

Background Information and Justifications of the Research Program

1. Assessment of Natural Environment and Resources

1.1 Land classification and planning land use

The soil survey was introduced into Thailand by 1935. In 1964 the Land Development Department (LDD) was formed functioning in the areas of soil survey, soil classification, soil improvement, soil and water conservation, land planning, and land policy. An outgrowth of this work attempts to direct the agricultural community towards better land utilization.

The National Economic and Social Development Board (NESDB) has formulated the fourth five year plan (1977-1981) in order to direct and organize land plan policy at Province and Regional level in Thailand. These directives aim toward high production and proper use of land for maximum benefits. Nevertheless, the evidence reviewed by the fifth five year planning session of NESDB, shows both diminishing resources and crop yields per area. Some reasons for this decrease include misuse of land, improper crops planted for present conditions, and poor management or lack of technical skills.

Under these conditions, the Land Development Department is currently working on a semi-detailed soil survey at the district (amphoe) level for every province in Thailand. Priority will be placed on the survey for the Northeast as its need is recognized as greatest. Drought, low fertility, erratic rainfalls, and low water holding capacity in the soils are major reasons why there are frequent crop failures in the Northeast. In this connection, there is an urgent need to implement land classification by combining a series of soil survey data and agro-climatic factors, including satellite images, to set up guidelines for improvement of utilization and conservation of such natural resources as land, water and other environmental factors.

The research program will be implemented by the Soil Survey Division of the Land Development Department.

1.2 Stochastic analysis of rainfall

Agriculture in the Northeast almost entirely depends upon rainfall, as irrigable lands, either actually or potentially, are quite limited. As described in the previous section (climate), problems exist in the erratic pattern of rainfall both in locality and sequence although the total amount of annual rainfall exceeds 1,000 mm anywhere in the region.

Recently, extensive studies on rainfall in Thailand were undertaken by AIT^{1), 2)}. The studies include: rainfall distribution both in space and time; effective rainfall related to irrigation; minimum rainfall expected at different probability levels; maximum expected rainfall of different duration and return period; analysis of rainfall with reference to intensity, duration and frequency; analysis of evaporation. The studies are mostly based on the records obtained at 269 meteorological stations/observatories which are scattered all over the country. Out of them 89 are in the Northeast.

There will be necessity to examine inter-relationship of rainfall pattern among those 89 stations and some other available sites. Climatic data of the areas surrounding the Northeast should be utilized as many as possible.

The findings of the study could be utilized for assessment of drought conditions at each locality as well as land classification by combining with available environmental factors such as soils. Utilization of satellite images should also be considered.

The Khon Kaen University will be responsible for this research program.

2. Improvement of Crop Performance

2.1 Interaction among environment, water stress and crop performance

Under this research program, basic studies will be conducted on soil-plant-water relationship under the prevailing physical conditions of the Northeast. The studies will concentrate on the response of major crop/species to water stress at different growth stages. For example, evapotranspiration, dry matter increase and development of root systems at each growth stage under different water stress will be investigated in the studies. Efforts are also directed at studying the relative significance of various environmental components such as several climatic parameters, land form and soil physical/chemical properties as determinants of water stress. The research program will be implemented by KRU with assistance of other participating research institutions. It is expected that the findings of the studies will contribute very much to development of farming systems adaptable to each locality in the Northeast.

2.2 Development of appropriate Crops (annual and perennial) for drought conditions

As well known, the Northeast of Thailand is under severe natural conditions characterized by erratic rainfall, low soil fertility, improper soil and crop management, insects, diseases and so on. However, it does not mean that there will be no possibility of developing a series of appropriate technology of agriculture adaptable to farmers in the region. Among other items, development of drought tolerant crops, annual or perennial, and farming practices suitable to each crop or locality is essential as countermeasures against the adverse environmental conditions mentioned above.

The main upland crops which are predominantly grown at present in the Northeast are cassava and kenaf. However, the future of these upland crops is rather obscure due to their unstable prices, which greatly depend on the fluctuations of the world market. For example, restrictions on cassava trading recently proposed by the European Community (EC) have exerted an adverse effect on farm prices of cassava.

Although efforts should be made to increase domestic consumption of cassava through feeding to livestock, processing for edible stuffs, etc., the general solution of the problem will be to provide farmers with alternative crops. In this connection, the Department of Agriculture has proposed drought tolerant and short duration crops such as groundnut, cotton, sesame, castor bean, rice bean, cowpeas etc. for that purpose.

These are potentially grown before or after rice in paddy fields, in addition to ordinary cultivation in upland fields throughout the year. Among these crops, groundnut and cotton have been involved in some research/development projects which have started earlier, although there still exist

a number of problems to be solved. Unfortunately, only little effort has been exerted on sesame, castor bean and other drought tolerant crops despite of the big potential of these crops. It is expected that most of the products from these crops will be accepted in domestic and international markets. For example, farm prices of sesame and castor bean are steadily going up in recent years according to the Agricultural Statistics; Thailand has been importing a certain amount of edible oils every year.

In recognition of this, the present research program is intended to strengthen research activities on: a) breeding these crops for early maturity, drought tolerance and yield stability under erratic environmental conditions and possibly with minimum inputs; b) developing farming practices appropriate to each crop/cultivar or to each locality in the Northeast. Farming practices include: suitable time for planting and harvesting; land preparation and farm management to ensure good stands of crops, suitable spacing either in solid planting or intercropping; appropriate method of fertilizer application; and pre- and post-harvest technology. In pursuing this research, due attention should be given to farming practices now locally adopted by farmers since exploration and analysis of such practices would help find clues to a technology adaptable to specific areas.

As is generally recognized, the Northeast covers a wide area; each locality has its own features. For considerable acreage of the region, planting perennial/tree crops would be more appropriate than annual or short-lived field crops. Perennial crops are generally less susceptible to drought; once these crops establish good stands, they would conserve lands over the long term. In this context, much more effort should be made to explore and develop perennial crops adaptable to the region.

For instance, Jatropha curcas L. (Sabu Dum) is of exotic origin but has been cultivated in Thailand for many years. It is grown as a housefence

nearly all over the country, being acclimatized to local conditions. The oil extracted from its seeds can be utilized as one substitute for diesel oil either by mixing at a certain ratio or as it is. Selection of good varieties from local collections would be the first job.

The aforementioned research program will be pursued by the Field Crop Research Institute of the Department of Agriculture, assigning the Khon Kaen Field Crop Experiment Station as the Key Station. In addition, Khon Kaen University will be responsible for exploration and development of perennial crops.

3. Soil Condition and its Improvement

3.1 Amelioration of soil salinity

Salt-affected soils occur extensively in the Northeast Region, particularly in the Khorat and Sakon Nakhon Basins where a majority of the people are poor. According to the application of LANDSAT imagery to soil salinity study, the area of salt-affected soil in the N.E. is approximately 17.8 million rai or 17% of the total area, they are ranging from slightly (4-8 mhos/cm), moderately (8-16 mhos/cm) and strongly affected (>16 mhos/cm). It has been found that the most extensive areas of salt-affected soil of all classes are in Khorat. The possible origins of salt are salt-bearing sedimentary rocks of the Salt Formation and shallow saline ground water. It is expected that the area of saline soil will increase unless ameliorative measures are undertaken. The problem could be solved by preventing salinization and reclaiming areas which are already affected. The land use of the slightly salt-affected areas are mainly for rice growing occupying an extensive area of 12 million rai. It is considered feasible as high priority to reclaim such areas in order to increase rice production through planting salt tolerant rice varieties, older seedlings, at closer spacing, with appropriate crop management, etc.

Under this Research Project, efforts will concentrate on facilitating detailed topographic, soil and ground water surveys/researches to determine the possible origins and seasonal movement of soluble salts in selected landscapes. The surveys/researches will, in turn, contribute to prevention of secondary salinization in potential salt source areas as well as planning water resource development in the future.

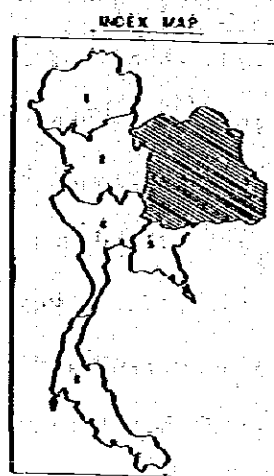
This research program will be implemented by Soil and Water Conservation and Management Division, LDD in cooperation with the Soil Salinity Research Center at Cho Ho and another research station to be

Soil Salinity Distribution in the Northeast

(Provided by : Land Development Department)

LEGEND

Salinity Class	Soil Type	Area	
		Ha.	%
1	Highly saline soil	19,762	1.43
2	Moderately saline soil	33,953	2.50
3	Slightly saline soil	42,837	31.94
4	Partly saline soil	79,423	59.41
5	Non-saline soil	17,400	12.95
6	Barren	837	0.62
Total		155,332	100.00



- CONVENTIONAL SIGNS
- ⊙ Cloud
 - Spot
 - Road
 - Railway
 - - - - - National Boundary
 - - - - - Provincial Boundary
 - ~ ~ ~ ~ ~ River, Canal
 - Water Tank

SCALE = 1:500,000

SOL SURVEY DIVISION BANGKOK, 1978



established in the near future at Non Sung in Khorat.

3.2 Management of organic matter for soil productivity

The concept of improving the yield of crops through improved nitrogen supply are well known. Because of increasing costs of energy and capital investments required for fertilizer plants in the recent years, the importance of recycling organic wastes or materials to improve or maintain soil productivity is likely to increase. Thailand imports nearly all its nitrogen fertilizers; the price has risen steeply in parallel with oil prices. This results not only in balance of payment problems but also discourages farmers from using chemical fertilizers.

In spite of well-recognized concepts of utilization of waste materials for agricultural purposes, organic recycling in agriculture is not widespread in Thailand. One of the major deficiencies is lack of information on the management and application of wastes. Important organic resources available locally are: animal wastes (i.e. cattle dung, pig excretion, etc.) Human habitation waste (i.e. garbage, sewage, sludge), crop wastes (i.e. straw, husks, stalks, weeds etc.), green manure and aquatic plant, non-symbiotic nitrogen fixation (azolla, blue green algae etc.). It is generally realized that the amount of nitrogen contained in manures and organic residues far exceeds the amount of chemical fertilizer nitrogen available to farmers.

As research subject, compost making by using available materials in rural areas and the effects of its application (including utilization of green manure crops) will be pursued by LDD. Also basic studies will be made by KRU on the question whether organic materials can play a significant role in soil fertility under tropical conditions.

3.3 Conservation of soil fertility

The soils of the Northeast are less fertile than in other regions

of Thailand. The combination of low fertility, sandy soils of low moisture-supplying capacity, and year to year fluctuations in rainfall, both in pattern and amount, create serious problems for crop production in this region.

In addition to low levels of nutrients, the unfavorable ratios of magnesium to calcium and sodium to potassium result in an overall poor balance of cations. The low levels of calcium and high amounts of sodium and magnesium, in part, account for the poor soil structure and the crusting effect. This condition, plus low organic matter content (usually less than 1%), aggravates the situation. The poor soil structure, in turn, results in low water infiltration rates, even though the soils are often very sandy. The finer sand and silt particles tend to bridge the gap between larger sand grains, decreasing porosity of the soils. Water run-off becomes a major problem during intense rain storms; upland soils are easily eroded.

The mineralogy of the soils of the Northeast is largely siliceous; clay content, though usually low, is primarily kaolinite with some 2:1 layer clays such as vermiculite. Some indurated lateritic zones occur in the soils that have fluctuating water tables.

The conditions related to the unpredictable rainfall pattern, low moisture retention of the soil, and frequent flooding of the poorly structured low lying soils pose problems inherently different from the fertility problems.

The present research program is intended to tackle the aforementioned problems from the viewpoints of soil physics, chemistry and microbiology. The efforts will concentrate on identification of specific limiting factors (e.g. deficiency of certain nutrient elements) of each soil type so that crop production can be stabilized through minimum inputs. The Soil Science Division, DA is responsible for the research program.

Research Program

1. Assessment of Natural Environment and Natural Resources

1.1 Land classification and planning land use (LDD)

By using information obtained through semi-detailed soil surveys at the district level, land suitability maps for agriculture and other uses at the district level will be developed.

1.2 Stochastic analysis of rainfall (KKU)

Rainfall pattern and its fluctuation both in locality and sequence will be analyzed in relation to cropping seasons in the Northeast.

2. Improvement of Crop Performance

2.1 Interaction among environment, water stress and crop performance (KUU).

Response of major crop species to water stress will be studied with special reference to their growth stages. Effects of environmental factors (climate, land form, etc.) on plant water stress will also be studied.

2.2 Appropriate crops (annual and perennial) for drought conditions.

2.2.1 Development of drought tolerant crops in the Northeast (DA)

Breeding, farming practices of major annual upland crops such as sesame, castor bean, rice bean etc. will be pursued.

2.2.2 Improvement of Jatropha curcas (Sabu Dum) for high yield (DA)

Breeding and cultivation techniques for high yielding will be pursued.

2.2.3 Exploration of perennial crops adaptable to the Northeast (KKU, DA)

3. Soil Conditions and Its Improvement

3.1 Amelioration of soil salinity (LDD)

On-going surveys/studies on saline soils will be facilitated.

3.2 Recycling of organic materials

3.2.1 Compost making and its effects on soil condition (LDD).

Compost making by using available materials in rural areas, and the effect of its application (including green manuring) will be studied.

3.2.2 Role of organic matter in soil productivity (KKU).

Under the research subject, basic questions such as :

(a) Effect of organic matter application on soil properties and crop yields, and (b) organic matter decomposition under different micro-climates and soil types, will be studied.

3.3 Conservation of soil fertility (DA)

3.3.1 On-farm level soil and water management research

(a) Rooting patterns of crops, (b) field management for increasing soil moisture storage, and (c) seed emergence in relation to the physical properties of soils will be studied.

3.3.2 Soil fertility and fertilizer application

(a) Identification of nutrient deficiencies in plants and soils, (b) long-term effect of chemical fertilizers and organic materials application, (c) management of adverse soil conditions primarily through screening crops/varieties, and (d) series of experiments on fertilizer application to set forth fertilizer recommendations, will be conducted.

3.3.3 Biological nitrogen fixation

Effective utilization of micro-organisms such as Rhizobium for leguminous crops and free living nitrogen-fixing micro-organisms in upland soils will be studied. Blue-green algae and azolla will be studied for nitrogen fixation in paddy fields.

Implementation of the Project

1. Research Subjects and Responsible Research Institutions

The Research Program will be implemented by the three research institutions according to the mandate. The research subjects to be undertaken by each institution are summarized as follows:

- DA: 2.2.1. Development of drought tolerant crops in the Northeast.
2.2.2. Improvement of Jatropha curcas (Sabu Dum) for high yield.
2.2.3. Exploration of perennial crops adaptable to the Northeast.

Responsible institution: The Field Crop Research Institute assigning the Khon Kaen Field Crop Experiment Station as the Key Station.
The subject (2.2.3) is to be pursued in cooperation with KKV.

- 3.3.1. On-farm level soil and water management research.
3.3.2. Soil fertility and fertilizer application.
3.3.3. Biological nitrogen fixation.

Responsible institution: The Soil Science Division. The responsible staff are to be stationed at the Research Center which will be established under the Project at Khon Kaen Land Development Center Site.

- LDD: 1.1. Land Classification and planning land use.

Responsible institution: The Soil Survey Division. The responsible staff are to be stationed at the Research Center.

- 3.1. Amelioration of soil salinity.
3.2.1. Compost making and its effects on soil condition.

Responsible institution: Soil and Water Conservation and Management Division. The responsible staff are to be stationed at the

Research Center. The subject (3.1) is to be undertaken in cooperation with the Salinity Research Center in Korat.

- KKU: 1.2 Stochastic analysis of rainfall.
- 2.1 Interaction among environment, water stress and crop performance.
- 2.2.3. Exploration of perennial crops adaptable to the Northeast.
- 3.2.2. Role of organic matter in soil productivity.

Responsible institution: KKU. The research activities will be mostly carried out at the campus of KKU. The subject (2.2.3) is to be pursued in cooperation with DA.

2. Research Equipment and Instruments.

To undertake the research activities pursuing the aforementioned research subjects it is required to procure a certain amount of equipment and instruments for the respective institutions. The tentative list of the research equipment and instruments is attached as Annex I.

3. Establishment of the Research Center.

To achieve the common target of the project to develop agricultural technology which could stabilize agricultural production in the Northeast possibly with minimum input, the research activities should be executed in a close coordination and collaboration of the three research institutions. In this connection, it is required to establish the Research Center (hereinafter referred to as the Center) as a research and coordination body. The function of the Center is to be:

- 1) to coordinate research activities to be undertaken by the respective institutions.
- 2) to provide research and experiment facilities and office spaces for common use necessary to undertake the research activities.

3) to provide scientific and technological information related to the research activities.*

4) to provide conference facilities to hold seminars/workshops to facilitate the research activities.

Tentatively, the Center will be called "Northeast Agriculture Research Center". The major facilities of the Center is tentatively planned as shown in Annex II.

4. Organization of the Center.

The following organization is suggested for administration and management of the Center.

The Coordinating Committee, already set up in Bangkok and chaired by the Under-Secretary of the State, the Ministry of Agriculture and Cooperatives (MOAC), will administrate and coordinate the Project in general.

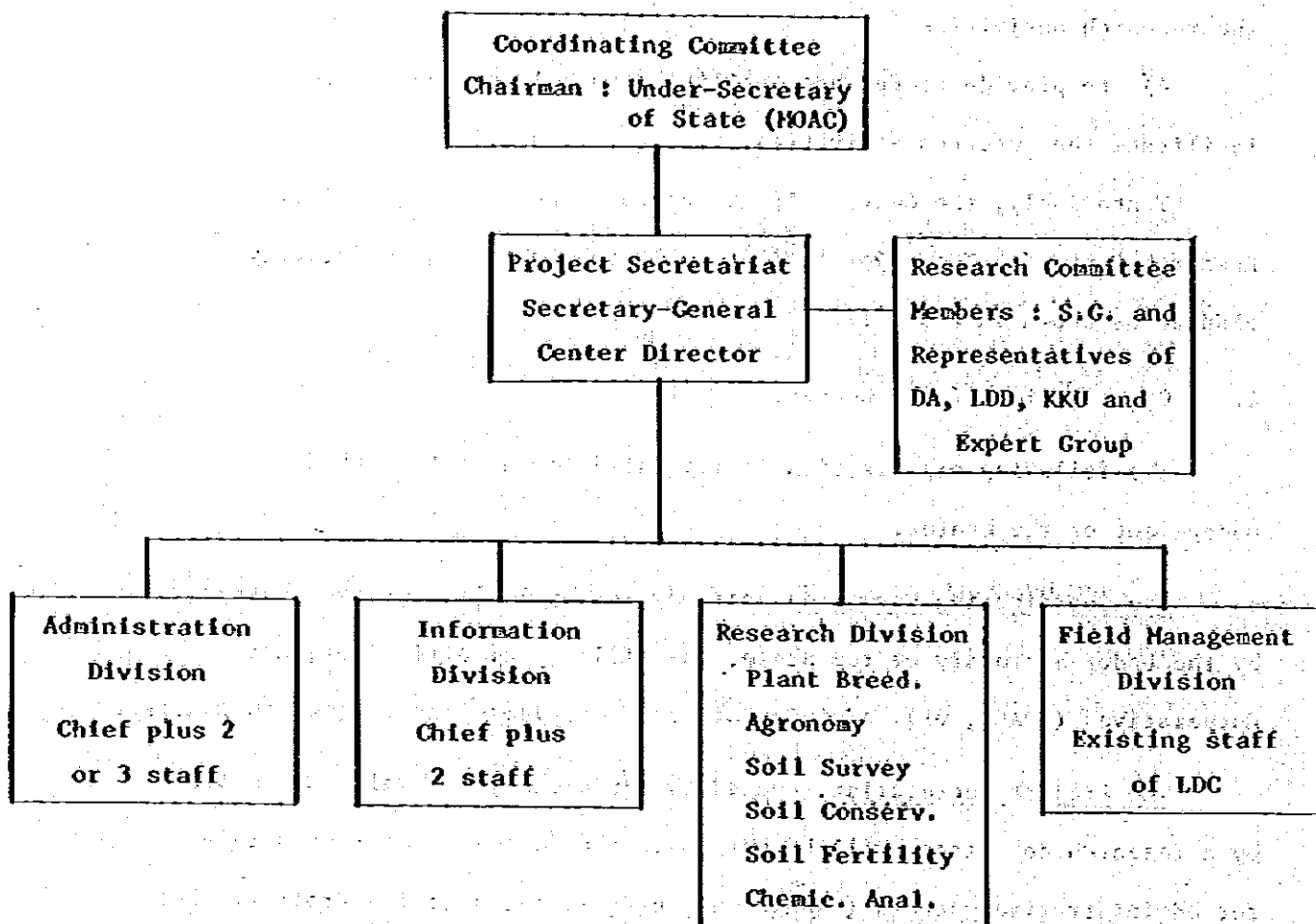
The Project Secretariat, headed by a secretary general and assisted by a research committee, will be set up in the Center to be responsible for administrative matters (management, budget, etc.) of the Project. The Research Committee will coordinate the research program primarily from technical/academic points of view. The Research Committee will be represented by the three research institutions (DA, LDD and KKU) and an expert group to be assigned to the Project. A director of the Center will be assigned to the Project Secretariat as an executive officer.

Four Divisions which are responsible for Administration, Information, Research and Field Management respectively, will be set up.

The organization chart will be as the following figure.

* Fundamental information including recent research findings on topography, climate, geology, soils, agriculture, forestry, etc. in the Northeast and other places under the similar conditions will be collected for easy access of researchers; some of them will be displayed in an appropriate manner.

Organization Chart of the Center



The number of staff in this figure indicates key staff only.

Experts to be Assigned to the Project

To assist and facilitate the research activities under the Project, it is desirable to assign a certain number of experts to the Center. The following disciplines of experts are suggested for this purpose.

1) Long term experts

Plant breeding

Agronomy

Soil science (soil fertility)

Soil chemistry (chemical analysis)

Chemical engineering

2) **Short term experts in such specific fields as:**

Meteorology

Plant breeding

Soil microbiology

Agricultural engineering

Plant protection

Agricultural economy

Information/display

It is also highly desirable that Thai counterpart scientists and technicians to work together with these experts will be given opportunities to study further or brush up their capabilities in the home country of the experts.

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ANNEX I. Tentative List of the Research Equipment and Instruments

DA (The Khón, Kaen Field Crop Experiment Station):

Research subjects: 2.2.1, 2.2.2 and 2.2.3.

**A certain number of equipment/
instruments necessary to undertake
field experiments.**

KKU:

Research subjects

Equipment/instruments

1.2

Micro computer

2.1

**A certain number of equipment/
instruments necessary to study
plant-water-soil relationship.**

3.2.2

**One set of laboratorial equipment
for chemical analysis of soils and
soil organic materials.**

The Center:

Research subjects

Equipment/instruments

1.1

**Compugraphic edit writer
Automatic drafting machine**

3.1

**Truck mounted auger boring
Mobile laboratory**

Research subjects: 3.2.1, 3.3.1, 3.3.2 and 3.3.3.

**- One set of laboratorial equipment
for chemical analysis of soil and
plant samples, including an atomic
absorption spectoro-photometer,
a spectoro-photometer, conductivity
bridges and a flame photometer, etc.**

- One set of soil physics equipment including soil core samplers, pH measurement equipment, soil moisture meters, etc.
 - One set of soil microbiology equipment including a gas chromatography, microscopes, an autoclave, centrifuges, colony counters, etc.
- Information:** One set of audio-visual equipment including a micro video set, a television camera etc.
- Display:** Several sets of display equipment.
- Common use:**
- Meteorological digital data acquisition system.
 - Machines and tools for workshop.
 - Vehicles.

ANNEX II. Tentative Plan of the Center

The following is planned preliminarily:

Studying rooms

Director

Breeders/Agronomists

Soil Scientists

Soil Chemists

Visiting Scientists

Laboratories

Chemistry

Chemical instruments

Soil sample preparation

Plant sample preparation

Autoclaving

Seed storage (low temp. & humid.)

Soil physics

Soil microbiology

Breeding/Agronomy

Information

Information Officer

Library

Drafting machine

Projecting room

Photographying

Display and demonstration

Conference room

Meeting room

Canteen

