

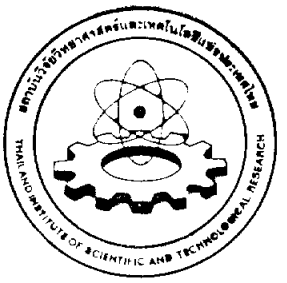

Res. Proj. No. 23–18/Rep. No. 4

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH

# EXTENSION WORK ON SHIITAKE MUSHROOM CULTIVATION

BY

SIENGTONG NUTALAYA

SAMPAO PATARAGETVIT

SOMSAKUL SRIMANEE

TISTR, BANGKOK 1989

not for publication

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EDIBLE MUSHROOM CULTIVATION IN THAILAND

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The publication of this report has been approved by

the Governor of Thailand Institute of Scientific and Technological Research

Smith Kampempool

(Professor Dr. Smith Kampempool)

Governor

# FOREWORD

This is the final report of Contract Project No. 53-31R6-2-121, between United States Department of Agriculture (USDA) and Thailand Institute of Scientific and Technological Research (TISTR). The project is also part of the main program initiated by TISTR namely Project No.51-23-18 "Edible Mushroom Cultivation in Thailand".

We are indebted to many people, notably M.C. Bhisatej Rajanee who made this project possible. Also to Dr. Jack Bond and his assistants from USDA whose support and contribution made possible the implementation of this project and its subsequent outcome as reported in this paper. To those people and associated organizations, a sincere appreciation is being recorded. Impacts had been great and widespread throughout the North. If success can be claimed anywhere it will be for the better life of the hilltribes people and mankind as a whole.

Extension Work on Shiitake
Mushroom Cultivation

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# EXTENSION WORK ON SHIITAKE MUSHROOM CULTIVATION

## 1. Introduction

There are more than one million Highlanders living in Northern Thailand, depending on the forest area for their subsistence agriculture. Out of this total, there are about 500,000 hilltribe people, who practice shifting cultivation and slash and burn systems. These systems destruct the forest leading to accelerated soil erosion and disrupting the forest water regulating function. Some of these farmers are opium growers.

In order to solve the following problems of slash and burn agriculture; of increasing farmer incomes and of replacing opium production, the Royal Project has looked for appropriate crops that can replace opium and provide an alternative income.

The Royal Project has been able to research and extend alternative like temperate fruit tree crops, coffee, flowers, vegetables, and mushroom as opium replacement crops.

Mushroom protein contains all nine essential amino acids for human well being (Chang 1980). In addition to their good protein, the mushrooms are a relatively good source of the following individual nutrients: fat, phosphorus, iron, thiamine ($B_1$), riboflavin ($B_2$), and niacin. They are low in calories, carbohydrates and calcium, but high in ascorbic acid (Vitamin C) in Agaricus and ergosterine (Vitamin D) in lentinus and Volvariella. All mushrooms, however, are devoid of vitamin A activity.

World production of Agaricus has developed rapidly in the last decade, from about 390,000 tonnes in 1970 to 884,000 tonnes in 1980 (Courvoisier 1984). Three geographical zones contributed 93% of world production in 1980 :-

1. Western Europe, with 413,000 tonnes, produced 47% of the world's total output.
2. North America, with 242,000 tonnes represents 27% of world production.
3. The Far East produced 167,000 tonnes, 19% of the total.

World production of some cultivated edible mushroom in 1979 (Chang and Miles 1982).

| | |
|---|---|
| Lentinus edodes | 170,000 tonnes pa. |
| Flammulina velutipes | 60,000 " |
| Volvariella volvacea | 49,000 " |
| Pleurotus spp. | 32,000 " |
| Tremella spp. and Auricularia spp. | 10,000 " |

Tantayaporn (1986) estimated that the 1981 mushroom production in Thailand was as follows:-

| | | |
|---|---|---|
| - Volvariella volvacea | 60,000 | tonnes |
| - Oyster mushroom | 5,760 | " |
| - Fresh Auricularia | 3,888 | " |
| - Dried Auricularia | 12 | " |
| - Agaricus spp. | 300 | " |
| Total | 69,950 | " |

Production of fresh shiitake mushroom reached about 1,000 kg in 1982 (Nutalaya et al. 1983), and 11 tonnes in 1984 (Nutalaya et al. 1986). This kind of mushroom can be grown in the mountainous area of Northern Thailand. Various species of oak wood can be found in the highland evergreen forests above 700 meters asl. Dominant trees are Quercus spp., Lithocarpus spp. and Castanopsis spp. (Nutalaya et al. 1980).

The research carried out on the shiitake mushroom has been initiated since 1974 by Project TISTR with cooperation from the Royal Project. In 1981, the King provided the funds to construct the shiitake mushroom demonstration centers at Ban Pang Bong, Doi Saket district and Ban Teen Tok, San Kamphaeng district, Chiang Mai province.

In 1982, the shiitake mushroom project received 210,000 ฿ from TISTR; another 1,800,000 ฿ from the Secretariat Office of the Co-ordinating Committee for the Royal Project Patronage Development and Welfare Programme and US $ 10,000 (250,000 baht) from USDA for the construction of the mushroom spawn production plant at Doi Pui improvement station.

From the previous studies on shiitake mushroom, the shiitake mushroom gives high yields compared to other varieties. The average yield is 0.1965 g/log. The farmer could earn supplement income of about 11.40 ฿/log. From a previous study, one farmer produced 100 logs of shiitake mushroom and received an average income of 1,200 ฿.

The suitable storage temperature is 1 - 5 degrees Celsius with the weight loss of about 21 - 25 %. The farmers accept shiitake mushroom production well.

## 2. Shiitake Cultivation Techniques.

Shiitake mushroom cultivation is principally undertaken outdoors in a sheltered site under forest cover. Cultivation techniques can be divided into seven stages (Singer 1961) :-

1. preparation of the inoculum.
2. preparation of the bed logs.
3. inoculation.
4. log laying in the shelter.
5. raising the logs.
6. cropping and harvesting the fruiting bodies.
7. marketing.

The basic procedures used for shiitake mushroom growing are as follows (Nutalaya et al. 1980):-

Preparation of the inoculum:

The spawning method employed is similar to the method used in the case of other mushrooms but the medium used for spawn making is logically adapted to the biology of shiitake mycelium. It has been found that mycelium grows quicker on sawdust of Ko wood (Castanopsis accuminatissima Rehd.) with rice bran and corn meal (5 per cent each by weight).

Preparation of wood logs:

The logs were cut from trunks or branches of Ko trees or oak wood, which grew on the highlands, at an elevation between 800 and 1,400 meters above sea level. The trunks are cut into logs into sizes of the following dimensions: 1 meter long and 5 to 20 centimeters in diameter. During the transportation of wood logs to the cultivation area, care should be taken to avoid damage to the wood bark.

Inoculation:

Holes half an inch wide are drilled using an electric hand drill. Each log drilled with hole about one inch deep, spaced at certain intervals. A small piece of spawn is pressed into each hole and the hole is sealed with a small plug made from bark. Plugs were tapped into place with a hammer to prevent fungal interference, and to keep the moisture in the hole constant.

Laying:

After inoculation, inoculated wood logs will be placed in heaps in a favourable position for the development of mycelium. They should be kept moist but not saturated with excess water, to avoid contamination of the logs by hygrophilous wood destroyers. The best site for storing inoculated wood is at the edge of a forest area or inside a forest area woods with low crowns, where shading can be provided. The optimum temperature for the development of mycelium of shiitake mushroom is 24 degrees C.

Raising:

After the mycelium has spread through the logs thoroughly, the logs will be transferred to another place to be re-arranged for the fruiting-body formation. The optimum temperature is between 12 to 20 degrees Celsius. For highland conditions, it is most suitable to undertake mushroom production between September and February. Shiitake mushroom at this stage requires considerably more moisture than during the vegetation growth period.

Cropping:

Once the logs have begun to produce fruiting bodies, they will continue to do so for a number of years. The producing wood logs should be kept wet by frequent watering. The fruiting bodies, at picking time should be young just at the time when they begin to sporulate, with a still strongly convex pileus and traces of the veil available.

Marketing:

The produced mushroom can be sent to the market both fresh and dried. Paper boxes are better for transporting fresh mushrooms than plastic bags, especially in warm weather over 30 degrees Celsius. Mushroom can be dried in the indirect hot air oven designed similarly to the one extensively used for curing tobacco leaves. The temperature is usually at 50 to 60 degrees Celsius and the drying process lasts about 8 to 12 hours. The ratio of drying mushroom is 10 kg fresh : 1 kg dry.

3. Project Contract:

The contract statements signed by Dr. Smith Kampempool, the governor of TISTR and Dr. Kovit Kovitvadhi, project director on June 10, 1983 are as follows:

1. Furnish physical facilities and laboratory space, employ personnel, and obtain necessary materials and supplies as proposed to accomplish project objectives.

2. Hold training sessions, work with extension agents and farmers, and provide on-the-job instruction in the culture, growth and packing of shiitake mushroom as a source of income for hilltribesmen.

3. Develop wood log-cutting methods so as to provide high quality logs for mushroom culture and to minimize damage to the forest environment.

4. Develop packing methods and procedures in order to assure high quality mushroom, even where long hauls are necessary for marketing.

5. Develop mushroom drying techniques for situations where transportation of fresh mushrooms is inconvenient or impossible.

6. Evaluate the acceptability of shiitake mushroom cultivation by farmers.

7. Prepare extension-type publications and training aids and other materials in order to facilitate the technology transfer of shiitake mushroom cultivation to hilltribesmen.

## 4. Workplan:

### 4.1 Training and Demonstration Activities:

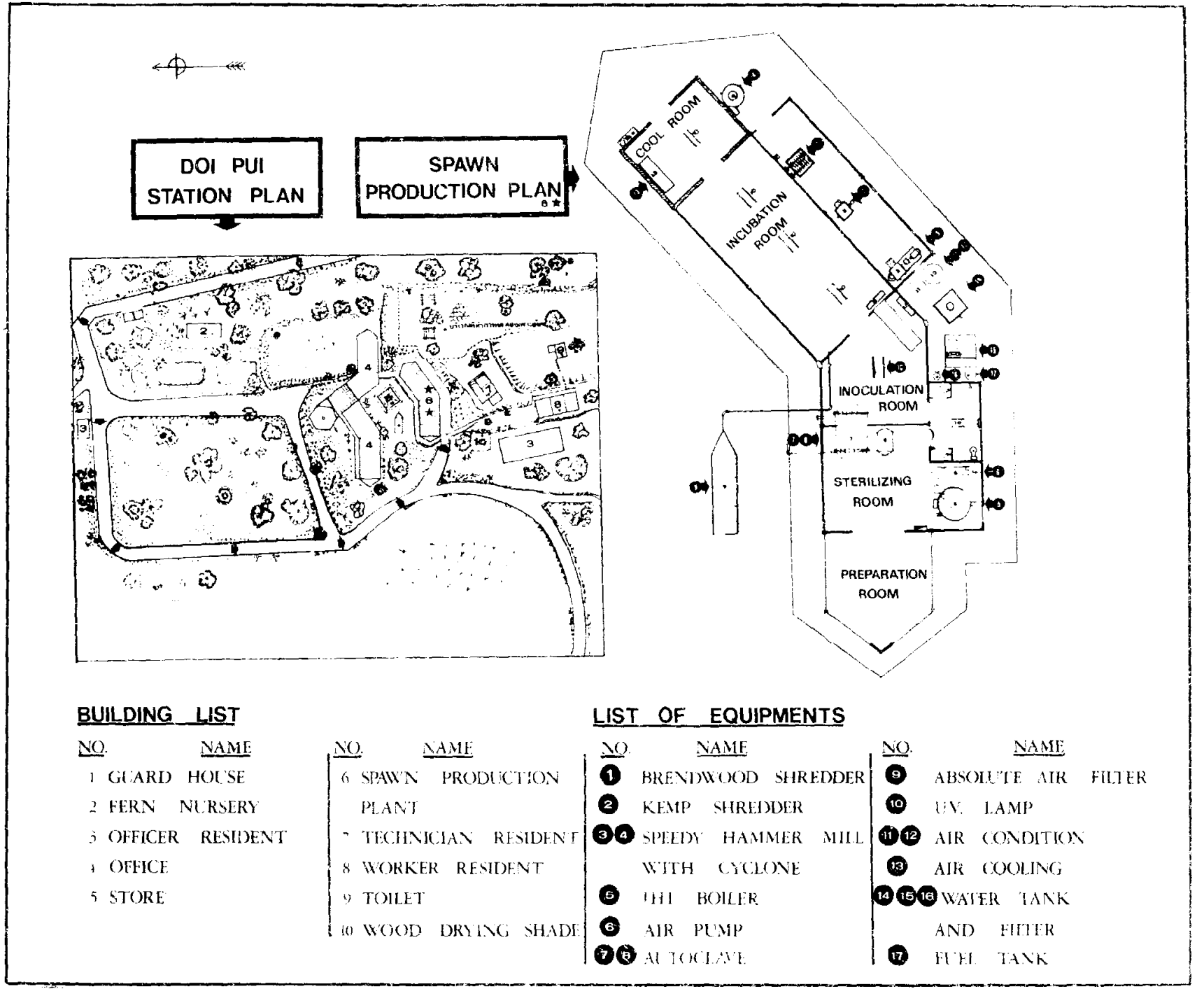
The training was held at a suitable village location and attended by interested farmers. The Mushroom Specialists explained to the farmers about the purposes of the mushroom project and activities to be undertaken. Farmers were split into working groups of 8 - 10 families and were given explanation of how to cultivate the mushroom and other production aspects.

The Specialists also explained about the problem concerning the future shortage of wood logs for cultivation of the mushroom and suggested to the farmers how to preserve the Ko tree variety and how to plan for providing a future source.

Interested farmers formed groups and cut the wood logs and took these logs to a suitable area ready for mushroom cultivation. The specialist demonstrated the necessary steps of how to cultivate the mushroom, thereafter the farmers were able to cultivate the mushroom by themselves.

### 4.2 Extension work:

The main part of the extension work is the provision of spawn, which was supplied to the farmers by the project. The spawn making plant requires complicated and expensive equipment and the process is too difficult to be carried out by farmers. The mushroom project organized and built a spawn making center at Doi Pui experiment station in 1983. The plant was completed and in operation by late 1984 (see Figure 2-11).




**BUILDING LIST**

| NO. | NAME |
|---|---|
| 1 | GUARD HOUSE |
| 2 | FERN NURSERY |
| 3 | OFFICER RESIDENT |
| 4 | OFFICE |
| 5 | STORE |
| 6 | SPAWN PRODUCTION PLANT |
| 7 | TECHNICIAN RESIDENT |
| 8 | WORKER RESIDENT |
| 9 | TOILET |
| 10 | WOOD DRYING SHADE |

**LIST OF EQUIPMENTS**

| NO. | NAME |
|---|---|
| 1 | BRENDWOOD SHREDDER |
| 2 | KEMP SHREDDER |
| 3 4 | SPEEDY HAMMER MILL WITH CYCLONE |
| 5 | FHT BOILER |
| 6 | AIR PUMP |
| 7 8 | AUTOCLAVE |
| 9 | ABSOLUTE AIR FILTER |
| 10 | UV. LAMP |
| 11 12 | AIR CONDITION |
| 13 | AIR COOLING |
| 14 15 16 | WATER TANK AND FILTER |
| 17 | FUEL TANK |

Figure 1. Spawn production plan.

Figure 2. Part of spawn making plan at Doi Pui.

Figure 3. Cutting wood log into small pieces.

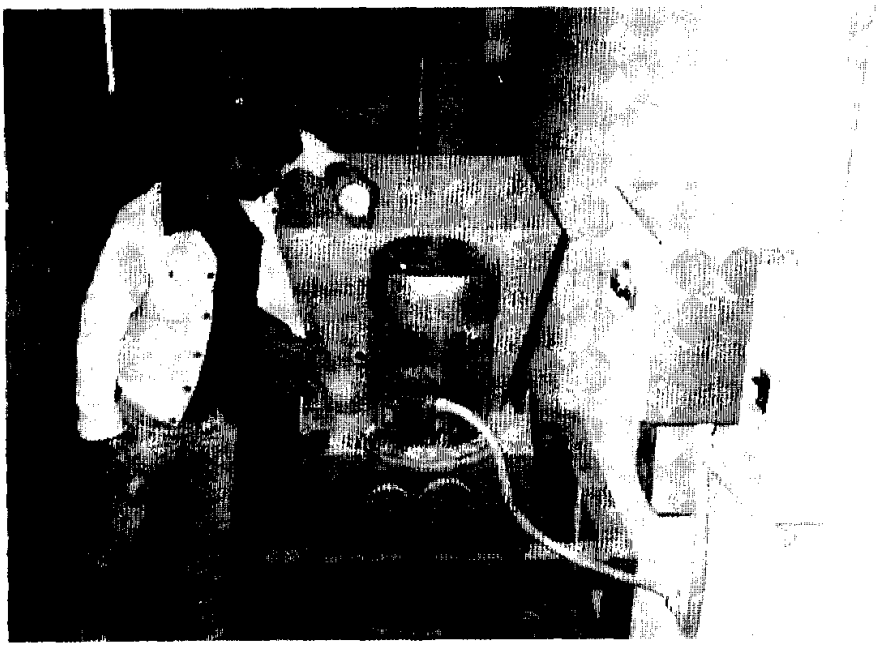


Figure 4. Brent wood shredder.

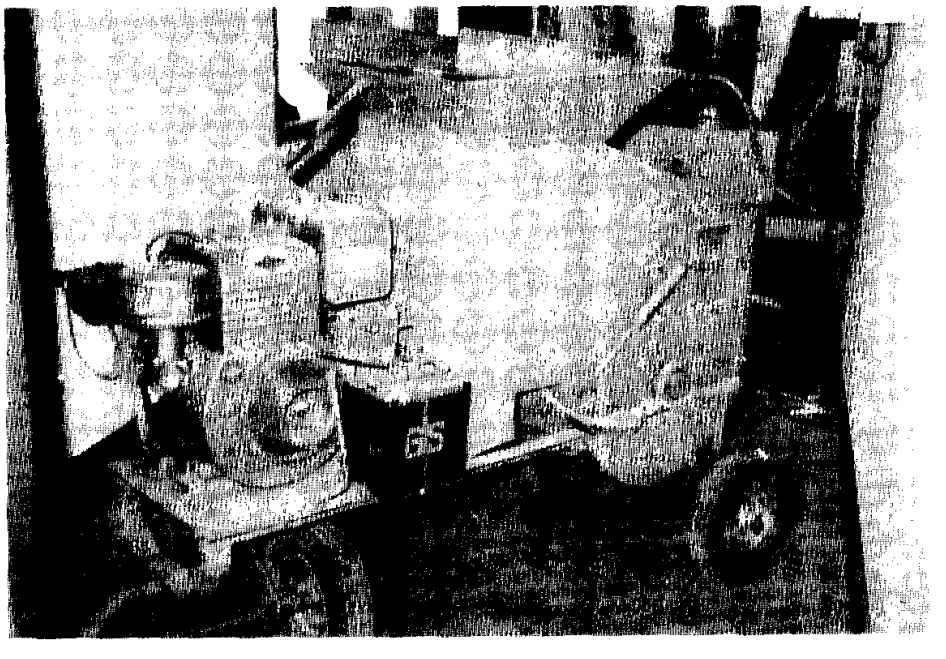


Figure 5. Kemp shredder.

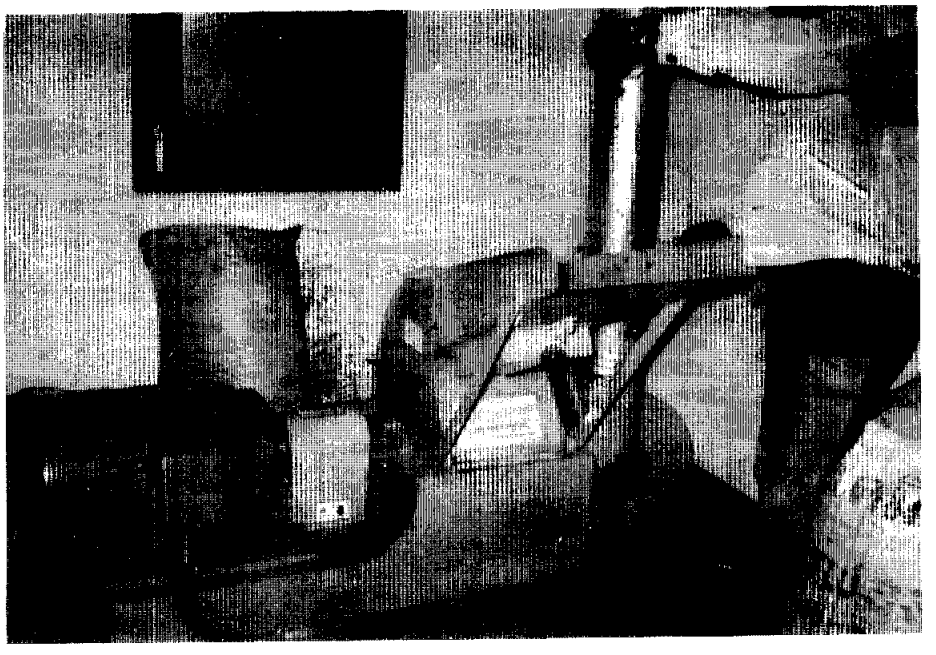


Figure 6. Speedy hammer mill.

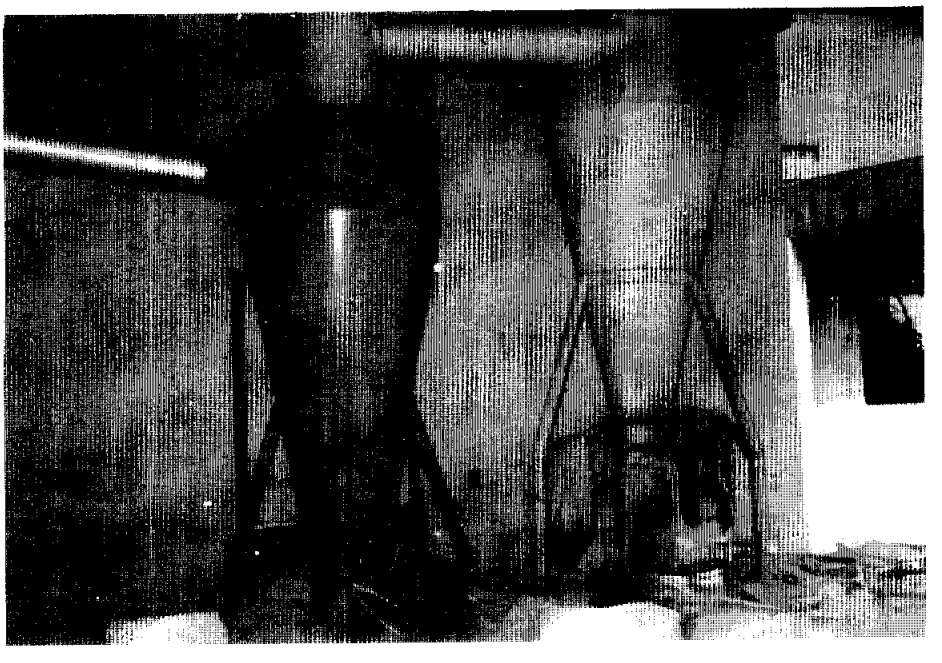


Figure 7. Cyclone collecting saw dust

Figure 8. IHI steam boiler.

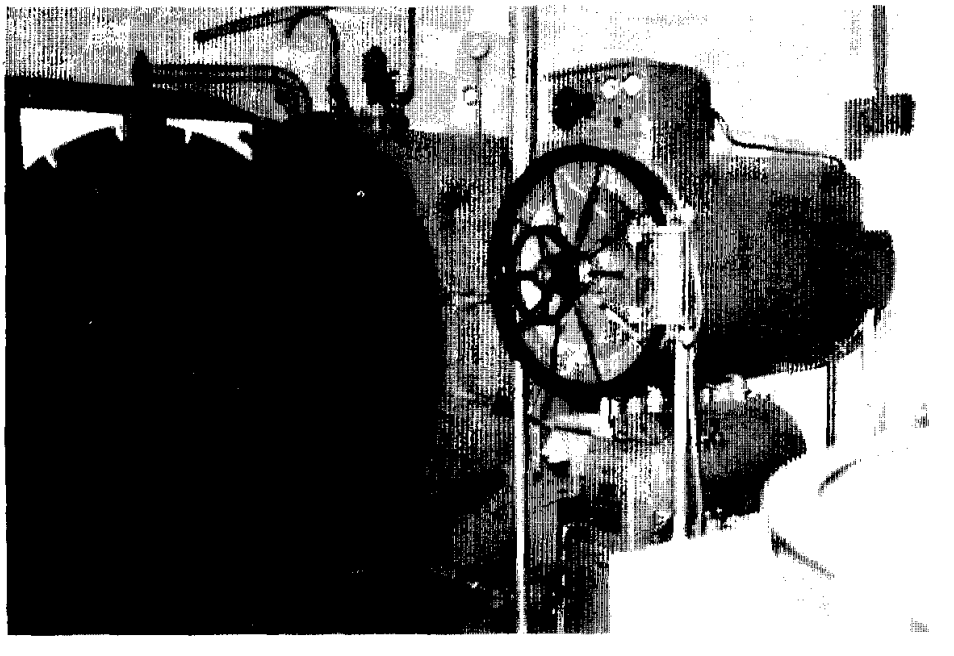


Figure 9. Two-door autoclave for sterilization.

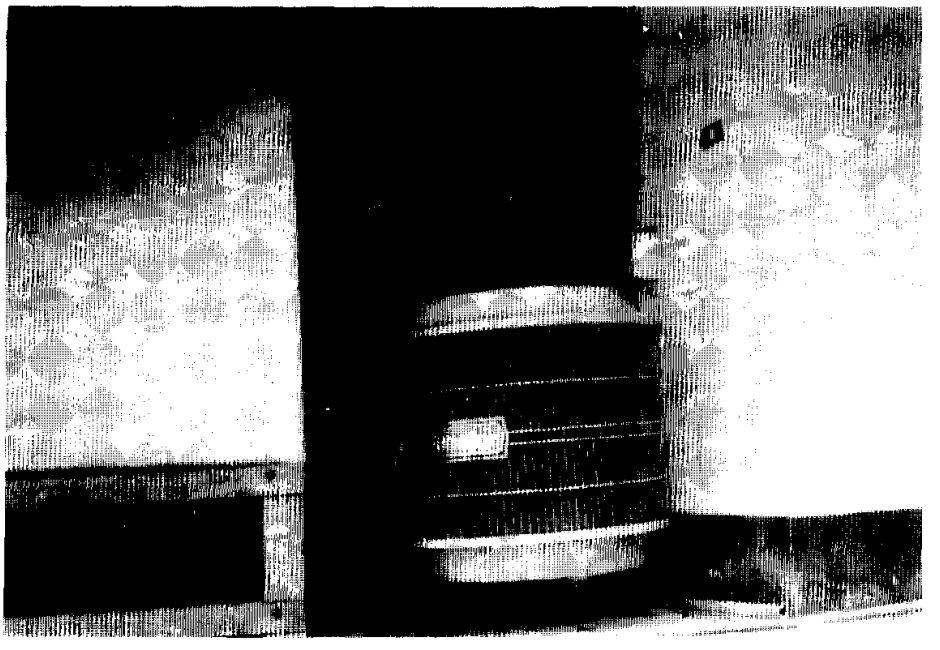


Figure 10. Two air conditioners for incubation and inoculation.

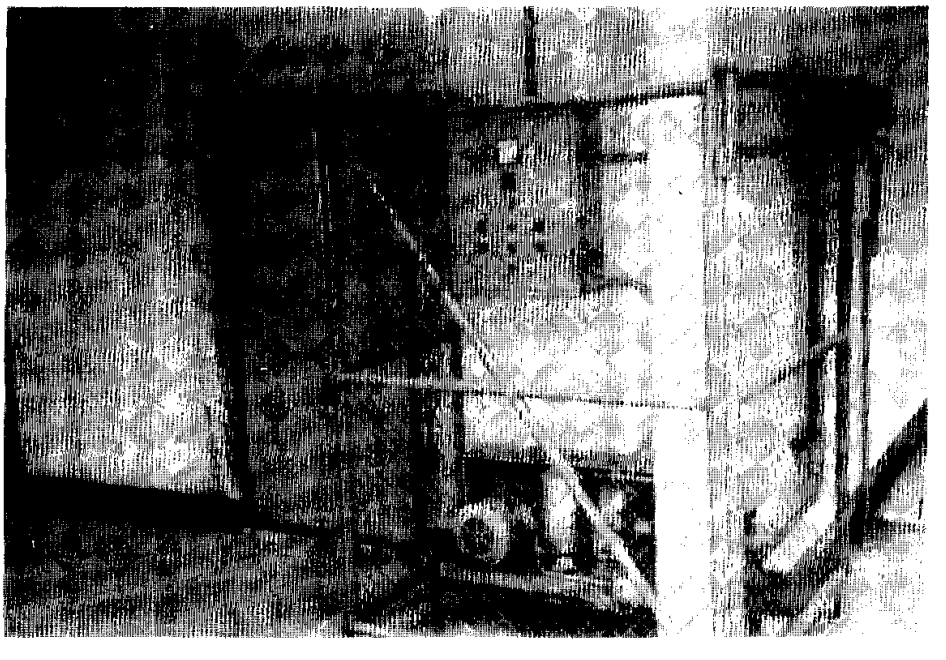


Figure 11. Cool room for keeping finished spawn run.

To begin with, the project filled the heat resistant plastic bag (PP bag) by hand, which was slow and also allowed the spawn to be subjected to high contamination, while the bags were kept in the incubation room about 45-60 days. So, more equipments were requested from Taiwan such as sawdust mixer (Figure 12), automatic filling machine (Figure 13).

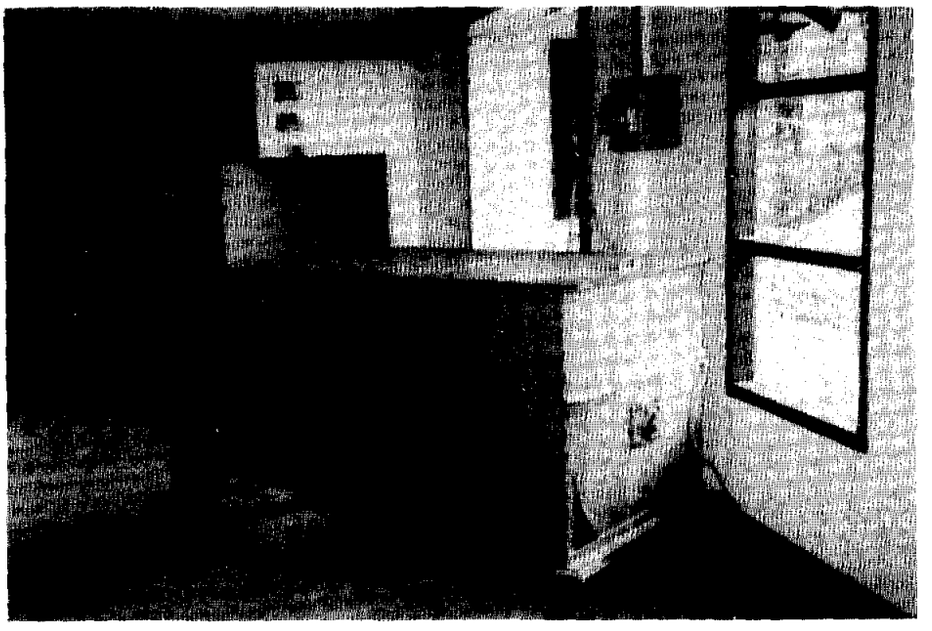


Figure 12. Saw dust mixing unit.

Figure 13. Automatic filling machine with plastic bag.

We found that contamination by Trichoderma sp., Aspergillus sp. and Penicillium sp. still interfered during the incubation period. It penetrated through the plastic bags according to the amount of damage down to the plastic bags at the time of filling the bags. So, the PP-bottles were used together with the new automatic filling machine (Figure 14) which reduced the rate of contamination from about 20 to 30 per cent using the old system to about 0.5 percent. At the same time, the growth rate of spawn kept in the PP bottles (about 400 g) during incubation period was found to be faster than in the PP-bag (about 800 g). Also, transportation was more convenient from the spawn making plant to the rural area along rough mountain roads using the new system.

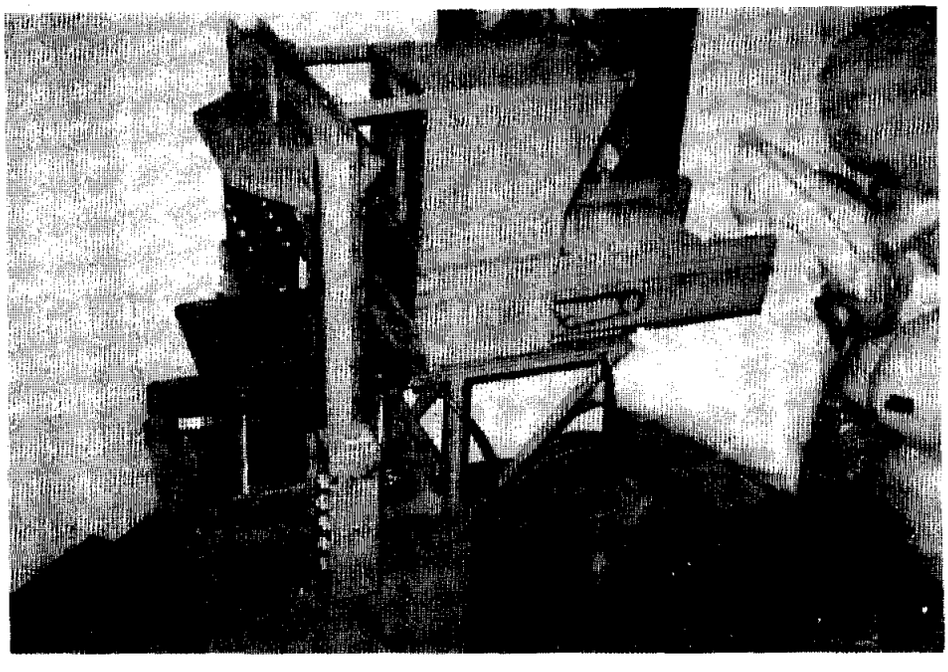


Figure 14. Automatic filling machine with plastic bottle.

After spawn and mycelium was fully matured in the bottles, they were kept in the cool room waiting for distribution to the farmers (Figure 15). At present, the plant can produce about 1,500 to 2,000 bottles per week using a total labour staff input of 5 persons to undertake the process of milling the wood chip to saw dust, filling, sterilizing and the inoculation of the spawn.

Figure 15. Finished spawn run in plastic bag.

The finished spawn will be routine checked to be sure that there is no contamination before sending to the farmers (Figure 16-17).

Figure 16. Temporary growing chamber.

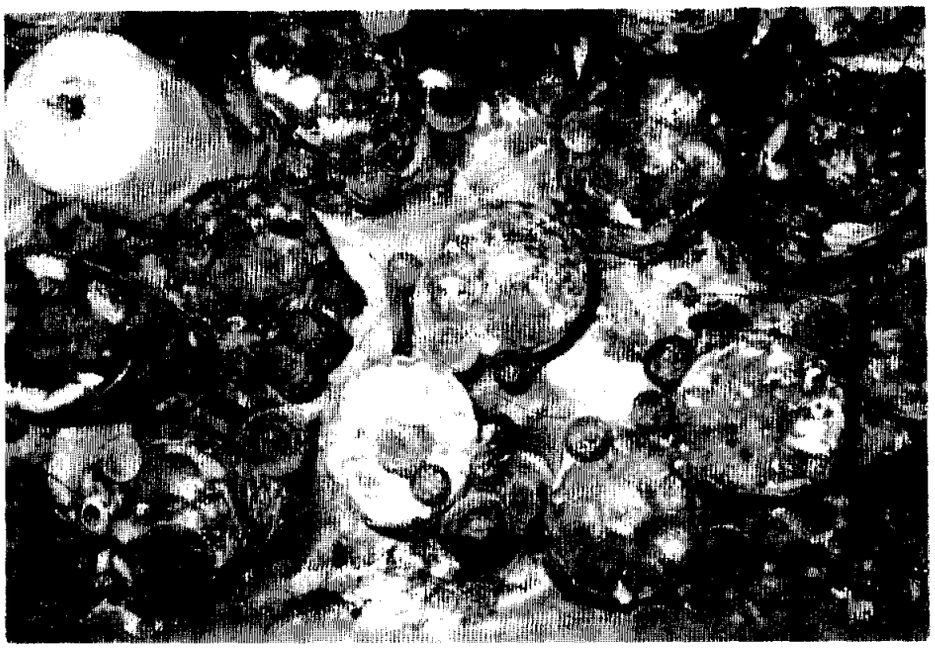


Figure 17. Mushroom fruiting bodies during observation at Doi Pui.

Locations of extension are shown in Table 1. The extension restarted again in late 1985 to the beginning of 1986. It was delayed by the construction and fixing of equipment at the spawn making plant at Doi Pui. Initially, there were 203 families who participated with the project using a total of 38,567 inoculated wood logs. About 427 families producing a total 82,644 wood logs joined the project in the following year. At the end of 1986, a total of 630 families were cultivating 121,211 wood logs, which gave a yield of approximately 36.3 tonnes. This was three times the quantity produced in the previous 2 years.

TABLE 1. LIST OF EXTENSION LOCATIONS

| Location | 1984 | | 1985 | | 1986 | | Type of Tribe |
|---|---|---|---|---|---|---|---|
| | No. of Families | No. of Logs | No. of Families | No. of Logs | No. of Families | No. of Logs | |
| 1. Santhakiri village | | | | 6,500 | | 26,500 | Chinese |
| 2. Ban Pang Khum | | | 39 | 5,100 | | | Karen |
| 3. Ban Mae La Noi | | | | | | | Karen |
| 4. Ban Kae Noi | | | | | | | |
| 5. Ban Mon Ngao | | | | | 59 | 3,800 | Hmong |
| 6. Ban Khun Sarb | | | | | 31 | 1,600 | Thai |
| 7. Ban Pang Bong, Pa Miang | | | | | | | Thai |
| 7.1 Ban Kew Tum | | | 19 | 3,132 | | | |
| 7.2 Pang Bong | | | 24 | 4,077 | | | |
| 7.3 Mae Wan | | | 14 | 2,351 | | | |
| 7.4 Pang Ma Kluay | | | 9 | 1,171 | | | |
| 7.5 Fa Muai | | | 7 | 1,032 | | | |
| 7.6 Kam Paeng Hin | | | | | 15 | 2,535 | |
| 7.7 Tin Tok | | | | | 21 | 4,081 | |
| 7.8 Pong Tong | | | | | 27 | 4,542 | |
| 7.9 Ban Dong | | | | | 15 | 2,507 | |
| 7.10 Pang Hi | | | | | 42 | 7,526 | |
| 7.11 Muang Kaow | | | 14 | 2,414 | | | |
| 7.12 Mae Wong | | | 10 | 128 | | | |
| 7.13 Ban Prod | | | 17 | 2,691 | | | |
| 8. Ban Tin Tok | | | | | | | |
| 8.1 Mae Lai | | | 50 | 8,171 | | | |
| 8.2 Ban Pok | | | | | 51 | 8,518 | |
| 8.3 Mae Kam Pong | | | | | 86 | 12,733 | |
| 8.4 Pang Perng | | | | | 42 | 6,136 | |
| 8.5 Pang Jeem Pi | | | | | 38 | 2,166 | |
| Total | | | 203 | 36,767 | 427 | 82,644 | |

To ensure that the production of mushroom was undertaken in a suitable environment, the inoculation of wood logs were made at 3 sites and climatic conditions were recorded as shown in Tables 2 - 9.

About 70% of farmers achieved a margin of over 20 baht per log, as shown in the bar chart below :

**TABLE 2.** TEMPERATURE RECORD

AT DOI PUI IN 1985

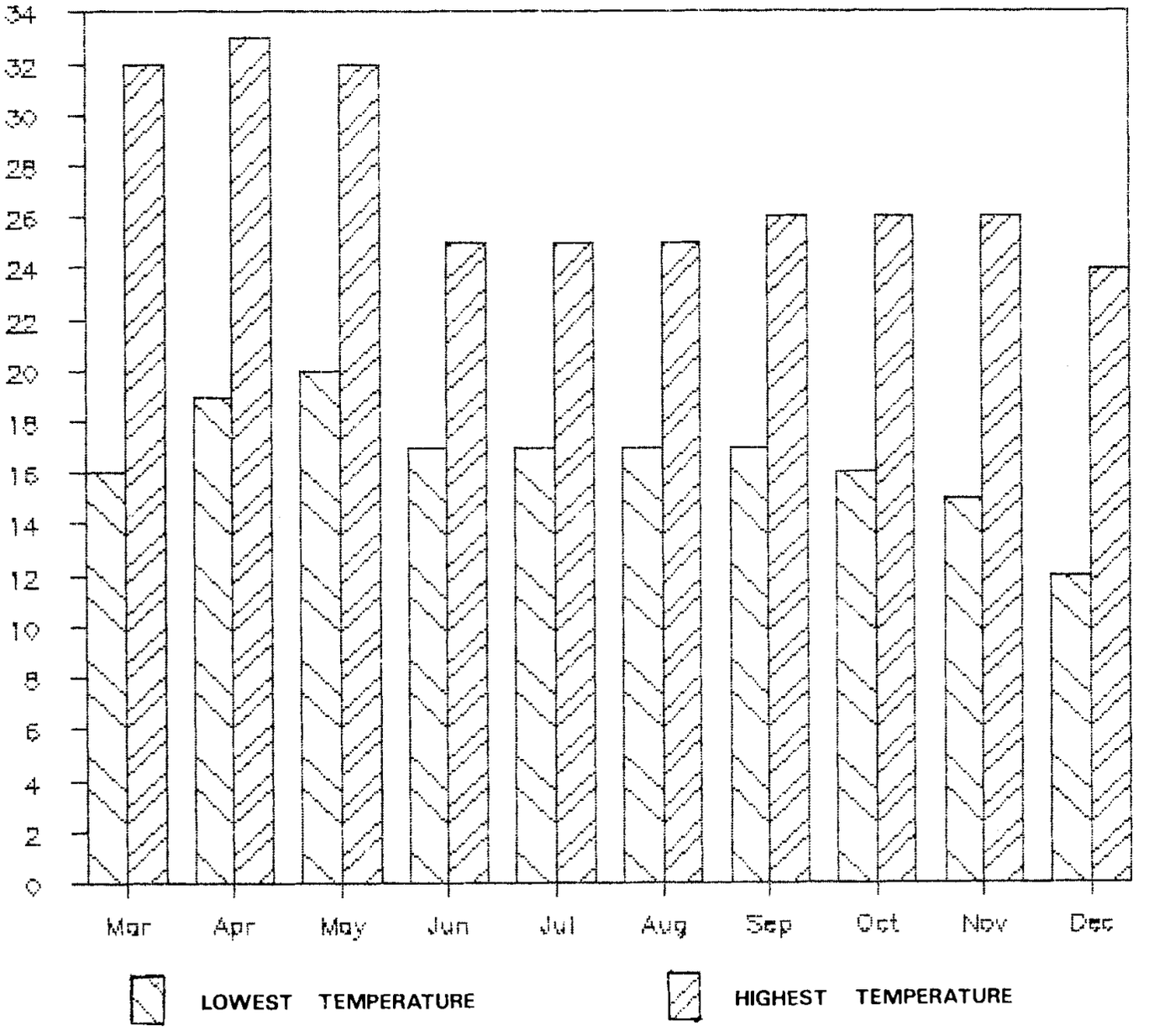


**TABLE 3.** TEMPERATURE RECORD

AT DOI PUI IN 1986

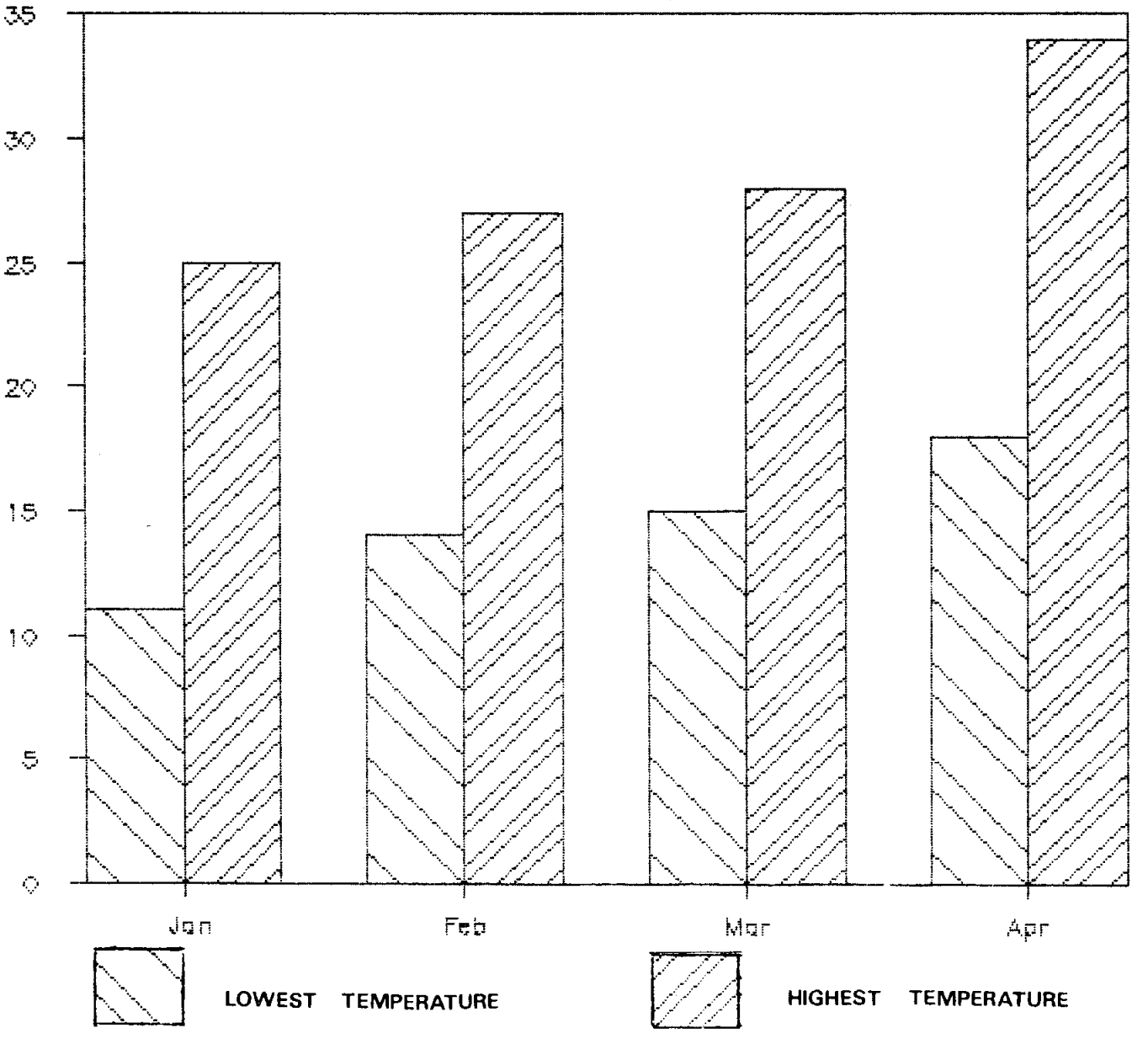


TABLE 4. TEMPERATURE AND RELATIVE HUMIDITY RECORD AT TEEN TOK IN 1984

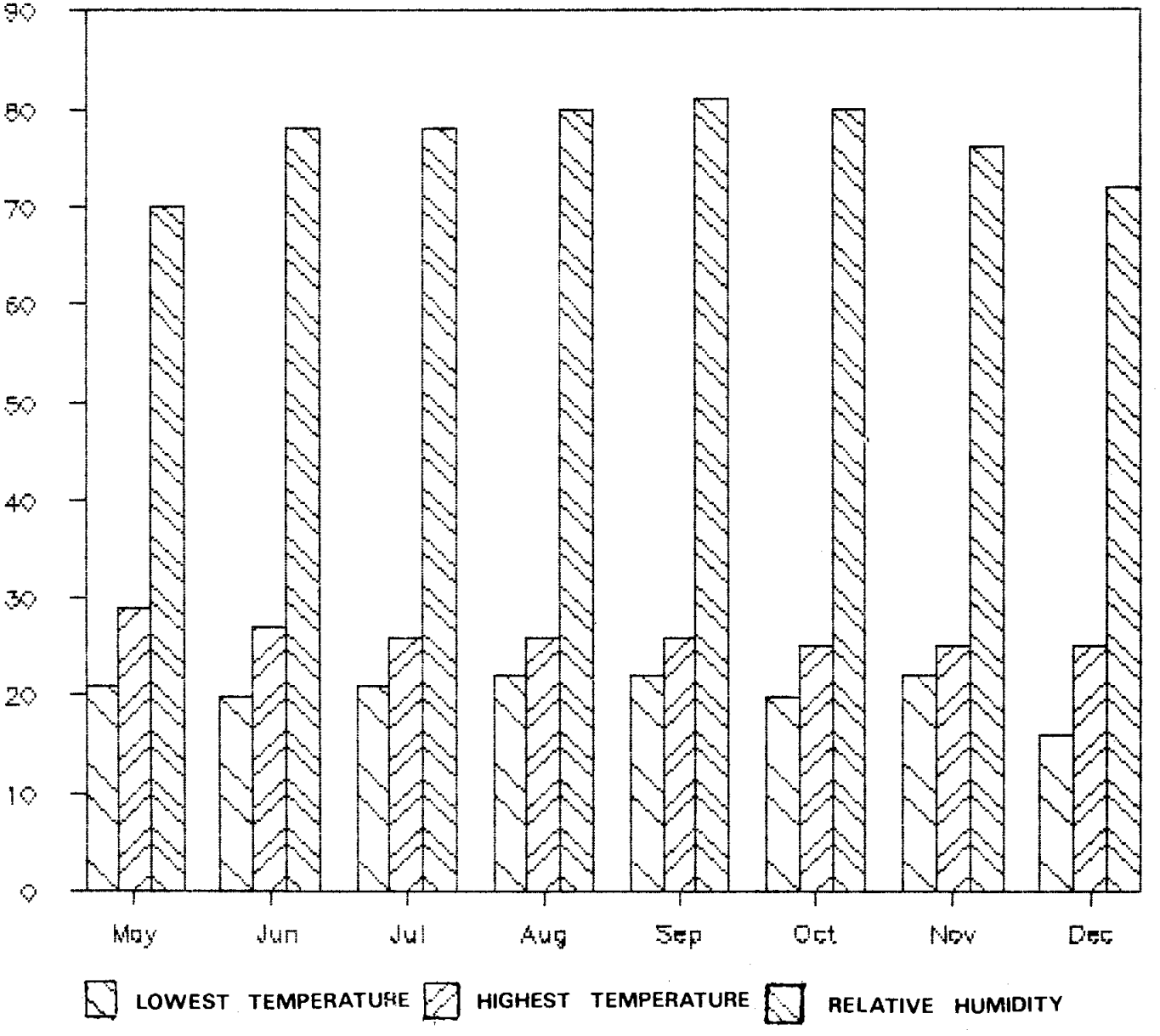


TABLE 5. TEMPERATURE AND RELATIVE HUMIDITY RECORD AT TEEN TOK IN 1985

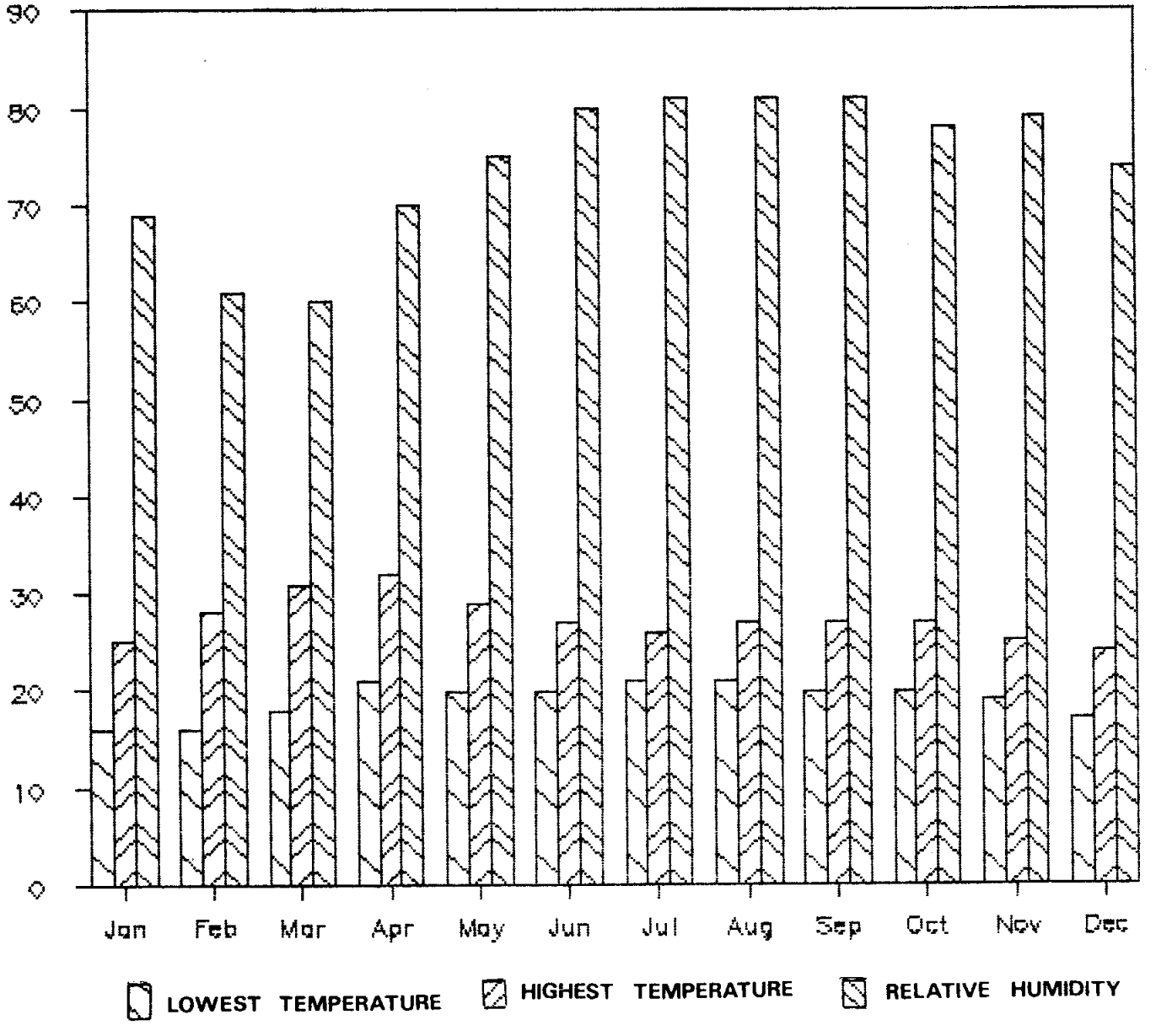


TABLE 6. TEMPERATURE AND RELATIVE HUMIDITY RECORD AT TEEN TOK IN 1986

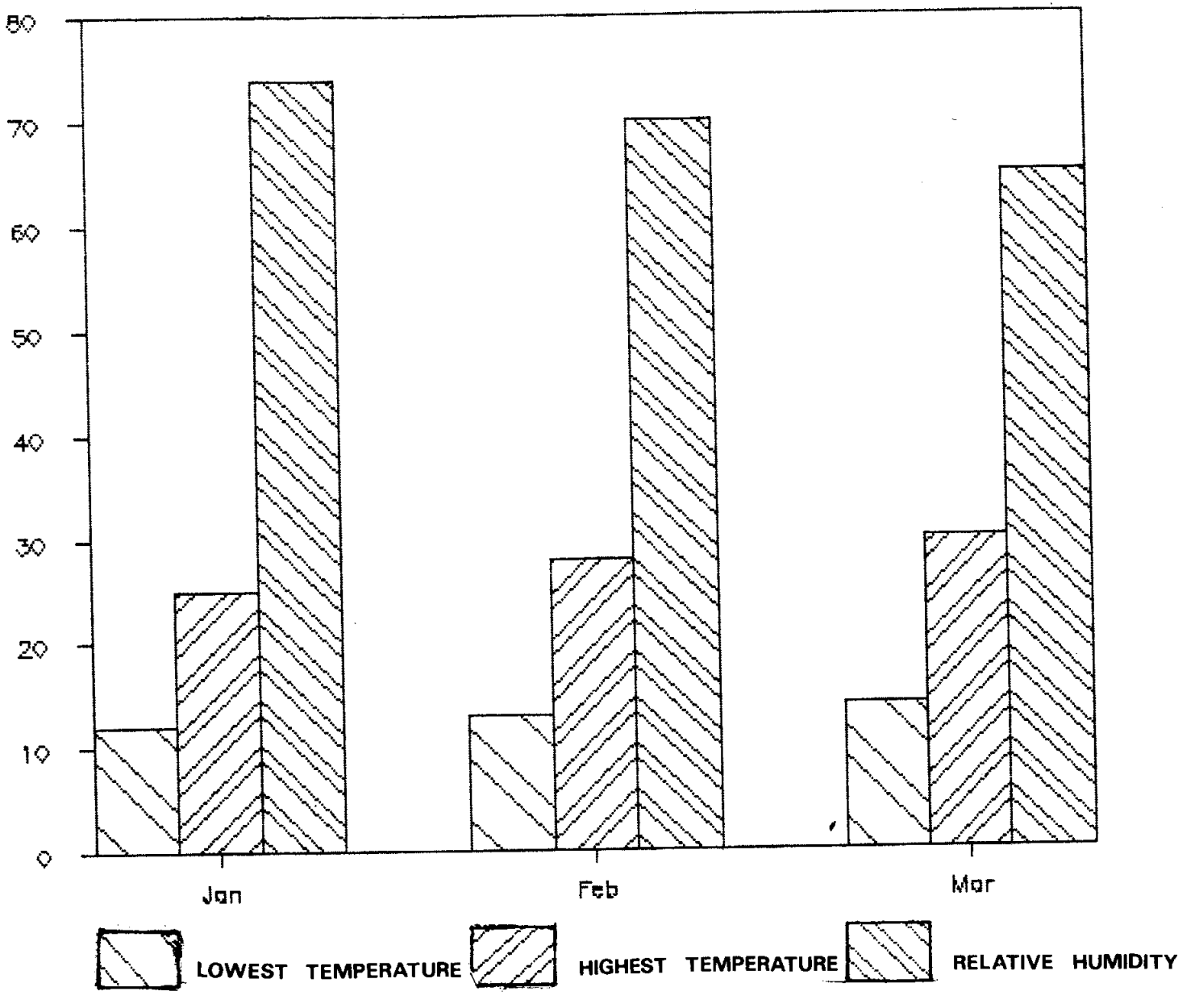


TABLE 7 TEMPERATURE AND RELATIVE HUMIDITY RECORD AT PANG BONG IN 1984

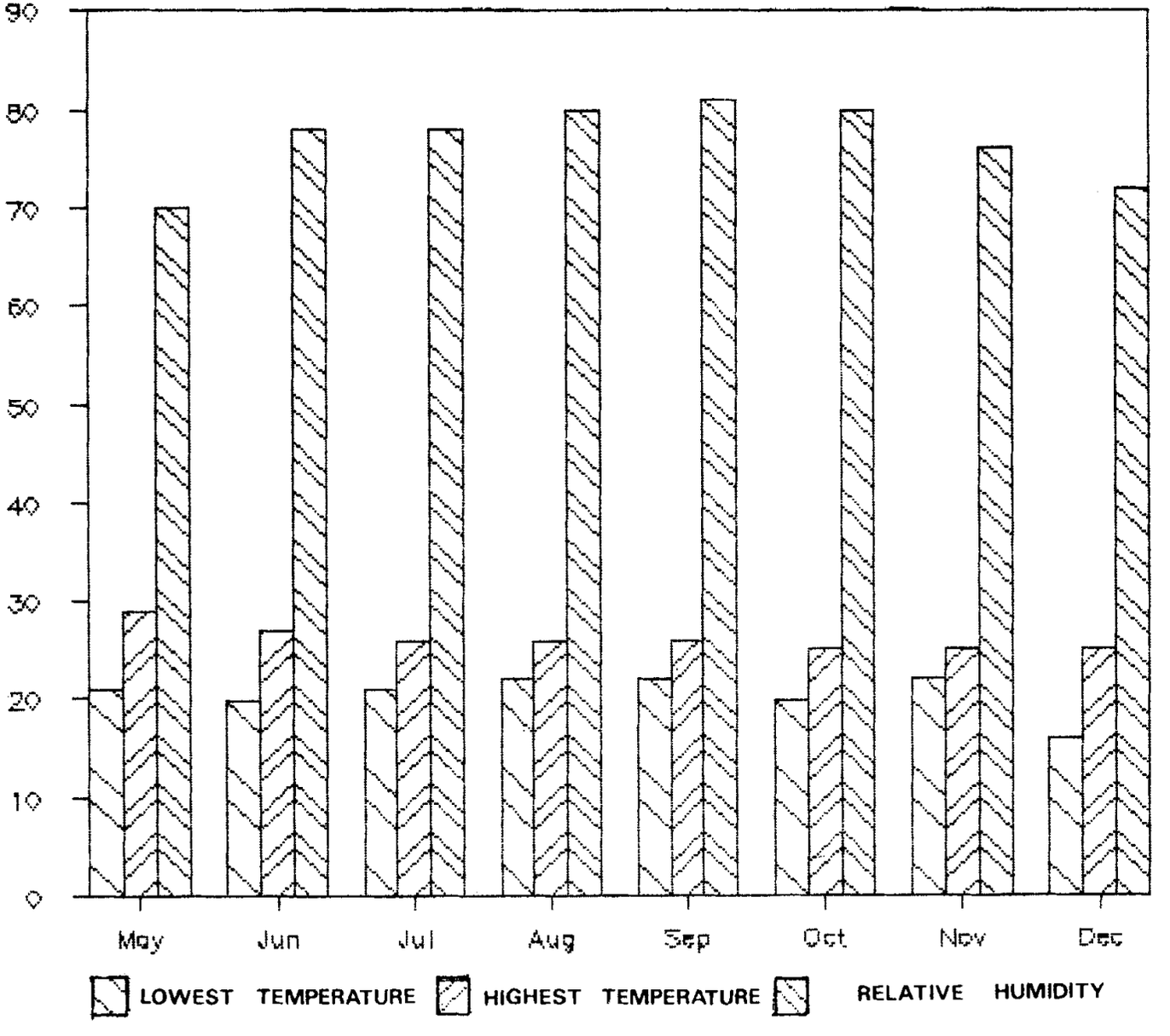


TABLE 8. TEMPERATURE AND RELATIVE HUMIDITY RECORD AT PANG BONG IN 1985

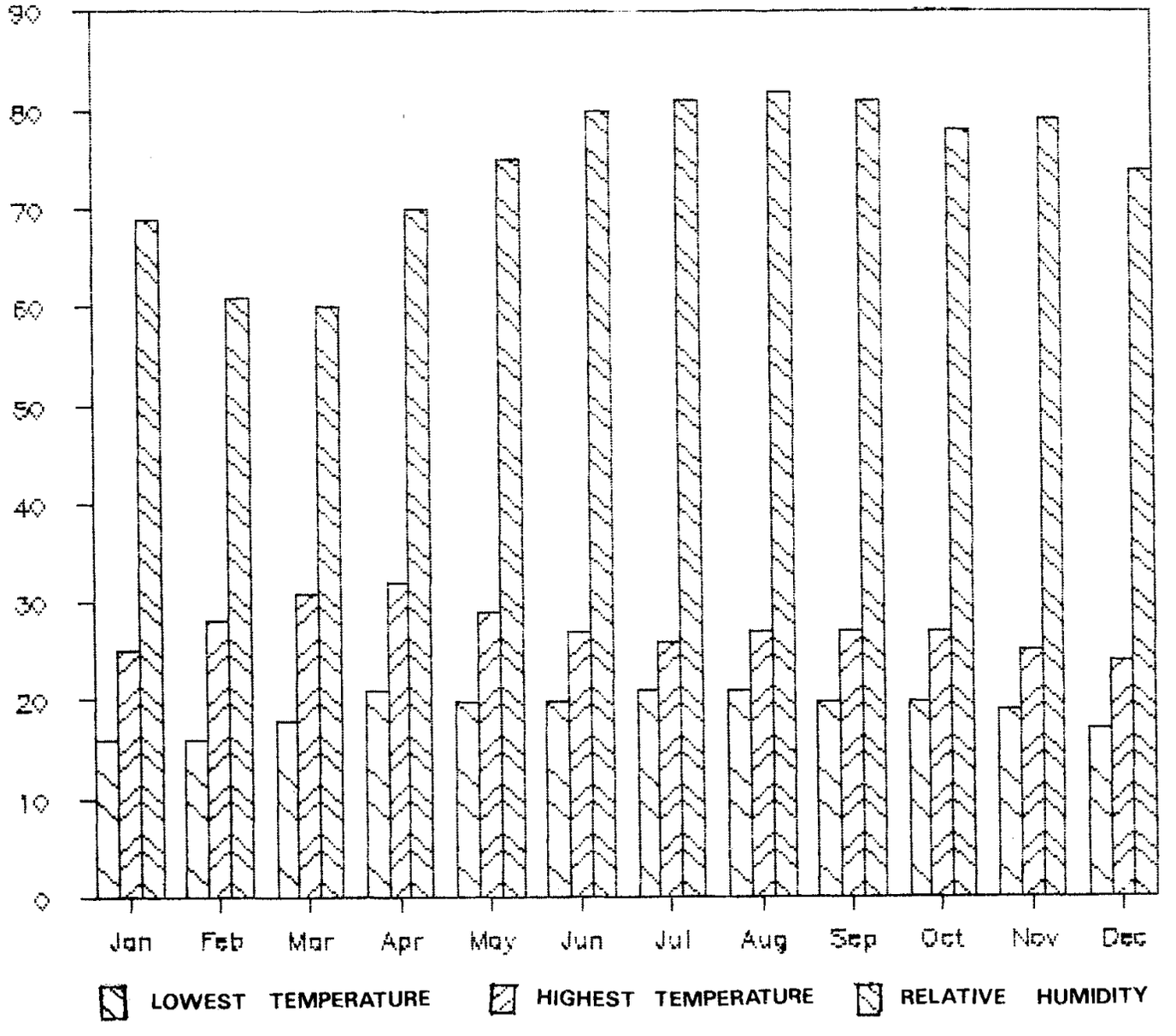
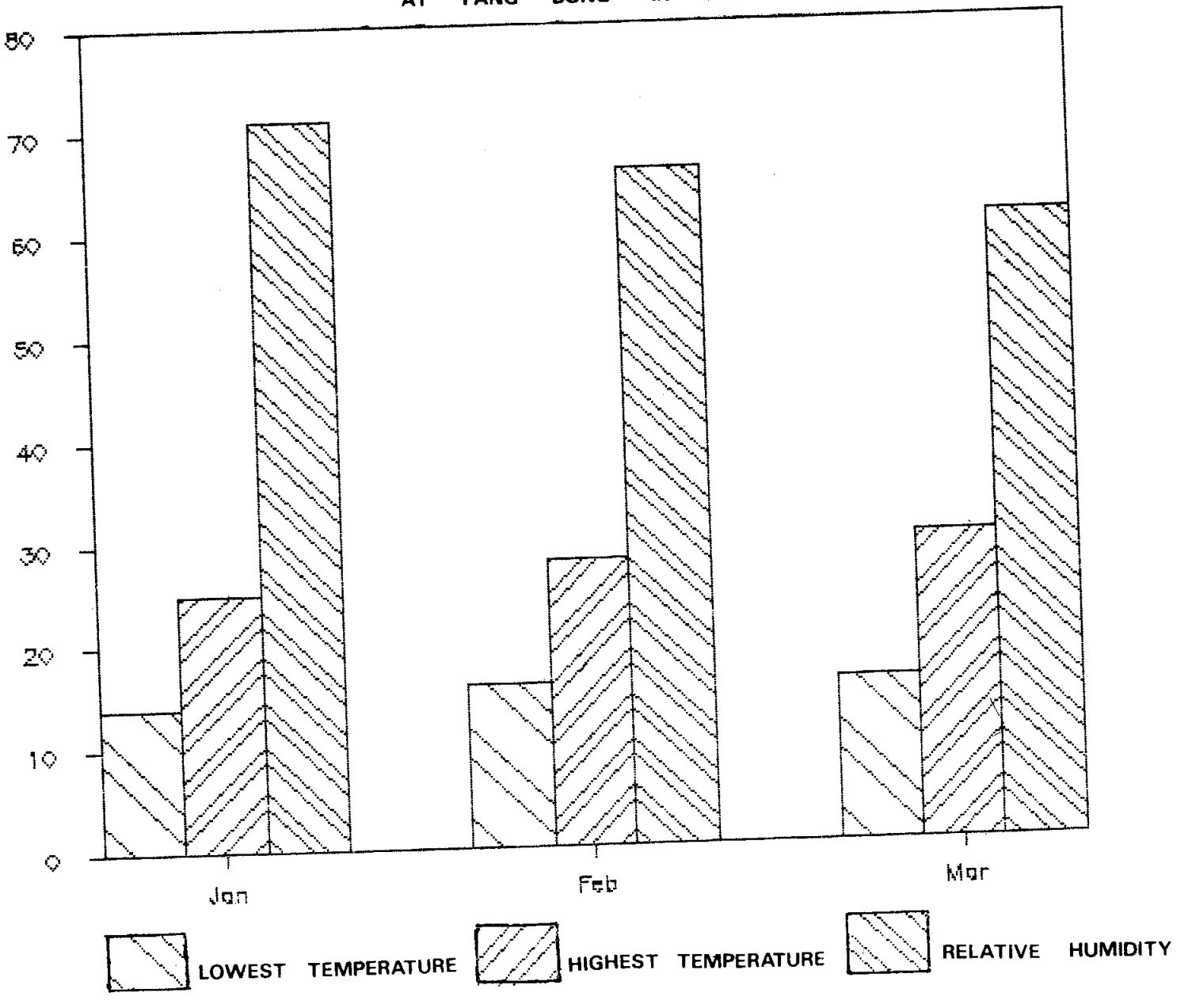


**TABLE 9.** TEMPERATURE AND RELATIVE HUMIDITY RECORD AT PANG BONG IN 1986



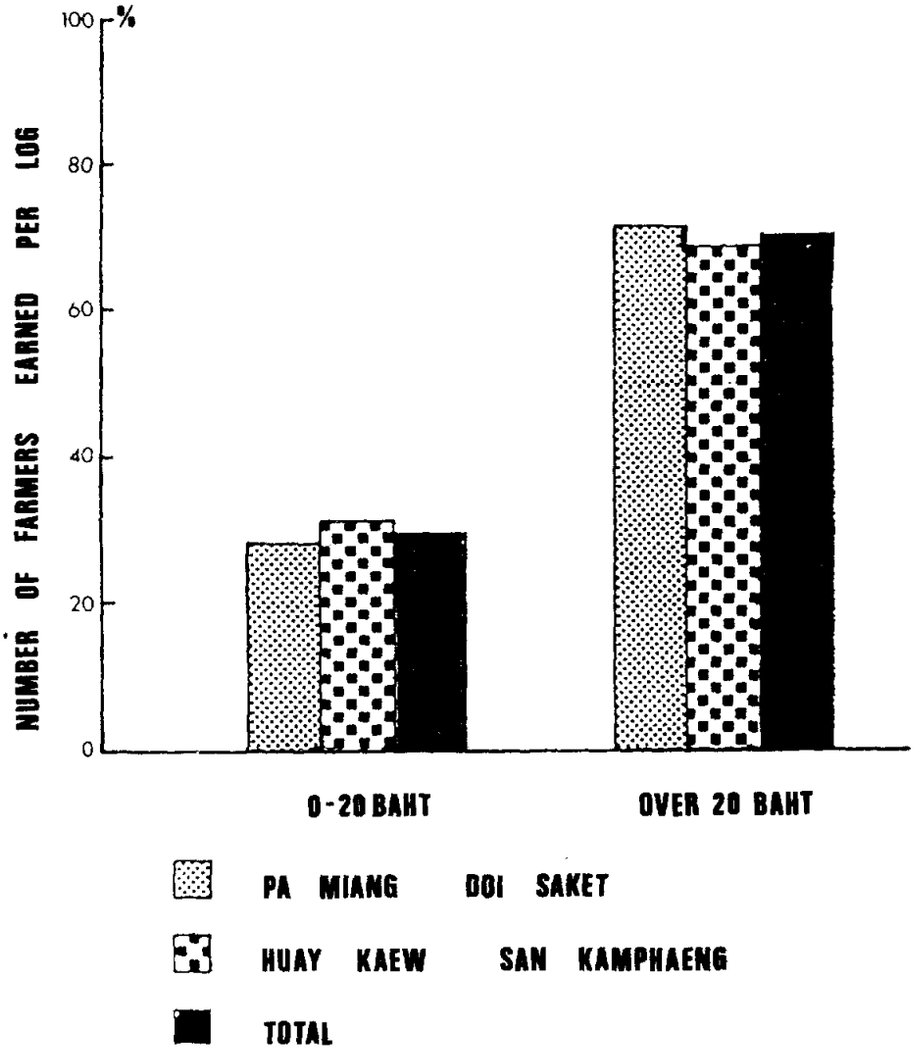



Figure 18. Level of income earned by farmers (%) per log in the project area.

From the previous reports, data collected showed that 41.7% of farmers earned income less than 2,000 baht and 58.3% earned more than 2,000 baht (Figure 19).

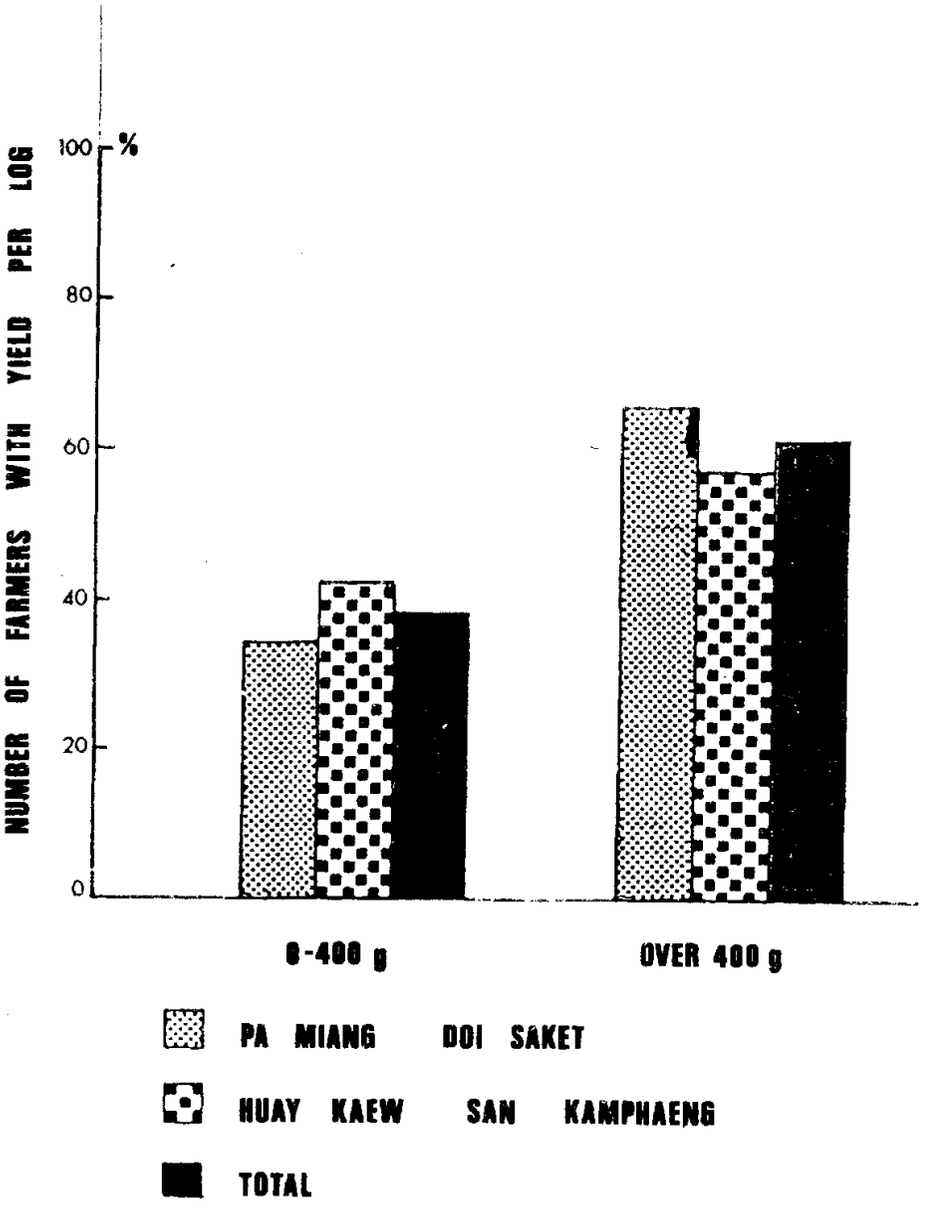



Figure 19. Total income earned by farmers (%) in the project area.

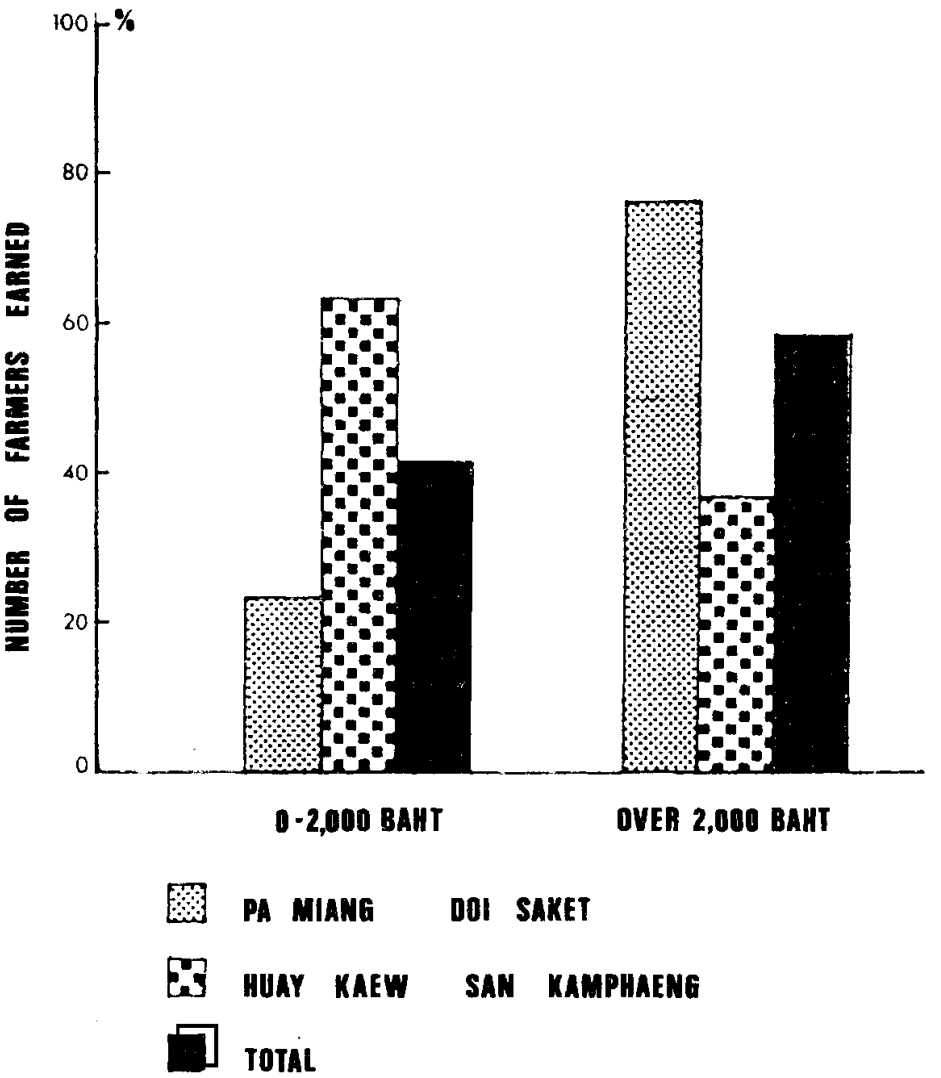



Figure 20. Yield per log achieved by farmers (%) in the project area.

Cultivation Practice

During the extension period, production techniques using wax to cover the inoculation hole were eliminated, as the wax, being of poor quality, caused increased rotting of the wood and would sometimes fall out, if the logs were turned, allowing infection of other fungus. This resulted in poor yield and a bad return. Using wax was also real expensive than using bark to cover the spawned holes (Figure 21-24).

Figure 21. Growing yard without shelter at Mae Salong, Chiang Rai.

Figure 22. Growing yard without shelter at Mae Salong, Chiang Rai.

Figure 23. Waxed spawn inoculated holes.

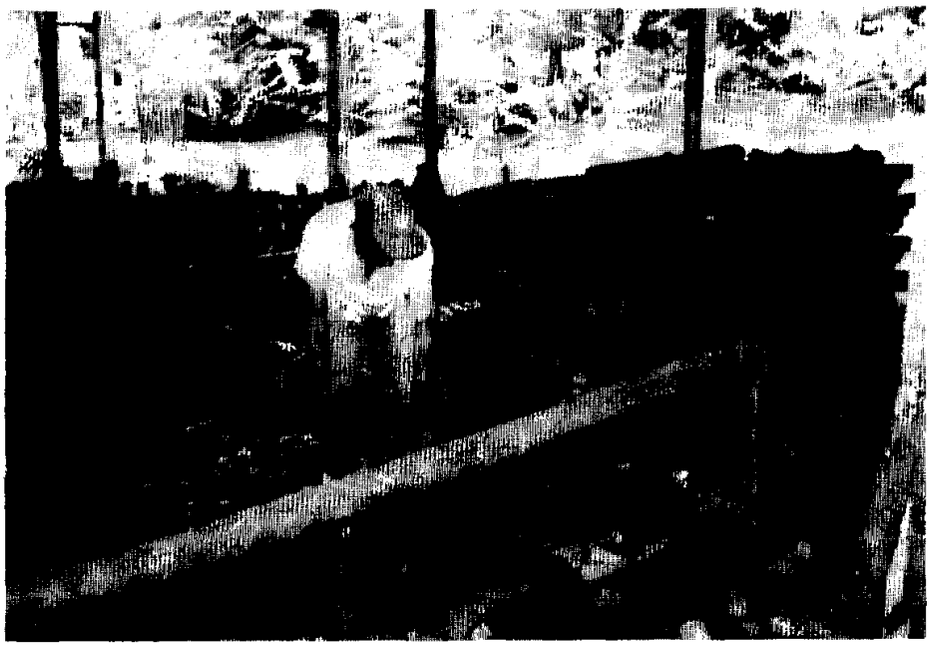


Figure 24. Cropping yard in shelter after treated in water at Mae Salong, Chiang Rai.

The quality of mushrooms were improved because shelter was provided. Produce was graded and prices were set according to grades. In the past year, the Royal Project had to support the return price to the farmers, as the standard of produce was not as high as the market demanded.

To improve quality, shelters were built over the logs to protect them from excessive moisture and climatic conditions. Project personnel travelled to different sites to monitor the farm situation and report back to the main office.

An attempt to solve farmer problems was undertaken during the time of collecting the product or paying back the money to the farmers. Income and production data and problems were recorded for analysis (see Figures 27 - 32).

Figure 25. Meeting at the village by project personnel.

Figure 26. Inspection at the inoculation site.

Figure 27. Mushroom growing bamboo house.

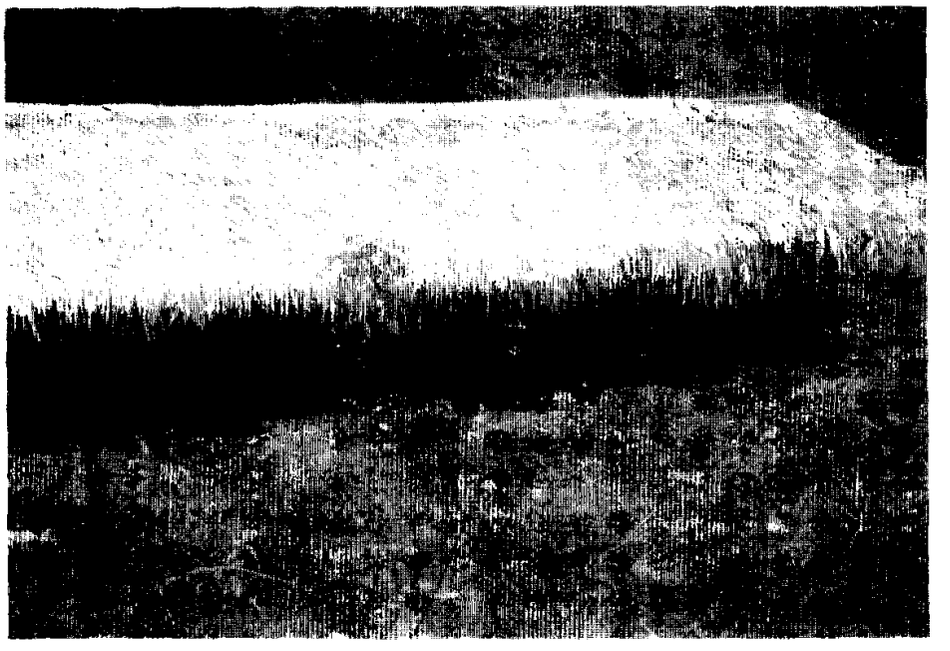


Figure 28. Mushroom growing house with palm leaf roof.

Figure 29. Mushroom production in the local farm.

Figure 30. Mushroom production in the local farm.

Figure 31. Collecting the production from members.

Figure 32. Return payment meeting after 2 weeks from collecting the product.

Farmer Production Problems:

The survey on contamination of inoculated wood was made and the samples were collected and brought back for identification at TISTR. They were classified by Professor Dr. Ramos Ramires as follows:-

Trichoderma spp.
Penicillium sp.
Aspergillus sp.
Mucor hiemalis
Acrioguakigira sp.
Gliocladium sp.
Curvularia leurata
Septoria sp.
Cladosporium

The contaminated fungi were found in the bad ventilation growing yard where too much moisture existed. Infected logs should have been thrown away and eliminated or moved elsewhere when the problem was met at the laying stage. At the raising stage it had to be taken away and to be used as fire wood. Despite some contamination, it was not a major extension problem.

Project farmers who produced mushrooms followed Project guidelines and recommendations and borrowed equipment (e.g. electric drills and other tools with no major problems arising). Television exposure on Channel 7 Agricultural programme increased local farmer interest in mushroom production in the area.

Management and Marketing:

It was previously reported that the Royal Project and the mushroom project planned to alleviate the problems due to the inconsistency of the selling price.

With more marketing experience, the Project was able to improve post harvest activities, particularly packaging activities which enabled mushrooms to be packed at the stations into 4 kg packs. At the Chiang Mai pack house, mushrooms were re-packed into small packs of 2 kilogram packets for shipment to Bangkok by air freight the same day if possible. Mushrooms were sent in refrigerated trucks to improve the shelf life of the mushrooms. Prices were reduced from 60 - 50 baht per kg for grade A produce. Dried produce still sold at 40 (A) baht, 30 baht (B) and 20 baht (C) per kg.

The rotation technique to control the cropping time to co-incide with expected demand meant that the Project could supply the market with a consistent supply throughout the year. The data of cost benefit on management of mushroom extension programme will be collected and analysed at the end of cropping season.

4.3 Reforestation:

Testing different propagation methods: Different method on preparation the Ko seedling was found that the seedling one year old from the nursery 631 seedlings could be survived 391 (62%)and 240 (38%) were died. While 383 seedlings collected directly from the forest and planted immediately 233 (60.8%) were died and only 150 (39.2%) were left behind. About two weeks later 586 of the chinese maple Liquidambar formosana seedlings in plastic bags from Angkhang Royal Station were planted, only 3 (0.5%) died. These figures were checked in December 1983, and the causes of seedling to die out may due to the lack of rain fall for two weeks after planting.

The seed of Ko tree is a recalcitrant seed. The percentage of germination will decrease quickly over time, even though seeds are kept in the cold room. Consequently, bare root seedlings collected in the natural forest seem to grow faster. This is a more practical cultivation method of the Ko tree and should be recommended for future production. At Teen Tok Demonstration Center, apart from Ko tree, other varieties were also planted for comparison purposes including:

Chinese maple; Liquidambar formosana, Cinnamomum camphora and Fraxinus griffithii.

The experiment on intensive cultivation of Ko tree started in October 1981 at Teen Tok Demonstration Center, (800 meters asl.) This experiment improved our knowledge the way the Ko tree grows. The methods of planting the Ko tree are as follows:-

1. Plant spacing under rainfed cultivation system is recommended at 1.5 x 1.5 meter.

2. Fertilizer 15-15-15 should be applied at the beginning of the rainy season (June) once a year (100 g/tree and 50 g added later on in the year).

3. Weeding done twice a year before and after the rainy season.

4. Measuring the height and diameter done in October each year by random sampling 20 trees.

Average growth of Ko tree at Teen Tok Demonstration Center is shown below:-

| | Oct. 1981 | Oct. 1982 | Oct. 1983 | Oct. 1984 | Oct. 1985 |
|---|---|---|---|---|---|
| Average height in cm | 30 | 75.95 | 143.75 | 243.44 | 455 |
| Average diameter in cm at 130 cm above ground level. | - | - | - | 1.19 | 2.45 |

At Teen Tok, the coppicing system of wood cutting were observed at 5, 50, 100 and 150 centimeters above ground level. The cutting was done on March 1983 and checking on October 1984. The coppicing result by sampling from five trees of each level are as follow:-

| Level | No.1 | No.2 | No.3 | No.4 | No.5 | Total |
|---|---|---|---|---|---|---|
| 1 | 4 | 3 | died | died | died | 5 |
| 2 | 3 | 3 | 5 | 1 | died | 5 |
| 3 | 2 | 2 | died | died | died | 5 |
| 4 | 1 | 1 | 1 | 1 | died | 5 |

Twelve (60%) trees were successfully coppiced and eight (40%) died due to bush fire.

## 5. Conclusion and Recommendation:

With the cooperation of the Royal Project, the TISTR could establish the mushroom research project working on shiitake and button mushroom cultivation. Its aim is to eliminate problems of slash and burn agriculture; to improve living standards of the hilltribe people and to establish an alternative crop to opium production in Northern Thailand.

The basic research undertaken gave an encouraging result, whereby 70.4% of farmers could produce mushrooms worth over 20 baht per wood log. There are many farmers interested in cultivating the mushroom.

The mushroom extension work carried out between 1985 and 1986 was successful, resulting in a total of 630 families from 8 villages cultivating the mushroom. The mushroom yielded approximately 36.3 tons worth 2,160,000 baht, during this time.

The extension work shall be continued and expanded only through the requests of farmers or in areas where other Government agencies have suitable production conditions for shiitake mushroom cultivation. Research should be continued to improve quality and yields of mushrooms produced.
Research should cover aspects of:

- Mushroom strain improvement.
- Post harvest with handling, grading and packing techniques.
- Processing techniques using local materials in the area.
- Reforestation of Ko tree for future production.