MINISTRY OF AGRICULTURE AND CO-OPERATIVES

MALAYSIA

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PADI

(Oryza sativa L.)

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(*Oryza sativa L.*)

INTRODUCTION

Rice is one of the oldest of foodcrops and has been in cultivation in China, India, Java (probably including the whole of the East Indian region) and East Africa from very ancient times. It is a most important food crop and is the main cereal for over half the population of the world.

VARIETIES

Rice is grown under a wide range of environmental conditions, and there are in existence a mass of varieties, showing large variations in morphological and physiological characteristics, evolved to suit local conditions. In Malaya, the actual number of varieties is difficult to assess. Over 1,200 varieties have so far been recorded but not all of these are capable of giving high yields. Rice breeders in Malaya are continuously working to improve the existing varieties and to replace the large number of nondescript varieties now grown by the padi farmers with a reduced number of proved varieties or strains. This work has resulted in at least one variety being recommended for almost every padi area in the Federation. These varieties sometimes give spectacularly increased yields but even if this is not so, the farmer can be sure of a consistently good crop of good quality padi if he uses the variety recommended for his area. The current varietal recommendations are given in Table I and any further information required can be obtained from the Department of Agriculture in each State. The farmer must of course also look after his crop well, and much work has also gone into ascertaining how to increase yields by improving husbandry practices. This leaflet describes the improved practices evolved to ensure the higher yields.

Selection of the Seed

Careful selection from the growing crop of the seed required for next crop is essential to ensure that the standard and purity of the variety is maintained. If the seed is not good and pure, uniformity of growth will be lost and yields will decline. Seed of the recommended variety can be obtained from the Ministry of Agriculture and although you can select seed from your own crop if you have the right variety, it is advisable to obtain new seed every three years.

Selecting seed from a growing crop should be done from a healthy crop when it is fully ripe. Vigorous plants of uniform height should be chosen from the centre of the field to avoid contamination. The selected ears should be ripe and well-filled, free from diseases and true to type for the variety being grown. When harvested, the selected ears should be dried thoroughly and stored in a dry airy place

TABLE I

CURRENT PADI VARIETAL RECOMMENDATIONS IN MALAYA

State	*Region*		*Current Varietal Recommendations*
Perlis	Perlis		Radin Ebos 33, Subang Intan 16 & 117
Kedah	North and Central	Short Term :	Radin Kling
		Medium Term :	Radin Ebos 33, Subang Intan 16 & 117
	South	Short Term :	Radin Kling
		Medium Term :	Radin Ebos 33, Radin China 4, Subang Intan 16 & 117
	Coastal	Long Term :	Seraup 50
Province Wellesley	North	Medium Term :	Radin China 4, Subang Intan 16 & 117
	Central	Main Season :	Radin Kling, Bongor
		Long Term :	Seraup 50
Penang			Seraup 50
Perak	North Krian	:	Seraup 50
	Central Krian	:	Seri Raja, Seraup 50
	South Krian	:	Seri Raja, Radin Che Ali
	Sg. Manik (South Perak)	:	Seraup 50
Selangor	Tanjong Karang	:	Radin Kuning
Negri Sembilan		:	Serendah Kuning 60
Malacca	Coastal	:	Nachin 39, Siam 48
	Inland	:	Serendah Kuning 23, Siam 48
Johore	North	:	Acheh Puteh
Pahang	Riverine areas	:	Serendah Kuning 60
	Other areas	:	Milek Kuning
Kelantan		Medium Term :	Anak Naga 21
		Long Term :	Mayang Sagumpal
Trengganu		:	Padang Trengganu Morak Sepilai
General		Off-season :	B.M. 5

until required. To avoid insect damage during storage the ears should be dusted with an insecticide or naphthalene balls should be placed in the bag or box containing the seed.

Three gantangs of good selected seeds will be required for every acre of padi land to be planted. To obtain this amount approximately 20 lbs. of selected ears are required.

Treatment of the Seed

No matter how well the ears are selected they will inevitably include a proportion of light weight and partially filled grains which are unsuitable for use as seed. When the grain has been removed from the ear and winnowed to remove the empty grain and chaff, the light-weight seed can be separated by the technique known as floatation. To do this, a strong salt solution of 1.13 specific gravity should be prepared in a kerosene tin or other suitable container. An approximation to this specific gravity can be achieved by either dissolving salt in water until a fresh hen's egg floats half in and half out of the solution or by dissolving 2 milk tins of salt in a kerosene tin of water. The padi seed is then stirred gently into the solution so that the well-filled heavy grains sink, and the light weight grains float on the surface. The "floaters" should then be scooped off the surface and discarded. The selected heavy seed, removed from the brine, must then be washed with fresh water to remove all traces of salt.

When sowing the nursery, pregerminated seed should be used. Such seed develops more quickly and minimises the damage which can be caused by birds and flood water. Pregerminated seed is prepared by soaking the seed in fresh water for 24-48 hours until a white protuberance can be seen at the basal end of the seed. The water is then drained off and the seed spread thinly on sacking placed in the shade. The seed is then left to germinate for the next 48 hours during which period it must be covered by another piece of sacking to keep it moist. On no account must the seed be allowed to become dry during this period and it may be necessary on hot dry days to sprinkle water on the sacking cover.

Preparation of the Nursery

The selection of the site for the nursery is most important. It should never be situated under the shade of trees and it should always be on the best available soil. Good water control is also essential for the healthy establishment and growth of the seedlings.

(i) Wet Nursery

Wet nurseries are normally used except where water supply is inadequate or where the water on the fields is too deep. It is essential that the surface soil of the nursery is absolutely level in order to ensure perfect water control over the whole nursery area. It is advisable to incorporate

dry well rotted, cattle or buffalo manure into the soil at a rate of not less than one hundred lbs. per 500 sq. feet of nursery bed and this must be evenly spread and thoroughly worked in.

Nursery beds should not be more than five feet wide but may be as long as convenient. They should be well cultivated and it is most important that the final cultivation and puddling of the soil should achieve a flat and level surface. Ammonium phosphate 11:48 at the rate of two lbs. per 500 sq. feet should be lightly worked into the prepared surface of the nursery bed.

Prior to sowing, the water level must be maintained just below the surface of the soil in such a way that the surface of the bed is kept in a very damp condition. At sowing, the pregerminated seed should be broadcast evenly over the surface of the prepared nursery bed at the rate of one gantang (about 5½ lbs.) per 500 square feet. Once the seedlings are established, the water level should be raised and the depth of the surface water gradually increased as the seedlings grow.

(ii) DRY NURSERY

Dry nurseries are used in areas where water supply depends on rainfall and the latter is usually inadequate prior to transplanting, e.g. in the monsoonal State of Kelantan. The site selected for a dry nursery should, as far as possible, be level and close to a source of water. A nursery area of 500 square feet is recommended for every gantang of seed to be sown. A dressing of dry well-rotted cattle or buffalo dung should be evenly applied and thoroughly mixed with the soil at a rate of at least 200 lbs. per 500 square feet of nursery. Where cattle manure is not available ammonium phosphate 18:50 or 21:53 may be used at the rate of 2 lbs. per every gantang of seed. Nursery beds should not be more than 5 feet wide. The pregerminated seed is broadcast and then watered in. It may be necessary to water the seedlings periodically if rainfall is inadequate.

(iii) RAKIT NURSERY

This type of nursery is used only when the water is too deep to permit the use of the ordinary wet nursery. It is a technique that is at present unavoidable in certain districts, such as Krian in Perak.

The "rakit" consists of a raft usually constructed from cut fallow grass and weeds with a few inches of very fine soil on the surface. Pregerminated seed is sown on the rakit and remains there until the seedlings are tall enough for planting to the second nursery that is

when they are 5 inches or 6 inches tall after some seven to ten days. The second nursery consists of a prepared area of the field in which the water is shallow and into these small clumps of seedlings, two or three inches in diameter are transplanted. From this second nursery, as soon as the seedlings are of sufficient height they are transplanted into the field. Before sowing the seed, $\frac{3}{4}$ lb. ammonium phosphate 11:48 per 50 square feet of rakit should be broadcast over the surface of the soil and lightly worked in. The seed is then broadcast evenly and covered with palm or attap fronds which are removed 3-4 days later.

Nursery Management

All three types of nursery need to be protected by a strong fence from domestic livestock. Rat control is very important and can usually be achieved by using poisoned baits. An effective method is to place at intervals around the nursery, little heaps of boiled padi, prawn dust or fish refuse into which some zinc phosphide has been mixed. The nursery should also be kept free from weeds and should be regularly inspected to ascertain whether any pests or diseases are present.

LAND PREPARATION

The objects of land preparation for padi planting are:—

(a) To clear and bury the rice stubble and weed growth.

(b) To make the surface of the soil level.

(c) To produce soil conditions suitable for rice cultivation.

Throughout the major padi growing areas of the Federation, the dates for starting cultivation, for sowing rice nurseries, for transplanting seedlings and for weeding the growing crop are laid down by Gazette notification. The dates are fixed in relation to the probable availability of water, either natural rainfall or irrigation supply, so it is necessary to adhere to the gazetted dates if full advantage is to be taken of the irrigation provided and of seasonal rains.

Methods of land preparation employed in the Federation vary from primitive types of hand and animal cultivation to more modern cultivation with tractor powered implements. Where double-cropping is carried out it is particularly advantageous to cultivate by tractor since a very short period between crops is available for cultivation. In all cases it is essential that the bunds are repaired prior to cultivation to make good damage done during the off-season by grazing cattle and buffaloes. All water courses, irrigation and drainage channels should likewise be repaired and cleared of weeds to ensure an efficient water supply.

The land must be thoroughly cultivated and puddled before transplanting. This is usually, achieved by ploughing, harrowing and rolling. Initial cultivation, especially ploughing with animal or tractor

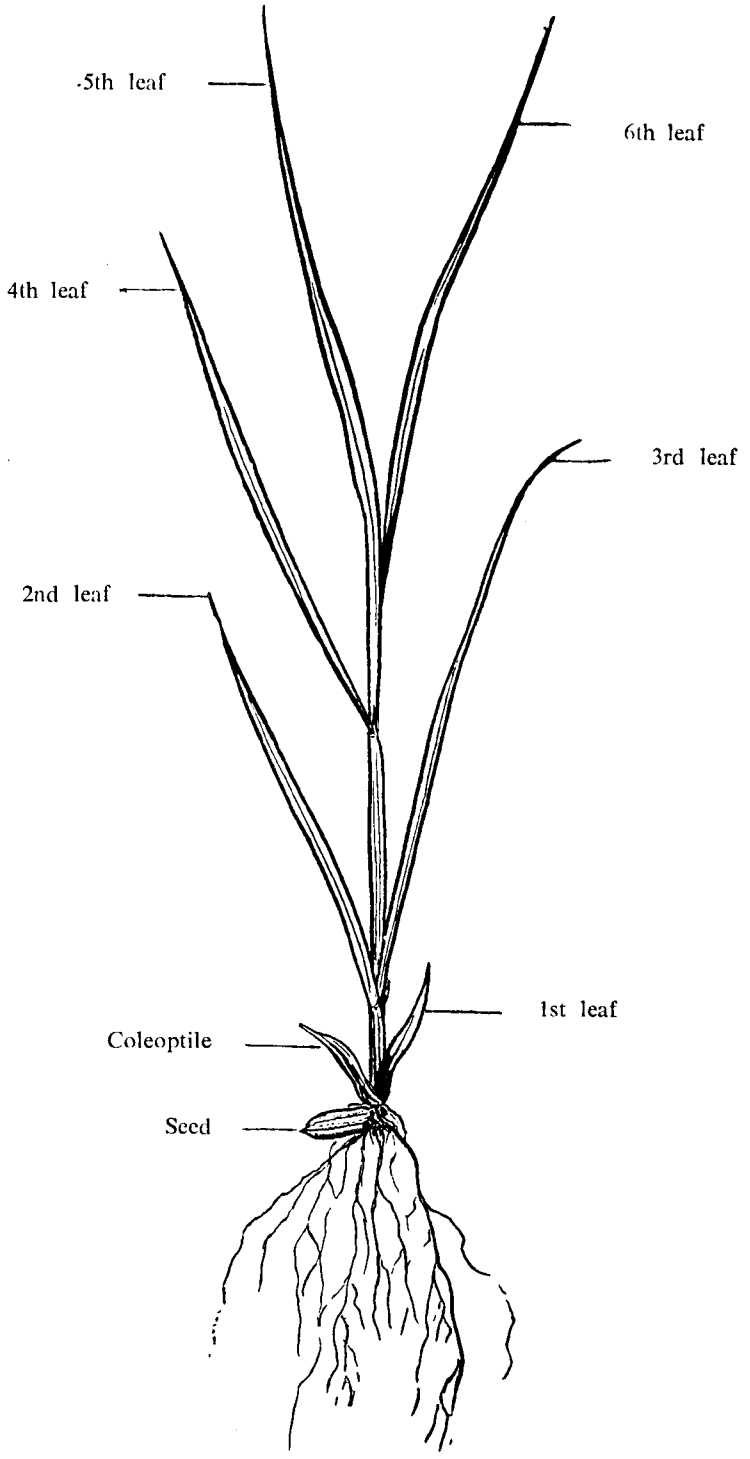
drawn ploughs, can best be carried out in fairly dry conditions. Subsequent cultivations such as harrowing and rolling are best carried out with water on the land. Final preparation of the land (puddling) must naturally be carried out under water.

Land levelling is important. The yield of rice is dependent to a great extent on the water levels throughout the growing period, and high or low parts in the field, where water is either too shallow or too deep, can cause significant reductions in yield. Weed growth is suppressed by deep water while shallow water allows rapid regeneration of the weeds. The optimum depth of water is 3 or 4 inches; if the water is deeper than this early tillering may be inhibited and if it is shallower weeds grow too rapidly.

TRANSPLANTING

Seedlings are ready for transplanting from the nursery into the field when 5 or 6 leaves have formed.

Fig. I


5th leaf
6th leaf
4th leaf
3rd leaf
2nd leaf
1st leaf
Coleoptile
Seed

The age at which this stage is reached varies according to the standard of nursery management and the maturation period of the padi variety used. The following table of transplanting times is offered as a guide: —

TABLE II

Maturation Period (sowing to harvest)		*Optimum Time for Transplanting*
140 days or less	...	20-25 days after sowing
140 days to 180 days	...	25-35 „ „ „
180 days to 200 days	...	35-40 „ „ „
200 days or more	...	40-50 „ „ „

The potential yield of the crop is irrevocably reduced if the seedlings are transplanted at stages later than those suggested. The longer the seedlings remain in the nursery beyond the correct age the more severe is the reduction in yield.

Whenever possible, the gazetted planting dates should be adhered to. This is necessary to ensure that the padi ripens at the optimum time taking full advantage of the seasonal weather variations. Major departures from these dates will result in a reduction in yield. In extreme cases total crop failures have occurred. When transplanting, damage to the seedlings should be kept to a minimum. The seedlings should be lifted carefully using a suitable tool to keep the roots intact. On no account should root pruning be carried out. In some cases it is necessary to prune the seedling leaves to prevent them from being blown down by the wind after transplanting, but such pruning should be kept to a minimum. When transplanting, the objective should be to plant each group of seedlings only one or two inches deep in the soil. If planting is deeper than this, growth is retarded and the number of tillers reduced. Shallow planted seedlings produce the largest number of early tillers and a higher proportion of these are fertile.

Only two or three seedlings should be transplanted per hill and the roots should be protected to minimise damage when pushing them into the soil. This can be achieved by pushing the fingers into the soil two or three inches ahead of the seedling plant. Seedlings should be planted upright as this promotes even tillering around the hill.

Fig. II

Spacing

The optimum planting distance varies according to the maturation period of the variety used, its tillering capacity and the fertility of the soil. Varieties of short maturation period should be planted more closely than varieties of long maturation period. Planting distances should be closer on soils of low fertility than on soils of higher fertility. The following table should be used as a guide to the optimum planting distance: —

TABLE III

Soil Fertility	Maturation Period		
	Short	Medium	Long
Low	9″× 9″	12″×12″	14″×14″
Medium	12″×12″	14″×14″	16″×16″
High	14″×14″	16″×16″	18″×18″

FIELD MANURING

Manuring of padi in Malaya presents a number of problems peculiar to this country. Padi soils in Malaya are usually acidic in nature, frequently deficient in bases and of very variable inherent fertility. Padi husbandry techniques vary considerably in their efficiency, as a consequence of the differing importance of padi in the rural economy from one region to another and the facilities for irrigation. The very acid nature of many padi soils prevents the effective utilization by the plant of nutrients which would otherwise be available. This harmful effect can be counteracted by the addition of limestone. Trials have indicated that responses in terms of increased padi yield can be expected in many areas as a result of such treatment.

In most areas, an economic response in terms of increased grain yield can be expected as a result of the judicious use of fertilisers. Recommendations will of course vary according to the area, soil type and method of irrigation, etc., but generally nitrogen and phosphorus are the two most important major nutrients lacking in padi areas of Malaya. The need for potassium on heavy clay soil has not as yet been clearly demonstrated, but is probably beneficial in areas of sandy soil and it is usually included in small quantities in general fertiliser mixtures as an insurance measure. For any specific area, manurial recommendations are available from the State Department of Agriculture, and the following paragraphs outline the values and methods of application of the main fertiliser types.

Organic Manures

Organic manures are beneficial on all padi soils. Not only do they provide nutrients to the plants but they also improve the structure and aeration of the soil. Animal manure in some form or other, green matter from off-season vegetation, and green manure should be ploughed into the land with the first cultivation.

Inorganic Fertiliser

(i) NITROGENOUS FERTILISER

Padi plants require nitrogen throughout their growing period and because the nitrogen in most organic nitrogenous fertilisers is released rapidly it can be quickly lost to the padi plant or the over availability of it may harm the padi plant. Because of this, the type of nitrogenous fertiliser used and the method of its application are important. Nitrogen in the ammonium form should be used under conditions of continuous flooding because only in this form can the nitrogen be retained in flooded soils until utilised by the padi plant. Urea is included in the ammonium group because when applied to flooded soil it quickly forms ammonium carbonate. Urea and sulphate of ammonia are the two commonest nitrogenous fertilisers of padi, urea being most suitable for application as a top dressing and sulphate of ammonia for mixing into the basal mixture applied before transplanting. To obtain the maximum utilization of nitrogenous fertilisers they should be applied at the critical growing stages of the plant. These are: —

(a) just before transplanting. A basal dressing including part of the nitrogenous fertiliser should be thoroughly puddled into the soil to encourage the seedlings to recover from transplanting.

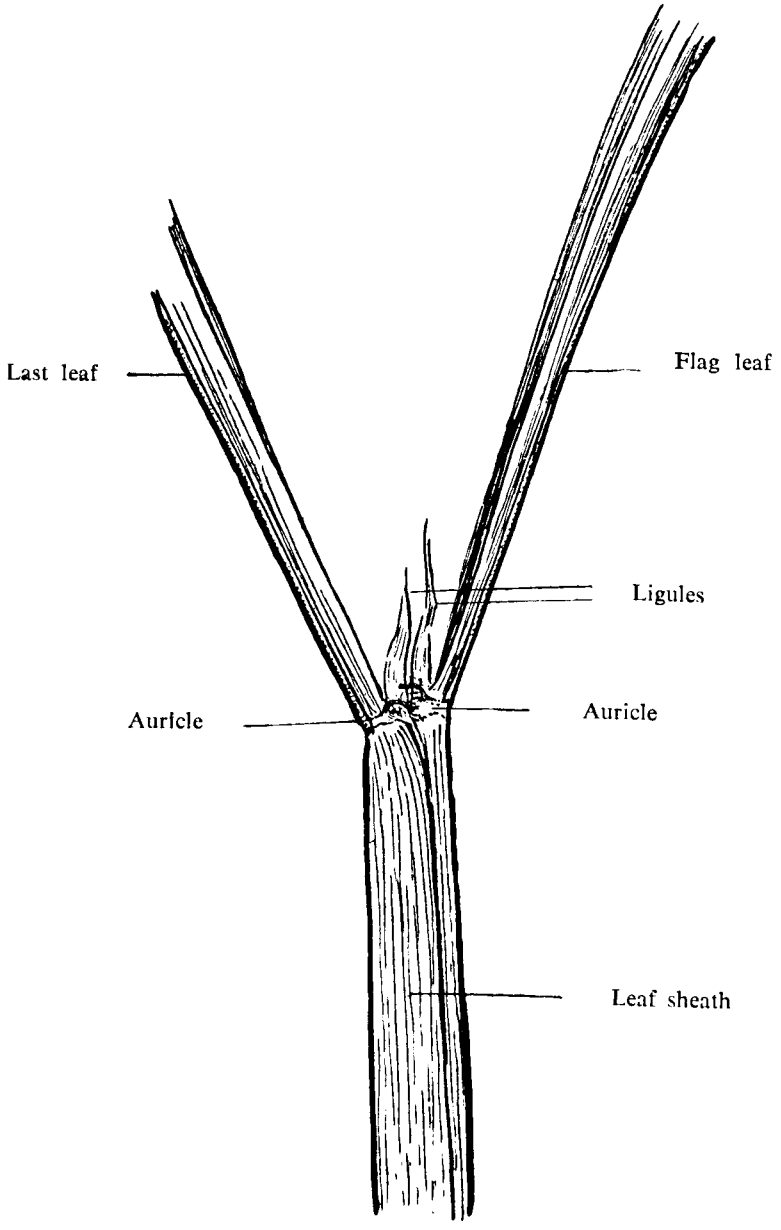
(b) two to three weeks after transplanting. A top dressing at this stage will ensure maximum tillering;

(c) two or three days before the 'reduction division' stage. This is the stage when the young grains are forming in the young ear still inside the leaf-sheaths. Unless nutrients are available at this stage, the young grains, particularly those at the base of the ear or panicle, will degenerate. For all varieties, whatever their maturation period, the reduction division stage begins from 15 to 18 days before ear-emergence or from 45 to 48 days before ripening.

In the field, this stage can be identified by a simple examination of the padi plant, especially the last leaf and the flag leaf. Reduction division in the panicle of the padi plant starts when the auricle of the flag leaf is about 4 inches below the auricle of the last leaf, and is most active when the two auricles are at the same level. Reduction division is completed when the flag leaf auricle is about 4 inches above the auricle of the last leaf.

In practice, the time to apply this top-dressing of nitrogenous fertiliser is decided by examining the very first few early plants in the field. When the auricle of the flag leaf of such early plants is just below that of the last leaf the majority of the plants in the field will be about to enter the reduction division stage.

Fig. III



(d) just after heading. Top dressing at this stage will ensure fullness of grain.

(ii) PHOSPHATIC FERTILISER

Padi plants require phosphate throughout their whole growing period and the need for this nutrient increases as the plants grow older. When applied to the soil phosphate does not get leached away quickly, but is slowly made available to the plant. Because of this characteristic phosphatic fertilisers should be applied to the root zone before transplanting. The fertiliser should be incorporated with the soil during the course of final cultivation, prior to transplanting.

(iii) POTASSIC FERTILISER

Where potassic fertiliser is to be applied, it should be applied during the course of final field cultivation prior to transplanting.

The quality of fertiliser required depends on several factors, such as the inherent fertility of the soil and amount of organic residue returned to the soil. In general, during a favourable growing season, it is profitable to add 20-40 lbs. of actual nitrogen 30-60 lbs. of actual P_2O_5, and 15-30 lbs. of actual K_2O per acre. The common inorganic fertilisers contain a guaranteed percentage of the required nutrient, and a standard quantity of fertiliser per acre can therefore be applied. The following table is offered as a guide to the quantity of each fertiliser normally recommended: —

	Nutrient Rate lbs./ac.	*Fertiliser Rate lbs./ac.*
Nitrogenous Fertiliser	20-40 lbs. N.	
Sulphate of ammonia (21% N)		95-190
Urea (46% N)		44- 89
Phosphatic Fertiliser	30-60 lbs. P_2O_5	
Christmas Island Rock Phosphate (36% P_2O_5)		83-167
Florida Rock Phosphate (36% P_2O_5)		83-167
North African Rock Phosphate (30% P_2O_5)		100-200
Superphosphate (18% P_2O_5)		167-333
Double Superphosphate (40% P_2O_5)		75-150
Potash	15-30 lbs. K_2O	
Muriate of Potash (60% K_2O)		25- 50

Bat guano, and organic fertiliser, contains very variable amounts of Phosphate (P_2O_5) and no economic dressing of this product can be suggested.

WEED CONTROL

Weed control is essential if maximum padi yields are to be achieved. Weeds compete with the crop for nutrients, water and light and they may act as hosts for pests and diseases which attack the crop.

The preliminary cultivation of the field should, amongst other things, eradicate most of the weeds but there will be some regrowth which has to be removed by hand, or more easily using a simple tool such as a weed-roller.

Fig. IV

If a weed-roller is to be used, transplanting must be done in reasonably straight rows.

Weeding should be done as often as possible, the first round being carried out two weeks after transplanting. If this is done thoroughly and carefully, subsequent weed control will be easy and weeding once a month will be sufficient. This should be continued until the shade from the developing padi becomes sufficient to prevent further weed growth.

Some of the common weeds of rice fields can be controlled easily by spraying selective herbicides, such as the salts on iso-butyl esters of MCPA and 2, 4-D.

PESTS AND DISEASES

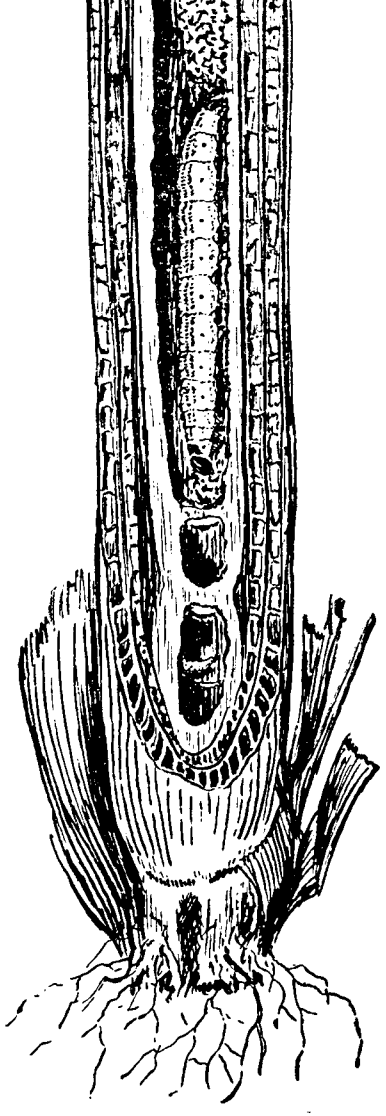
(A) Rodents

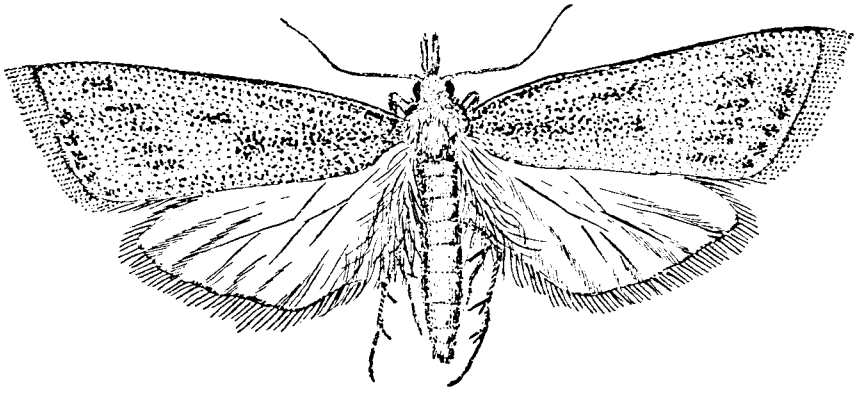
Rats constitute one of the most serious and widespread menaces to rice production in Malaysia. They do not only destroy the growing crop by gnawing the stems and eating the developing grains but given the opportunity they also feed on stored padi and rice. Rat traps of various types are in use in most districts but the most effective control measure is achieved by using poisoned baits. To protect the nursery or the growing crop, zinc phosphide should be mixed with boiled padi, boiled rice, prawn dust or fish refuse and the mixture placed in small heaps at strategic points in the attacked areas. The prepared baits can be obtained from the staff of the Division of Agriculture. Rat control is most effective if all the farmers in the infested area set baits to kill rats at the same time. So co-operative effort is necessary if success is to be achieved. Rat populations are also kept down by keeping the fields free of all weed growth throughout the year.

All stores for keeping harvested padi or rice should be constructed in such a way as to be rat proof.

(B) Insect Pests

Stem-borers are the most damaging insect pests of growing padi.





Moth

Caterpillar

Fig. V

Chilotraea polychrysa Meyr.

The damage is done by the stem-boring caterpillars (Ulat Batang) which, after hatching from eggs laid on the leaves, burrow down inside the leaf-sheath of the plant where they feed for about 15 days. The damaged stems either die or produce little or no crop or empty "white ears". The stem-borers multiply rapidly. Several generations occur each year and they can do considerable damage to the crop. Four species of stem-borers of major importance in Malaya are: —

(i) *Chilotraea polychrysa* Meyr
(ii) *Chito suppressalis* Walk
(iii) *Schoenobius incertulas* Walk
(iv) *Sesamia inferens* Walk.

No complete control measures have yet been evolved for use in Malaya against the stem-borers but spraying with insecticides such as dieldrin will lessen the attacks considerably. These insecticides, unfortunately, are toxic to fish in the padi fields as well. The problem of control in areas where padi-field fish are economically important is therefore complicated.

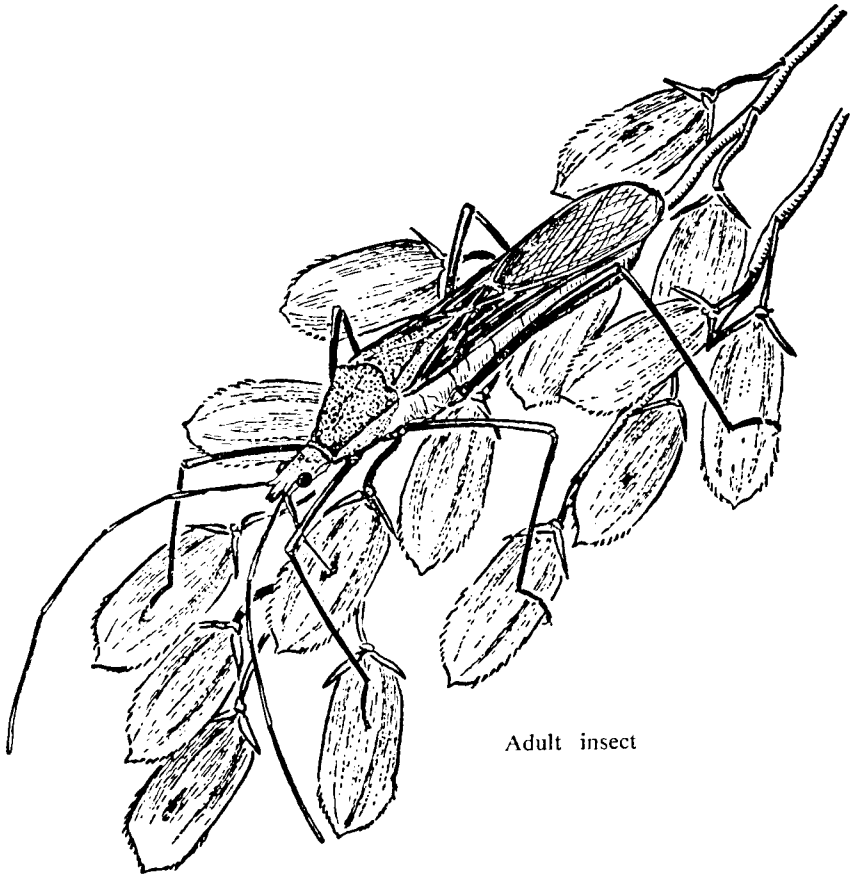
Several species of sucking bugs cause damage to the padi crop in Malaya. They are: —

(i) *Leptocorisa acuta* Thunbg (Malay = Pianggang)
(ii) *Scotinophara coarctata* Thunbg (Malay = Kutu bruang)
(iii) *Sagota furcifera* Horv (Malay = Bena puteh)
(iv) *Nephotettix bipunctatus* F (Malay = Bena hijau).

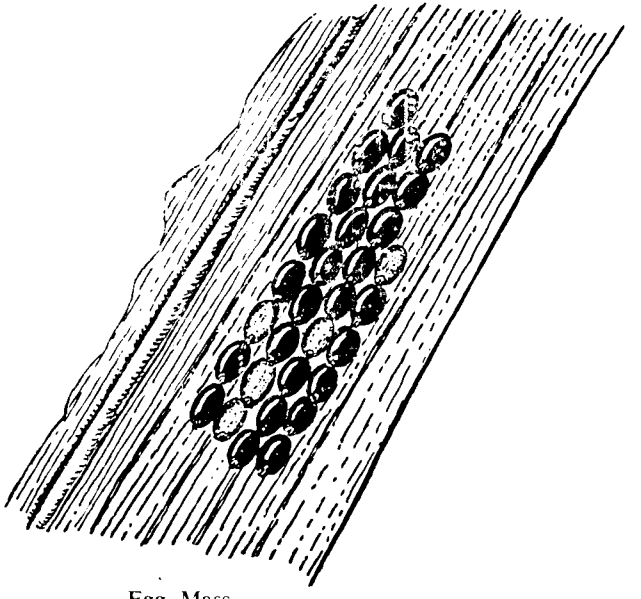
(i) *Leptocorisa acuta* is a pest only when the grain is developing as it feeds on the milk-ripe grains, sucking the contents until only the empty seed coat remains.

Fig. VI

Leptocorisa acuta.



Adult insect



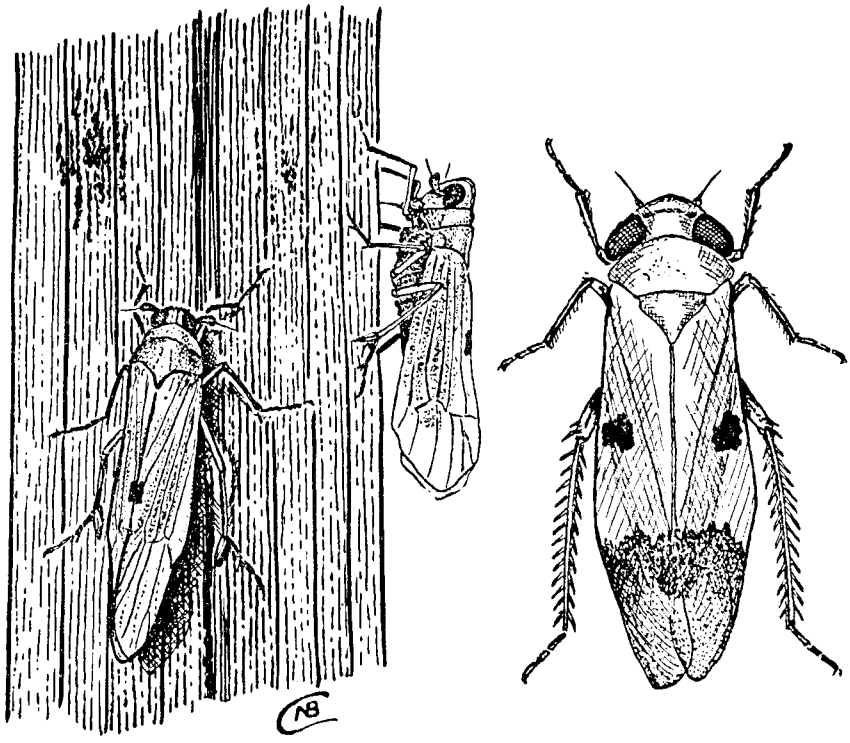
Egg Mass

The eggs are laid in regular rows on the padi leaves and on hatching the nymphs suck the leaf-sap for one or two days before climbing into the panicles where they feed for a further three weeks before reaching the adult stage. Control can be effected by fogging in the early morning or the late evening with dieldrin or DDT. The adults are easily disturbed and can fly short distances. They can, therefore, be trapped by waving above the padi a net or a branch smeared with a sticky substance to which the insects will adhere when they rise from the crop.

(ii) *Scotinophara coarctata* is a bug which lays its eggs in masses at the base of the plants. Both nymphs and adults feed by sucking the sap generally at the base of the plant causing it to be stunted. Control can be effected by spraying with dieldrin. Some control can also be achieved by raising the water level in the field for two or three days to kill the bugs and by turning ducks, which eat the insects, in affected area.

(iii) *Sogata furcifera* and (iv) *Nephotettix bipunctatus* are commonly known as leaf-hoppers.

Fig. VII



Sogata furcifera

Nephotettix bipunctatus

Nymphs and adults of both species feed by puncturing the leaf-sheaths, sucking the sap and leaving the leaves to dry up. With young plants, the attack can be serious. *Nephotettix* lays eggs in leaf-sheath, and *Sogata* in slits in the mid-rib of leaves. Both species complete their life cycle within about three weeks. Control can be effected by dusting with Malathion, B.H.C. or Dieldrin or by coating the surface of the water with kerosene and shaking the padi plants so that the insects fall and are killed by the kerosene.

Leaf Eating Caterpillars can cause considerable damage to the padi crop. These caterpillars are the larvae of the following species:-

(i) *Spodoptera mauritia* Boisd (Army Worms) (Malay – Ulat ratus or Ulat ribu).
(ii) *Cnaphalocrocis medinalis* Guen (Malay = Ulat gulong).
(iii) *Nymphula depuntalis* Guen (Malay = Ulat hampong).

Spodoptera mauritia is the most damaging of the swarming caterpillars attacking padi in the nursery. Very severe damage can be caused as the caterpillars migrate from field to field. Frequently they are not noticed in the early stages when the leaf tips are only scraped before the leaf blade is consumed. Dusting with a 2½% D.D.T. dust gives an effective control. One pound of insecticide dust is sufficient for a nursery of 250 square yards in area.

The best results are obtained when treatment is carried out early in the morning.

Cnaphalocrocis medinalis is a minor pest of padi in Malaysia. The caterpillar lives between the folded leaves and feeds on chlorophyll of the leaves. It can be controlled by hand picking or by dusting with a 5% D.D.T. dust.

The Nymphula depunctalis caterpillar is semi-aquatic living in a tube made of rolled pieces of padi leaf and filled with water. The caterpillar may cause considerable damage to young padi plants by feeding and cutting the leaves. Eggs are laid in masses on padi leaves, and hatch in about three days. Control can be effected by dusting or spraying with B.H.C., or by draining off the water from the affected field for two or three days or by covering the water with a thin film of kerosene, achieving this by applying one or two gallons of kerosene per acre.

(C) **Diseases**

Several diseases of padi are present in Malaysia, some occurring every year in most padi areas, while others are more sporadic and localised. The amount of damage caused by these diseases is difficult to assess. Some such as leaf-spots, cause no obvious decrease in yield although in the aggregate their weakening effect on the plants must result in considerable overall loss. Of the many diseases observed on padi in Malaya only the main ones for which control measures may be necessary are described below.

Brown spot is caused by a fungus (*Helminthosporium oryzae* Breda de Hann) and occurs to a great or lesser extent every year in practically all padi areas. Except when very young seedlings are attacked, plants are not killed by this disease the damage consisting mostly of a decrease in yield due to weakening of the plants. It is mainly a disease of the leaves and occurs most commonly at the nursery stage. It is characterised by small oval spots on the leaves. The spots are initially chocolate brown but later develop lighter brown centres. Attack in the nursery is often severe and leads to dying back of the leaf tips giving the nursery a brownish scorched appearance.

When the seedlings are transplanted the disease usually almost disappears but towards maturity leaf spots may again become common. The disease also infects the grains causing the formation of small oval spots on the glumes and in the case of more severe attack complete blackening of the whole grain.

The severity of the disease can be reduced by improving the nursery husbandry. Wet nurseries should be used as dry nurseries are more susceptible to attack and nurseries on poor soil should be manured as this will increase the resistance to brown spot. Excessive manuring however must be avoided as this increases the susceptibility of the seedling to blast and leaf and sheath rot. Grain which is known to be heavily infected should not be used for planting.

Blast (caused by the *fungus Piricularia oryzae*) is a common disease but only occasionally causes severe damage. When conditions are favourable to the disease nursery seedlings may be killed in large numbers and occasionally serious loss of crop is caused by heavy, although localised, attacks just before harvest.

Blast most commonly occurs as a seedling leaf spot where it appears as large elongated spots pointed at both ends, uniformly brown at first but later developing a light greenish-grey or grey centre. Spores which spread the disease can often be seen as a grey coating on the surface. The tips of affected leaves dry out and die and in severe attacks seedlings may be completely killed.

After transplanting the disease almost or completely disappears but under conditions favourable to the disease it may occur about the time of flowering. Then leaf spots similar to but larger than those found on seedlings may occur, but the most serious damage is caused by stem infections. If attack occurs early the flowering head may dry up and fail to emerge, or it may emerge but have empty ears. In either case when the stem is pulled out of the leaf sheath, brown rotten areas in the stem can be seen. These indicate where the disease has developed. More easily recognised is the broken neck phase of the disease which occurs when the attack is later. The stem is rotted just below the flowering head and breaks so that the whole head hangs down. The grains are as a result thin, light and only partly filled. Control of the disease can be effected by altering husbandry practices to reduce susceptibility to attack. Wet nurseries are less severely affected than dry nurseries as the disease is favoured by dry soil, and well manured nurseries are less severely affected than nurseries which

have received excess nitrogen. Where seedling attack occurs frequently nitrogen manuring of the nursery should, therefore, be reduced. Some padi varieties are less susceptible to blast than others and where necessary those resistant varieties should be used. The most resistant varieties are the following: —

TABLE *V*

Reyong 20	Serendah Puteh	Radin Kuning
Acheh Puteh	Anak Naga	Seri Raja
Subang Intan 117	Morak Sipilai	Padang Trengganu 22
Radin Siak 34	Radin Che Ali	Anak Ikan Gresing
Mayang Sagumpal	Anak Ikan China	Chantek Puteh

Sheath Blight which is caused by the fungus *Rhizoctonia solani*, although widespread occurs sporadically and usually appears only in small patches. Being very dependent on high humidity the disease usually develops in low lying areas, particularly where the water tends to be stagnant. In such places the disease appears year after year and is difficult to eradicate.

The disease begins on the outer leaf sheaths usually in plants which have passed the tillering stage. The fungus causes large irregular spots to appear, dull green at first but becoming light brown as they dry out. As the diseased areas enlarge, the whole leaf sheath is killed and the leaf blade dries up and withers. The fungus then penetrates to the inner leaf-sheaths, killing off the leaves successively until in severe cases the whole tiller dies.

Seedlings are also occasionally attacked by the fungus which causes irregular spots similar to those on older plants on the leaves. Later the whole seedling is killed, the dead seedlings occurring in circular patches. This is particularly liable to occur when the seedlings are making lush growth in a sheltered, humid position.

The fungus of sheath blight appears as small rounded bodies with a roughish surface, white at first but later becoming brown, which are formed on the surface of dead leaf-sheaths usually near water level. These small bodies, called sclerotia, fall off the rotted sheath and help to spread the disease.

Control is difficult as the fungus can live in the soil during the off-season and so reappears in the same place the next season. Generally anything which can be done to reduce the humidity and to prevent water stagnation will reduce the infestation and where severe damage is caused, destruction of the infested plants to remove the sclerotia is advisable.

Stem Rot caused by the fungus *Sclerotium oryzae,* is often difficult to recognise particularly when the attack is slight. If an affected stem is split open the fungus can be seen as a fluffy grey mass filling the hollow centre. The fungus also forms sclerotia — tiny black spherical bodies which occur in the hollow centre of the stem, between the leaf-sheaths or embedded in the tissues of stem or leaf-sheath. The disease does not affect large areas.

Attack begins on the outer leaf-sheath, where black rotten areas are formed. As infection spreads, the sheath dries up and the whole leaf dies. The fungus then penetrates inwards until the stem itself is killed. Affected plants are therefore stunted, with many tillers completely dead, and most of the outer leaves of the remaining tillers dead or dying. Typical of the disease is the production at a very late stage of young tillers at the base of an affected plant, these young green tillers being conspicuous among the dead and rotted old tillers.

Control of this disease, as with sheath-blight, is difficult and depends on reducing the amount of infective material. The diseased plants should be removed, dried and burnt and after harvest thorough burning of the stubble should be undertaken.

The name *penyakit merah* is used to describe a variety of conditions in padi all of which are characterised by stunting of the whole plant and discoloration and dying back of the outer leaves. This condition is widespread, being found in most padi growing areas, and frequently but not necessarily recurring year after year in the same localities.

Symptoms usually appear about two to three months after transplanting. In all cases growth is arrested and affected plants become stunted. Invariably also the outer leaves dry out and die-back from the tips. Before they die the leaves become discoloured—dark purple, red, rusty brown, light orange or yellow, the colour varying with the locality and the variety of padi.

The cause of this condition has not yet been wholly determined but the disease appears to be associated with unfavourable soil conditions and a reduction in the yield losses caused by *penyakit merah* can be effected by the use of correct fertilisers for the locality and by ensuring that water control is effective.

HARVESTING

Padi should be harvested as soon as possible after it is fully ripe, as delays after full ripeness result in a considerable loss of grain due to shattering. The crop can be judged to be fully ripe as soon as the panicle stalk has lost all its greenness. Wherever possible a sickle should be used to harvest the crop, the whole plant being cut and the straw after threshing being used for bedding cattle or for composting.

In some districts, however, due to difficulties in drainage or to the use of mixed seed the crop ripens unevenly and it is necessary to harvest individual heads as they ripen with a *tuai*. This method of harvesting is much slower and more tedious and every effort should be made to obtain even ripening and thus enable a sickle to be used.

STORAGE

After harvesting, threshing and winnowing padi grains need to be dried and the moisture reduced to a safe level before storage. 14% moisture content is usually taken as the safe level and often at harvest the moisture content of the grain is as high as 20%. Thorough drying is, therefore, necessary and the store should be designed to keep the moisture content of the stored grain, as low as possible and at the same time to provide free circulation of air and protection against birds and rats. Many types of padi store are in use and, provided they are sited in a dry place, given adequate protection and permit good air circulation, most are suitable for keeping padi for periods up to one year. If storage is to be for longer periods, special storage facilities designed to give efficient control of all environmental factors are required if quality is to be maintained.

For further information, please write to :—

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