No. 1 November, 1937

SIAM
SCIENCE BULLETIN

DEPARTMENT OF SCIENCE
MINISTRY OF ECONOMIC AFFAIRS
BANGKOK, SIAM.

NO. 1 NOVEMBER, 1937

SIAM
SCIENCE BULLETIN

DEPARTMENT OF SCIENCE

MINISTRY OF ECONOMIC AFFAIRS

BANGKOK, SIAM.

SIAM SCIENCE BULLETIN

Published by the Department of Science
Ministry of Economic Affairs
BANGKOK, SIAM

NO. 1 NOVEMBER, 1937

CONTENTS

CHEMICAL STUDIES OF SIAMESE KAPI

(กะปิไทย)

BY

Toa Labanukrom and Pue Rochanapurananda

In Collaboration of

Sangar Sharasuvana

Tongchai Punyasingha

and

Chalaem Bhumiratana.

Of the Department of Science, Bangkok.

Introduction.

The diet of the Siamese in general consists of rice wtih fish as a protein food. Shrimps are also used wherever available. The basic form of fish consumption is fermented fish (Pla-ra) or dried salt fish or paste (Kapi). The paste is made mostly from shrimps or a mixture of shrimps and small fishes. The paste made exclusively from fishes is also found, but this is considered inferior to that made from shrimps.

Preserved fish and shrimps are used more than the fresh kind because fresh fish and shrimps are not found all the year round. During the rainy season they are scarce and the people are too busy in the fields so that they have to use preserved food to compensate for the lack of fresh food during this season.

It is, however, very interesting to note that Kapi is not only popular among the peasants and the poor, but also among the wealthy. In fact Kapi is considered a delicacy and an indispensable foodstuff in all Siamese homes.

Ngapi which is a preparation of a similar nature is considered no less important in Burma.

There are two kinds of Ngapi in Burma; one is known as Seinsa Ngapi made from shrimps or a mixture of shrimps and small fishes and another is known as Nga Ngapi which is a fish paste made exclusively from medium sized fishes.

Purpose of Present Investigation.

Since Kapi plays such an important part in the Siamese diet it has been chosen as the subject of this investigation. The purpose is to find:— (1) its proximate composition (2) whether there is adulteration for the sake of extra profit as this a common practice of some retail dealers and (3) what should be the standards for genuine Kapi.

The last aim will especially be helpful in fixing a legal standard of purity for Kapi when the Food and Drug Act is promulgated.

Proximate Compositions of Siamese Kapi Previously Analysed.

During the economic survey of the rural problems in Siam undertaken by a Commission headed by Dr. Carle C. Zimmerman in 1930—1931, the study of food and diet was made. Samples of different kinds of food were sent to the Department of Science (then the Government Laboratory) for analysis. Results of analyses of Kapi may be seen in the following table.

Locality	Lab. No.	Moisture Percentage	Protein Percentage	Fat Percentage	Ash Percentage	Crude Fiber Percentage	Carbohydrate Percentage	Sodium chloride Percentage	Rough estimate of calories per Kg.
Chandaburi - -	H 168	48.4	21.0	3.2	Waste & Salt		—	—	1,159
Chaxerngsao - -	H 367	42.8	20.0	1.8	4.6	—	—	27.2	987
Chiengmai - -	G 939	59.5	19.9	—	5.7	—	—	13.4	816
Trang - - -	H 342	40.5	32.9	3.4	8.4	—	—	6.8	1,665
Average - - -	—	47.8	23.4	2.8	6.2	—	—	15.8	1,156

Origin of Samples Examined.

In this present study, samples of Kapi prepared by various makers were kindly supplied by the Governors of different provinces which are well-known for their Kapi. To them the authors are greatly indebted. Several samples were also bought from local markets for examination.

Methods of Manufacture of Kapi.

There are four kinds of Kapi known so far; the first is that made exclusively from small sized shrimps known as Keui (เคย), the second from a mixture of small and ordinary sized shrimps (กุ้ง), and sometimes small fishes, the third exclusively from ordinary sized shrimps and the fourth exclusively from fishes. The last kind is sometimes known as Kapi Mon (Peguan paste).

The names of small sized shrimps are found to be several namely Keui Ta Dam (เคยตาดำ), Keui Ta Deng (เคยตาแดง), Keui Som-O (เคยส้มโอ), Keui Ma-Luk (เคยแม่ลูก), Keui Nuad Dang (เคยหนวดแดง), Keui Foong Tao (เคยฝุ่งตัว), Keui Kee Toa Kai (เคยขี้เท่าไข่), Keui Kee Toa Tao (เคยขี้เท่าตัว), Keui Sam Lee (เคยสำลี). So are the ordinary sized shrimps namely Koong Plong (กุ้งปล้อง), Koong Onn (กุ้งอ่อน), Koong Cha Kad (กุ้งชะกาด).

The authors were able to obtain only one sample of the paste made exclusively from fish. It was stated in the report submitted simultaneously with the sample that only one kind of fish was used in that sample namely Pla Sai Tan (ปลาใส้ตัน).

All these different names are, however, only known among the local people. Their scientific names have not yet been studied by the authors, but it is thought that some may be of the same species. The variation of names may be accounted for the difference of localities.

The principle of manufacturing Kapi is the same every where that is by mixing shrimps or fishes with common salt as a preservative then reducing the mixture to a homogeneous paste. Minute details are found to be different according to different localities. They may be summarized as follows.

First: Shrimps or fishes and common salt are mixed, allowed to remain in the sun till the water content is considerably reduced then pounded thoroughly.

Second: Shrimps or fishes and common salt are mixed, but instead of pounding the mixture as aforementioned the makers walk on it until the paste is obtained then left to dry for a couple of days.

Third: Shrimps or fishes and common salt are mixed then kept in a container without rendering the mixture to a paste. After some time this becomes a paste by itself due to the action of salt but this usually takes a longer time.

In practice, whether the mixture is reduced to a paste at once or not, it is not used soon after the preparation. The mixture is always allowed to stand for a certain period during which the shells and bones soften and become powdery. At this stage the paste is ready for consumption.

Some samples of Kapi bought from local markets have been found to be badly colored with artificial dyestuff. It is believed that the addition of dyestuff to Kapi in such cases is not to imitate the natural color of Kapi but rather to make it attractive to the buyers. This practice should not be encouraged at all.

Scheme of Analyses.

The scheme of analyses in this study is not the usual one of determining moisture, ash, proteins, crude fibre, fat and carbohydrate because the purpose is not merely to find the proximate composition of the sample but to find its quality.

Since genuine Kapi is made from fishes or shrimps which are very rich in proteins and fat content, if broken rice, starch or bean curd is added to increase the bulk, the percentages of proteins and fat will be considerably lower than those of the genuine Kapi because the two constituents in either of the substances used as adulterants are very low compared with those of fish and shrimps. Consequently, the amounts of proteins and fat must be regarded as important in determining the purity of Kapi.

In this connection, the scheme of analyses used by the Chemical Examiner, Government of Burma is adopted, that is, in order to get significant figures for proteins and fat the percentages should be calculated on the dry sample minus sodium chloride. The reason for this is that the amount of

water in different samples vary within a wide limit, so is the amount of common salt or sodium chloride. Such a great variation may be attributed to the absence of a standardized method of manufacture. If the percentages of proteins and fat are calculated on the wet basis as is usually the case no comparable figures will be obtained.

Four items are, therefore, to be analysed namely, moisture, sodium chloride, proteins and fat. The procedure used may be briefly stated as follows:

Determination of Moisture.

About 5 gms. of Kapi are dried in an electric oven at the temperature of between 105—110°C. until the weight is constant. The loss in weight is calculated as moisture.

Preparation of Sample for the Determination of Sodium Chloride, Proteins and Fat.

About 25—30 gms. of Kapi are first dried on a water bath in a shallow basin until most of the moisture content is driven away then further dried in the electric oven. The partially dried Kapi is powdered in a mortar then re-dried to a constant weight. The powdered sample which is moisture free is kept in a desiccator for further determinations.

Determination of Sodium Chloride.

About 1—2 gms. of the dried Kapi are gently heated over a small Bunsen flame in such a manner that all the organic matter is burnt away. The temperature must be

kept not more than a dull red heat because sodium chloride is decomposable at high temperature. If such decomposition is possible a lower percentage of sodium chloride will result and this will correspondingly lower the percentages of proteins and fat which are to be calculated on a dry basis minus sodium chloride.

The residue obtained after the above ignition is extracted with hot distilled water then filtered into a 250 c.c. volumetric flask. Care must be taken such that no soluble salts are left both in the container and in the filter paper. When the solution attains the room temperature, distilled water is added up to the mark. The chloride is determined gravimetrically by the precipitation method with silver nitrate solution. In calculating the percentage of sodium chloride all the chlorides present in the solution is taken as coming from sodium chloride.

Determination of Fat.

Fat is determined as ether extract by the use of the Soxhlet fat extractor. The period of extraction is about ten hours. The calculation is made on a dry basis minus sodium chloride.

Determination of Proteins.

The amount of proteins is obtained by multiplying the total nitrogen which is determined by Gunning's modified Kjeldahl method by the factor 6.25. The calculation is also to be made on a dry basis minus sodium chloride.

Test for Starch.

The test for starch is made qualitatively in order to find out whether the genuine Kapi is adulterated since it has been known that the substance used mostly in this connection is starchy in nature such as rice bran, bean curd and other forms of starch.

The test is carried out in the following manner:

A portion of Kapi, about 10 gms. is mixed with about 100 c.c. of water in a beaker, stirred with a glass rod then allowed to settle for a few minutes. The supernatant liquid is decanted and the process repeated several times until only the residue insoluble in water remains. This consists generally of shell from shrimps. If rice bran, bean curd or any kind of starch is present it will be seen clearly with the naked eye.

The chemical test may be made by boiling the residue with a small amount of water, then a drop of iodine test solution is added. The presence of starch is indicated by the dark blue coloration which appears immediately.

In order to determine the kind of starch present, simple microscopical tests may be resorted to.

TABLE I.

A Brief Description of Kapi Examined.

No.	*Lab. No.*	*Locality*	*Source*
1	Q 15	Commune of Tai Ban, Samutra Prakara (ตำบลท้ายบ้าน สมุทรปราการ)	Small sized shrimps (เคย)
2	Q 16	Commune of Tai Ban, Samutra Prakara (ตำบลท้ายบ้าน สมุทรปราการ)	Small sized shrimps (เคย)
3	N 802	Commune of Klam Chagpong, Rayong (ตำบลกร่ำชากพง ระยอง)	Small sized shrimps (เคย)
4	N 803	Commune of Klam Chagpong, Rayong (ตำบลกร่ำชากพง ระยอง)	Small sized shrimps (เคย)
5	N 804	Commune of Pa-Klang, Rayong (ตำบลแพแกลง ระยอง)	Small sized shrimps (เคย)
6	N 805	Commune of Pa-Klang, Rayong (ตำบลแพแกลง ระยอง)	Small sized shrimps (เคย)
7	N 502	Commune of Bangsai, Jolburi (ตำบลบางทราย ชลบุรี)	Small sized shrimps (เคยตาดำ)
8	N 503	Commune of Bangsai, Jolburi (ตำบลบางทราย ชลบุรี)	Smal sized shrimps (เคยตาแดง)

No.	*Lab. No.*	*Locality*	*Source*
9	N 484	Commune of Kloong, Chandaburi (ตำบลขลุง จันทบุรี)	Mixture of small sized shrimps (เคยตาดำ และเคยส้มโอ) and ordinary sized shrimps
10	N 485	Commune of Kloong, Chandaburi (ตำบลขลุง จันทบุรี)	Mixture of small sized shrimps (เคยตาดำ และเคยส้มโอ) and ordinary sized shrimps
11	N 492	Commune of Bang Chan, Chandaburi (ตำบลบางชัน จันทบุรี)	Mixture of small sized shrimps (เคยตาดำ และเคยส้มโอ) and ordinary sized shrimps
12	N 486	Commune of Bang Chan, Chandaburi (ตำบลบางชัน จันทบุรี)	Small sized shrimps (เคยแม่ปุก)
13	N 487	Commune of Bang Chan, Chandaburi (ตำบลบางชัน จันทบุรี)	Small sized shrimps (เคยตาดำ)
14	N 488	Commune of Bang Chan, Chandaburi (ตำบลบางชัน จันทบุรี)	Small sized shrimps (เคยตาดำ)
15	N 489	Commune of Bang Chan, Chandaburi (ตำบลบางชัน จันทบุรี)	Small sized shrimps (เคยหนวดแดง)

No.	*Lab. No.*	*Locality*	*Source*
16	N 490	Commune of Bang Chan, Chandaburi (ตำบลบางชัน จันทบุรี)	Small sized shrimps (เคยแม่ลูก)
17	N 491	Commune of Bang Chan, Chandaburi (ตำบลบางชัน จันทบุรี)	Small sized shrimps (เคยแม่ลูก)
18	N 493	Commune of Bang Ka-Chai, Chandaburi (ตำบลบางกะไชย จันทบุรี)	Small sized shrimps (เคย)
19	N 437	Commune of Krog-Krag, Samutra Sakara (ตำบลโกรกกราก สมุทรสาคร)	Ordinary sized shrimps (กุ้ง)
20	N 439	Commune of Krog-Krag, Samutra Sakara (ตำบลโกรกกราก สมุทรสาคร)	Fish (ปลาใส้ตัน)
21	N 435	Commune of Krog-Krag, Samutra Sakara (ตำบลโกรกกราก สมุทรสาคร)	Small sized shrimps (เคยตาดำ)
22	N 436	Commune of Krog-Krag, Samutra Sakara (ตำบลโกรกกราก สมุทรสาคร)	Small sized shrimps (เคยฝูงตัว)
23	N 438	Commune of Krog-Krag, Samutra Sakara (ตำบลโกรกกราก สมุทรสาคร)	Small sized shrimps (เคยขี้เท่าไข่)
24	N 440	Commune of Ya-Prag, Samutra Sakara (ตำบลหญ้าแพรก สมุทรสาคร)	Small sized shrimps (เคยขี้เท่าตัว)

No.	*Lab. No.*	*Locality*	*Source*
25	N 441	Commune of Ya-Prag, Samutra Sakara (ตำบลหญ้าแพรก สมุทรสาคร)	Small sized shrimps (เคยฝุงตัว)
26	N 442	Commune of Ya-Prag, Samutra Sakara (ตำบลหญ้าแพรก สมุทรสาคร)	Small sized shrimps (เคยสำลี)
27	N 423	Samutra Songkram (สมุทรสงคราม)	
28	N 424	Samutra Songkram (สมุทรสงคราม)	
29	N 425	Samutra Songkram (สมุทรสงคราม)	
30	N 426	Samutra Songkram (สมุทรสงคราม)	
31	O 213	Ta-Tien market (ตลาดท่าเตียน)	
32	O 214	Vorachakra market (ตลาดวรจักร์)	
33	O 215	Nang Loy market (ตลาดนางลอย)	
34	O 216	Ban Moh market (ตลาดบ้านหม้อ)	
35	O 217	Mahanag market (ตลาดมหานาค)	
36	O 218	Mahanag market (ตลาดมหานาค)	

No.	*Lab. No.*	*Locality*	*Source*
37	O 219	Nang Lerng market (ตลาดนางเลิ้ง)	
38	O 220	Sapan Kao market (ตลาดสะพานขาว)	
39	O 221	Sapan Yomaraja market (ตลาดสะพานยมราช)	
40	O 337	Sapan Urupongse (สะพานอุรุพงษ์)	
41	O 338	Sapan Raja Davi (สะพานราชเทวี)	
42	O 379	Pratumvan market (ตลาดประตูน้ำประทุมวัน)	
43	O 380	Sala Deng market (ตลาดศาลาแดง)	
44	O 381	Wat Kaek (ตำบลวัดแขก)	
45	O 382	Bangrak market (ตลาดบางรัก)	
46	O 383	Talad Noi market (ตลาดน้อย)	
47	O 384	Sapan Han market (ตลาดสะพานหัน)	

TABLE II.

Results of Analyses.

No.	Lab. No.	Locality	Moisture	NaCl (dry basis)	On dry basis minus sodium chloride		Starch
					Proteins	Fat	
1	Q 15	Samutra Prakara	47.45	46.47	62.59	5.62	—
2	Q 16	Samutra Prakara	41.39	45.41	64.22	5.12	—
3	N 802	Rayong	42.29	30.39	61.35	9.53	—
4	N 803	Rayong	58.20	33.64	48.89	7.32	—
5	N 804	Rayong	55.54	47.62	60.78	9.27	—
6	N 805	Rayong	45.51	53.43	58.03	8.09	—
7	N 502	Jolburi	52.69	60.89	46.50	12.41	—
8	N 503	Jolburi	50.40	39.60	49.79	6.19	—
9	N 484	Chandaburi	51.39	36.25	61.77	8.82	—
10	N 485	Chandaburi	43.53	39.40	67.87	5.94	—
11	N 492	Chandaburi	61.27	59.86	69.76	6.45	—
12	N 486	Chandaburi	57.56	54.48	68.23	6.17	—
13	N 487	Chandaburi	48.51	31.57	67.13	8.96	—
14	N 488	Chandaburi	49.51	32.04	68.25	8.96	—
15	N 489	Chandaburi	46.87	35.31	60.19	9.31	—
16	N 490	Chandaburi	48.43	35.89	60.74	8.63	—
17	N 491	Chandaburi	47.76	39.87	63.31	7.88	—
18	N 493	Chandaburi	50.06	47.82	64.56	6.50	—
19	N 437	Samutra Sakara	50.25	37.51	50.81	4.38	—
20	N 439	Samutra Sakara	47.07	36.28	56.82	7.77	—
21	N 435	Samutra Sakara	56.28	45.07	60.52	5.94	—
22	N 436	Samutra Sakara	45.26	49.56	50.90	5.51	—
23	N 438	Samutra Sakara	64.21	65.59	76.19	7.86	—
24	N 440	Samutra Sakara	64.66	54.65	54.61	11.06	—

No.	Lab. No.	Locality	Moisture	NaCl (dry basis)	On dry basis minus sodium chloride		Starch
					Proteins	Fat	
25	N 441	Samutra Sakara	58.60	54.83	51.63	7.08	—
26	N 442	Samutra Sakara	68.66	60.69	84.07	11.45	—
27	N 423	Samutra Songkram	46.16	35.56	64.22	7.58	—
28	N 424	Samutra Songkram	42.56	42.38	62.29	5.06	—
29	N 425	Samutra Songkram	70.71	56.09	46.27	8.01	—
30	N 426	Samutra Songkram	50.12	46.20	61.70	5.11	—
31	O 213	Ta-Tien	35.52	53.28	53.96	9.59	Present
32	O 214	Vorachakra	37.60	53.66	56.04	8.46	Present
33	O 215	Nang Loy	33.64	52.32	50.82	11.38	Present
34	O 216	Ban-Moh	39.75	47.05	47.64	9.38	Present
35	O 217	Mahanag	34.83	54.98	52.08	14.62	Present
36	O 218	Mahanag	41.69	42.23	52.83	9.05	Present
37	O 219	Nang Leng	46.35	43.26	56.27	7.22	—
38	O 220	Sapan Kao	40.45	41.18	50.81	11.28	Present
39	O 221	Sapan Yomaraja	41.55	40.65	56.06	5.57	—
40	O 377	Sapan Urupongse	34.01	47.47	54.33	7.02	—
41	O 378	Sapan Raja Davi	43.08	38.67	57.12	5.35	—
42	O 379	Pratumvan	37.51	47.43	53.25	9.61	Present
43	O 380	Sala Deng	26.50	55.47	48.53	8.19	—
44	O 381	Wat Kaeg	42.43	40.76	58.05	8.32	—
45	O 382	Bangrak	52.37	30.24	56.36	6.67	—
46	O 383	Talad Noi	37.44	45.51	51.84	6 70	—
47	O 384	Sapan Han	33.90	51.73	61.58	6.48	—

TABLE III.

Average Results for Every Province.

No.	Lab. No.	Locality	Moisture	NaCl (dry basis)	Calculated on dry basis minus sodium chloride		Starch
					Proteins	Fat	
1	Q 15-16	Samutra Prakara	44.42	45.94	63.40	5.37	—
2	N 803-805	Rayong	50.38	41.28	57.51	8.55	—
3	N 502-503	Jolburi	51.54	50.24	48.14	9.30	—
4	N 484-485, 492	Chandaburi	52.09	45.17	66.47	7.07	—
5	N 486-491, 493	Chandaburi	49.81	39.57	64.63	8.06	—
6	N 435-436, 438, 440-442	Samutra Sakara	59.61	55.06	62.99	8.15	—
7	N 423-426	Samutra Songkram	52.39	45.06	58.62	6.44	—
8	O 213-221, 377-384	Bangkok markets	38.74	45.05	53.96	8.52	—

Discussion.

From table II it will be seen that on the basis of the proposed calculation the percentages of moisture vary from 26.50% (sample No. 43) to 70.71% (sample No. 29), sodium chloride from 30.24% (sample No. 45) to 65.59% (sample No. 23), proteins from 46.50% (sample No. 7) to 84.07% (sample No. 26) and fat from 4.38% (sample No. 19) to 14.62% (sample No. 35).

The lowest percentage of fat is 4.38% (sample No. 19), found in the Kapi from Samutra Sakara (สมุทรสาคร) and made exclusively from ordinary sized shrimps. Apart from this, all the samples contain more than 5% of fat.

The amount of proteins in all samples except in those numbered 4 (48.89%), 8 (46.50%), 29 (46.27%), 34 (47.67%) and 43 (48.53%), is over 50%. Two samples of those containing less than 50% of proteins are found to be adulterated and the rest genuine.

For the purpose of comparison, it will be seen that out of 39 genuine samples, four are found to contain less than 50% of proteins that is, equivalent to 1.02% and out of 8 samples which are found to be adulterated, there are 2 samples containing less than 50% of proteins that is equivalent to 2.5% which is higher than that in the previous case.

The average percentage of proteins in all the eight samples which are not genuine, is 52.18% which appears to be less than the average percentages of proteins in the

samples from all provinces except that from Jolburi (samples numbered 7 and 8). It is unfortunate, however, that there are only two samples from that province and, therefore, it is to be considered as insufficient to be representative of the Jolburi Kapi as a whole.

The amounts of fat in the samples which appear to be adulterated are averaged to be 10.42%. This figure is higher than that of the fat present in each sample of Kapi obtained from every province and also in the genuine samples bought from local markets (see table III).

The result so obtained in this particular case is quite interesting because adulterants such as broken rice, and bean curd contain only small percentages of fat as compared with that of shrimps and fishes. It should be expected, consequently, that if a genuine Kapi is adulterated with any of the above substances the amount of fat would be far below the corresponding amount in the genuine sample. But what actually happens in this study is contradictory to this expectation.

However, we can see from table II that the amount of fat in the genuine Kapi except that in sample No. 19 which is the Kapi made exclusively from ordinary sized shrimps, varies from 5.11% (sample No. 30) to 12.41% (sample No. 7), and that this is not much different from the average amount of fat in the adulterated Kapi. Furthermore, it is found in the detection of the added substance that the quantity present is not so much as to be called abundant.

If however the adulterant used was rice bran these results would be explained because rice bran usually contains 15% of fat and 11% of protein as well as small amounts of broken rice. *(See Government Laboratory 5th. report.)*

Another interesting item is the moisture content (see table III). The average percentage of moisture in 17 samples bought from local markets is 38.74% which is less than that of Kapi from every province.

This may be explained from the fact that Kapi prepared by and obtained from the makers is always kept in earthenware containers with narrow mouths which make it difficult for the water content to evaporate while Kapi sold in local markets is placed in shallow enameled basins in which case evaporation can take place more easily. Another possibility is that Kapi which comes to Bangkok for sale is older than that newly prepared, thus the water content is considerably lessened also by the process of evaporation.

The presence of starchy material as found by the previously stated simple detection is not very great in quantity. This fact, therefore, suggests that even if the adulteration of Kapi is practised for the sake of profit, it is only to a small extent.

Summary.

(1) Thirty samples of Kapi from various provinces namely Samutra Prakara, Samutra Sakara, Samutra Songkram, Jolburi, Rayong, and Chandaburi and seventeen samples of Kapi bought from local markets were examined.

(2) Kapi is found to be of four kinds namely that made from small sized shrimps (เคย), that made from a mixture of small sized shrimps and ordinary sized shrimps (กุ้ง), or small fishes, that made exclusively from ordinary sized shrimps and lastly that made exclusively from fishes.

(3) The moisture content in Kapi varies from 26.50% to 70.71%, sodium chloride in dry Kapi from 30.24% to 65.59%, proteins in dry Kapi minus sodium chloride from 46.50% to 84.07% and fat in dry Kapi minus sodium chloride from 4.38% to 14.62%.

(4) The fat found in all samples except one which is made exclusively from ordinary sized shrimps is over 5%.

(5) Almost all samples of Kapi contain more than 50% of proteins. Only 1.02% of the total samples of genuine Kapi is found to contain less than 50% of proteins and 2.5% of the samples found to be adulturated contain less than 50% of the same.

(6) The amount of fat in the adulterated Kapi is higher than that in the genuine samples and is probably due to adulteration with rice bran.

(7) The moisture content of Kapi bought from local markets is less than that found in the samples supplied from all provinces.

(8) The starchy material found to be present was identified, in most cases, to be broken rice which is always present in rice bran.

FERTILIZING MATERIALS AND PEPPER FERTILIZATION.

BY

Magdaleno M. Cero

Of the Department of Science.

Introduction.

The fertilization of pepper at Amphur Ta Mai, Changwad Chandhaburi is one of the most interesting practices as well as a good scientific study in so far as the use of organic fertilizer is concerned. The people in this particular locality resort to every possible means of acquiring fertilizing materials, ranging from burned earth and household refuse to decayed organic matter and forest soils. This painstaking effort has become a part of their daily chore in an endeavor to make pepper growing as one of their sources of livelihood.

Pepper cultivation had been handed down for generations and developed, having been originated by farmers of Chinese ancestry of the pepper district which until the present time is still the dominant characteristic in the kinds of people in the locality. Pepper had always been considered a garden crop and as such all possible attention is given to its culture and care and the Chinese are adept in the peculiar technic of maintaining the fertility of the gardens. These gardens are often many years old lasting

thirty years without changing the plants. As the soil loses its fertility, there is a corresponding decrease in the vitality of the pepper plants and only the patient care and constant addition of food nutrients into the soil can keep up and maintain their growth and yields. As the age of these gardens increases in the passing of years, the fervent tasks required for its maintainance sometimes waver and then the garden is first interplanted with orchard trees which gradually eliminate the pepper plants shortly afterwards. Others however, totally renew the whole garden by starting the process of planting all over again. But this is very seldom done. Many of these old gardens which are partly or totally neglected succumbed most abruptly to the invasion of weeds. A garden that is not weeded for one rainy season will never come up again to its former condition. In such cases, the garden when cleared again, is utilized further by interplanting with annual crops mostly pineapple, corn, and peanuts, leading to the eventual elimination of the pepper garden. But so dependent are the people upon pepper as one of their sources of money crops that only dire situations could part them from caring for and the abandonment of their gardens.

There is no literature which could be obtained as to the exact history of the pepper cultivation in Chandhaburi and its fertilization. Such informations are only obtainable from the old members of the community upon whom practices of fertilizations had been handed down and made almost a tradition.

Investigations on the culture of pepper by our neighboring countries, notably from that of the Netherland Indies had been published. One of these investigations is that of Hardon and White (1934/35) which deals intimately with the physical and chemical changes in burned soil employed in the fertilization of pepper. Another paper on pepper investigation was published by Rutgers in three parts; the first part gives a survey of the pepper district in the Netherland Indies with the object of studying the pepper disease problems. The second part deals with the culture of pepper in the island of Banka in connection with the study on pepper disease. The third part deals with the study of pepper culture in Lampong District which is also in connection with the study of disease on pepper. An article on "black fruit" disease of pepper by Sharples (1923) of Malaya, discussed the use of burned earth in the pepper gardens aside from discussion of production, botanical studies, culture, and pepper disease and control measures.

This paper will be devoted mainly to a discussion of the acquisition of these different fertilizers, their sources and application with a brief discussion on their chemical analysis and some important remarks given to the handling of these fertilizers. The manner in which the fertilizers are prepared or otherwise stored do not seem to look after the loss involved as a result of defective ways of handling them. As has been observed, the plant nutrient contents of these fertilizers were lost either by volatilization

or leaching by rain water. It appears in the present situation that one of the important solutions for the improvement of pepper yield at Changwad Chandhaburi should be in the direction of correcting the ways in which the fertilizers are being handled, stored, and prepared ready for application rather than advocating types of fertilizers suitable to be used for the pepper plants. For until the present time, no result has so far been obtained from any experiment as to the type of fertilizer best suited for pepper under Chandhaburi conditions.

It would not be surprising if one half of the available plant nutrients from a given bulk of these fertilizers had been removed due to improper care in storing and handling. As is usually the case with organic fertilizers of indefinite composition and origin, their chemical content would be very radically different even for the same kind of fertilizer. But still they are similarly affected by losses when subjected to the same conditions of leaching and volatilization. It is hoped that these informations will serve for the enlightment of those interested in the more scientific questions involved in the pepper culture.

These notes have been secured in the course of a soil and crop survey which the writer has been doing in cooperation with the Department af Agriculture and Fisheries at Amphur Ta Mai, Changwad Chandhaburi during a period of about five months, from January to May, 1937.

General Description of the Pepper District of Amphur Ta Mai.

The pepper district of Amphur Ta Mai is more concentrated around the Gao Ngua Hill but its extent runs from the village of Nong Pawe to the north down to Tambon Siphya to the south and generally lying northeast, east, and southeast of Amphur Ta Mai. The topography of the entire area is fairly irregular, made up mostly of small narrow water logged valleys, very gentle foot slopes, and hills as well as knolls. The pepper gardens occupy the gently sloping and level sections of the region which are fairly to excessively well drained of very deep (usually 4 to 10 m.) reddish brown soils. The soils on the sides of the hills which are steep and gravelly easily erode so that they are very seldom utilized in the cultivation of pepper and if ever used, the pepper gardens last only for a short duration as the fertility of the land is exhausted much faster than the soils on the level lands and very gentle slopes. The pepper gardens thrive best on fairly well drained soil only. When the soil is poorly drained the pepper plants are easily affected by the excess water. When the land is excessively drained, the growth of the pepper plants is also poor. The soils of the pepper district although high in clay content ranging as high as 60 to 80 per cent clay are fairly granular and do not hold much water. Even after a heavy rain, the surface soil very quickly dries off within one hour except in the low depressions where the water stays for a considerable time.

Outside of the reddish brown soils are pepper gardens also but they can only be maintained through a liberal application of organic fertilizers because of the light character of the soils as well as low fertility. These soils are gray and poorly drained occupying the low surrounding lands of the reddish brown soils of Chandhaburi and are not extensively utilized to pepper culture. But in the region northeast of the village of Nong Kar are some good pepper gardens on well drained gray soils, which seem to show the probability of fairly utilizing the gray soils to pepper cultivation.

Types of Fertilizers and Their Preparations.

1. Burned earth. Burning earth for increasing its fertility is an ancient practice. It consists of piling branches of trees and leaves and the soil put on top in order to receive most of the heat from the burning material. In this locality various types of materials are being used for burning in fact almost any kind of grass, herbs bamboos, trees, as well as discarded old parts of houses, are put into the heaps. And these heaps may consist of any proportion of admixture of these materials. However, the most common practice is the use of small branches of trees with leaves. If twigs are mostly used, some small growing herbs such as the "sap shua" *(Eupatorium odoratum)* or "yaka" *(Imperata sp.)* are mixed among the branches and leaves, putting especially more on the top portion to prevent the soil from falling into the spaces in the inflammable materials.

The soil beneath the pile is usually pulverized and slightly raised preparatory to the putting of the branches. The thickness of the branches is about 1 foot and the pulverized soil on the top of the burning material is about 1 meter thick with the top being shaped conically or sometimes flat. If the burned earth is to be used immediately, and the materials in the heap are dry, this pile is ignited at once. But the usual practice is to make heaps long before they are ignited because the materials can be prepared to dry easily during the summer season. Burning usually takes place at the beginning of the rainy season.

The slow and gradual burning of a soil heap continues for days and even for weeks depending upon the size, before the whole pile is completely burned. The fallen soil is raked from time to time in order to allow combustion to proceed uninterruptedly. When burning is completed, the burned mass is reheaped into a rectangular shape ready to be used as fertilizer. In some cases, before they are used as fertilizer, animal manure is added on top and mixed thoroughly.

2. *Animal manure.* Every animal owner realizes the importance of the wastes as sources of fertilizer. So that owners often construct a rectangular fence enclosing an area from 50 to 200 sq. m. in which to keep the animals at night in order to confine them at one place and thereby conserve all the wastes in the form of manure and urine for a period of one year. This is rather a cruel practice in the sense that the animals are made to live in a very insanitary and

unhealthy condition where their wastes and urine make the ground very filthy. And these corrals, without exception, are located in an open place, usually near the house of the farmer. In other cases, if the owner does not have a fence, the animals are tied to a post with a rope not more than one or two meters long in order to prevent the animals scattering their excreta widely. This is often a slightly better treatment for the animals as some owners transfer the posts when the ground becomes too filthy with urine. In places near the rice fields, when the farmer has rice straw, the animals fed with the straw at night often trample portion of the straw and mixed it with the manure, increasing the bulk of the manure and the straw itself serves as a good fertilizer when properly decayed. When the manure is taken from the corral, the mud is included, so that the animal manure in this locality consists of manure as well as soil. Some animal owners who do not have pepper gardens or only have small areas, have extra animal manure which is sold at about 1 to 2 ticals per cartlord. Animal manure is seldom used alone as fertilizer. It is usually mixed with either forest soil or burned earth.

3. *Burned earth and animal manure.* In cases where burned earth is mixed with animal manure, the amount of burned earth is always more than the manure. As previously discussed, when the burning of the soils is completed, the burned earth is again mixed with the ash and made into either a rectangular or rounded heap from a half to three quarters of a meter high. Then a layer of animal manure

is laid on top of the burned earth from 10 to 20 cm. in thickness. The whole pile is mixed, as shown in figure 5, by cutting from the top down to the bottom of the pile in a slanting position with a hoe, which is most convenient, until the whole mixing process is completed. After this process, the mixed burned earth and animal manure is again formed into a heap and is ready to be applied to the garden.

4. "*Forest soil.*" The term forest soil, when referred literally to the practice in this locality, does not really apply to soils taken from the forest. Soils from under bamboo trees, bananas, forest as well, and soils from water pits are also considered forest soil. Real forest soil has been utilized as fertilizer because it holds more plant food content than any agricultural cultivated soil. The use of the real forest soil had been tried as fertilizer but the effect upon the plants was destructive to a certain degree. For although the growth of some pepper plants was maintained, the other plants were found to be badly infested with nematodes which seems to have been introduced through the use of forest soil -it being rich in organic matter which serves as food for different micro-and macro-organisms which may be destructive to economic plants.

So that in almost all cases, forest soil is used only in combination with animal manure. It is piled in heap of about 50 to 80 cm. deep and leveled flat on top. The well-rotted manure is added on top in thickness of from 10 to 20 cm. The manure and soil is mixed by cutting straight in a slanting position downward in thin slices as in the burned soil and animal manure mixing. This mixture is applied in the same way as is the burned soil.

Forest or ordinary soil is used when burned earth is not always present in sufficient quantity, and to minimize the concentration of the animal manure as the latter is seldom used alone especially when the animal manure is quite fresh and not so well mixed with mud from the corral.

Miscellaneous Fertilizers.

The above mentioned fertilizers are commonly and extensively used in the pepper district of Amphur Ta Mai. The following are rarely used or at least not in large quantities.

a. Pepper leaves. The farmers do not usually put leaves of any kind in the pepper gardens as fertilizer. When pepper leaves fall in large quantities, they are usually raked to the sides of the gardens so as to keep the garden as clean as possible. Some owners who collect the pepper leaves bury them between the pepper vines. This practice of burying the leaves in the ground is usually done only during the rainy season weeding, and the weeds are buried with the leaves. During the dry season, some few farmers put leaves around the pepper plants in the shallow circular trench where water is poured, as the pepper plants without exception are watered during the summer. Pepper leaves used in this manner serve as a mulch which retards evaporation of the water from the soil. And when they are decayed they automatically fertilize the plants. But as with the present case most of the pepper leaves, especially during the dry season when the leaves fall off in great amount, are not all utilized in this way and are raked to the sides of the

garden and considered practically as useless. Better utilization of pepper leaves would be to put them into an improvised pit as shown in fig. 6, where these are allowed to decay and later serve as organic fertilizer. Every organic material in this locality should be properly conserved as source of organic matter.

b. Rice straw. Because of the scarcity of feeds for work animals in this district, the use of rice straw as feed has greatly minimized its use as organic fertilizer. The use of rice straw was noted only in two gardens, where it was intended for mulching around the pepper plants during the summer. As in the case with the pepper leaves, when these straw are decayed it is buried in the ground as fertilizer. The major use of rice straw however comes from its use as fodder and bedding in the corrals or in places where the work animals are fed with the straw. As is usually the case, not all the straw is eaten, but portions are trampled and left on the ground. The rice straw in the animal manure as an absorbent helps conserve the liquid portion of the manure which otherwise would be lost. And in the process of decomposition of the manure the microorganisms are able to work better with the presence of straw as source of carbohydrates while nitrogen is taken from the urea of the manure. When the manure is properly handled in order to prevent overheating, the ammonia would be properly conserved and directly or indirectly converted into nitrates by some of the nitrifying organisms in the soil.

c. Night soil. Small huts are constructed in most of the big pepper gardens where human wastes are accumulated in a septic tank. The tank contains a little amount of water so that every form of waste is properly saved and diluted. But most of these tanks are open and aside from the free exit of gases, maggots feed upon the valuable substances which are lost. This diluted manure is applied to the pepper plants almost throughout the year. During the dry season, the tanks are liberally filled with water and used for watering the plants.

d. Waste from pig pens. On account of the acute need of fertilizing materials for gardens, the farmers who keep swine never fail to conserve the manure from the pig pens. The pens are usually provided with wooden floors which slope slightly toward a wooden receptacle or merely into an excavation in the ground where the wastes can be conserved. When a wooden receptacle is used, the waste is usually diluted with water and the mixture is applied in the garden, giving an exceptionally rich fertilizer. The waste from an excavation in the ground is taken with the mud and used with ordinary soil as fertilizer.

e. Bat guano. Only one case was found where a farmer used bat guano as fertilizer for pepper plants in this district. Since the soils of the area are poor in plant food and the reaction ranges between pH 4 and 5, the used of bat guano, especially when high in lime and phosphorus content should be beneficial. Undoubtedly, most of the weathered rocks in the floor of the caves where the bat guano had been

incorporated with the manure, and its decomposition hastened by the presence of organic acids, are rich in calcium which may serve to neutralize the high acidity at the same time giving more calcium to the soil. Probably the cost of guano prevents the farmers buying the materials more generally.

f. Commercial fertilizers. The use of commercial fertilizers on some of the plots of pepper in the Pepper Station of the Department of Agriculture & Fisheries, is still under experiment. As these tests were started about 2 years ago, definite results have not yet been obtained. It is undoubtedly worthwhile to make such tests to find out which commercial fertilizer would give the most economical production of pepper. And commercial fertilizers being on a standard basis could be used more or less with assurance. The concentrated form in which the elements are applied would diminish the labor of digging deep holes into the ground and avoid possible injury to the root systems of the plants. Some of the fertilizers being tried in this station are different brands of complete fertilizers and lime.

g. Ash and unburnt fragments from purposely burned shrubberies and grass. In the latter part of the dry season, usually in the month of April, most of the fallen leaves and dead twigs become dry, and places such as along roads and around *kao rai* cultivation where there are small trees, are burned down purposely. The ashes and litter portion of the soil are stripped off and yield another good source of fertilizing material. Such materials are treated in the same

way as burned earth. The amounts being very small, are often mixed with burned earth or with forest soil. This method is practiced to a very limited extent on account of the scarcity of such native vegetation in this locality.

h. Soils from water pits. Pits are usually found in the open places and grass lands. These pits are of various sizes ranging from 2 m. diameter to about 20 m. diameter and 2 m. deep. Generally round in shape but are badly indented along the periphery into which the water enters, and out of the pit as well as the differences in the erosiveness of the sides. When the buffalo wallows, wastes and urine are left in the pit. When dry season comes, the brown mud dries with the wastes, which are scraped for fertilizing purposes and often mixed further with animal manure before application.

The soils in the pits not only possess some fertility derived from the manure but also from the organic matter carried by the water as surface runoff into the pit with the organic portion of the surface soil as well. As time increases, the repetition of wallowing by the animals during the rainy season followed by the stripping during the dry season increases the size of these pits tremendously. The bigger these water pits are, the more water can be accommodated and the more useful they are for source of rich organic soil. Some of these pits are, however, purposely made by the farmers just to accumulate water which carries rich sediments and organic matter. In fact some of the big water pits are no longer used by water-buffalo to wallow. They mainly serve as water reservoirs and to accumulate soil sediments.

Fertilizer Application

The conscientious application of fertilizers takes place at the beginning of the rainy season, although some minor applications also occur during any part of the year which consist of some of the fertilizers mentioned under the miscellaneous fertilizers such as pepper leaves, rice straw, night soil, etc. Burned earth, animal manure, or the combination of both as well as with forest soil are the most common and are used in larger quantities than of any other fertilizer. These fertilizers are applied towards the latter part of May after a few showers have fallen, or some time later towards the middle of the rainy season depending upon the readiness of the fertilizers.

The various ways of applying fertilizers are shown in fig. 1. There are principally five types of application. Type I, shows the digging of the fertilizer holes on both sides of the pepper plants (as shown in fig. 7) by the side of the row, with an approximate width of 20 cm. and length of 30 cm. and 25 cm. deep at a distance of 8 to 14 cm. from the base of the plant. The next year, type II is used. Type II consists of two holes, one on each side of the plant and located along the row and approximately of the same size of holes and distance from the plant as in type I. Type III is a single hole system dug between each plant instead of two holes as in type II. Type III is really a fusion of the two holes in type II but the edge of the hole is farther from the base of the plant than in type II, usually 14 cm. from the base. Type III is followed by type II application the next year. The type IV fertilizer application consists of

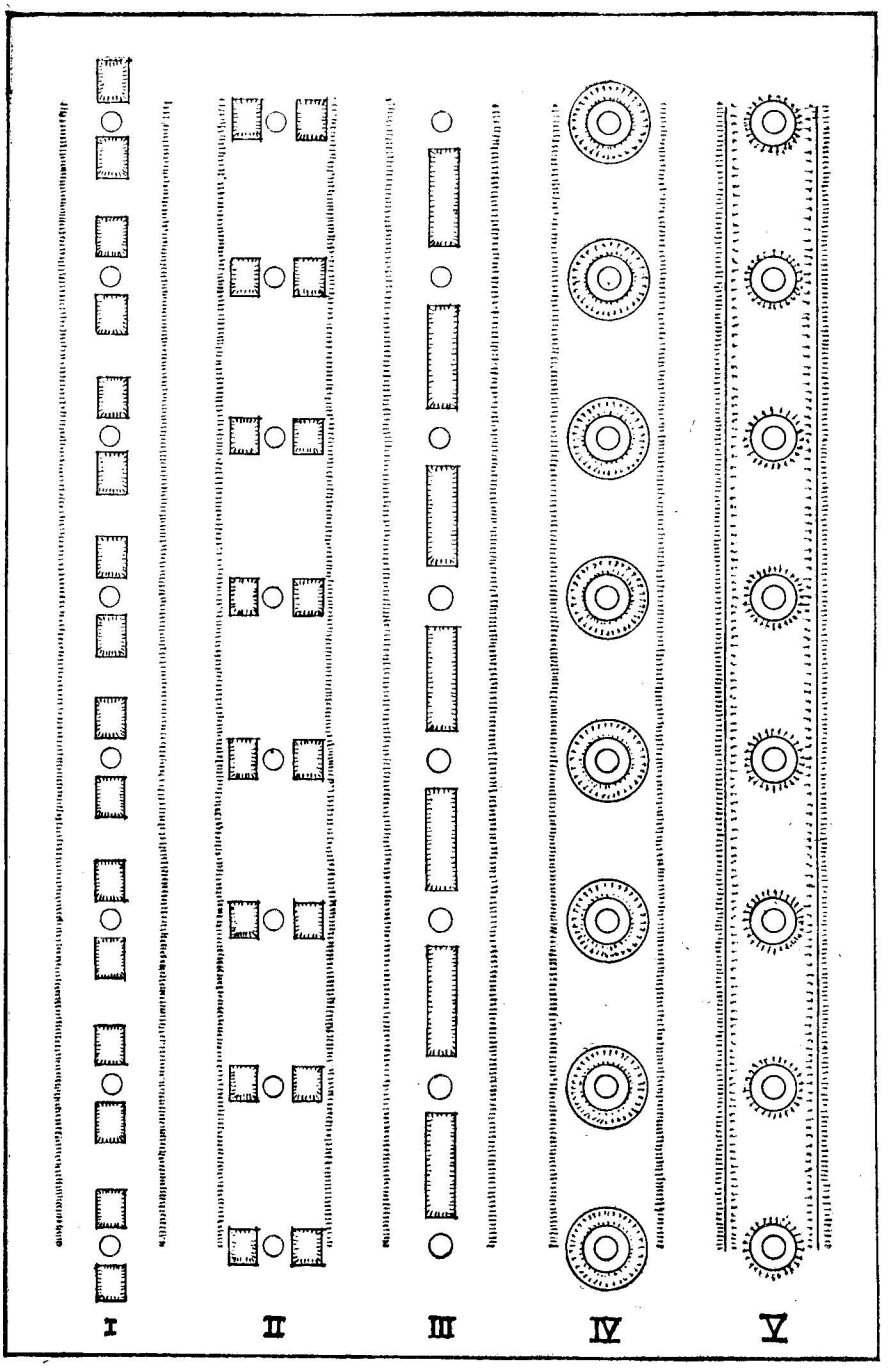

Fig. 1. Types of fertilizer application

O----------Pepper plant

----------Pit for fertilizer

}--------Both sides of the row

digging a shallow ring around the plant having a width of usually 15 cm. and quite close to the plant sometimes excavating the soil from the base of the base of the plant itself. Type IV may be followed by either type II or type III the next year. Type V of fertilizer application consists of actually removing the soil covering throughout the whole row and shape like a furrow, the pepper plants standing at the center of the furrow. An almost the same amount of fertilizer is placed in the furrow, this furrow having a width of nearly half a meter and about 12 cm. deep. When the application is shallow the amount of fertilizer may be the same as in the first two types. But this type of application prevents destruction of roots as the fertilizer is applied only at shallow depth but in most cases it uses the most amount of fertilizer. Type V may be followed by any of the above four types, the following year.

Type I and II are used more often among plants of early age usually from 1—10 years, although in some cases these types are applied to older plants also. These types of application requires less amount of fertilizer aimed purposely for younger plants. Type III is used among older plants usually ranging from 10 to 20 years and sometimes of a much older garden. In this type, there is really more amount of fertilizer used as the holes are often 40 to 60 cm. long and about 24 cm. wide. Type IV is rarely practiced and only among older plants of about 20 years old and the amount of fertilizer used in this type is usually more than type III. Type V is the most liberal amount of fertilizer application, where the whole surface soil is completely replaced by an almost equal amount of fertilizer.

It is quite important to note that while fertilizer application is unquestionably beneficial for the growth and maintenance of the pepper plants, yet certain considerations as to the ways in which these different fertilizers are applied should not be overlooked. The methods of applying fertilizers just described and especially the first three types, deep digging close to the plant is generally practiced by nearly all gardeners in this locality. It is not yet certain whether the practice is detrimental to physiological functions in the root system and favorable to the pathological invasions of plant pathogene through the root system. The root rot disease which is found prevalent in this locality seems to be caused by fungus organism and which possibly finds a more favorable entry into the plant through the injured or cut portions of the roots. This root rot disease never shows signs of its presence until the whole root system and portion of the stem below the ground surface are completely rotted and until then the whole plant dies in two to five days. As the plant grows older, it must have a corresponding increase in amount of root system, otherwise when its root system is weakly or poorly developed, there is naturally a consequent inhibition in the amount of plant foods taken. Or when the plants are still young the growth may become stunted.

Handling of Fertilizers

As mentioned above, the most common fertilizers in this locality are burned soil and animal manures. The application of these fertilizers usually come when the soil is fairly well moist down to a depth of 1 foot.

The nature of rainfall in this place is very peculiar. The sudden heavy downpours are of short duration. Consequently most of the water runs off over the surface; little water is absorbed by the soil. In the case of the burned earth on the other hand, the water easily leaches through because the soil particles are very loosely piled as compared to the structure of the natural soil, and added to it is the presence of more porous crumbs and granules resulting from the burning process. Hence, water passes more rapidly through the burned earth than the natural soils. And the process of leaching by water takes very place rapidly carrying the available plant elements down in corresponding amount to the mixture of burned soil and manure where the structure is even looser and more porous. Hence before the application of these fertilizers a considerable portion of the soluble plant food materials may have been already leached out.

The same case happens to the animal manure. Most of the manure has never been stored under shade. In cases where the manure comes from the corrals, it has been subjected to leaching due to occasional rains, for nearly a period of one year, until it is taken for annual fertilizer application in the pepper gardens. Some of the erroneous practices of piling manure in heaps for many weeks resulted to loss of volatile elements of which nitrogen is the most important. These heaps are never spread and the heat generated as a result of its bacteriological and chemical decomposition reaches as high as 60° to 80°C. Closer examination of these heaps revealed vapors being emitted from

the upper portion of the mound. This vapor not only consists of water but also of gases, mostly ammonia and other gases of pungent odor, probably mixed with carbon dioxide. Such heaps are never applied to the field "until they are properly cooled down." And so they are exposed to the rain to cool. When they are cooled down, the different water soluble elements are naturally released through leaching after so many rains.

Duley (1919) found "that manure should be spread while fresh if possible and that plenty of bedding should be used to absorb the liquid manure. Manure exposed to the weather four or five months may lose one third to one half of its plant food". Fermentation can be prevented by storing them compact and moist or by putting them in covered containers. The consequent loss of nutrients owing to such a practice is of course never realized by the farmers and unless they are given advice through extension service, the practice will continue to happen to the detriment of fertilizer conservation.

Expected Variability in Chemical Composition

Chemical analysis of these different fertilizers would not give a constant figure because of their variability, and impossibility of proper sampling, so that figures of the composition of the different organic fertilizers are liable to be misleading and misinterpreted, especially when used in experimental work where comparisons with other fertilizers in their fertilizing values would give their actual fertilizing capacities. In the burned soil, for example, one point to be considered is the amount of burning materials used in

proportion to the amount of soil. Where more burning materials are used, there is naturally a corresponding increase in the amount of ash of the different plant constituent elements or vice versa. And the other factor to be taken into consideration is the kind or kinds of burning materials used which in their chemical compositions are also variable, such as bamboo, "sap shua" *(Eupatorium) odoratum,* branches and twigs of trees, and grass. However, chemical analysis is of value to determine the probable chemical compositions of these different fertilizers and their proportions of phosphorus, potassium and nitrogen.

The animal wastes are also variable in composition, depending upon the kind of feeds as well as the condition of the animal. In most cases the animal manure is mixed up with either burned soil from water pits or sometimes with forest soil. The variability of the final mixture in the proportion of manure and soil, is another factor in the variability of the fertilizing capacities of the organic fertilizers. The same is true with the degree of dilution with night soil and the manure from hog pens. Therefore in pure line of scientific investigation, the formulation of any result based upon a definite chemical data of one kind of fertilizer should not be taken as true for the same kind of fertilizer which have been taken from other sources.

Ingle (1933) pointed out the fact that the composition of animal excreta is liable to such enormous variations that it is almost impossible to give any average figures.

The chemical analysis may be of value in comparing the relative amounts of elements for each type of fertilizer as for example, the amount of nitrogen, phosphorus, and potassium in buffalo manure, in horse manure, burnt soil, pig manure, and others separately. This would give rise to class distinction chemically of the different organic fertilizers in the pepper district.

The determination* of the nitrogen, phosphorus, and potassium content of the most commonly used fertilizers at the pepper district had been performed at the Department of Science and the results are shown in table 1.

TABLE 1.

Showing relative fertilizing values of the extensively used fertilizers for pepper.

Description of materials	N	P_2O_5	K_2O
	Per cent	*Per cent*	*Per cent*
520—U Soil alone - - - -	0.242	1.154	0.067
520 M1 Thoroughly burned soil -	0.102	1.314	0.112
525—X Buffalo manure - - -	1.555	2.475	0.467
536—X Buffalo manure - - -	1.280	1.356	0.312
537—X Buffalo manure - - -	1.100	1.509	0.490
538—X Duck - - - - -	0.790	1.843	0.392
539—X Horse - - - -	0.800	1.832	0.198
540—X Buffalo manure and mud -	1.000	1.880	0.230

* The procedures were taken from Chapter on fertilizer of the A. O. A. C. 1935.

(1) It should be noted that the manure of animals included the liquid and solid waste and in some cases well decayed rice straw. But in order to represent the typical conditions in which these fertilizer are used in the gardens, the sampling was done as to represent the general character of the materials.

Soils without any treatment, have 0.242 per cent total nitrogen. But when this soil is burned for fertilizing purposes, about one half of the nitrogen is lost apparently through volatilization due to burning, as only 0.102 per cent was found. The highest amount of nitrogen of all the samples gathered was obtained from a moist buffalo manure No. 535—X with 1.555 per cent or about seven times the nitrogen content of the ordinary soil. Of the four commonly used fertilizers, the buffalo manure gives relatively the highest nitrogen content with an average of about 1.3 per cent. When buffalo manure is mixed with mud and soil from water pits, the nitrogen content of the mixture is 1.00 per cent. The only sample of duck manure found in this locality, had been badly leached out due to exposure to the rain so that the main bulk of the materials constituting the manure were rice hulls which remained undigested. Although lower than the buffalo manure its nitrogen content was 0.70 per cent or about three times the nitrogen content of ordinary soil. The horse manure which had been heaped in an open field and had been subjected to rain for three weeks, gave 0.80 per cent nitrogen.

The total P_2O_5 content of these fertilizers also shows that as a whole, the buffalo manure has a comparatively higher phosphorus content than the other fertilizers, ranging from 1.356 per cent to 2.475 per cent. The duck manure and the horse manure give approximately the same percentages of total P_2O_5, with 1.843 per cent and 1.832 per cent respectively. It seems that these pepper soils are not

exactly poor in phosphorus. According to the analysis, the soil alone contains 1.154 per cent total P_2O_5. The thoroughly burned soil gives 1.314 per cent or an increase of 0.160 per cent due probably to the ash from the burned materials.

The potash content of the buffalo manure seems more or less uniform ranging from 0.312 per cent to 0.490 per cent. The duck manure contained 0.390 per cent, which is approximately the same as the buffalo manure. The horse manure on the other hand gives only 0.198 per cent K_2O which is lower than the buffalo manure mixed with mud that gives 0.230 per cent K_2O. But in estimating the actual fertilizing value of the duck manure, it is doubtfel whether the duck manure will give actually a better potash supply than the horse manure on account of the presence of an appreciable amount of undecomposed rice hull in the duck manure. Whereas the horse manure on the other hand, although very much leached through exposure to the rain, was only partly decomposed and its actual chemical composition would yield to the plants in comparatively shorter time than the duck manure. The horse manure and the buffalo manure are about the same in this respect. The burned soil gives 0.112 per cent K_2O or an increase of 0.045 per cent over the original soil which may be due to plant ash remained from the burned materials. It has been found however that burned soil yields more available plant nutrients after being burned and this, coupled with the biological factors, can not be measured alone through the results of their chemical analysis.

The values of the above analysis are subject to various fluctuations, which are principally due to the age and method of handling in the case of the various manures, and the variability of mixing materials in the case of burned soil.

Recommendations

1. That small animal corrals should be roofed in order to prevent sunlight striking directly upon the manure heap which promotes high temperature and cause volatilization of the nitrogen content. Also to prevent rain water leaching through the layer of manure and cause the loss of available plant nutrients.

2. Animal manure should be spread when fresh with plenty of bedding to absorb the liquid manure. Fermentation is reduced by keeping the manure compact and moist or by storing them in concrete containers provided with cover.

3. Never allow the manure to stand in the open air and be "cooled by the rain". Such practice is very conducive to an enormous loss of plant nutrients through leaching.

4. Burned soil should be protected from the rain or if mixing with manure is desirable, it should be carried to the corral which is provided with shade, so it can be protected from leaching.

5. Septic tanks should be well covered to prevent rapid fermentation and exit of gases and the entrance of maggots into the wastes, that lead to the loss of important substances upon which they feed.

6. Pits should be designed for the accumulation of leaves from pepper as well as leaves from other plants. This will provide another rich source of organic fertilizer.

7. In view of the high acidity of the soil in this locality, a little lime application would bring a better environment of the soil for the working of microorganisms preferably the azotobacter or the nodule bacteria for peanuts which are sometimes planted between the pepper plants at the same time giving more calcium to the thoroughly weathered and leached soil.

8. In order to prevent rapid movement of elements in the soil as well as the soil itself removed through erosion, the pepper rows should be laid more or less on the contour of the land and provided with "trough" in between the rows.

9. Clean culture should be practiced by all gardeners especially during the rainy season when weeds become very abundant.

Summary

The pepper fertilizing materials and pepper fertilization at the pepper district of Amphur Ta Mai, Changwad Chandhaburi is discussed in detail in this article for general information and for those particularly interested in the more scientific side of pepper culture. The most common fertilizing materials are burned soil, animal manure, and forest soil and a combination of either burned and forest soil with animal manure. Miscellaneous organic fertilizers

such as pepper leaves, night soil, poultry and swine manure, soils from water pits, and scraps from burned vegetation are seldom used or if ever are used often only in minor quantities.

There are approximately five ways in which fertilizers are applied, depending upon the age of the plant or of the amount of fertilizers to be applied. It would be advisable to introduce proper methods of conserving or storing fertilizers to the farmers in order to minimize the loss of plant food nutrients through volatilization and leaching. The main difficulty in the proper handling, especially of the most common ones such as the burned soil and the forest soil is their great bulk. However, it would not be absolutely difficult to put them even under temporary shade.

Chemical analyses of the common fertilizers have been worked out to compare their relative phosphorus, nitrogen, and potash contents. As these fertilizers are variable in composition, it would be difficult to formulate any chemical data for any of the native fertilizers.

Literature Cited

Anonymous. 1930. Official and tentative methods of analysis of the Association of Official Agricultural Chemists. 3rd. ed., xviii+593., 38 ills. Published by the Association of Official Agricultural Chemists at Washington D. C.

Duley, F. L. 1919. Handling farm manure. Missouri Sta. Bull. 166. pp. 3—29, figs. 13.

Hardon, H. J. and Ir. J. Th. White. 1934/35. Gebrande aarde (Tanah Bakar). Department of Economic Affairs. Government of the Netherlands Indies. Brief Communications from the General Agricultural Experiment Station No. 14. (From an unpublished translation by Robert L. Pendleton, Department of Agriculture and Fisheries, Bangkok, Siam. 1935.)

Ingle, H. 1933. A manual of Agricultural Chemistry. 5th ed., x + 448., 16 ills. London: Ernest Benn Limited.

Rutgers, A. A. L. 1915. Investigations regarding the untimely dying of pepper vines in the Netherlands Indies. I. Review of the earlier investigations. Department of Agriculture, Industry, and Commerce, Netherlands Indies. Institute for Plant Diseases and Plantation Crops. Bulletin of the Laboratory for Plant Diseases. No. 18. (Unpublished translation from the Dutch by Robert L. Pendleton, Department of Agriculture and Fisheries, Bangkok Siam. 1936.)

——— 1916. Investigations regarding the untimely dying of pepper vines in the Netherlands Indies. II. Pepper culture on the island of Banka. Department of Agriculture, Industry, and Commerce, Netherlands Indies. Institute for Plant Diseases and Plantation crops. Bulletin of the Laboratory for Plant Diseases. No. 19. (Unpublished translation from the Dutch by Robert L. Pendleton, Department of Agriculture and Fisheries, Bangkok, Siam. 1936.)

——— 1916. Investigations regarding the untimely dying of pepper in the Netherlands Indies. III. Pepper culture in the Lampong Districts. Department of Agriculture, Industry, and Commerce, Netherlands Indies. Institute for Plant Diseases and Plantation Crops. Bulletin of the Laboratory for Plant Diseases. No. 27. (Unpublished translation from the Dutch by Robert L. Pendleton, Department of Agriculture and Fisheries, Bangkok, Siam. 1936.)

Sharples, *A.* 1923. Disease of pepper vines in Sarawak. The Malayan Agricultural Journal. 11: 120—128.

Printed at the "Daily Mail Press", Si-phya Road, Bangkok, Siam.
by Choo Limsaroj, publisher. November, 1937.

Fig. 2. A 4 x 1.5 x 1 m. heap of soil in the process of burning. Note the raked burned portion of soil around the heap.

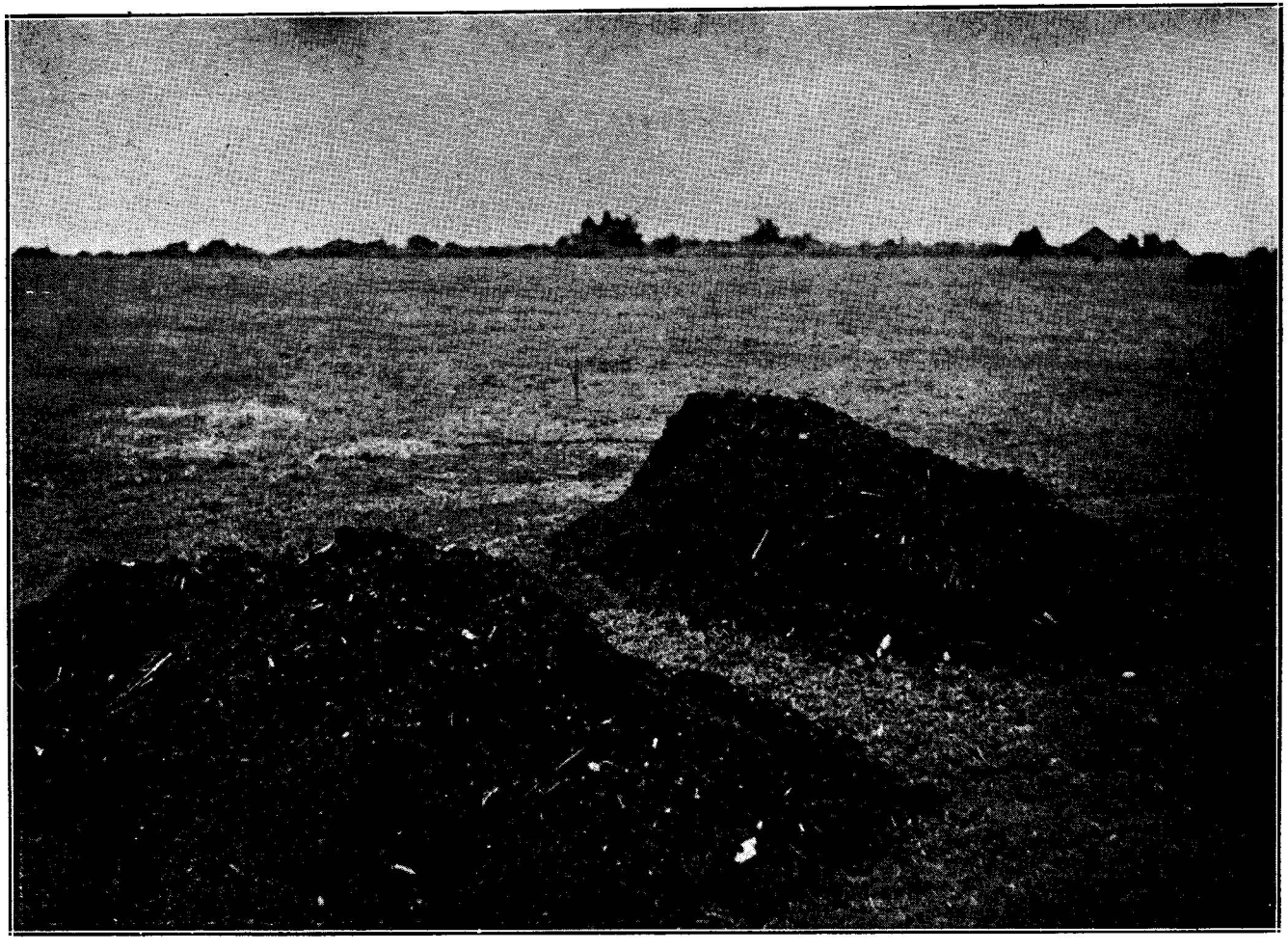

Fig. 3. Horse manure exposed under rain and sunshine for more than three weeks in an open field.

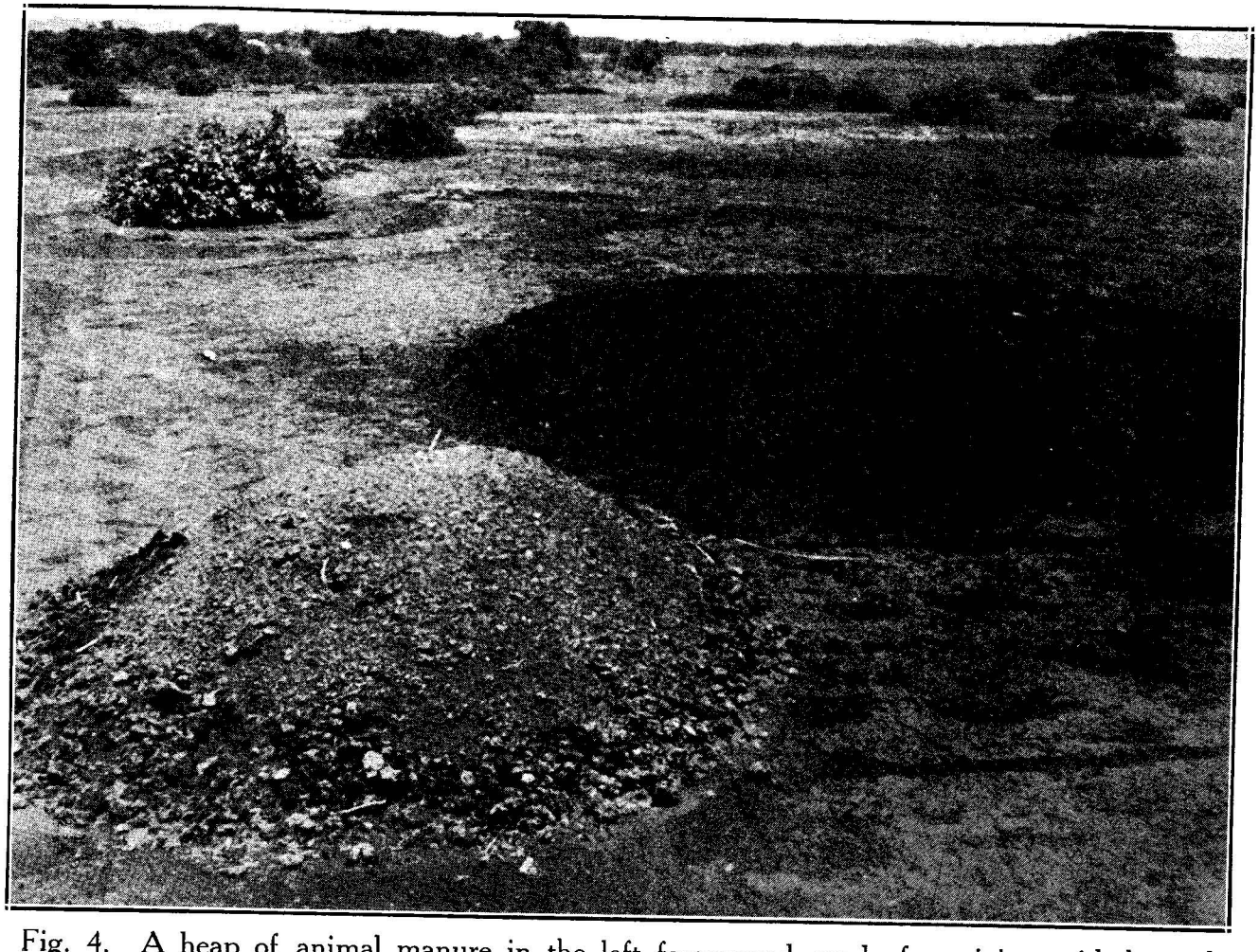

Fig. 4. A heap of animal manure in the left foreground ready for mixing with burned earth in the right background.

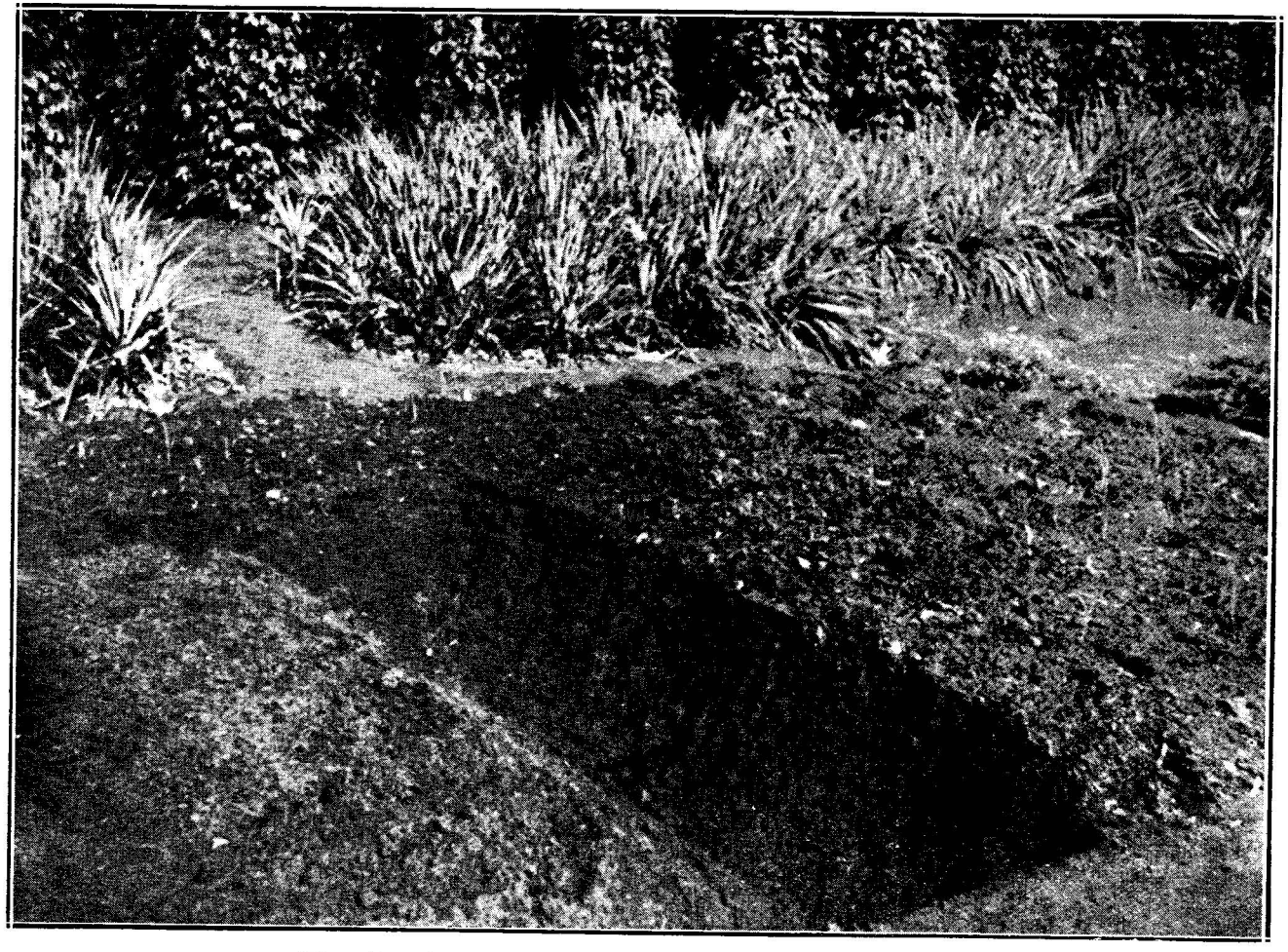

Fig. 5. Mixing forest soil and animal manure.

Fig. 6. Pit designed for accumulation of pepper leaves at the Agricultural Pepper Experiment Station, Chandhaburi.

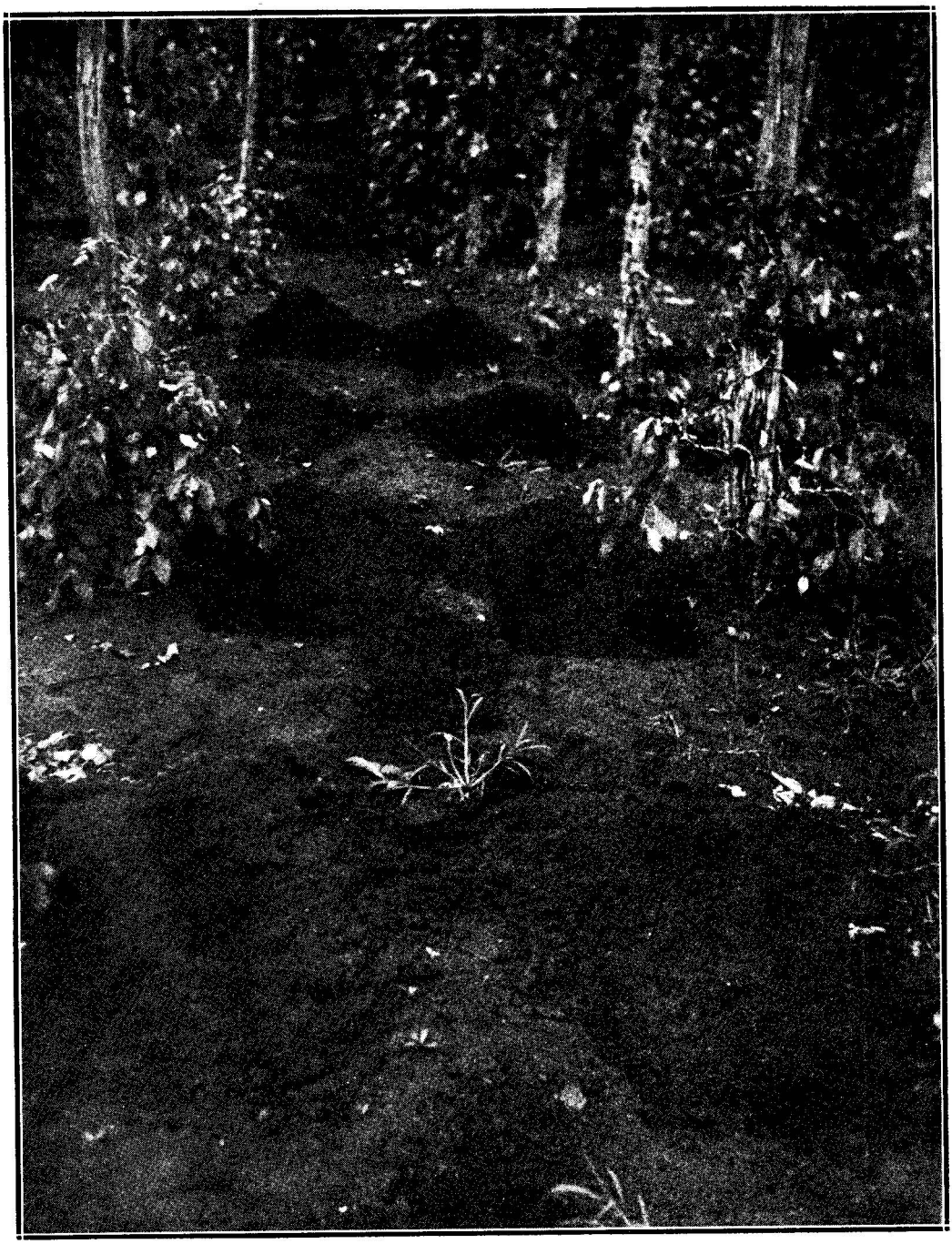

Fig. 7. Holes for fertilizer – two between each plant along the row.

กรมพัสดุ
๗๕๐ ถ: ๘.๘๐
พิมพ์ที่โรงพิมพ์เดลิเมล์