties and three premises, in Jaffna, Vavuniya and Kilinochchi. In addition to the Faculty of Agriculture, the Faculty of Engineering and the Sports Science Unit will also be in Kilinochchi Premises.

The Maintenance Branch, under the Registrar Office of the University of Jaffna, takes care of all the buildings and facilities of UOJ, and the Kilinochchi Maintenance Branch is in charge of building maintenance in Kilinochchi.

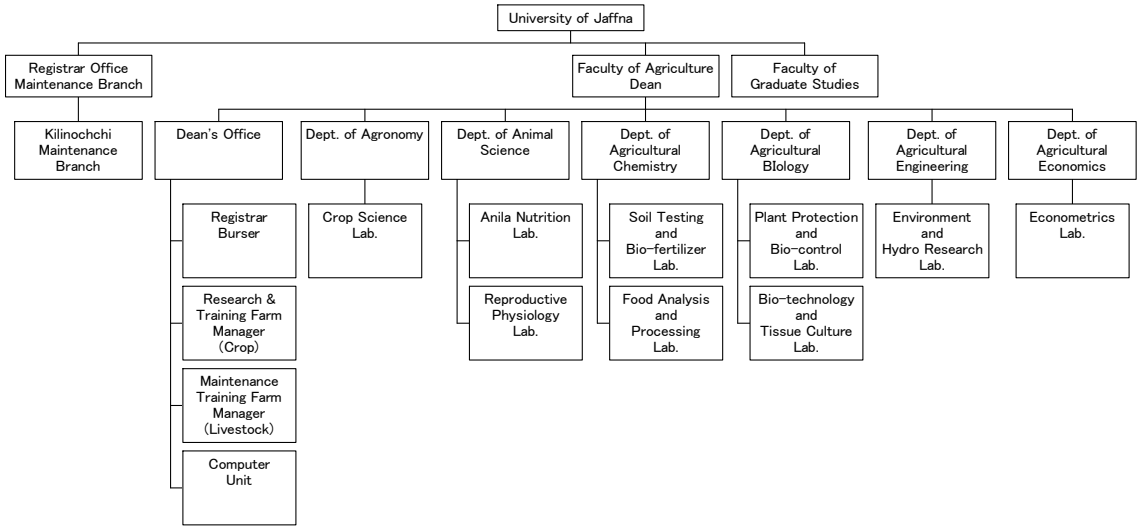
The Capital Work and Planning Division, which is also under the Registrar Office, is in charge of the planning and implementation of the projects of new building construction projects or repairing the existing buildings.



Source: Faculty of Agriculture, UOJ

Figure 2-23 Organization of the University of Jaffna

Figure 2-24 below shows the organization of the Faculty of Agriculture, which consists of six departments and the Dean's office. Administration staff, such as the registrar and bursar, belong to the Dean's office.



Source: Faculty of Agriculture, UOJ

Figure 2-24 Organization of Faculty of Agriculture, UOJ

Table 2-87 Staff of Kilinochchi Maintenance Branch

Title	No.	Degree
Works Engineer	1	B.E (Project Management)
Supervisor	2	NCT (National Certificate in Technology)
Supervisor	4	-
Trainee	4 (Temporary)	Internship in the last year of diplomat course

Source: Faculty of Agriculture, UOJ

Staff of Kilinochchi Maintenance Branch have been working on supervising construction of buildings for the Faculty of Engineering, and are going to supervise construction of the ICT & library building, lecture hall, gymnasium, and canteen, which will be built under support of the Indian government, and followed by this project.

As it is expected that some construction works will be implemented in parallel, the Kilinochchi Maintenance Branch may need to increase their staff.

The Computer Unit under the Dean's Office is taking care of the computers (68 PCs), servers, and its networks in the computer laboratory, and two instructors are providing lectures regarding computer studies programs. This unit is in charge of the computer network on campus, including the Research Laboratory Complex and Processing Training Building.

2.4.2 Operation and Management Structure of Research and Training Farms

Farms are managed by farm managers and other staff, who are supervised by the Dean and belong to the Presidential Office. Although there is currently only one assistant farm manager employed, farms will be managed under the following structure:

The actual operations of crop research and training farms, livestock research and training farms, and agricultural workshops are to be managed by the Agronomy, Animal Science, and Agricultural Engineering Departments respectively, and personnel in charge of farms will be allocated according to their tasks. Full-time positions have already been secured for farm staff and their employment is scheduled to commence when the farms are constructed.

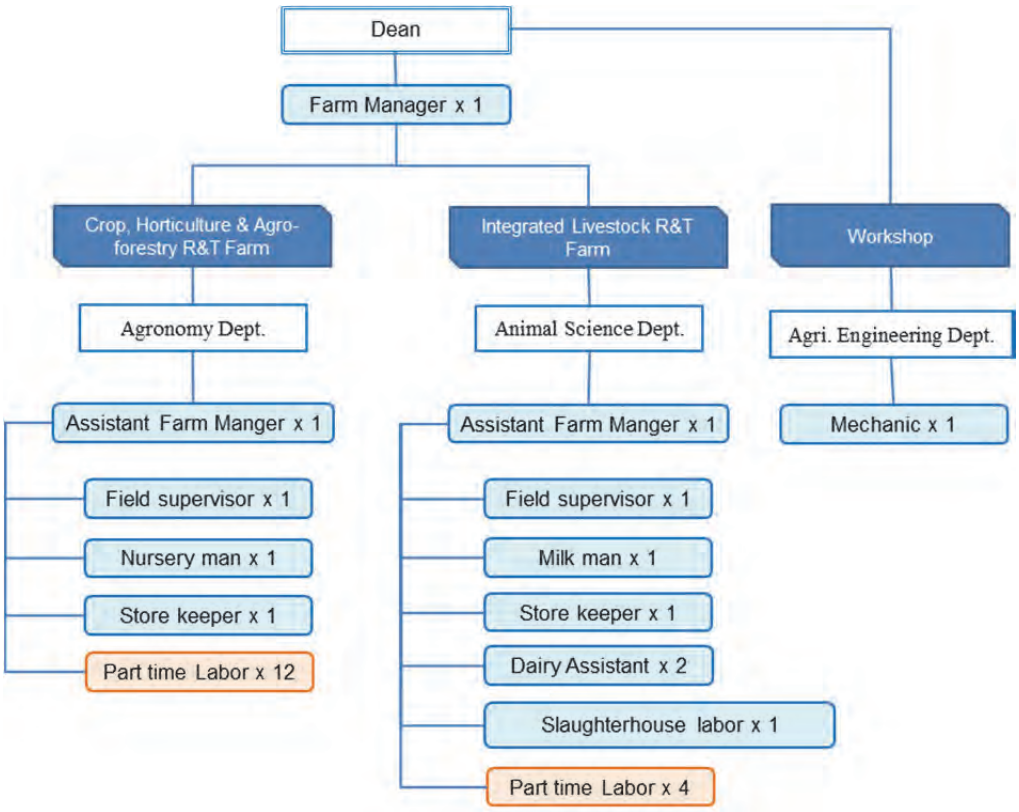


Figure 2-25 Farm Management Structure

2.4.3 Operation and Maintenance of the Equipment

One Technical Officer and one Laboratory Attendant are allocated to each laboratory in principle, to take care of the equipment and chemicals, and to support experiments and research activities. Table 2-88 shows the current numbers of these staff.

Table 2-88 Technical Officers and Laboratory Attendants

Departments	Current Number		Requested Number (2015-2016)	
	Tech. Officer	Lab. Attendant	Tech. Officer	Lab. Attendant
Dept. of Agronomy	1	1	2	2
Dept. of Animal Science	1	1	2	2
Dept. of Agricultural Chemistry	2	1	2	2
Dept. of Agricultural Biology	1	1	1	1
Dept. of Agricultural Engineering	1	1	1	1
Dept. of Agricultural Economy	1	0	1	1
Total	7	5	9	9

In total, nine new laboratories will be constructed in the Research Laboratory Complex, which will be used mainly for the Specialized Courses for third and fourth year students and graduate school students, and number of equipment will also be provided by this project. As there will be some additional laboratories in the existing buildings, an increase in technical officers and laboratory attendances is required for the future.

2.5 Project Cost Estimation

2.5.1 Initial Cost Estimation

(1) Costs to be borne by Sri Lankan side

Item	Quantity	Total (LKR)
1) Site Clearance and Preparation Works		
・Detection of landmines and UXO, and their clearance	1 set	-
・Removal of unnecessary existing trees	1 set	1,200,000
・Demolition of concrete floors at the training farm site	1,200 m^2	3,600,000
・Gate for the training farm	2 units	400,000
2) Installation of Utility Work		
・Electrical Works	1 set	14,000,000
・Network and Telecommunication Works	1 set	150,000
3) Application Procedures		
・Planning Clearance (UDA)	1 set	170,000
・Building Construction Application	1 set	1,500
4) Banking Arrangement Fee	1 set	1,500,000
Total		21,021,500

(2) Condition of Cost Estimation

1) Date of Estimation： June 2015
2) Exchange rate： 1USD = 121.21 Japanese yen, 1LKR = 0.91 Japanese yen
3) Construction Period: ： 17 months
4) Other： The Project shall be implemented in compliance with the Japanese Grant Aid Scheme.

2.5.2 Operation and Maintenance Cost

(1) Utility Running Cost for new buildings

The running cost (expenses for power and fuel) for the new building is calculated as follows:

1) Electricity Cost

a) Assumption

Maximum Demand	128.4 kw
Load Factor	0.15

b) Tariff of Electricity Charge by CEB

Fixed Charge	3,000 LKR/ month
Demand Charge	1,100 LKR/ kW
Unit Charge	14.55 LKR/ kwh

c) Monthly Electricity Cost

Fixed Charge	3,000 LKR/month	=	3,000 LKR/month
Demand Charge	128.4kw×1,100 LKR/kw	=	141,240 LKR/month
Unit Charge	128.4KW×720h/month×0.15×14.55LKR/kwh	=	201,765 LKR/month
Total		=	346,005 LKR/month

d) Annual Electricity Cost

346,005 LKR/month	×	12 Month	=	4,152,059 LKR/year

2) Telephone Cost

Telephone (IP) cost is included in data communication cost.

3) Data Communication Cost

Inter-net Access Cost (400GB)	19,890 LKR/month
Annual Data Communication Cost	19,890LKR/month × 12 month = 238,680 LKR/year

※According to the Tariff of Sri Lanka Telecom

4) Water Supply and Sewage Cost is not applicable

5) Fuel Cost

Conditions Stand-by Generator	125KVA 3φ 400/230 V50HZ (Diesel Fuel)	
	Fuel consumption:	20.5 L/h
	Assuming Eight (8) hours running a month	8h/month
Unit price of Diesel Fuel		95 LKR/L
Annual Fuel Cost	20.5 L/h×8h/month×12month/year ×95 LKR/L=	186,960 LKR/year

6) Gas Cost

Conditions of Gas	0.080kg/h 2h/day 10 burners	
	Assuming 22day/month 0.080kg/h×2h/day×22day×10 burners	35.2 kg/month
Unit price of Gas		159 LKR／kg
Annual Fuel Cost	35.2kg/month×12month/year×159 LKR／kg=	67,161 LKR/year

7) Annual Running Cost

1) Electricity Cost	4,152,059 LKR/year
2) Telephone Cost	(including data communication cost)
3) Data Communication Cost	238,680 LKR/year
4) Water Supply and Sewage Cost	-
5) Fuel Cost	186,960 LKR/year
6) Gas Cost	67,161 LKR/year
Total	4,644,860 LKR/year

8) Maintenance cost for Facility

1)	Building Utility: 386,235 LKR/year (2013-14Average)×1.5（New Building）	=579,352 LKR/year
2)	Building: 447,007 LKR/year (2013-14 Average) ×1.5（New Building）	=670,510 LKR/year
3)	Furniture: 1,150 LKR/year (2013-14 Average) ×1.5（New Building）	= 1,725 LKR/year
4)	Other: 97,685 LKR/year (2013-14 Average) ×1.5（New Building）	=146,527 LKR/year
	Total	=1,398,114LKR/year

(2) Expenses of farms needed for new facilities

The costs of operating and managing farms are calculated as per the following table based on the cultivation plan and the rate of annual use of farms.

Table 2-89 Calculation of Annual Costs to Operate and Manage Farms

Item	Contents	Annual costs (LKR)
1) Well facility	• Annual pump operation hours: 2,900 • Number of pumps and required power: 1.9 kW x 2 pumps • Annual electricity consumption: 1.9kW x 2,900 hr x 2 pumps = 11,020 kWh • Metered rate: 11,020 kWh x 0.15 x 14.55 LKR/kWh = 24,052 LKR (Basic charge and demand charge are included in the research building)	≒24,100
2) Farming (plowing)	• Annual plowing area: 13.92 acres (excluding fruit crops) • Tractors used (50HP): fuel consumption per hour 5.71 litres • Plowing hours per unit area: 0.13 hr./100 m² • Plowing hours needed: 73 hours (56,334 m² (13.92 Ac) / 100 m² x 0.13 hr) • Fuel consumption: 417 litres • Unit price of diesel: 95LKR	≒39,700
3) Farming (fertilization)	• Area for fertilization: 13.92 (5.6 ha) (excluding fruit crops) • Annual fertilization volume per unit: 100 kg/ha (according to WB) • Unit price of fertilizer: 6,400 LKR/ha (according to WB) • Fertilization volume: 5.6 ha (13.92 Ac) x 6,400 LKR = 35,840 LKR/year	≒35,900
4) Maintenance and management	• Basic tractor price (50HP class): 1,100,000 LKR • Tractor repair fees: 60% of the basic price • Standard period of use: 11.5 years • Annual tractor repair fees: 1,100,000 x 60% / 11.5 years	≒57,400
5) Goat rearing	• Replacement of old breeding doe with young doe (per six years): 1,670 LKR/year/10 does • Risk of mortality of adult breeding doe: 450 LKR/year/10 does • Concentrates: 2,220 LKR/year/10 does • Deworming and medicines: 700 LKR/year/10 does • Minerals: 900/year/30 goats • Stud fee: 450 LKR/year/ 10 does • Marketing and transportation: 300 LKR/year/15 goats • Tools: 200 LKR/10 does • Repairs: 540 LKR/year/10 does	≒7,500
Total		164,600

(3) Utility Running Cost for new Equipment

The annual running cost for equipment is calculated as follows:

Table 2-90 Annual Running Cost for equipment

1) Replacement parts	2,313,271 JPY/year
2) Reagents・expendables	2,955,468 JPY/year
3) Maintenance Fee (gas chromatography (GC))	4,500 USD/year
Total (1USD＝121.21JPY)	43,468USD + 4,500 USD/year 47,968 USD/year

Chapter 3 Project Evaluation

Chapter 3 Project Evaluation

3.1 Preconditions

The following are the essential conditions, which are undertaken by GoSL, before the implementation of this project by Japan's Grant Aid:

- Detection and clearance of land mines and unexploded ordnances from the project site.
- Clearance and preparation of the site: demolition of unnecessary existing facilities and removal of unnecessary existing trees, securing the area for temporary facilities for construction i.e. stock yard, fabrication yard and site office, etc.
- Obtaining necessary permits required for the construction work prior to the commencement of the construction and/or at necessary times during construction.

3.2 Necessary Inputs by Recipient Country

In order to create an appropriate university environment, necessary buildings and farms shall be developed and the equipment shall be procured in this project. For the purpose of achieving the project objectives, it is essential that the facilities and equipment shall be utilized effectively and continuously, and the following inputs are necessary to be taken by the Sri Lanka side:

- Increase admissions and secure the necessary budget.
- Increase the number of academic staff and upgrade their academic status to improve the quality of experiments.
- Incorporate experiments and practical training, narrowing the curriculum in-line with the local agricultural condition (if necessary, reorganization and expansion of the departments), and to put importance in basic agricultural subjects.
- Increase the research capacity of the academic staff to strengthen the overall research function.
- Secure the necessary staff to manage the facilities, equipment, and the farm fields.
- Secure the necessary budget for maintenance, consumables and reagents for continuous research activity.

3.3 Important Assumptions

This project aims to provide effective and efficient research and education activities for the Dry Zone agriculture in the Northern Province at FoAg of UOJ, through the development of the Research and Training Complex, including the Research Laboratory Building and the Processing Training Building, and the Research & Training Farms, with the provision of necessary equipment. The goal of this project is to increase agriculture productivity in the northern Dry Zone. Therefore, in order to make the outcome of this

project last, it is crucial not to have any more war, rapid deterioration of the economy, or dramatic changes in the industrial needs in Kilinochchi where FoAg of UOJ is located.

3.4 Project Evaluation

3.4.1 Relevance

This project aims to contribute to improving the efficiency and effectiveness of research and human resource development of the agricultural and livestock sector in the northern Dry Zone, as well as the productivity of the agricultural and livestock sector in the same region by developing research building, processing training building and farm fields for research and training in the Faculty of Agriculture, University of Jaffna, so that the priority goal of activating the local economy in the Northern Province through agriculture can be achieved. Thus, the beneficiary of this project is all residents in the Northern Province (about 1.05 million people).

Furthermore, the implementation of this project is agreed upon based on the priority areas of 'Development of Emerging Regions' as described in "Country Assistance Policy to Sri Lanka" by the Japanese Government in contributing to the improvement of Dry Zone agriculture based on 'Livelihood Improvement Support in Conflict-affected Areas' in "Promotion of Regional Development in Emerging Regions Program".

Moreover, from the environmental and social points of view, there is no negative impact in the implementation of this project. It is considered possible to conduct this project using Japan's Grant Aid.

Based on the above argument, the implementation of this project is considered valid.

3.4.2 Effectiveness

(1) Quantitative Effect

Table 3-1 Verifiable Indicators for Quantitative Effect

Indicators	Base (Actual value in 2014)	Target (2021) (3years post-project completion)
Number of undergraduate students and graduate students of the Faculty of Agriculture	Undergraduate students：280 Graduate students：14	Undergraduate students：480 Graduate students：30
Number of teachers in the Faculty of Agriculture	24	43
Number of research papers related to improvement in productivity on Dry Zone agriculture of the northern region, by students and teachers of the Faculty of Agriculture. (referred, papers/year)	12	24
Hours of practical training on the Training Farm for students. (hours/year)	0	105
Number of training programs for people outside the university (officers at the agricultural organization, agricultural extension workers and private relations in the Agricultural sector) (times/year)	2	6

(2) Qualitative Effect

- Students acquire practical knowledge and skills.
- Implementation of practical research activities that can contribute to increased productivity in agriculture and animal husbandry on Dry Zone in the Northern region through the enhancement of the research capability of teachers.
- Productivity of agriculture and animal husbandry on Dry Zone in the Northern region is improved through training provided by the FOA to enhance the expert knowledge of officers in agriculture organizations, agricultural extension workers and private sectors trained by the Faculty of Agriculture.