The relative importance of pre-harvest crop pests in Indonesia (NRI Bulletin 47)

Natural Resources Institute

Bulletin 47

THE RELATIVE IMPORTANCE OF PRE-HARVEST CROP PESTS IN INDONESIA

Overseas Development Administration

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Bulletin 47

Published by

NRI

The scientific unit of the
Overseas Development Administration

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Natural Resources Institute
ISBN: 0-85954-295-5
ISSN: 0952-8245

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ACKNOWLEDGEMENTS

The help and advice given by the experts consulted in this study is gratefully acknowledged. A list of the respondents contributing to the ranking of pests is given in Appendix 1. Without the benefit of their knowledge and experience and willingness to devote time to the study this report could not have been written.

The following people in the UK helped by suggesting contacts in Indonesia:

Dr J. Terry, Tropical Weeds Unit, Long Ashton Research Station
Dr S. Eden-Green, Rothamsted Experimental Research Station
Dr J. Waage, CAB International Institute of Biological Control, Ascot
Dr J. R. Wall, Natural Resources Institute
Dr J. Magor, Natural Resources Institute
Dr J. M. Thresh, Natural Resources Institute
Mr A. Hone, Natural Resources Institute
Ms C. O'Reilly, Natural Resources Institute
Dr J. Waller, CAB International Mycological Institute, Kew

In Jakarta, Mrs S. P. Isbagio, Secretary, Agency for Agricultural Research and Development, and her two members of staff, Ms Fatimah and Mr Winarno, helped to arrange some of the appointments in Indonesia. The CAB International Institute of Entomology, London, helped in checking the scientific names of arthropods; Dr N. D. Jago and Dr D. F. Waterhouse contributed to this also. Miss K. S. L. Wilson helped in checking the scientific names of pathogens.

The contribution of all those above to this study is gratefully acknowledged.

Summaries

SUMMARY

This is the third in a series of studies of crop pest importance carried out by the Natural Resources Institute (NRI). The aim of this study was to assess the relative economic importance of crop pests in the agro-climatic zones of Indonesia. The country was divided into four agro-climatic zones defined by length of dry season, the presence or absence of irrigation and altitude. The study provides guidance on the important pests in each zone and on the zones that are important for particular pests.

In each zone, pests were arranged in seven ranks of importance, with an indication of the crops they attacked. Pests were defined as harmful organisms (arthropods, nematodes, pathogens, vertebrate pests, molluscs and weeds).

Pest importance estimates were given by experts. Whilst the majority of experts were research scientists, staff from the Crop Protection Directorates were also interviewed. The relative importance of crops based on production value was calculated for each zone as an important factor in ranking pests across crops.

The ranking estimates of experts were synthesized into ranking lists for each zone across all pests. By converting ranks into scores and weighting these by zonal production values, aggregate weighted scores were generated to analyse the relative importance of pests in Indonesia as a whole. This was done for pests of all crops and for pests of rice.

A comparison was made between the ranking of rice pests in Indonesia with that in the rest of Southeast Asia. The latter was assessed by consulting scientists at the International Rice Research Institute (IRRI) in the Philippines.

The results of the study are presented as tables ranking the pests in each zone, both for all crops in the zone and for each crop separately. Some background information is given on agriculture in each zone.

Rats are the most important pre-harvest pest in Indonesia as a whole. Rats, stemborers, bacterial leaf blight and the brown planthopper are the most important non-weed pests of rice. Besides rats, armyworm (*Spodoptera* spp.), bacterial wilt and root-knot nematodes are the most important non-weed pests attacking a wide range of crops.

The most important weeds are *Imperata cylindrica* in perennial crops and *Echinochloa crusgalli* and *Monochoria vaginalis* in rice.

Some salient features of the pest control strategy are described, including the innovative and successful national project for integrated pest management in rice and secondary food crops.

It is suggested that Indonesian scientists might like to carry out further studies on pest importance in greater depth tailored to national development requirements.

RESUME

Cette étude est la troisième d'une série d'études portant sur l'importance des parasites des cultures exécutée par l'Institut des Ressources Naturelles (NRI). Cette étude avait pour objet d'évaluer l'importance économique relative des parasites des cultures dans les zones agro-climatiques d'Indonésie. Le pays a été divisé en quatre zones agro-climatiques définies par la durée de la saison sèche, la présence ou l'absence d'aménagements d'irrigation et l'altitude. L'étude fournit des conseils quant aux parasites importants dans chaque zone ainsi que sur les zones qui sont importantes du point de vue des parasites particuliers.

Dans chaque zone, les parasites ont été classés selon sept échelons d'importance, avec une indication des cultures affectées. Les parasites ont été définis en tant qu'organismes nuisibles (arthropodes, nématodes, pathogènes, parasites vertébrés, mollusques at mauvaises herbes).

Des estimations de l'importance des parasites ont été fournies par des experts. Tandis que la majorité de ces derniers étaient des chercheurs scientifiques, le personnel des Directorats de la Protection des Cultures a aussi été interrogé. L'importance relative des cultures, se basant sur la valeur de production a été calculée pour chaque zone en tant que facteur prépondérant dans le classement des cultures.

Les estimations de classement des experts ont été synthétisées en listes de classement pour chaque zone pour tous les parasites. Grâce à la conversion des classements en scores et en les pondérant par valeurs de productions zonales, il a été généré des scores pondérés collectifs pour analyser l'importance relative des parasites dans l'Indonésie dans son ensemble. Cette disposition s'est appliquée à tous les parasites de toutes les cultures et les parasites du riz.

Une comparaison a été effectuée entre le classement des parasites du riz en Indonésie et le reste du Sud-Est asiatique. Cette dernière étude a été effectuée par des chercheurs consultants de l'Institut International de Recherche sur le Riz (IRRI) aux Philippines.

Les résultats de l'étude sont présentés sous forme de tableaux, classant les parasites dans chaque zone, aussi bien pour toutes les cultures dans la zone que pour chaque culture individuelle. Des informations générales concernant l'agriculture dans chaque zone sont fournies.

Les rats constituent le parasite le plus important préalablement à la récolte. Les rats, les insectes perforants, les flétrissures bactériennes des feuilles et la sauterelle (esp. *Nilaparvata lugens*) sont les parasites, autres que les mauvaises herbes, les plus fréquents du riz. En dehors des rats, des chenilles légionnaires (esp. *Spodoptera*), du flétrissement bactérien et des nématodes "noeud de racines" sont les parasites les plus importants (autres que les mauvaises herbes) s'attaquant à une large gamme de cultures. Les mauvaises herbes les plus courantes sont *Imperata cylindrica* sur les cultures perpétuelles et *Echinochloa crusgalli* et *Monochoria vaginalis* du riz.

Il est décrit certains traits saillants de la stratégie en matière de lutte contre les parasites, y compris le projet national innovateur et couronné de succès en matière de gestion intégrée des parasites concernant les cultures du riz et les cultures vivrières auxiliaires.

Il est suggéré que les scientifiques Indonésiens pourraient exécuter des études complémentaires plus approfondies concernant l'importance des parasites, études que seraient adaptées aux impératifs nationaux de développement.

RESUMEN

Este es el tercero dentro de una serie de estudios sobre la importancia de las plagas de los cultivos, realizados por el Instituto de Recursos Naturales (NRI). El objetivo de este estudio fue llevar a cabo una evaluación de la relativa importancia económica de las plagas de los cultivos en las distintas zonas agroclimáticas de Indonesia. Para ello, se dividió el país en cuatro zonas agroclimáticas, definidas por la longitud de su temporada seca, la presencia o ausencia de regadío y la altitud. El estudio proporciona orientación sobre plagas de importancia para cada zona y sobre las zonas que son importantes para plagas específicas.

En cada zona, las plagas fueron clasificadas en siete categorías, de acuerdo con su importancia, indicando los cultivos a los que atacaban. Las plagas fueron definidas como organismos nocivos (artrópodos, nematodos, patógenos, plagas de vertebrados, moluscos y malas hierbas).

Los expertos realizaron cálculos sobre la importancia de las plagas. Mientras que la mayor parte de los expertos eran científicos experimentales, se entrevistó también a personal de la Dirección General de Protección de Cultivos. Se calculó para cada zona la importancia relativa de los cultivos sobre la base de su valor de producción, como importante factor en la clasificación de las plagas.

Los cálculos de clasificación de los expertos se sintetizaron en listas para cada zona y para todas las plagas. Mediante la conversión de las categorías en puntuaciones y ponderadas para analizar la importancia relativa de las plagas en toda Indonesia. Esto se hizo para las plagas de todos los cultivos y para plagas del arroz.

Se llevó a cabo una comparación entre la clasificación de las plagas del arroz en Indonesia y las del resto del Sureste Asiático, habiéndose evaluado éstas últimas mediante consulta con científicos del Instituto Internacional de Investigaciones sobre el Arroz (IRRI), ubicado en Filipinas.

Los resultados del estudio se presentan a manera de tablas, en las que se clasifican las plagas de cada zona para todos los cultivos de la zona y para cada cultivo por separado. También se presenta información sobre la agricultura de cada zona.

En general, en Indonesia, la principal plaga con anterioridad a la recolección son las ratas. Las ratas, taladradores del tallo, mancha foliar bacteriana y pulgón son las plagas más importantes del arroz, dejando aparte las malas hierbas. Además de las ratas, la oruga combatiente (*Spodoptera* spp.), el marchitamiento bacteriano y los nematodos de los nódulos radiculares son las más importantes plagas, distintas de las malas hierbas, que atacan a una vasta gama de cultivos. Entre las malas hierbas, poseen especial importancia la *Imperata cylindrica* en cultivos perennes y la *Echinochloa crusgalli* y *Monochoria vaginalis* en el arroz.

Se describen ciertas caracterzaisticas de la estrategia para el control de las plagas, incluyendo el innovativo y satisfactorio proyecto nacional para la gestión integrada de plagas en el arroz y cultivos alimenticios secundarios.

Se sugiere la posibilidad de que científicos indonesios realicen estudios adicionales más profundos sobre la importancia de las plagas, adaptados a los requisitos del desarrolo nacional.

The relative importance of pre-harvest crop pests in Indonesia

INTRODUCTION

The study

This study is the third in a series carried out by the Natural Resources Institute (NRI). The first two studies covered sub-Saharan Africa and South Asia (India, Pakistan, Sri Lanka, Bangladesh and Nepal). This study covers Indonesia, by far the largest country in Southeast Asia both in terms of population and geographical area.

The study assesses the relative importance of pre-harvest crop pests defined in the wide sense of harmful organisms, i.e. arthropods, nematodes, vertebrate pests (rodents, pigs, birds etc), molluscs, pathogens and weeds. For rice pests some comparison is made between Indonesia and the rest of Southeast Asia; weeds are excluded from this comparison.

Indonesia is divided into four agro-climatic zones and non-weed pests are ranked separately for each zone. Ranking is done by both individual crop and for all crops in the zone collectively. Weeds are ranked for groups of crops with no separate assessment by zone. Separate assessments are made of the most important weeds and non-weed pests in Indonesia as a whole.

Objectives and uses

The formal objectives of the study were:

(1) to establish a system of agro-climatic zones reflecting cropping systems in Indonesia;

(2) to rank the main pre-harvest pests in order of importance in each zone, treating weeds separately if necessary;

(3) to indicate the worst pests in Indonesia as a whole and the zones in which they are most important;

(4) to assess the degree of similarity in relative importance of rice pests between the agro-climatic zones of Indonesia and the corresponding zones in the rest of Southeast Asia.

The study should prove useful in planning research as it moves 'downstream' from the basic and strategic to the more applied and adaptable. Where there is a prior interest in a zone, the study will provide guidance on the relative importance of pests in that zone. When there is a prior interest in a pest, it will indicate the zones in which the pest is likely to be important.

The pest rankings for Indonesia as a whole will provide limited guidance for resource allocation on a broader scale. The relative importance of pests is only one of several factors which need to be taken into account in allocating research resources for pest management. Other factors include the gap between current knowledge of suitable control measures and their application by farmers, the prospects for research proving successful and research in progress elsewhere.

The relative importance of pests changes over time in response to many factors (Geddes, 1990). The ranking tables in this report give a current assess-

ment of pest importance. Their validity will decrease over time and they will need to be updated periodically. As a number of years usually elapse between the start of research and its large-scale application in the field, some caution is necessary. Before using the study to make any major decisions about allocation of national research resources, it would be advisable for the appropriate institutions in Indonesia to review the assessments made and then consider any likely future trends.

Pest importance and rank

It is obviously necessary to define what is meant by pest importance in this study. Pests are a problem if they cause crop losses, hence pest importance is defined as economic importance. This also provides a common factor for comparison across all crops and all pests. Economic importance is determined by:

actual losses with existing control measures

the cost of existing control measures

reduction in output due to deviation from the cropping pattern which would have been optimum without pests (substituting less productive crops which are less affected by pests or not growing crops at certain times of the season)

reduction in yield potential of cultivars due to plant breeders having to incorporate pest resistance at the expense of yield, and farmers having to grow more pest resistant but lower-yielding varieties.

Respondents were asked to rank pests for economic importance taking these factors into account. The first two factors are responsible for most of the economic loss and consequently were given more consideration by respondents.

Some pests cause fairly consistent losses from year to year, others are sporadic, causing little or no loss in one year and serious or even devastating losses in other years. For two pests causing the same percentage losses averaged over a number of years, the sporadic one is considered to be the more important. A farmer may take a long time to recover from a bad year or never fully recover, whereas he is likely to find it easier to cope with steady, more predictable, losses.

In each zone pests are placed in one of seven ranks. The first rank indicates highest importance. Pests in any one rank are rated more important than those in the ranks below; the order within the rank has no significance.

Where pests are ranked as a group, or more than one genus or species are listed as a single entry, this indicates that they are ranked collectively; they might not warrant such a high ranking individually.

AGRO-CLIMATIC ZONES

Both the types of crop grown and the climate are important factors in determining the pest situation. As the climate is the principal determinant of the types of crop grown, agro-climatic zones provide a suitable framework for differentiating between pest situations.

A major study of the natural resources of Indonesia has recently been carried out (Directorate General of Settlement Preparation and Natural Resources Institute, 1990). This divides Indonesia into six agro-climatic zones:

sub-montane

montane

seasonally wet

permanently wet

seasonably dry

permanently dry

A simplified version of these were used to provide the framework for the present study.

First of all, Irian Jaya was excluded from the study as little information could be collected about its pests. As there is little cropping in the montane zone outside Irian Jaya, the montane zone was also excluded.

There is not much difference between the cropping patterns of the seasonally and permanently wet zones and the latter covers a relatively small area, so these two zones were amalgamated. The permanently dry zone is very small so this was included with the seasonally dry zone to form a dry zone. As irrigation makes a great difference to the cropping pattern in the dry zone, this zone was divided into dry irrigated and dry unirrigated zones.

The zones are shown on the fold-out map in the centre of the report. This does not distinguish between the sub-montane and montane zones. As the divisions between the irrigated and unirrigated parts of the dry zone are very local, these two zones are also not distinguished.

The zonal definitions are:

sub-montane:	altitude 1000 – 2000 m; most of the zone has a dry season of less than five months
wet:	altitude less than 1000 m; dry season of four months or less
dry unirrigated:	altitude less than 1000 m; dry season of five months or more
dry irrigated:	altitude less than 1000 m; dry season of five months or more, the land is irrigated at some period in the year (some crops may be grown without irrigation).

The sub-montane and wet zones include both irrigated and unirrigated areas. Dry season months are defined as having a mean monthly rainfall of less than 100 mm.

THE RELATIVE IMPORTANCE OF CROPS

Criterion for crop importance

Once the zones were established, the next task was to estimate the relative importance of crops. This was done on the basis of the value of crop production. This is obviously a criterion highly relevant to crop importance, although it suffers from the defect of taking no account of income distribution and gives no extra weighting to losses of poorer farmers.

The relative importance of crops is an important factor in pest importance, being directly related to production losses from pest damage, cost of control measures and loss of yield potential through planting pest resistant crops. However, it may divert attention from the economic loss incurred by farmers in reducing their area of crop attacked and substituting a crop of lower value. For this reason it may result in some underestimation of the importance of the more serious pests.

Calculation of crop importance

Crop prices and production figures were taken from various publications. Details of sources and calculation methods are given in Appendix 2. All figures are for 1987 accept those for production volume of fruits and vegetables, which are for 1988 as 1987 figures were not available. For a few crops, partial data only was available and some estimation procedures had to be used.

Table 1 gives the estimates of production value of each crop and their distribution between zones. Table 2 shows the value of production of each crop as a percentage of the zonal crop production value for each zone. The figures in

Table 2 were an important factor in determining pest ranking by zone across all crops.

The proportion of each crop grown in each zone was estimated. The strength of the grounds for making this estimation varied between crops. For instance, it was fairly clear that many of the major perennial estate crops such as rubber only grew in the wet zone. Some data from a study carried out by the International Rice Research Institute (IRRI) (Tuke, 1982) gave a good basis for estimating the distribution of rice between zones (Table 3). A study made by a Dutch supported project (Buurma *et al.*, 1989) gave an excellent basis for the distribution of vegetables between the sub-montane and the lower altitude zones. It was also quite easy to allocate vegetables between the wet, dry unirrigated and dry irrigated zones on the basis of their agronomic requirements.

Estimates of the ranking order of importance of crops in each zone were made by various respondents and these estimates were helpful in making final decisions on crop distribution.

Nevertheless the basis for allocating crop value between zones was weak for a number of crops, particularly citrus, banana and pineapple. This weakness reduces the reliability of the tables of pest ranking by zone (Tables 6-9). These tables are less reliable than those of pest ranking by crop.

From Buurma *et al.* (1989), it is clear that many vegetables normally considered as highland are grown extensively down to about 700 m. This altitude would have made a boundary for the sub-montane zone which fitted the differences in cropping pattern rather better. However, the 1000 m boundary is maintained, as many respondents had made pest rankings using the 1000 m zone boundary. Further reasons are that a 700 m boundary would have departed from the classification given in Directorate General of Settlement Preparation and Natural Resources Institute (1990) and in addition no map of Indonesia is available with the 700 m contour marked.

METHODOLOGY FOR ASSESSING RELATIVE IMPORTANCE OF PESTS

Consultation with experts at IRRI

On the way to Indonesia a short visit was made to IRRI to consult scientists about the pest situation in both Indonesia and the rest of Southeast Asia (see Appendix 1). Various useful references were also obtained.

Consultation with experts in Indonesia

Most of the information for the study was obtained during a visit to Indonesia lasting just over three weeks. Appendix 1 lists the institutions and persons consulted.

Before embarking on the tour, letters were written to appropriate institutions to inform them of the study and to arrange the programme of visits. During the tour discussions were held with as many well-informed and experienced people as possible to elicit their estimates of the relative importance of pests in each zone. They would first be reminded of the climatic conditions of the zone and informed of the relative importance of crops on the basis of production values in each zone. They were asked to base their ranking on the experience of the last five years. With a changing pest situation a longer period would give too much weight to outdated history, whereas a shorter period would not give proper consideration to sporadic pests.

Discussions were particularly useful with panels of three or more specialists in different disciplines who could make estimates across all pests considered together. Some respondents, such as weed experts, gave information on one class of pest only.

No institution had responsibility across all crops and virtually all respondents were only prepared to rank pests for each crop that they studied separately. This meant that no respondents were able to rank pests across all crops in any zone, so the syntheses of zonal pest ranking given in Tables 6-9 had to be done by the author, relying a great deal on the estimates of relative importance of crops.

Postal inquiries

Before leaving Indonesia, letters were written to nine institutions requesting them to make pest rankings for the crops for which they were responsible. Replies were received from seven of them as indicated at the end of Appendix 1, and these provided important additional information to that collected from the institutions and individuals visited. No reply was received from Solok Research Institute for Horticulture, which has the national mandate for fruit crop research, with the result that pest ranking for fruit relied on information from one institution (the Directorate of Production Development for Horticulture) and was not supported by additional information from another institution, as was the case for vegetables. One result of this is that more detailed information was gathered on vegetables and more pests are listed for vegetables than for fruit.

Seminar

When most of the analysis of pest ranking had been done a seminar was held at NRI and the results were presented. Relevant staff from the NRI were invited, plus a few from other institutions who had given guidance on whom to visit in Indonesia. Some useful discussions were held and a few corrections to scientific names of pests were provided.

Literature study

Literature studied as an additional source of information is listed in the Bibliography. Most of this was collected during the tour. Whilst this provided useful background information and in some cases confirmation or clarification of the identity of species mentioned by informants, it was little direct help in ranking pests. Relative importance of pests is hardly ever mentioned in the literature which rarely goes beyond a few instances of lists of a number of major pests with no attempt at distinguishing their relative importance.

CROP AGRICULTURE IN INDONESIA

Rainfall and altitude

The agroclimate zones used in this study are defined according to the length of dry season and altitude and are described on page 4. Most of the wet zone (dry season of less than five months) has an annual rainfall of 2000-4000 mm. The west coast of Sumatra and the highlands of Sumatra and Java are the wettest areas. However, there are rain shadow areas with reduced rainfall intensity in some of the northern and central highland valleys of Sumatra. The major part of these valleys are in the wet zone as they lie below 1000 m altitude and experience no reduction in rainy days.

Most of the sub-montane zone (altitude >1000 m) has a rainfall of over 3000 mm. Annual rainfall in the dry zone (dry season of more than four months) is mostly 1000-2000 mm, but in a few areas, such as parts of the island of Sumba, it falls below 500 mm.

Population and farm size

The population of Indonesia in 1991 was 186 million; 60% of these were in Java. Table 4 lists population density by island (and island group) and shows the very high population density of Java compared with the other islands.

To relieve the ever-growing pressure on land in Java the Government has been supporting a transmigration policy of settling people from Java in agricultural communities on the other islands.

Soerjani *et al.* (1986) give the mean farm size for the whole of Indonesia as slightly less than 1 ha, with the largest mean farm size (5 ha) found in Kalimantan. No date is given for this data and it is not clear whether estates are included. Scholz (1983) reports the mean size of smallholding in Sumatra to be 1.4 ha. No date is given for the data but it is probably 1982. No other data on farm size was found during this study.

Agricultural land use systems

There are three major types of land use:

Wetland cultivation: production of annual crops on wetland. This is found in both the wet and dry zones. Rice production predominates but other crops are also grown, particularly in the dry season.

Dryland cultivation of annual crops: this can be continuous or interspersed with fallow periods.

Perennial crop cultivation on both estates and smallholdings.

Table 3 shows the distribution of rice between zones and ecosystems in the first two land use systems.

Wetland cultivation

Three main rice ecosystems are distinguished in wetland farming: irrigated, rainfed (shallow and immediate) and deep water (see Table 3).

Almost two-thirds of the rice area is irrigated. Nearly all the systems are gravity fed. Many of them were constructed by village self-help groups, some several hundred years ago: others have been provided with different standards of technical equipment by the government. In irrigated cultivation rice is usually transplanted into puddled fields and increasingly two rice crops are obtained in each year. Irrigated cultivation is found in both the wet and dry irrigated zones. In the latter zone vegetables are often grown as the dry season irrigated crop, particularly near large towns.

Sugar cane is the second most important irrigated crop. A single crop lasting 16 months may be grown in rotation with rice and other annual crops, or the sugar cane crop may be ratooned for several generations. It is grown mostly, but not exclusively, by smallholders. Java and Lampung, the southernmost province of Sumatra, are the principal sugar cane growing areas. As rice production has expanded it has pushed sugar cane on to more marginal land and even into dryland cultivation.

In rainfed rice cultivation fields are bunded, but flooding occurs through rainfall rather than irrigation. In other respects cultivation methods are the same as in irrigated fields. As transplanting has to await sufficient rainfall to flood the fields, only one rice crop a year is grown under rainfed conditions. If there is adequate rainfall after harvesting the rice crop, secondary food crops, vegetables or other arable crops, are grown as a second crop.

Most of the deepwater rice cultivation is in Sumatra and Kalimantan. Three types of deepwater rice ecosystem can be distinguished: tidal swamps, permanently flooded non-tidal coastal swamps, and seasonally flooded swamps *(lebaks)* either side of river levees.

Tidal swamps are irrigated by river water backed up by the flood tide. The water is led to the fields by main canals dug perpendicular to the river with secondary canals leading off the main canal parallel to the river. A single long season rice crop is cultivated, and the first nursery is planted at the beginning of the rainy season in October/November. Seedlings are transplanted up to three

times to allow the final transplantation into deep water. Tidal swamp cultivation is being increased through transmigration projects.

In the permanently flooded non-tidal swamps the water rises so much during the rainy season that floating rice has to be planted. This grows fast enough to match the rate of rise of the flood water. Harvesting is done from canoes.

Most of the seasonally flooded swamps either side of the river levees occur along the middle courses of the big eastern rivers in Sumatra. *Lebaks* are flooded up to a depth of 3 m from October to April. The water level falls from May to July and the fields dry up in August and September. The depth of water in the *lebak* is greatest closest to the river levee. Seed is sown in nurseries in April and seedlings are transplanted in May and June as the water level falls. Seedlings destined for later planting in the deeper part of the *lebak* are transplanted twice to enable them to grow taller. Weeding in the shallower *lebak* transplanted first is done two to three times, whilst no weeding is carried out in the deepest *lebak* where the deep water suppresses weed development.

Dryland cultivation of annual crops

Dryland cultivation of annual crops is carried out primarily in the wet, sub-montane and dry unirrigated zones. Rice is usually the most important crop but is not nearly so dominant as in wetland cultivation. Dryland rice cultivation relies on rainfall but the fields do not flood and the rice is direct sown rather than transplanted. Dryland rice may be grown as part of an intercrop with other annual food crops. Nearly all the dryland farming in Java is cropped every year and some fields may include permanent tree crops. Soil erosion is a serious problem on the steeper slopes with high rainfall in Java, and is common at higher elevations, particularly in the sub-montane zone. In the less densely populated islands such as Kalimantan and parts of Sumatra and Sulawesi, shifting cultivation is quite common, particularly amongst the indigenous population.

Perennial crop cultivation

The location of the most important areas of production of the main perennial crops is given in Table 5.

As can be seen in Table 2 most of the perennial crop cultivation is in the wet zone. However, coffee, tea, banana, apple and clove are found in the sub-montane zone and mango, banana, coconut, citrus, cashew, kapok and avocado in the dry unirrigated zone. Rubber, coffee and oil palm are the most important export crops, followed by pepper and tea. Although many of these crops are called estate crops, they are by no means exclusive to estates. About 80% of the rubber and virtually all coconut, clove, coffee and pepper are grown on smallholdings. Standards of husbandry, levels of input use and yields tend to be lower on smallholdings than on estates. A programme of nucleus estate smallholdings with a 'plasm' area of smallholdings supported by a 'nucleus' estate has been introduced to improve production from smallholdings.

The largest concentration of estate crops, particularly rubber and oil palm, is in the 'estate belt' of North Sumatra Province, lying northeast of the 150 m contour and extending almost to the sea.

NON-WEED PEST RANKING BY CROP AND ZONE

Tables 6-9 show pest ranking by zone across all crops. This ranking is derived from the single crop rankings in Tables 10-50.

Pests are ranked by crop and zone in Tables 10-50. These rankings are the author's synthesis of those made by the various respondents. Nearly all the rankings made by respondents referred to one crop rather than a group of crops; separate rankings were usually made for each zone in which the crop is grown.

These rankings were combined into zonal rankings taking account of the relative importance of crops in each zone. Account was also taken of qualitative information on the level of crop loss. For instance, it was clear that crop losses from pests in, say, vegetables, were much higher than in rice. There were also certain pests such as Sumatra disease of cloves and citrus greening, known to be particularly destructive. Obviously pests which were important in several important crops in the zone were given a high ranking. In all zones rice is the dominant crop, so rice pests tend to dominate the rankings.

Rats are the leading pest in all zones except the sub-montane and *Rattus argentiventer*, the swamp rat, is the most important species of rat. Rats are the major pest of rice.

As indicated in Tables 44, 45, 47 and 48 no information was obtained on the differences between zones in pest ranking for citrus, bananas, pineapple and pawpaw. The zonal rankings (Tables 6-9) for these crops were made on the assumption that there was no difference between zones which was unlikely to have been entirely correct.

Tea was assumed to be grown only in the sub-montane zone, i.e. above 1000 m. There was some uncertainty as to whether it is in fact grown down to a lower altitude and some tea pests may be found in the wet zone.

The importance of cloves and tobacco and their pests is assessed from the point of view of farmers. Nearly all the clove output is used in the making of 'Kretek' cigarettes. Account should be taken of the harmful effect on smokers' health and this would greatly reduce the importance of clove and tobacco pests. However, striking the correct balance would require investigations into the field of public health outside the scope of this study and so the health factor was excluded from the rankings.

Potato is included as a crop attacked by bacterial wilt *(Pseudomonas solanacearum)* in the wet zone as it is considered that this pest is an important factor preventing potatoes being grown more extensively in this zone. For vegetables in general insect pests are worse in the dry season and diseases are worse in the wet season.

Throughout the study fungi are usually given the scientific name of the imperfect state, e.g. for brown spot of rice, *Drechslera oryzae* is given rather than *Cochliobolus miyabeanus*. The author has endeavoured to use the latest preferred scientific names, e.g. *Scirpophaga* rather than *Tryporyza*. Wood (1989) is a useful guide to the preferred scientific names of the more common arthropod pests, but as time goes by later editions will need to be consulted.

Species names are those provided by respondents. During the study some warnings were given that occasionally incorrect identification of species has been found to occur in Indonesia, so mistakes in the species given in the lists cannot be ruled out. There is some tendency to label disease organisms as causal before they have been proven to be such, and should therefore still be referred to as 'associated' likely causes. *Cercospora* sp. occurs more than once as a pest attacking different crops in some tables. It was not always clear whether different species were involved. *Agromyza* sp. and *Ophiomyia phaseoli* sometimes occur in the same table, described as bean fly. There is some possibility of confusion due to the renaming of *Agromyza phaseoli* as *Ophiomyia phaseoli* and the two pests listed may in fact both be *Ophiomyia phaseoli*. *Fusarium oxysporum* also sometimes occurs more than once in the same table, attacking different crops. In this case the pests are assumed to be different *forma speciales*.

With only four zones, each zone covers a wide geographical area and is spread across the many islands which constitute Indonesia. The tables of crop importance do not show any geographical distribution of crops within the zone. Clearly in the parts of the zone where there is a greater concentration of the crop its pests will be ranked higher than their ranking in the zone as a whole.

THE RELATIVE IMPORTANCE OF NON-WEED PESTS IN INDONESIA

Non-weed pests are ranked for the whole of Indonesia in Table 51. Ranking is done by a system of aggregate weighted scores. The ranks in Tables 6-9 are converted into intermediate scores which are then weighted by the value of total crop production in the zone in million million (10^{12}) rupiah (from Table 2) and then aggregated to give final scores. The intermediate scores are the reverse of the ranking, i.e.:

Rank	Score
1	7
2	6
3	5
4	4
5	3
6	2
7	1

Less important pests with scores below 40 are excluded from Table 51.

This system of synthesizing the zonal rankings is inevitably crude. It assumes that the same relationship between ranks exists in each zone and that this relationship is represented by the scoring system chosen. The system is considered to be valid for large differences in final score which will reflect real differences in economic importance. It will not be suitable for finer differentiation.

Rats are the most important pest in Indonesia, followed by the three other main pests of rice: stemborers, bacterial leaf blight and brown planthopper. In addition to rats, armyworm (*Spodoptera* spp.), bacterial wilt and root-knot nematodes are outstanding pests attacking a wide range of crops.

It is interesting to compare the ranking of rice pests in Table 52 with the rice pest ranking which can be obtained from Table 51. As explained below, the ranking in Table 52 is obtained by scoring the tables of relative importance of rice pests by zone (Tables 10-13). As Table 52 ranking is derived more directly from Tables 10-13 than Table 51, it is a more reliable guide to the relative importance of rice pests in Indonesia as a whole.

This comparison of consistency is shown in Table 53. The two methods of scoring give a broadly similar assessment of relative importance. Nevertheless in Table 51 rice blast is ranked rather too high in relation to other rice pests and sheath blight rather too low, and this illustrates that only large differences in score are a reliable guide to relative economic importance. However both scoring systems group the pest rankings in the same way as indicated by double spacing in Table 53.

As Table 51 also shows the rankings by zone it indicates the zones in which each pest is most important.

THE RELATIVE IMPORTANCE OF NON-WEED RICE PESTS IN INDONESIA COMPARED WITH SOUTHEAST ASIA

Table 52 shows the relative importance of non-weed rice pests in Indonesia as a whole. This table is a synthesis of Tables 10-13 which rank rice pests separately for each zone. The ranks in Tables 10-13 are converted into intermediate scores which are then weighted by the percentage of the national rice crop in each zone and aggregated to give the final scores which determine the ranking.

Rats are the clear leader amongst rice pests as is readily acknowledged in Indonesia. The position of bacterial leaf blight, occupying third place, was

unexpectedly high, as little attention is paid to it in the literature on pests in Indonesia.

With this system of scoring only fairly large differences of score can be taken to indicate differences of importance. The pests in Table 52 have been divided into different groups by double spacing on the basis of relatively large differences in scores between the lowest scorer in one group and the highest scorer in the group below. These groups represent a tentative overall ranking of rice pests in Indonesia.

Table 54 is a rice pest ranking for Southeast Asia synthesized from rankings given by staff at IRRI. The main difference between this ranking for Southeast Asia and that for Indonesia (Table 52) is the higher position of bacterial leaf blight and narrow brown leaf spot in Indonesia and the lower position of brown spot. Three pests of the rest of Southeast Asia, hispa, golden apple snail and the *Ditylenchus angustus* nematode, causing ufra disease, are unknown or unimportant in Indonesia.

The golden apple snail is now the most important rice pest in the Philippines and is also serious in Taiwan and southern Japan. Ufra disease is mainly a problem in deepwater rice. Yellow dwarf virus disease does not warrant a ranking in Southeast Asia, but it has some importance in Thailand. Recently bacterial red stripe has been a problem in Vietnam, and in Thailand brown planthopper and stemborer have caused extensive damage. Stemborers in Thailand have been serious pests of deepwater rice.

China is not included in this definition of Southeast Asia, but rice blast is particularly important there and may rank as the worst rice pest.

THE RELATIVE IMPORTANCE OF WEEDS

Tables 55 to 64 give the relative importance of weeds in Indonesia. Since irrigation is such a major factor in the determination of weed species, weed ranking is done by ecosystem in some of the tables (i.e. 55-58, 63). In Tables 59, 60 and 62 insufficient information was obtained to differentiate between zones or ecosystems for the crops covered. Table 64 is a summary table synthesizing the rankings of the preceding tables to pick out the worst weeds and put them in two ranks. *Imperata cylindrica, Echinochloa crusgalli* and *Monochoria vaginalis* stand out as the most important weeds.

Imperata cylindrica is a noxious weed of dryland crops, particularly of perennial estate crops. It infests much of the extensive uncultivated land available and it adds to the problems and costs of bringing such land under cultivation. As well as competing with crops *Imperata cylindrica* is a fire hazard. It is possible to control it by chemicals and by planting cover crops in strips to smother it.

Echinochloa crusgalli and *Monochoria vaginalis* are both weeds of irrigated and rainfed rice; they thrive in flooded fields. They owe their importance to the dominating position of flooded rice cultivation amongst Indonesian crops.

PAST AND POSSIBLE FUTURE TRENDS IN PEST IMPORTANCE

Attention was drawn above to the need to consider probable future trends in pest importance. Forecasting is obviously difficult and little consideration of trends was possible in the time available for the study. However some tentative comments on trends for a few pests are possible.

Since 1985 there has been much less tungro virus attack. There were a number of outbreaks from 1969-85 with the worst in South Sulawesi in 1972-75. The use of resistant varieties has probably contributed most to control of the

virus. If IRRI is successful in its programme of breeding new varieties which are resistant to the virus as well as the vector, the importance of tungro virus is likely to decline further. The constraint to breeding for high yield imposed by the need to incorporate tungro resistance is likely to be the main economic cost of the pest. Tungro, however, is a sporadic disease and the risk of major outbreaks occurring is unlikely to be eliminated entirely.

Recent major outbreaks of rice stemborer have been of *Scirpophaga innotata*, the white stemborer. This was the main stemborer reported in colonial times (pre-1942), but later and up until 1989, the yellow stemborer (*Scirpophaga incertulas*) was more abundant.

Both rice stemborers and the brown planthopper are considered to be pests which have been made worse by over-use of insecticides. With the adoption of integrated pest management as national policy in November 1986, the phasing out of pesticide subsidies and the reduction of insecticide use, both rice stemborers and the brown planthopper are likely to reduce in importance. Ragged stunt and grassy stunt, the two virus diseases transmitted by the brown planthopper, should decline in importance as brown planthopper declines. These two viruses are already minor pests. There is a possibility that resistance to rice stemborer may be obtained from wild rice by IRRI. If this were to happen stemborer might be further reduced in importance.

Sheath blight is a rice pest which might become more important. No resistance to it is available and intensification of production with higher applications of nitrogen make it worse.

IRRI will attempt to develop a new generation of higher yielding rice varieties designed to be direct seeded rather than transplanted. If this is done weed control will be more difficult and weeds in irrigated and rainfed rice are likely to increase in importance.

Recent developments in horticultural production may result in some pests declining in importance. The programme of production and distribution of disease-free planting material may reduce the importance of diseases of citrus. The introduction of the parasite *Diadegma eucerophaga* may reduce *Plutella xylostella*, the diamond-back moth, which causes so much damage to cabbage. The development of resistant varieties of chilli may reduce the importance of chilli virus diseases. The production and distribution of virus-free potato seed may reduce potato leaf roll virus, potato virus Y and other potato viruses.

Root-knot nematodes are already a very important pest (see Table 51). Continuing population increase may encourage the more frequent growing of vegetables and reduce fallows (where used) and this may further increase the importance of root-knot nematodes.

The type of Sigatoka disease present in most of Indonesia is *Mycosphaerella musicola* (Stover and Simmonds, 1987). If the much more damaging disease, black sigatoka (*Mycosphaerella fijiensis* var. *difformis*), spreads through Indonesia it would be a serious pest. Either *Mycosphaerella fijiensis* or M. *fijiensis* var. *difformis* is already present in Papua New Guinea and the Philippines and Stover and Simmonds (1987) mention that its likely origin is the New Guinea – Solomon Islands area from whence it probably reached some of the adjacent Indonesian islands.

There are two weeds of estate crops which are becoming more important due to the increasing use of the herbicide glyphosate. They are *Borreria alata* and *Paspalum conjugatum*. Glyphosate tends to be used at rates which are too low to control these weeds.

SOME SALIENT FEATURES OF THE PEST CONTROL STRATEGY

Rice pests

Rats

Most farmers are well aware that rats do considerable damage to rice and some action is usually taken to control them. This is most effective when it is organized on a community basis; if a farmer takes action on his own his efforts will be negated by rats invading from the surrounding farms. Lack of community action and failure to act until infestation is severe are the most common weaknesses in farmers' control.

Rats live in burrows and dense vegetation in the bunds of irrigated rice fields and the land surrounding them. Cutting and burning weeds will discourage rats from colonizing these areas so densely. When food is scarce in the early stages of rice growth rats may migrate to the homestead areas.

The rat population can be reduced by physical destruction of both the burrows and any rats encountered. This is best done between harvest and land preparation by communal parties of neighbouring farmers and their dogs.

Poison baiting is effective during any period except that of rice ripening. Blood anti-coagulants are more effective than acute poisons but farmers tend to prefer the latter as they can see the evidence of dead rat corpses. Rats killed by anti-coagulants usually die unseen in their burrows and other harbourages.

Once the grain begins to ripen rats cannot be tempted by baits as rice grains are their preferred food. During this period they raise litters in their burrows. Fumigation of the burrows at the ripening stage is important to stop the rat population increasing. It is done by burning rice straw with sulphur crystals in a home-made fumigator and blowing the smoke into the burrows.

Control is most effective if it is accompanied by an ongoing study of the local rat behaviour and habitat. Cost-effectiveness will be increased by taking the most intensive control measures in the areas of greatest rat concentration.

Brown planthopper

This pest became a serious problem in the early 1970s as a result of the introduction of the first generation of high yielding varieties and the intensification of rice production. Varieties of rice resistant to the pest were first introduced in 1975. Their resistance soon became ineffective due to changes in the characteristics of the brown planthopper population. With the help of IRRI new varieties resistant to the new population were introduced. The earlier pest population was termed biotype 1 and the later one biotype 2. Subsequently a third virulent population developed in North Sumatra and a variety resistant to this population, PB56*, was introduced to control it. Further varieties resistant to virulent populations, including some Indonesian varieties, are now available.

The recent reduction in the use of insecticide as a result of phasing out the pesticide subsidies and the introduction of integrated pest management (IPM) has improved the control of brown planthopper still further.

Tungro

Tungro virus disease became a major problem in the late 1960s. In the 1970s it was particularly serious in South Sulawesi and the most comprehensive measures to control it have been taken in that province. Varieties resistant to the

*IR56, bred by IRRI, renamed. The term biotype for these populations is criticized in Claridge and Den Hollander (1980, 1982).

vector, the green leafhopper, were introduced in about 1975. Most of these varieties were also resistant to brown planthopper. As in the case of brown planthopper it was found that there were populations of green leafhopper showing different virulence patterns to rice varieties initially resistant to the insect, and the rice varieties varied in the green leafhopper populations to which they were resistant.

In 1982 the Maros Research Institute for Food Crops grouped the available improved varieties according to the green leafhopper populations to which they were resistant and recommended that only varieties from the same group should be grown in the same season. In the following season varieties from a different group should be grown. This recommendation of 'gene rotation' was quickly adopted by the authorities in South Sulawesi and farmers were made to follow the system on a large scale from 1983. Maros Research Institute, the Maros Food Crop Protection Centre, the local university, the extension service and the local government co-operate in recommending the varieties to be grown in different localities and in persuading the farmers to implement the scheme.

The statistics* for the area attacked by tungro in South Sulawesi were examined to determine if the gene rotation policy had been effective. No conclusion could be drawn as it was found that an analysis of national statistics† for area and intensity of pest attack for Indonesia as a whole gave such low estimates of percentage yield loss that the data on area attacked could not be accepted without further investigation.

Some attempt has been made to introduce gene rotation in other parts of Indonesia but the system has not been adopted to nearly the same degree as in South Sulawesi and the neighbouring province of Central Sulawesi.

Synchronized planting at recommended times is another measure promoted to control green leafhopper and other pests in South Sulawesi and to some extent elsewhere in Indonesia. It has the disadvantage of increasing labour bottlenecks and creating sharper peaks in the demand for marketing services.

Integrated pest management

Until 1987 the Indonesian government promoted the use of pesticides in the belief that they were necessary to achieve high yields of most crops. Even where studies showed negative returns to insecticides, they were recommended as an insurance against potential pest outbreaks. As well as being important components in agricultural extension 'packages', pesticide use was encouraged by 85% subsidies and aggressive marketing by chemical companies. Large quantities of pesticide were used by farmers particularly on rice and vegetables.

Attention focussed on the brown planthopper, which became a serious pest in the 1970s. Although it was brought under control by the introduction of new varieties, new outbreaks occurred each time their resistance broke down and they had to be replaced (see above). The outbreaks of the early 1980s caused more attention to be paid to the results of research which had begun in 1977 and showed that regular heavy doses of insecticide increased the brown planthopper population rather than reduced it. Under natural conditions the insect was kept under good biological control in most fields by indigenous predators. Only when these predators were killed by unnecessary insecticide treatments did brown planthopper escape natural control and become a serious pest.

Following up this research, pilot IPM programmes were started and in 1986 1600 farmers and 300 extension workers were trained*. The performance of the trained farmers was monitored in the field: they used less than half the number of insecticide applications and still achieved a small increase in rice yield.

*Table 7 in a report produced by the Maros Food Crop Protection Centre circa 1990 (personal communication from Head of the Centre).
†Food Crops Statistics Division, Ed. (1986, 1987, 1988).

Encouraged by these results the government made a dramatic change in policy. In November 1986 Presidential Instruction 3 of 1986 (Inpres3/1986) declared IPM the national pest control strategy for rice. The Instruction declared that:

- the type of insecticides used and the method of application must take into account the protection of natural enemies of the brown planthopper and other insect pests of rice;
- the development of insect resistance to insecticides must be avoided through insecticide resistance management;
- insecticides are to be used only if other control methods are not effective, and then in a judicious way.

To achieve these goals, the decree further stated:

- the knowledge and skills of crop protection field personnel should be improved;
- results of field observations by these personnel should determine pest management recommendations to farmers;
- agricultural extension officers should provide information for farmers based on directives laid down by crop protection field personnel in such a way that farmers are aware of, and are willing to and capable of, practising correct pest control;
- agricultural extension officers, farmer groups, and farmers are to be trained to increase their skills.

At the same time 57 broad-spectrum insecticides, of which about 20 were widely used, were banned for use on rice. Subsequently the 85% insecticide subsidy was phased out and by January 1989 had been removed completely.

With support from the Food and Agriculture Organization (FAO), the pilot IPM project was expanded into a major programme for training in IPM of rice pests. Since 1989 the range has been widened to include other arable food crops (*palawija* crops) as well. This national programme 'Training and development of integrated pest management in rice-based cropping systems' is impressive. It trains pest observers, extension workers and farmers. By November 1990 100 000 farmers had been trained; the target is to train nearly 2.5 million farmers by 1994, a quarter of Indonesia's food crop farmers. With one in four farmers trained, it is hoped that IPM will become the dominant crop protection practice in food crops in Indonesia. It remains to be seen whether the quality of training can be maintained during such a major expansion. The project staff seem very confident that it can and so far evaluation reports have been very favourable (Pontius, 1990).

The project has a standard training process with basic content and methodology similar for all levels, whether extension staff or farmers. Thus trainers train trainees in the same way as they were themselves trained. Nearly all training takes place in a field of growing crop designated a 'field school'. All learning activities take place in the field or are based on what is happening in the field. Training lasts the entire growing season of the crop. It is focussed on the analysis of the agro-ecosystem of the field to give farmers an insight into the ecological interactions. This includes closely examining plants, then drawing them and their insect population.

Other key features of the training are:

growing a healthy crop, i.e. good agronomy rather than just a narrow focus on insect pests;

dialogue and learning by discovery;

empowering farmers as farm level IPM experts in order to ensure sustainability at the village level and promote horizontal spread – every learner a teacher. To quote from Pontius (1990)

"Empowering farmers as a principle of the project gives direction to the project in terms of both content and process. Content includes, besides the technical information, skills relevant to decision making. Training process focusses on active learning that treats participants as fellow humans with the expectation that learners will be teachers. Thus farmers are not patronized by training nor are they placed in a dependency relationship in which they need others to provide the information required for basic farm level decisions. The project is providing the skills to farmers that will make them self-reliant farm level IPM experts."

FUTURE WORK

Revision and updating of this study

This study could be further refined by obtaining ranking assessments from a wider range of experienced informants. Accordingly reactions to this *Bulletin* are invited; a format for suggesting changes to the rankings is included as Appendix 3. Such changes could either be suggested because the original assessment is considered incorrect or because a change in the actual pest situation has occurred.

If enough revisions accumulate to warrant it a revised edition of the bulletin will be issued. Until that time any readers who wish to update the Bulletin can write to the Head of Pest and Vector Economics Section, NRI, for any ranking revisions made.

Possible further studies

Indonesia

This study had a wide scope and was carried out in a short time. Indonesian scientists may wish to pursue the study in greater depth in a manner related to their national concerns. Selected respondents could be asked to review research in various fields before making rankings and the study directors could carry out a general literature review. After some initial analysis of rankings, respondents could be given the chance to resolve major differences of judgement and an attempt made to get a closer consensus before making the final synthesis. A greater number of zones could be used and the pest situation could be related more directly to different farming systems and classes of farmer and to control measures and their effectiveness. More attempt could be made to investigate how and why the pest situation has been changing and to predict future trends.

If sufficient resources cannot be devoted to such a comprehensive study, a more modest approach would be to improve the estimates of relative importance of crops by zone (Table 2) and then adjust the pest ranking by zone (Tables 10-50) in the light of any revisions to Table 2, still using the same estimates of relative importance of pests by crop (Tables 10-50). The estimates in Table 2 might be improved by searching for better data on crop price in the cases where there was uncertainty (Appendix 2) and by reviewing the assumptions made about distribution of crops between zones. The latter could be estimated better if organizations with cartographic facilities such as Badan Koordinasi Survey Dan Pemetaam Nasional (BAKOSURTANAL) helped to assign districts or sub-districts to agro-climatic zones, allowing district (or sub-district) crop production data to be aggregated by zone.

Regional

It is the intention that the Natural Resources Institute extends this series of studies to South America.

Table 1 Estimated value* of production of each crop and its assumed distribution between zones

Crop	Production value (billion (10^9) rupiah)	Percentage distribution of crop value between zones			
		Wet	Sub-montane	Dry unirrigated	Dry irrigated
Rice (unhusked)	9819	61	5	7	27
Cassava	1120	75		25	
Maize	944	30	10	50	10
Coffee	868	65	35		
Rubber	793	100			
Soyabean	714	30	10	50	10
Coconut	701	80		20	
Sugar cane	661	15			85
Groundnut	586	40	10	45	10
Banana	535	50	15	35	
Clove	505	93	7		
Chilli	501	20	5	55	20
Oil palm	446	100			
Citrus	405	33.3	33.3	33.3	
Shallot	371	46	7		47
Tobacco	363	10		90	
Mango	309			100	
Pepper	302	100			
Garlic	269		19		81
Durian	269	100			
Mung bean	259	20	5	70	10
Sweet potato	217	55	15	20	10
Cabbage and Chinese cabbage	215	29	43		28
Tea	144		100		
Potato	139		45		55
Rambutan	132	100			
Guava	119	100			
Yardlong bean and cowpea	106	28	2		70
Nutmeg	92	100			
Cucumber	86		1		99
Pineapple	83	33.3	33.3	33.3	
Pawpaw	80	90		10	
Salak	67	100			
Tomato	61		19		81
Apple	58		100		
French, snap and kidney bean	56		20		80
Cassiavera	56		100		
Cashew	48			100	
Cocoa	39	100			
Carrot	30	35	30		35
Avocado	29	33.3	33.3	33.3	
Eggplant	27		4		96
Cotton	19			100	
Kapok	14			100	
Sago	?	100			

*1988 production volume for fruit and vegetables; 1987 production volume for other crops; 1987 prices for all crops.

Table 2 Relative importance of crops in the sub-montane, wet, dry irrigated and dry unirrigated zones : value* of crop production as a percentage of zonal crop production

Crop	%	Crop	%
Sub-montane zone		**Wet zone**	
Rice	25.9	Rice	47.5
Coffee	16.0	Cassava	6.7
Tea	7.6	Rubber	6.3
Citrus	7.1	Coffee	4.5
Maize	5.0	Coconut	4.5
Cabbage and Chinese cabbage	4.9	Clove	3.7
Banana	4.2	Oil palm	3.5
Soyabean	3.8	Pepper	2.4
Potato	3.3	Maize	2.3
Groundnut	3.1	Durian	2.1
Apple	3.1	Banana	2.1
Cassiavera	2.9	Groundnut	1.9
Garlic	2.7	Soyabean	1.7
Clove	1.8	Shallot	1.4
Sweet potato	1.7	Citrus	1.1
Pineapple	1.5	Rambutan	1.0
Shallot	1.4	Sweet potato	1.0
Chilli	1.3	Guava	1.0
Mung bean	0.7	Chilli	0.8
Tomato	0.6	Sugar cane	0.8
French, snap and kidney bean	0.6	Nutmeg	0.7
Avocado	0.5	Pawpaw	0.6
Carrot	0.5	Salak	0.5
		Cabbage and Chinese cabbage	0.5
		Mung bean	0.4
		Cocoa	0.3
		Tobacco	0.3
		Yardlong bean and cowpea	0.2
		Pineapple	0.2
		Carrot	0.1
		Avocado	0.1
Total crop value: 1 899 153 million rupiah		Total crop value: 12 608 329 million rupiah	
Dry irrigated zone		**Dry unirrigated zone**	
Rice	60.2	Rice	18.2
Sugar cane	12.8	Maize	12.5
Garlic	4.9	Soyabean	9.4
Shallot	4.0	Tobacco	8.6
Chilli	2.3	Mango	8.2
Maize	2.1	Cassava	7.4
Cucumber	1.9	Chilli	7.3
Potato	1.7	Groundnut	7.0
Yardlong bean and cowpea	1.7	Banana	5.0
Soyabean	1.6	Mung bean	4.8
Cabbage and Chinese cabbage	1.4	Coconut	3.7
Groundnut	1.3	Citrus	3.6
Tomato	1.1	Cashew	1.3
French, snap and kidney bean	1.0	Sweet potato	1.2
Eggplant	0.6	Pineapple	0.7
Mung bean	0.6	Cotton	0.5
Sweet potato	0.5	Kapok	0.4
Carrot	0.2	Avocado	0.3
		Pawpaw	0.2
Total crop value: 4 405 512 million rupiah		Total crop value: 3 784 709 million rupiah	

*1988 production volume for fruit and vegetables; 1987 production volume for other crops; 1987 prices for all crops.

Source: derived from Table 1.

Table 3 Distribution of rice ecosystems between zones

Rice ecosystems	Zones (% area)			
	Wet	Dry irrigated	Dry unirrigated	Sub-montane
Dryland	8	0	4	2
Deep water (>1 m)	4	0	0	0
Irrigated	36	27	0	2
Shallow rainfed (0-30 cm)	7	0	2	1
Intermediate rainfed (30-100 cm)	6	0	1	0
Total	61	27	7	5

Source: based on the table of rice area allocations between ecosystems for Indonesia in about 1978 (Tuke, 1982). The author made some small adjustments to these figures to allow for historical change and then made 'guestimates' of the division of each ecosystem between zones.

Table 4 Density and distribution of population in Indonesia (1990)

Island	Population/km^2
Java	826
Nusa Tengarra (group)	117
Sumatra	80
Sulawesi	67
Kalimantan	17

Source: Central Bureau of Statistics (1990) Table 3.1.4. In *Statistical Year Book of Indonesia 1989*. Jakarta: Central Bureau of Statistics.

Table 5 Location of principal areas of production of main perennial crops

Crop	Principal areas grown
Rubber	Sumatra, West Kalimantan
Coconut	Widespread around coasts, but particularly Java, Riau (Sumatra) and North Sulawesi
Oil palm	North Sumatra, Riau
Coffee	Sumatra (particularly South Sumatra, Lampung) and East Java
Black pepper	Lampung (Sumatra)
White pepper	Bangka island (Sumatra)
Clove	Widespread but Central Java and North Sulawesi largest producers
Mango	Java and South Sulawesi
Banana	Widespread
Tangerine	Java, West Kalimantan
Other citrus	Java, Bali, South Sulawesi
Tea	East Java and North Sumatra
Durian	Widespread in wet zone
Rambutan	Java and Lampung (Sumatra)
Guava	Java, Sumbawa, Lombok and South Sulawesi
Nutmeg	North Sulawesi, Molucca islands and D.I. Aceh (the most northern province of Sumatra)

Table 6 Pest ranking in sub-montane zone (1000-2000 m altitude)

Rank	Pest	Crops attacked
1	Rice blast (*Pyricularia oryzae*)	Rice
	Coffee berry borer (*Hypothenemus hampei*)	Coffee
	Citrus greening disease (CVPD) (psyllid vector – *Diaphorina citri*)	Citrus
	Root-knot nematode (*Meloidogyne incognita, M. javanica*)	Coffee, tea, cabbage, potato, sweet potato, tomato, kidney bean, carrot
2	Bacterial leaf streak (*Xanthomonas campestris* pv. *oryzicola*)	Rice
	Bacterial leaf blight (*Xanthomonas campestris* pv. *oryzae*)	Rice
	Rust (*Hemileia vastatrix*)	Coffee (particularly arabica)
	Root-lesion nematode (*Pratylenchus coffeae*)	Coffee
	Tea mosquito-bug (*Helopeltis antonii, H. theivora*)	Tea
	Diamond-back moth (*Plutella xylostella*)	Cabbage
	Cabbage moth (*Crocidolomia binotalis*)	Cabbage
	Clubroot (*Plasmodiophora brassicae*)	Cabbage
	Late blight (*Phytophthora infestans*)	Potato, tomato
	Armyworm (*Spodoptera litura, S. exigua*)	Soyabean, garlic, shallot, chilli, mung bean, kidney bean
3	Whorl maggot (*Hydrellia philippina*)	Rice
	Caseworm (*Parapoynx stagnalis*)	Rice
	Twig borer (*Xyleborus* sp.)	Coffee
	Root rot (*Phellinus noxius*)	Coffee
	Citrus mealybug (*Planococcus citri*)	Coffee
	Coffee mealybug (*Planococcus lilacinus*)	Coffee
	Mite (*Brevipalpus phoenicis, Polyphagotarsonemus latus*)	Tea (*P. latus* also on chilli)
	Blister blight (*Exobasidium vexans*)	Tea
	Diplodia gummosis and die-back (*Botryodiplodia theobromae*)	Citrus
	Banana weevil (*Cosmopolites sordidus*)	Banana
	Pink disease (*Corticium salmonicolor*)	Apple, coffee
	Stemborer (*Chilo suppressalis?, C. polychrysus?*)	Maize
	Downy mildew (*Peronosclerospora graminicola*)	Maize
4	Rat (*Rattus* spp.)	Rice, maize
	Birds (various species)	Rice
	Mole cricket (*Gryllotalpa* sp., probably *orientalis*)	Rice, potato
	Stemborer (*Zeuzera coffeae*)	Coffee
	Root rots as a group:	Tea
	brick-red disease (*Poria hypolateritia*)	
	Armillaria root disease (*Armillaria mellea*)	
	wine-red root disease (*Ganoderma pseudoferreum*) (found at lower altitude)	
	split canker or shoestring rot (*Armillaria fuscipes*)	
	Stem canker (*Phytophthora cinnamomi*)	Cassiavera
	Broken canker (*Endothia* sp.)	Cassiavera
	Foot rot or gummosis (*Phytophthora nicotianae* var. *parasitica*)	Citrus
	Tristeza virus	Citrus
	Seedling fly (*Atherigona* spp.)	Maize
	Bean fly (*Ophiomyia phaseoli*)	Soyabean, French, snap and kidney bean
	Pod borer (*Etiella zinckenella*)	Soyabean, mung bean
	Green stink bug (*Nezara viridula*)	Soyabean, mung bean
	Black rot and leaf scald (*Xanthomonas campestris* pv. *campestris*)	Cabbage
	Downy mildew (*Peronospora parasitica*)	Cabbage
	Powdery mildew (*Sphaerotheca fuliginea*)	Cabbage
	Bacterial soft rot (*Erwinia carotovora*)	Cabbage
	Bacterial wilt (*Pseudomonas solanacearum*)	Potato, tomato, groundnut
	Tuber moth (*Phthorimaea operculella*)	Potato
	Potato leaf roll virus (PLRV) and potato virus Y (PVY)	Potato (PVY also on chilli)
	Thrips (*Thrips palmi*)	Potato
	Sigatoka (*Mycosphaerella musicola*)	Banana
	Purple blotch (*Alternaria porri*)	Garlic, shallot
5	Stemborer (various species)	Rice
	Rice bug (*Leptocorisa* spp.)	Rice
	Soft green scale (*Coccus* spp.)	Coffee
	Apple aphid (*Aphis pomi*)	Apple
	Leaf rust (*Puccinia cinnamomi*)	Cassiavera
	Necrose spot (*Pestalotia cinnamomi*)	Cassiavera

Table 6 – *continued*

Rank	Pest	Crops attacked
	Leaf-eating caterpillar (*Cricula trifenestrata*)	Cassiavera
	Citrus aphid (*Toxoptera aurantii, T. citricidus* – both vectors of Tristeza virus, but *T.aurantii* is inefficient)	Citrus
	Neck rot (*Botrytis allii*)	Garlic, shallot
	Scab (*Elsinoe batatas*)	Sweet potato
	Panama disease (*Fusarium oxysporum* f. sp. *cubense*)	Banana
	Fruit fly (*Bactrocera* spp. near *dorsalis*)	Banana, chilli
	Fruit rot (*Thielaviopsis paradoxa*)	Pineapple
	Sumatra disease (*Pseudomonas syzygii*) (vector-*Hindola fulva* in Sumatra, *H. striata* in Java)	Clove (Java, Sumatra)
	Pig (Sus spp.)	Groundnut, maize
	Peanut stripe virus	Groundnut, soyabean
	Earworm or fruit borer (*Helicoverpa armigera*)	Maize, tomato
	Corn borer (*Ostrinia furnacalis*)	Maize
	Common smut (*Ustilago zeae*)	Maize
	Leafhopper (*Longitarsus suturellinus*)	Soyabean
	Cotton aphid (*Aphis gossypii*)	Soyabean
	Brown spot (*Septoria glycines*)	Soyabean
	Rust (*Phakopsora pachyrhizi*)	Soyabean, mung bean
	Soyabean mosaic virus	Soyabean
6	Sheath blight (*Rhizoctonia solani*)	Rice
	Root-lesion nematode (*Pratylenchus loosi*)	Tea
	Leaf roller (*Cydia leucostoma*)	Tea
	Tea tortrix (*Homona coffearia*)	Tea
	Gall mite (*Eriophyes boisi*)	Cassiavera
	Leaf blight (*Phyllosticta* sp., *Guignardia heveae*)	Clove
	Citrus leaf miner (*Phyllocnistis citrella*)	Citrus
	Prays endocarpa	Citrus
	Damping off (*Rhizoctonia solani*)	Cabbage and other seedlings
	Pineapple wilt disease (vector – pineapple mealybug, *Dysmicoccus brevipes*)	Pineapple
	Bunchy top virus	Banana (West Java)
	Early blight (*Alternaria solani*)	Potato
	Sweet potato weevil (*Cylas formicarius*)	Sweet potato
	Pink root (*Pyrenochaeta terrestris*)	Garlic
	Viruses (suspected – unidentified)	Garlic
	Thrips (*Thrips parvispinus*)	Shallot, chilli
	Cercopora leaf spot (*Cercospora capsici*)	Chilli
	Viruses as a group: cucumber mosaic tomato mosaic chilli veinal mottle potato virus Y	Chilli
	Anthracnose (*Colletotrichum capsici, C. piperatum*)	Chilli
	Ear rot (*Gibberella zeae*)	Maize
	Root rot (*Rhizoctonia* sp.)	Soyabean
	Stem rot (*Sclerotium* spp.)	Soyabean
	Seed discoloration (*Cercospora* spp.)	Soyabean
	Leaf folder (*Hedylepta indicata*)	Soyabean, groundnut
	Early leaf spot (*Cercospora arachidicola*)	Groundnut
	Late leaf spot (*Cercosporidium personatum*)	Groundnut
	Aphid (various species, including the *Aphis craccivora* complex, vector – cowpea aphid-borne mosaic virus infecting French, snap and kidney bean)	Groundnut, mung bean, French, snap and kidney bean
7	Sheath rot (*Sarocladium oryzae*)	Rice
	Orange leaf virus disease (possible confusion with tungro virus)	Rice
	Leaf fall (*Pestalotia* sp., *Colletotrichum* sp.)	Clove
	Die-back (*Rhizoctonia* sp., *Rosellinia* sp., *Phoma* sp., *Diplodia* sp.)	Clove
	Ring borer (*Hexamitodera semivelutina*)	Clove
	Stemborer (*Nothopeus* sp.)	Clove
	Common scab (*Streptomyces scabies*)	Potato
	Grey ear rot (*Physalospora zeicola*)	Maize
	Pod sucking bug (*Riptortus linearis*)	Mung bean
	Scab (*Elsinoe iwatae*)	Mung bean
	Leaf miner (*Aproaerema* sp.)	Mung bean
	Anthracnose (*Colletotrichum lindemuthianum*)	French, snap and kidney bean
	Rust (*Uromyces vignae*)	French, snap and kidney bean
	Cowpea aphid-borne mosaic virus	French, snap and kidney bean
	Cercospora leaf spot (*Cercospora* sp.)	French, snap and kidney bean
	Bean fly (*Agromyza* sp.)	French, snap and kidney bean

Table 6 – *continued*

Rank	Pest	Crops attacked
	Bark feeder (*Squamura maculata*)	Avocado
	Anthracnose (*Colletotrichum gloeosporioides, Leleum ustilaginoides)*	Avocado
	Alternaria sp.	Carrot

Table 7 Pest ranking in the wet zone (dry season four months or less; altitude <1000 m)

Rank	Pest	Crops attacked
1	Rats as a group, particularly *Rattus argentiventer*:	
	Rattus argentiventer	Rice (mostly wetland), sugar cane, maize, cassava, soyabean, groundnut
	Rattus tiomanicus	Oil palm
	Rattus diardii	Oil palm (and in stores)
	Rattus exulans	Rice (not Java), sugar cane
	Bandicota indica	Sugar cane
	Rattus spp.	Coconut, cocoa
2	Bacterial leaf blight (*Xanthomonas campestris* pv. *oryzae*)	Rice (wetland)
	Stemborer (*Sesamia inferens, Scirpophaga incertulas, S. innotata, Chilo suppressalis*)	Rice (wetland and dryland)
	Foot or pod rot (*Phytophthora palmivora*)	Pepper, coconut, cocoa (pepper race different from that attacking coconut and cocoa), rubber
3	Brown planthopper (*Nilaparvata lugens)*	Rice (wetland and dryland)
	White root rot (*Rigidoporus lignosus*)	Rubber
	Red spider mite (*Tetranychus urticae*)	Cassava
	Coffee berry borer (*Hypothenemus hampei*)	Coffee
	Anthracnose (*Colletotrichum gloeosporioides*)	Rubber, clove, oil palm, pawpaw, cocoa, citrus, nutmeg
	Sumatra disease (*Pseudomonas syzygii*) (vector – *Hindola fulva* in Sumatra, *H. striata* in Java)	Clove (Sumatra, Java)
4	Narrow brown leaf spot (*Cercospora oryzae*)	Rice (wetland and dryland)
	Rice blast (*Pyricularia oryzae*)	Rice (dryland)
	Sheath blight (*Rhizoctonia solani*)	Rice (wetland and dryland)
	Tungro virus (vector – *Nephotettix virescens, N. nigropictus)*	Rice (wetland)
	Seedling fly (mostly *Atherigona exigua*, some *A. oryzae*)	Rice (dryland), maize
	Pig (*Sus* spp.)	Rubber, coconut, oil palm, sugar cane; also annual crops near forest, particularly in transmigration areas
	Pink disease (*Corticium salmonicolor*)	Rubber, coffee, durian, cocoa
	Leaf spot (*Cercospora* sp., possible confusion with *Cercosporidium henningsii*)	Cassava
	Root-lesion nematode (*Pratylenchus coffeae*)	Coffee
	Root-knot nematode (*Meloidogyne incognita, M. javanica*) (*M. incognita* is also a component of yellow disease of pepper)	Coffee, sugar cane, sweet potato, chilli, carrot
	Bacterial wilt (*Pseudomonas solanacearum*)	Cassava, groundnut, chilli, potato, cigar wrapping tobacco, ginger
	Leaf blight (*Phyllosticta* sp., *Guignardia heveae*)	Clove
	Nettle caterpillar and bagworm as a group:	Oil palm
	nettle caterpillar (*Setothosea asigna, Setora nitens, Darna trima*)	(*Setothosea* sp. and *Setora* sp. are also coconut leaf pests)
	bagworm (*Mahasena corbetti, Metisa plana*)	
5	Rice bug (*Leptocorisa* spp.)	Rice (wetland and dryland)
	Gall midge (*Orseolia oryzae*)	Rice (wetland)
	Sheath rot (*Sarocladium oryzae*)	Rice (wetland and dryland)
	Secondary leaf fall (*Oidium heveae, Corynespora cassiicola*)	Rubber
	Leaf-eating bush-cricket (*Sexava nubila*)	Coconut, sago
	Leaf-eating caterpillar (*Hidari irava*)	Coconut
	Coconut leaf skeletonizer (*Artona catoxantha*)	Coconut
	Leaf-eating caterpillar (*Tirathaba* spp.)	Coconut
	Rhinoceros beetle (*Oryctes rhinoceros*)	Coconut, oil palm

Table 7—*continued*

Rank	Pest	Crops attacked
	Root rot (*Ganoderma boninense, Rigidoporus microporus*)	Oil palm
	Twig borer (*Xyleborus* spp.)	Coffee, clove
	Root rot (*Phellinus noxius*)	Coffee, cocoa, rubber
	Citrus mealybug (*Planococcus citri*)	Coffee, cocoa
	Coffee mealybug (*Planococcus lilacinus*)	Coffee, rambutan
	Banana weevil (*Cosmopolites sordidus*)	Banana
	Sigatoka (*Mycosphaerella musicola*)	Banana
	Stalk borer (*Lophobaris piperis*)	Pepper
	Yellow disease (complex of *Fusarium* sp., and the nematodes *Radopholus similis* and *Meloidogyne incognita*)	Pepper
	Fruit fly (*Bactrocera* spp. near *dorsalis*)	Guava, banana
	Fruit fly (*Drosophila lurida*)	Durian
	Citrus greening disease (CVPD) (psyllid vector – *Diaphorina citri*)	Citrus
	Bacterial blight (*Xanthomonas campestris* pv. *manihotis*)	Cassava
	Java downy mildew (*Peronosclerospora maydis*)	Maize
	Rust (*Puccinia arachidis*) combined with Cercospora leaf spot (*Cercospora arachidicola, Cercosporidium personatum*)	Groundnut
	Pod borer (*Etiella zinckenella*)	Groundnut, soyabean, mung bean
	Pod sucking bug (*Nezara viridula, Piezodorus hybneri, Riptortus linearis*)	Soyabean, mung bean, yardlong bean
	Armyworm (*Spodoptera litura, S. exigua*)	Soyabean, shallot, chilli, yardlong bean, mung bean
	Thrips (*Thrips parvispinus*)	Chilli, shallot
	Purple blotch (*Alternaria porri*)	Shallot
	Sweet potato weevil (*Cylas formicarius*)	Sweet potato
	Diamond-back moth (*Plutella xylostella*)	Cabbage
6	Brown spot (*Drechslera oryzae*)	Rice (dryland)
	Grain discoloration (*Drechslera* sp., *Cercospora* sp., *Fusarium* sp.)	Rice (dryland)
	Termite (*Macrotermes gilvus*)	Rubber
	Panel mouldy rot (*Ceratocystis fimbriata*)	Rubber
	Bark necrosis (*Botryodiplodia* sp., *Fusarium* sp.)	Rubber
	Root rot (*Ganoderma pseudoferreum, G. philippi*)	Rubber (*G. pseudoferreum* also on clove)
	Natuna wilt (unknown aetiology)	Coconut
	Batrachedra caterpillar (*Batrachedra* sp.)	Coconut
	Squirrel	Coconut
	Stem bleeding (*Ceratocystis paradoxa, Thieldaviopsis paradoxa*)	Coconut
	Coconut leaf diseases as a group:	Coconut
	grey leaf spot (*Pestalotiopsis palmarum*)	Age < 1 year
	Drechslera leaf spot (*Drechslera incurvata*)	Age < 1 year
	Curvularia leaf spot (*Curvularia eragrostidis*)	Age < 1 year
	petiole break (*Anthostonella cylindrospora*)	A Curvularia leaf spot
	Lasmeniella leaf spot (*Lasmeniella cocoes*)	(species uncertain) also
	Fusarium leaf rot (*Fusarium moniliforme* var. *intermedium*)	attacks oil palm
	Bunch rot (*Marasmius palmivorus*)	Oil palm
	Leaf fall (*Pestalotia* sp., *Colletotrichum* sp.)	Clove (particularly North Sulawesi)
	Die-back (*Rhizoctonia* sp., *Rosellinia* sp., *Phoma* sp., *Diplodia* sp.)	Clove
	Ring borer (*Hexamitodera semivelutina*)	Clove
	Stemborer (*Nothopeus* sp.)	Clove
	Leaf rot (*Cylindrocladium quinqueseptatum*)	Clove
	Pestalotiopsis leaf rot (*Pestalotiopsis versicolor*)	Clove
	Leaf spot (*Coniella castaneicola*)	Clove
	Arthriticus bug (*Arthriticus eugeniae*)	Clove
	Rust (*Hemileia vastatrix*)	Coffee
	Stemborer (*Zeuzera coffeae*)	Coffee, cocoa
	Panama disease (*Fusarium oxysporum* sp. *cubense*)	Banana
	Fusarium sp.	Salak
	Dry rot (*Coryneum myristicae*)	Nutmeg
	Stunted growth (unknown aetiology)	Pepper
	Lace bug (*Diconocoris hewitti*)	Pepper
	Coreid bug (*Dasynus piperis*)	Pepper
	Diplodia gummosis and die-back (*Botryodiplodia theobromae*)	Citrus
	Tristeza virus	Citrus
	Foot rot or gummosis (*Phytophthora nicotianae* var. *parasitica*)	Citrus
	Carea angulata	Guava
	Earworm (*Helicoverpa armigera*)	Maize, (possibly also soyabean)

Table 7—*continued*

Rank	Pest	Crops attacked
	Rust (*Phakopsora pachyrhizi*)	Soyabean
	Bacterial blight (*Xanthomonas campestris* pv. *glycines*)	Soyabean
	Soyabean looper (*Chrysodeixis eriosoma*)	Soyabean
	Bean fly (*Ophiomyia phaseoli*)	Soyabean, groundnut
	Groundnut viruses as a group:	Groundnut
	peanut stripe (aphid vector)	
	peanut mottle (vector – *Aphis craccivora* complex, *A. glycines*)	
	mosaic (vector – leafhopper (*Orosius argentatus*))	
	crinkle leaf	
	Chilli viruses as a group:	Chilli
	cucumber mosaic	
	tomato mosaic	
	chilli veinal mottle	
	potato virus Y	
	Mite (*Polyphagotarsonemus latus*)	Chilli
	Anthracnose (*Colletotrichum capsici, C. piperatum*)	Chilli
	Anthracnose (*Colletotrichum circinans*)	Shallot
	Downy mildew (*Peronospora destructor*)	Shallot
	Shallot viruses as a group:	Shallot
	onion yellow dwarf	
	shallot latent	
	Scab (*Elsinoe batatas*?, *Streptomyces ipomeae*?)	Sweet potato
	Cabbage moth (*Crocidolomia binotalis*)	Cabbage
	Clubroot (*Plasmodiophora brassicae*)	Cabbage
	Downy mildew (*Peronospora parasitica*)	Cabbage
	Alternaria spot (*Alternaria brassicae, A. brassicicola*)	Cabbage
	Top borer (*Scirpophaga nivella*)	Sugar cane
	Ratoon stunting disease (*Clavibacter xyli*)	Sugar cane
	Sugar cane mosaic virus	Sugar cane
	Sugar cane smut (*Ustilago scitaminea*)	Sugar cane
	Sugar cane stalk borer (*Chilo sacchariphagus*)	Sugar cane
	Stalk borer (*Chilo auricilius*)	Sugar cane
	Leaf scald (*Xanthomonas albilineans*)	Sugar cane
	Leucopholis sp.	Sugar cane
	Ceratovacuna lanigera	Sugar cane
	Leaf scorch (*Stagonospora sacchari*)	Sugar cane
	Pokkah boeng (*Fusarium moniliforme*)	Sugar cane
7	Leaf scald (*Rhyncosporium oryzae*)	Rice (dryland)
	Birds (*Passer* sp., *Ploceus* sp., *Padda* sp., *Munia* sp.)	Rice (dryland)
	Mole cricket (*Gryllotalpa* sp., probably *orientalis*)	Rice (dryland)
	False smut (*Ustilaginoidea virens*)	Rice (dryland)
	Foot rot or bakanae (*Gibberella fujikuroi*)	Rice (dryland)
	Black bug (*Scotinophara* spp.)	Rice (wetland)
	Grassy stunt and ragged stunt viruses (vector – *Nilaparvata lugens*)	Rice (wetland)
	Eye spot (*Drechslera hevea*)	Rubber
	Ustulina maxima	Rubber
	Algal leaf disease (*Cephaleuros mycoidis*)	Rubber
	Basal stem rot (*Ganoderma* sp.)	Coconut
	Thread blight (*Corticium* sp.)	Coconut
	Leaf pest (*Parasa* spp., *Chalcocelis* spp.)	Coconut
	Early leaf disease (*Botryodiplodia* spp., *Glomerella* sp.)	Oil palm
	Elephant (*Elephas indicus*)	Oil palm
	Stemborer (*Batocera* sp.)	Nutmeg
	White root (*Fomes* sp.)	Clove
	Thread blight (*Pellicularia koleroga*)	Clove, pepper
	Algal leaf spot (*Cephaleuros virescens*)	Clove (*Cephaleuros* sp. also on guava)
	Downy mildew (*Capnodium* sp.)	Clove
	Soft green scale (*Coccus* spp.)	Coffee, pawpaw
	Tea mosquito-bug (*Helopeltis antonii, H. theivora* – mostly *H. antonii*)	Cocoa
	Vascular streak die-back (*Oncobasidium theobromae*)	Cocoa
	Pod borer (*Conopomorpha cramerella*)	Cocoa
	Looper (*Hyposidra talaca*)	Cocoa
	Bunchy top virus	Banana (East Java)
	Blood disease (*Xanthomonas campestris* pv. *celebensis*)	Banana (Sulawesi, similar disease in West Java)
	Nectria sp.	Rambutan
	Leaf spot (*Colletotrichum piperis*)	Pepper
	Mehteria hemidoxa	Pepper
	Mealybug (*Planococcus* sp.)	Pepper
	Termite (*Microtermes* spp.)	Pepper

Table 7—*continued*

Rank	Pest	Crops attacked
	Citrus aphid (*Toxoptera aurantii, T. citricidus* – both vectors of Tristeza virus, but *T. aurantii* is inefficient)	Citrus, pepper
	Prays endocarpa	Citrus
	Citrus leaf miner (*Phyllocnistis citrella*)	Citrus
	Trabala vishnou	Guava (Java)
	Leaf blight (*Drechslera maydis*)	Maize
	Rust (*Puccinia polysora*)	Maize
	Corn weevil (*Sitophilus* sp., either *S. zeamis* or *S. oryzae* or both)	Maize
	Soyabean viruses as a group: Indonesian soyabean dwarf (vector – *Aphis glycines*) soyabean stunt (vector – *Aphis craccivora* complex, *A. glycines*) soyabean mosaic (vector – *Aphis glycines*) bean yellow mosaic (vector – *Aphis craccivora* complex, *A. glycines*) cowpea mild mottle	Soyabean
	Whitefly (*Bemisia tabaci*)	Soyabean
	Anthracnose (*Colletotrichum dermatium*)	Soyabean
	Leaf roller (*Aproaerema modicella*)	Groundnut
	Fusarium wilt (*Fusarium oxysporum*)	Chilli
	Cercospora leaf spot (*Cercospora* sp.)	Chilli
	Bacterial leaf spot (*Xanthomonas campestris* pv. *vesicatoria*)	Chilli
	Bacterial soft rot (*Erwinia carotovora*)	Chilli, cabbage
	Black rot and leaf scald (*Xanthomonas campestris* pv. *campestris*)	Cabbage
	Damping off (*Rhizoctonia solani*)	Cabbage
	Cutworm (*Agrotis ipsilon*)	Cabbage
	Neck rot (*Botrytis allii* ?)	Shallot
	White rot (*Sclerotium cepivorum*)	Shallot
	Stemphylium sp.	Shallot
	Pod borer (*Maruca testulalis*)	Yardlong bean
	Aphid (*Aphis fabae* complex, *A. craccivora* complex – *A. craccivora* also vector of viruses, e.g. bean yellow mosaic, soyabean stunt, peanut mottle)	Mung bean (*A. craccivora* also on yardlong bean)
	Cercospora leaf spot (*Cercospora canescens*)	Mung bean
	Little leaf mycoplasma	Sweet potato
	Viruses (unidentified)	Sweet potato
	Sweet potato borer (*Omphisa anastomosalis*)	Sweet potato
	Sweet potato beetle (*Asphidomorpha punctum*)	Sweet potato
	Phragmataecia castaneae	Sugar cane
	Tetramoera schistaceana	Sugar cane
	Yellow spot (*Mycovellosiella koepkii*)	Sugar cane
	Root-lesion nematode (*Pratylenchus* spp.)	Sugar cane
	Bacteriosis sp.	Sugar cane
	Rust (*Puccinia kuehnii*)	Sugar cane
	Red palm weevil (*Rhynchophorus ferrugineus*)	Sago

Table 8 Pest ranking in the dry unirrigated zone (dry season >four months; altitude <1000 m)

Rank	Pest	Crops attacked
1	Rats as a group (*Rattus* spp.)	Rice, maize, soyabean, groundnut, mung bean, coconut, sweet potato
2	Rice bug (*Leptocorisa* spp. (mostly *acuta*?))	Rice
	Rice blast (*Pyricularia oryzae*)	Rice (dryland)
	Stemborer (*Scirpophaga innotata, S. incertulas, Chilo suppressalis, Sesamia inferens* – *S. innotata* more important since 1989)	Rice (rainfed)
	Earworm or bollworm (*Helicoverpa armigera*)	Maize, soyabean, tobacco, cotton, pigeon pea, sorghum
	Armyworm (*Spodoptera* spp., particularly *S. litura*)	Rice, chilli, maize, tobacco, soyabean, cassava, cotton, mung bean, groundnut
3	Brown spot (*Drechslera oryzae*)	Rice (dryland)
	Seedling fly (*Atherigona* spp.)	Rice (dryland), possibly maize
	Corn weevil (*Sitophilus oryzae*)	Maize
	Leaf blight (*Drechslera maydis*)	Maize
	Asian corn borer (*Ostrinia furnacalis*)	Maize

Table 8 – *continued*

Rank	Pest	Crops attacked
	Pod borer (*Etiella zinckenella*)	Soyabean
	Viruses as a group:	Soyabean
	Indonesian soyabean dwarf (vector-*Aphis glycines*)	
	soyabean stunt (vector-*Aphis craccivora* complex, *A.glycines*)	
	soyabean mosaic (vector-*Aphis glycines*)	
	bean yellow mosaic (vector-*Aphis craccivora* complex, *A. glycines*)	
	Bean fly (*Ophiomyia phaseoli*)	Soyabean, mung bean
	Green stink bug (*Nezara viridula*)	Rice, soyabean, mung bean (cotton?)
	Red spider mite (*Tetranychus urticae*)	Cassava, taro
	Bacterial wilt (*Pseudomonas solanacearum*)	Tobacco, chilli, cashew
	Leafhopper (*Idioscopus clypealis, I. niveosparsus*)	Mango
	Thrips (*Thrips parvispinus*)	Chilli
	Citrus greening disease (CVPD) (psyllid vector-*Diaphorina citri*)	Citrus
	Fruit fly (*Bactrocera* spp. near *dorsalis*)	Mango, chilli, banana
4	Tungro virus (vector-*Nephotettix virescens, N. nigropictus*)	Rice (rainfed)
	Leaf folder (*Cnaphalocrocis medinalis*)	Rice (rainfed)
	Java downy mildew (*Peronosclerospora maydis*)	Maize
	Rust (*Puccinia sorghi*)	Maize
	Rust (*Phakopsora pachyrhizi*)	Soyabean
	Pod sucking bug (*Riptortus linearis, Piezodorus hybneri*)	Soyabean, mung bean
	Tobacco mosaic virus	Tobacco
	Tobacco leaf curl virus (vector-*Bemisia tabaci*)	Tobacco
	Pythium spp.	Tobacco
	Phytophthora nicotianae, P. parasitica	Tobacco (*P. parasitica* also attacks citrus)
	Anthracnose (*Colletotrichum capsici, C. piperatum*)	Chilli
	Leaf spot (*Cercospora* sp., possible confusion with *Cercosporidium henningsii*)	Cassava
	Rust (*Puccinia arachidis*) combined with Cercospora leaf spot (*Cercospora arachidicola, Cercosporidium personatum* – more *C. personatum*)	Groundnut
	Banana weevil (*Cosmopolites sordidus*)	Banana
	Rhinoceros beetle (*Oryctes rhinoceros*)	Coconut
5	Narrow brown leaf spot (*Cercospora oryzae*)	Rice (dryland)
	Brown planthopper (*Nilaparvata lugens*)	Rice (rainfed)
	Fusarium ear rot (*Fusarium moniliforme, F. oxysporum*)	Maize
	Diplodia gummosis and die-back (*Botryodiplodia theobromae*)	Citrus
	Foot rot or gummosis (*Phytophthora nicotianae* var. *parasitica*)	Citrus
	Soil-borne fungi (*Sclerotium rolfsii, Rhizoctonia solani*)	Soyabean, groundnut, mung bean
	Pod borer (*Maruca testulalis*)	Mung bean, pigeon pea
	Cercospora leaf spot (*Cercospora canescens*)	Mung bean
	Leafhopper (*Empoasca* sp.)	Groundnut
	Viruses as a group:	Groundnut
	peanut stripe (aphid vector)	
	peanut mottle (vector-*Aphis craccivora* complex, *A. glycines*)	
	mosaic (vector-*Orosius argentatus*)	
	crinkle leaf	
	Pseudomonas mangiferae	Mango
	Root-knot nematode (*Meloidogyne javanica, M. incognita*)	Tobacco, chilli (*M. javanica* infests tobacco)
	Viruses as a group:	Chilli
	cucumber mosaic	
	tomato mosaic	
	chilli veinal mottle	
	potato virus Y	
	Yellow tea mite (*Polyphagotarsonemus latus*)	Chilli
	Bacterial blight (*Xanthomonas campestris* pv. *manihotis*)	Cassava
	Sigatoka (*Mycosphaerella musicola*)	Banana
	Coconut whitefly (*Aleurodicus destructor*)	Coconut
	Coconut hispid (*Brontispa* sp.)	Coconut
	Black hispid (*Plesispa* sp.)	Coconut
	Batrachedra caterpillar (*Batrachedra* sp.)	Coconut
6	Whitefly (*Bemisia tabaci*) (also vector of tobacco leaf curl virus on tobacco and cowpea mild mottle virus on soyabean etc.)	Soyabean

Table 8 – *continued*

Rank	Pest	Crops attacked
	Bacterial blight (*Xanthomonas campestris* pv. *glycines*? *X. c.* pv. *phaseoli*?, *Pseudomonas syringae* pv. *glycinea*?)	Soyabean
	Tristeza virus	Citrus
	Leaf roller (*Aproaerema modicella*)	Groundnut
	Sweet potato weevil (*Cylas formicarius*)	Sweet potato
	Cercospora leaf spot (*Cercospora* sp.)	Chilli
	Fusarium wilt (*Fusarium oxysporum*)	Chilli
	Panama disease (*Fusarium oxysporum* f.sp. *cubense*)	Banana
	Leaf-eating caterpillar (*Cricula trifenestrata*)	Cashew
	Tea mosquito-bug (*Helopeltis* spp.)	Cashew
	Fruit borer (*Nephopteryx* sp.)	Cashew
	Fruit rot (*Thielaviopsis paradoxa*)	Pineapple
	Leaf-eating bush-cricket (*Sexava* spp.)	Coconut (particularly Moluccas and North Sulawesi)
	Coconut leaf skeletonizer (*Artona catoxantha*)	Coconut (particularly Moluccas and North Sulawesi)
	Leaf-eating caterpillar (*Hidari irava*)	Coconut (particularly Moluccas and North Sulawesi)
	Pink bollworm (*Pectinophora gossypiella*)	Cotton
	Spiny bollworm (*Earias vittella*)	Cotton
	Cotton jassid (*Amrasca biguttula*)	Cotton
7	Cotton aphid (*Aphis gossypii* complex)	Cotton
	Cotton stainer (*Dysdercus cingulatus*)	Cotton
	Bacterial blight (*Xanthomonas campestris* pv. *malvacearum*?)	Cotton
	Botryodiplodia (*phaseoli*? *theobromae*?)	Cotton
	Citrus aphid (*Toxoptera aurantii, T. citricidus*) (both vectors of Tristeza virus, but *T. aurantii* inefficient)	Citrus
	Prays endocarpa	Citrus
	Citrus leaf miner (*Phyllocnistis citrella*)	Citrus
	Bark feeder (*Squamura maculata*)	Avocado
	Anthracnose (*Colletotrichum gloeosporioides, Leleum ustilaginoides*)	Avocado (*C. gloeosporioides* also on pawpaw)
	Soft green scale (*Coccus viridis*)	Pawpaw
	Pineapple wilt disease (vector-pineapple mealybug, *Dysmicoccus brevipes*)	Pineapple
	Die-back complex (*Botryodiplodia* sp., *Pythium* sp., *Fusarium* sp., *Pestalotia* sp., *Gloeosporium* sp.)	Cashew
	Longhorn beetle (*Plocaederus ferrugineus*)	Cashew
	Leaf miner (*Acrocercops syngramma*)	Cashew
	Mango borer (*Rhytidodera simulans*)	Cashew
	Hypatima haligramma	Cashew
	Leaf-eating caterpillar (*Tirathaba* spp.)	Coconut
	Squirrels	Coconut
	Pig (*Sus* spp.)	Coconut and other crops
	Leaf pest (*Chalcocelis* spp., *Parasa* spp.)	Coconut
	Nettle caterpillar (*Setothosea* spp., *Setora* spp.)	Coconut
	Bacterial soft rot (*Erwinia carotovora*)	Chilli
	Bacterial leaf spot (*Xanthomonas campestris* f.sp. *vesicatoria*)	Chilli

Table 9 Pest ranking in the dry irrigated zone (dry season >four months; altitude <1000 m)

Rank	Pest	Crops attacked
1	Rats as a group, mostly *Rattus argentiventer*	Rice, sugar cane, maize, soyabean, groundnut, mung bean
2	Stemborer (*Scirpophaga innotata, S. incertulas, Sesamia inferens, Chilo suppressalis; S. innotata* more important since 1989 particularly in Java along coast east of Jakarta)	Rice
	Bacterial leaf blight (*Xanthomonas campestris* pv. *oryzae*)	Rice
	Brown planthopper (*Nilaparvata lugens*)	Rice
	Armyworm (*Spodoptera litura, S. exigua*)	Rice, garlic, shallot, chilli, maize, yardlong bean, soyabean, groundnut, mung bean, kidney bean

Table 9 – *continued*

Rank	Pest	Crops attacked
3	Sheath blight (*Rhizoctonia solani*)	Rice
	Tungro virus (vector-*Nephotettix virescens, N. nigropictus*)	Rice
	Rice bug (*Leptocorisa* spp. (mostly *L. acuta*?)	Rice
	Leaf folder (*Cnaphalocrocis medinalis*)	Rice
	Top borer (*Scirpophaga nivella*)	Sugar cane
	Ratoon stunting disease (*Clavibacter xyli*)	Sugar cane
	Sugar cane mosaic virus (aphid vector)	Sugar cane
	Smut (*Ustilago scitaminea*)	Sugar cane
4	Leaf scald (*Rhyncosporium oryzae*)	Rice
	Narrow brown leaf spot (*Cercospora oryzae*)	Rice
	Sheath rot (*Sarocladium oryzae*)	Rice
	Gall midge (*Orseolia oryzae*)	Rice
	Thrips (*Thrips parvispinus*)	Garlic, shallot, chilli
	Purple blotch (*Alternaria porri*)	Garlic, shallot
	Leaf scald (*Xanthomonas albilineans*)	Sugar cane
	Sugar cane stalk borer (*Chilo sacchariphagus*)	Sugar cane
	Stalk borer (*Chilo auricilius*)	Sugar cane
5	Root-knot nematode (*Meloidogyne* spp., mostly *M. incognita* and *M. javanica*)	Cucumber, potato, chilli, tomato, kidney bean, carrot, eggplant, sweet potato
	Bacterial wilt (*Pseudomonas solanacearum*)	Potato, chilli, eggplant, tomato, mung bean
	Bean fly (*Ophiomyia phaseoli*)	Yardlong bean, soyabean, kidney bean, mung bean
	Pod borer (*Etiella zinckenella*)	Soyabean, mung bean
	Rust (*Phakopsora pachyrhizi*)	Soyabean
	Cucumber mosaic virus (aphid vector)	Cucumber, chilli, tomato
	Leaf-eating beetle (unspecified)	Cucumber, eggplant
	Angular leaf spot (*Pseudomonas syringae*)	Cucumber
	Downy mildew (*Pseudoperonospora cubensis*)	Cucumber
	Earworm or fruit borer (*Helicoverpa armigera*)	Maize, soyabean, tomato
	Diamond-back moth (*Plutella xylostella*)	Cabbage
	Anthracnose (*Colletotrichum capsici, C. piperatum*)	Chilli
	Rice armyworm (*Mythimna separata*)	Maize (rice?)
	Ceratovacuna lanigera	Sugar cane
	Tetramoera schistaceana	Sugar cane
	Bacteriosis sp.	Sugar cane
6	Fusarium wilt (*Fusarium oxysporum*)	Garlic
	Phytophthora porri	Garlic
	Viruses?	Garlic
	Mite (Tetranychidae, various species)	Garlic
	Viruses as a group:	Soyabean
	Indonesian soyabean dwarf (vector-*Aphis glycines*)	
	soyabean stunt (vector-*Aphis craccivora* complex, *A. glycines*)	
	soyabean mosaic (vector-*Aphis glycines*)	
	bean yellow mosaic (vector-*Aphis craccivora* complex, *A. glycines*)	
	peanut stripe (aphid vector) (also attacks groundnut)	
	cowpea mild mottle	
	Damping off (*Sclerotium rolfsii, Pythium* spp. etc)	Soyabean, cucumber
	Powdery mildew (*Sphaerotheca fuliginea*)	Cucumber
	Anthracnose (*Colletotrichum lagenarium*)	Cucumber
	Cabbage moth (*Crocidolomia binotalis*)	Cabbage
	Clubroot (*Plasmodiphora brassicae*)	Cabbage
	Alternaria spot (*Alternaria brassicae* and/or *A. brassicicola*)	Cabbage
	Downy mildew (*Peronospora parasitica*)	Cabbage
	Fusarium wilt (*Fusarium oxysporum*)	Chilli
	Cercospora leaf spot (*Cercospora* sp.)	Chilli
	Fruit fly (*Bactrocera* spp. near *dorsalis*)	Chilli
	Yellow tea mite (*Polyphagotarsonemus latus*)	Chilli
	Tomato mosaic (TMV) and chilli veinal mottle viruses	Chilli (TMV also on tomato)
	Cutworm (*Agrotis ipsilon*)	Cabbage, tomato
	Early blight (*Alternaria solani*)	Potato, tomato
	Late blight (*Phytophthora infestans*)	Potato, tomato
	Tuber moth (*Phthorimaea operculella*)	Potato
	Thrips (*Thrips palmi*)	Potato
	Potato leaf roll virus	Potato
	Potato virus Y	Potato, chilli
	Smudge (*Colletotrichum circinans*)	Shallot
	Downy mildew (*Peronospora destructor*)	Shallot

Table 9 – *continued*

Rank	Pest	Crops attacked
	Phomopsis sp.	Eggplant
	Fruit borer? (*Leucinodes orbonalis*)	Eggplant
	Sweet potato weevil (*Cylas formicarius*)	Sweet potato
	Sweet potato borer (*Omphisa anastomosalis*)	Sweet potato
	Sweet potato beetle (*Aspidomorpha punctum*)	Sweet potato
	Rust (*Puccinia arachidis*) combined with Cercospora leaf spot (*Cercospora arachidicola, Cercosporidium personatum* – more *C. personatum*)	Groundnut
	Viruses as a group: peanut stripe (aphid vector) peanut mottle (vector-*Aphis craccivora* complex, *A. glycines*) mosaic (vector-leafhopper *Orosius argentatus*) peanut crinkle leaf	Groundnut
	Leafhopper (*Empoasca* sp.)	Groundnut
	Leaf blight (*Drechslera maydis*)	Maize
	Rust (*Puccinia polysora*)	Maize
	Pod sucking bug (*Nezara viridula, Piezodorus hybneri, Riptortus linearis*)	Soyabean, yardlong bean (*R. linearis* also attacks mung bean)
	Cowpea aphid-borne mosaic virus	Yardlong bean, kidney bean
	Anthracnose (*Colletotrichum lindemuthianum*)	Yardlong bean, kidney bean
	Groundnut aphid (*Aphis craccivora* complex)	Yardlong bean, kidney bean
	Bean fly (*Agromyza* sp.)	Yardlong bean, kidney bean, groundnut
	Cercospora leaf spot (*Cercospora cruenta, C. dematum*)	Yardlong bean, kidney bean
	Witches broom	Yardlong bean
	Pod borer (*Maruca testulalis*)	Yardlong bean, mung bean
	Bacterial spot (*Xanthomonas* sp.?)	Yardlong bean
	Rust (*Uromyces vignae*)	Kidney bean
7	Grassy stunt and ragged stunt viruses (vector-*Nilaparvata lugens*)	Rice
	Onion yellow dwarf virus (aphid vector)	Shallot
	Shallot latent virus	Shallot
	Bacterial soft rot (*Erwinia carotovora*)	Chilli, cabbage
	Bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*)	Chilli, tomato
	Scab? (*Cladosporium* sp.)	Tomato
	Fusarium wilt (*Fusarium oxysporum* f.sp. *lycopersici*)	Tomato
	Cercospora leaf spot (*Cercospora* sp.)	Tomato
	Cercospora leaf spot (*Cercospora ipomoeae*)	Sweet potato
	Scab (*Streptomyces ipomoeae*? *Elsinoe batatas*?)	Sweet potato
	Common scab (*Streptomyces scabies*)	Potato
	Mole cricket (*Gryllotalpa* sp., probably *orientalis, G. hirsuta*)	Potato
	Bug (unspecified)	Eggplant
	Mite (unspecified)	Eggplant
	Anthracnose (unspecified)	Eggplant
	Damping off (*Rhizoctonia solani*)	Cabbage
	Black rot and leaf scald (*Xanthomonas campestris* pv. *campestris*)	Cabbage
	Alternaria sp.	Carrot
	Leaf roller (*Aproaerema* sp.? *Lamprosema* sp.?)	Groundnut
	Anthracnose (*Colletotrichum dermatium*)	Soyabean
	Bacterial blight (*Xanthomonas campestris* pv. *glycines*)	Soyabean
	Cercospora leaf spot (*Cercospora* sp.)	Soyabean
	Whitefly (*Bemisia tabaci*)	Soyabean
	Java downy mildew (*Peronosclerospora* maydis)	Maize
	Fusarium ear rot (*Fusarium* spp.)	Maize
	Cercospora leaf spot (*Cercospora canescens*)	Mung bean

Table 10 Rice pest ranking in the sub-montane zone (1000–2000 m altitude)

Rank	Pest
1	Rice blast (*Pyricularia oryzae*)
2	Bacterial leaf streak (*Xanthomonas campestris* pv. *oryzicola*) Bacterial leaf blight (*Xanthomonas campestris* pv. *oryzae*)
3	Whorl maggot (*Hydrellia philippina*) Caseworm (*Parapoynx stagnalis*)
4	Rat (*Rattus* spp.) Birds (various species) Mole cricket (*Gryllotalpa orientalis*)
5	Stemborer (various species) Rice bug (*Leptocorisa* spp.)
6	Sheath blight (*Rhizoctonia solani*)
7	Sheath rot (*Sarocladium oryzae*) Orange leaf virus disease (tungro virus?)

Main source: Sukarami Research Institute for Food Crops.

Table 11 Rice pest ranking in the wet zone (dry season 4 months or less; altitude <1000 m)

Rank	Pest	Ecosystem*
1	Rats (mostly *Rattus argentiventer* some *R. exulans*)	B
2	Bacterial leaf blight (*Xanthomonas campestris* pv. *oryzae*)	W
	Stemborer (various species)	B
3	Brown planthopper (*Nilaparvata lugens*)	B
4	Narrow brown leaf spot (*Cercospora oryzae*)	B
	Rice blast (*Pyricularia oryzae*)	D
	Sheath blight (*Rhizoctonia solani*)	W
	Tungro virus	W
	Seedling fly (*Atherigona exigua, A. oryzae*)	D
5	Rice bug (*Leptocorisa* spp.)	B
	Sheath rot (*Sarocladium oryzae*)	B
	Gall midge (*Orseolia oryzae*)	W
6	Brown spot (*Drechslera oryzae*)	D
	Grain discoloration (various species)	D
7	Leaf scald (*Rhyncosporium oryzae*)	D
	Birds (various species)	D
	Mole cricket (*Gryllotalpa orientalis*)	D
	False smut (*Ustilaginoidea virens*)	D
	Foot rot or bakanae (*Gibberella fujikuroi*)	D
	Pig (*Sus* spp.)	D
	Black bug (*Scotinophara* spp.)	W
	Grassy stunt and ragged stunt viruses	W

*B = both wetland and dryland
W = wetland
D = dryland

Table 12 Rice pest ranking in the dry unirrigated zone (dry season > four months; altitude <1000 m)

Rank	Pest	Ecosystem*
1	Rat (*Rattus* spp.)	B
2	Rice bug (*Leptocorisa* spp.)	B
	Stemborer (various species)	R
	Rice blast (*Pyricularia oryzae*)	D
	Armyworm (*Spodoptera litura*)	B
3	Brown spot (*Drechslera oryzae*)	D
	Seedling fly (*Atherigona* spp.)	D
	Green stink bug (*Nezara viridula*)	D
4	Leaf folder (*Cnaphalocrocis medinalis*)	R
	Tungro virus	R
5	Narrow brown leaf spot (*Cercospora oryzae*)	D
	Brown planthopper (*Nilaparvata lugens*)	R

*B=both rainfed and dry land
R=rainfed
D=dry land

Table 13 Rice pest ranking in the dry irrigated zone (dry season > four months; altitude <1000 m))

Rank	Pest
1	Rats (mostly *Rattus argentiventer*)
2	Stemborer (various species, recently more *Scirpophaga innotata*)
3	Bacterial leaf blight (*Xanthomonas campestris* pv. *oryzae*)
	Brown planthopper (*Nilaparvata lugens*)
4	Sheath blight (*Rhizoctonia solani*)
	Tungro virus
	Rice bug (*Leptocorisa* spp.)
	Leaf folder (*Cnaphalocrocis medinalis*)
5	Leaf scald (*Rhyncosporium oryzae*)
	Sheath rot (*Sarocladium oryzae*)
	Narrow brown leaf spot (*Cercospora oryzae*)
	Gall midge (*Orseolia oryzae*)
	Armyworm (*Spodoptera litura*)
6	Grassy stunt and ragged stunt viruses

Table 14 Dryland rice pest ranking in the wet zone (dry season four months or less; altitude <1000 m))

Rank	Pest
1	Rice blast (*Pyricularia oryzae*)
2	Narrow brown leaf spot (*Cercospora oryzae*) Seedling fly (*Atherigona exigua, A. oryzae*)
3	Brown spot (*Drechslera oryzae*) Grain discoloration (various species)
4	Stemborer (various species) Rice bug (*Leptocorisa* spp.) Sheath rot (*Sarocladium oryzae*)
5	Sheath blight (*Rhizoctonia solani*) Leaf scald (*Rhyncosporium oryzae*)
6	Rat (*Rattus* spp.) Birds (various species) Mole cricket (*Gryllotalpa orientalis*)
7	False smut (*Ustilaginoidea virens*) Foot rot or bakanae (*Gibberella fujikuroi*) Brown planthopper (*Nilaparvata lugens*) Wild pigs (*Sus* spp.)

Main source: Sukarami Research Institute for Food Crops.

Table 15 Maize pest ranking

Rank	Pest
Sub-montane zone	
1	Stemborer (*Chilo suppressalis?, C. polychrysus?*) Downy mildew (*Peronosclerospora graminicola*)
2	Seedling fly (*Atherigona* spp.)
3	Asian corn borer (*Ostrinia furnacalis*) Common smut (*Ustilago zeae*)
4	Earworm (*Helicoverpa armigera*) Ear rot (*Gibberella zeae*)
5	Pig (*Sus* spp.) Rat (*Rattus* spp.) Grey ear rot (*Physalospora zeicola*)
Dry unirrigated zone	
1	Earworm (*Helicoverpa armigera*)
2	Corn weevil (*Sitophilus oryzae*) Leaf blight (*Drechslera maydis*) Asian corn borer (*Ostrinia furnacalis*)
3	Rust (*Puccinia sorghi*) Java downy mildew (*Peronosclerospora maydis*) Armyworm (*Spodoptera* spp.)
4	Fusarium ear rot (*Fusarium* spp.) Rat (*Rattus* spp.)

Rank	Pest
Wet zone	
1	Seedling fly (*Atherigona exigua*)
2	Java downy mildew (*Peronosclerospora maydis*)
3	Earworm (*Helicoverpa armigera*)
4	Leaf blight (*Drechslera maydis*) Rust (*Puccinia polysora*) Corn weevil (*Sitophilus* sp.)
Dry irrigated zone	
1	Armyworm (*Mythimna separata, Spodoptera* spp.; more *M. separata*)
2	Earworm (*Helicoverpa armigera*)
3	Leaf blight (*Drechslera maydis*)
4	Rust (*Puccinia polysora*)
5	Java downy mildew (*Peronosclerospora maydis*) Fusarium ear rot (*Fusarium* spp.) Rat (*Rattus* spp.)

Table 16 Soyabean pest ranking

Rank	Pest
Sub-montane zone	
1	Bean fly (*Ophiomyia phaseoli*) Armyworm (*Spodoptera litura*) Pod borer (*Etiella zinckenella*) Green stink bug (*Nezara viridula*)
2	Leafhopper (*Longitarsus suturellinus*) Cotton aphid (*Aphis gossypii*) Brown spot (*Septoria glycines*) Rust (*Phakopsora packyrhizi*) Peanut stripe virus Soyabean mosaic virus
3	Root rot (*Rhizoctonia* sp.) Stem rot (*Sclerotium* spp.) Seed discoloration (*Cercospora* spp.) Leaf folder (*Hedylepta indicata*)
Dry unirrigated zone	
1	Bean fly (*Ophiomyia phaseoli*) Pod borer (*Etiella zinckenella*) Viruses as a group: Indonesian soyabean dwarf soyabean stunt soyabean mosaic bean yellow mosaic
2	Pod sucking bug (*Riptortus linearis, Piezodorus hybneri*) Bollworm (*Helicoverpa armigera*) Rust (*Phakopsora pachyrhizi*)
3	Armyworm (*Spodoptera litura*)
4	Whitefly (*Bemisia tabaci*) Bacterial blight (*Xanthomonas campestris* pv. *glycines*) Rat (*Rattus* spp.)
5	Damping off (*Sclerotium rolfsii, Pythium* spp.)

Rank	Pest
Wet zone	
1	Soyabean looper (*Chrysodeixis eriosoma*) Pod sucking bug (various species)
2	Rust (*Phakopsora pachyrhizi*)
3	Bacterial blight (*Xanthomonas campestris* pv. *glycines*) Rat (*Rattus* spp.)
4	Armyworm (*Spodoptera litura*) Pod borer (*Etiella zinckenella*) Bean fly (*Ophiomyia phaseoli*) Viruses as a group: Indonesian soyabean dwarf soyabean stunt soyabean mosaic bean yellow mosaic cowpea mild mottle
5	Anthracnose (*Colletotrichum dermatium*) Whitefly (*Bemisia tabaci*)
Dry irrigated zone	
1	Rust (*Phakopsora pachyrhizi*) Bean fly (*Ophiomyia phaseoli*) Pod borer (*Etiella zinckenella*)
2	Viruses as a group: Indonesian soyabean dwarf soyabean stunt soyabean mosaic bean yellow mosaic peanut stripe cowpea mild mottle Pod sucking bug (various species) Bollworm (*Helicoverpa armigera*)
3	Armyworm (*Spodoptera litura*) Cercospora leaf spot (*Cercospora* sp.)
4	Bacterial blight (*Xanthomonas campestris* pv. *glycines*) Damping off (*Sclerotium rolfsii, Pythium* spp.) Anthracnose (*Colletotrichum dermatium*) Rat (*Rattus* spp.) Whitefly (*Bemisia tabaci*)

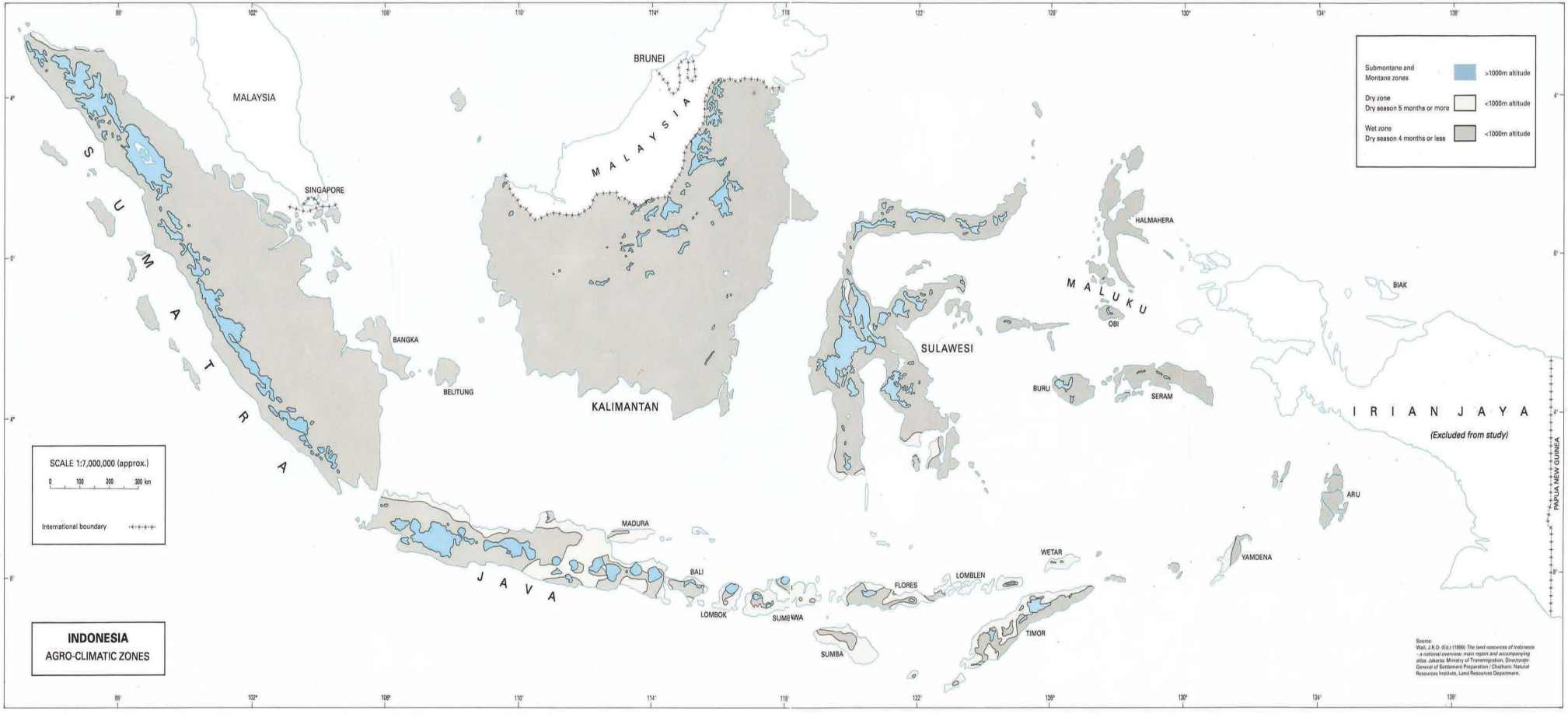
Submontane and Montane zones
>1000m altitude
Dry zone
Dry season 5 months or more
<1000m altitude
Wet zone
Dry season 4 months or less
<1000m altitude
BRUNEI
MALAYSIA
MALAYSIA
SINGAPORE
SUMATRA
BANGKA
BELITUNG
KALIMANTAN
SULAWESI
HALMAHERA
MALUKU
OBI
BURU
SERAM
BIAK
IRIAN JAYA
(Excluded from study)
PAPUA NEW GUINEA
ARU
YAMDENA
WETAR
LOMBLEN
FLORES
TIMOR
MADURA
BALI
LOMBOK
SUMBAWA
SUMBA
JAVA
SCALE 1:7,000,000 (approx.)
0 100 200 300 km
International boundary
INDONESIA
AGRO-CLIMATIC ZONES
Source:
Wall, J.R.D. (Ed.) (1990) The land resources of Indonesia – a national overview: main report and accompanying atlas. Jakarta: Ministry of Transmigration, Directorate General of Settlement Preparation / Chatham: Natural Resources Institute, Land Resources Department.

Table 17 Groundnut pest ranking

Rank	Pest
Sub-montane zone	
1	Bacterial wilt (*Pseudomonas solanacearum*) Peanut stripe virus Pig (*Sus* spp.)
2	Early leaf spot (*Cercospora arachidicola*) Late leaf spot (*Cercosporidium personatum*)
3	Leaf folder (*Hedylepta indicata*) Aphid (*Aphis* spp.)
Dry unirrigated zone	
1	Rust (*Puccinia arachidis*) with Cercospora leaf spot (*Cercospora arachidicola, Cercosporidium personatum*)
2	Viruses as a group: peanut stripe peanut mottle mosaic crinkle leaf
3	Leafhopper (*Empoasca* sp.) Soil-borne fungi (*Sclerotium rolfsii, Rhizoctonia solani*)
4	Leaf roller (*Aproaerema modicella*) Rat (*Rattus* spp.) Armyworm (*Spodoptera litura*)
Wet zone	
1	Rust (*Puccinia arachidis*) with Cercospora leaf spot (*Cercospora arachidicola, Cercosporidium personatum*)
2	Bacterial wilt (*Pseudomonas solanacearum*) Pod borer (*Etiella zinckenella*)
3	Viruses as a group: peanut stripe peanut mottle mosaic crinkle leaf Rat (*Rattus* spp.)
4	Leaf roller (*Aproaerema modicella*) Bean fly (*Ophiomyia phaseoli*)
Dry irrigated zone	
1	Rust (*Puccinia arachidis*) with Cercospora leaf spot (*Cercospora arachidicola, Cercosporidium personatum*)
2	Viruses as a group: peanut stripe peanut mottle mosaic crinkle leaf
3	Leafhopper (*Empoasca* sp.) Rat (*Rattus* spp.)
4	Leaf roller (*Aproaerema modicella* sp.) Armyworm (*Spodoptera litura*) Groundnut aphid (*Aphis craccivora*)

Main source: Sukarami Research Institute for Food Crops.

Table 18 Cassava pest ranking

Rank	Pest
Wet zone	
1	Red spider mite (*Tetranychus urticae*)
2	Leaf spot (*Cercospora* sp., possible confusion with *Cercosporidium henningsii*)
3	Bacterial blight (*Xanthomonas campestris* pv. *manihotis*)
4	Bacterial wilt (*Pseudomonas solanacearum*)
Dry unirrigated zone	
1	Red spider mite (*Tetranychus urticae*)
2	Leaf spot (*Cercospora* sp., possible confusion with *Cercosporidium henningsii*)
3	Bacterial blight (*Xanthomonas campestris* pv. *manihotis*) – in Java and Sumatra
4	Armyworm (*Spodoptera litura*)

Table 19 Chilli pest ranking

Rank	Pest
Sub-montane zone	
1	Armyworm (*Spodoptera* sp.) Anthracnose (*Colletotrichum capsici, C. piperatum*) Viruses as a group: cucumber mosaic tomato mosaic chilli veinal mottle potato virus Y
2	Fruit fly (*Bactrocera* spp. near *dorsalis*) Thrips (*Thrips parvispinus*) Mite (*Polyphagotarsonemus latus*) Cercospora leaf spot (*Cercospora capsici*)
Wet, dry unirrigated and dry irrigated zones	
1	Thrips (*Thrips parvispinus*)
2	Armyworm (*Spodoptera litura*) Anthracnose (*Colletotrichum capsici, C. piperatum*)
3	Viruses as a group: cucumber mosaic tomato mosaic chilli veinal mottle potato virus Y Fruit fly (*Bactrocera* spp. near *dorsalis*) Mite (*Polyphagotarsonemus latus*) Bacterial wilt (*Pseudomonas solanacearum*)
4	Fusarium wilt (*Fusarium oxysporum*) Cercospora leaf spot (*Cercospora* sp.)
5	Bacterial soft rot (*Erwinia carotovora*) Root-knot nematode (*Meloidogyne incognita, M. javanica*) Bacterial leaf spot (*Xanthomonas campestris* f. sp. *vesicatoria*)

Table 20 Garlic pest ranking

Rank	Pest
Sub-montane zone	
1	Armyworm (*Spodoptera* sp.) Purple blotch (*Alternaria porri*) Viruses?
2	Neck rot (*Botrytis allii*)
3	Pink root (*Pyrenochaeta terrestris*)
Dry irrigated zone	
1	Armyworm (*Spodoptera exigua*) Purple blotch (*Alternaria porri*)
2	Thrips (*Thrips parvispinus*)
3	Fusarium wilt (*Fusarium oxysporum*) *Phytophthora porri* Viruses?
4	Mite (Tetranychidae, various species)

Table 21 Shallot pest ranking

Rank	Pest
Sub-montane zone	
1	Purple blotch (*Alternaria porri*)
2	Armyworm (*Spodoptera* sp.) Neck rot (*Botrytis allii*)
3	Thrips (*Thrips parvispinus*)
Dry irrigated zone	
1	Armyworm (*Spodoptera exigua*)
2	Purple blotch (*Alternaria porri*)
3	Anthracnose (*Colletotrichum circinans*) Thrips (*Thrips parvispinus*) Downy mildew (*Peronospora destructor*)
4	Viruses as a group: onion yellow dwarf shallot latent
Wet zone	
1	Purple blotch (*Alternaria porri*) Armyworm (*Spodoptera exigua*)
2	Anthracnose (*Colletotrichum circinans*)
3	Thrips (*Thrips parvispinus*) Downy mildew (*Peronospora destructor*) Viruses as a group: onion yellow dwarf shallot latent
4	Neck rot (*Botrytis allii*) White rot (*Sclerotium cepivorum*) *Stemphylium* sp.

Table 22 Potato pest ranking

Rank	Pest
Sub-montane zone	
1	Late blight (*Phytophthora infestans*)
2	Bacterial wilt (*Pseudomonas solanacearum*) Tuber moth (*Phthorimaea operculella*) Viruses as a group: potato leaf roll potato virus Y Thrips (*Thrips palmi*)
3	Root-knot nematode (*Meloidogyne incognita, M. javanica*)
4	Early blight (*Alternaria solani*)
5	Mole cricket (*Gryllotalpa orientalis*) Common scab (*Streptomyces scabies*)
Dry irrigated zone	
1	Bacterial wilt (*Pseudomonas solanacearum*)
2	Late blight (*Phytophthora infestans*) Tuber moth (*Phthorimaea operculella*) Viruses as a group: potato leaf roll potato virus Y Thrips (*Thrips palmi*)
3	Root-knot nematode (*Meloidogyne* spp.)
4	Early blight (*Alternaria solani*)
5	Mole cricket (*Gryllotalpa* spp.) Common scab (*Streptomyces scabies*)

Table 23 Mung bean pest ranking

Rank	Pest
Sub-montane zone	
1	Pod borer (*Etiella zinckenella*) Green stink bug (*Nezara viridula*) Pod sucking bug (*Riptortus linearis*) Scab (*Elsinoe iwatae*)
2	Aphid (*Aphis* spp.) Armyworm (*Spodoptera litura*) Leaf miner (*Aproaerema* sp.)
3	Rust (*Phakopsora pachyrhizi*)
Dry unirrigated zone	
1	Bean fly (*Ophiomyia phaseoli*)
2	Pod borer (*Maruca testulalis*)
3	Pod sucking bug (*Riptortus linearis, Nezara viridula, Piezodorus hybneri*) Cercospora leaf spot (*Cercospora canescens*)
4	Rat (*Rattus* spp.) Armyworm (*Spodoptera litura*)
5	Soil-borne fungi (*Sclerotium rolfsii, Rhizoctonia solani*)
Wet zone	
1	Pod sucking bug (*Riptortus linearis, Nezara viridula, Piezodorus hybneri*) Pod borer (*Etiella zinckenella*) Cercospora leaf spot (*Cercospora canescens*)
2	Aphid (*Aphis fabae, A. craccivora*) Armyworm (*Spodoptera litura*)
Dry irrigated zone	
1	Bean fly (*Ophiomyia phaseoli*)
2	Pod borers as a group (*Maruca testulalis, Etiella zinckenella; M. testulalis* more important) Cercospora leaf spot (*Cercospora canescens*)
3	Pod sucking bug (*Riptortus linearis*) Rat (*Rattus* spp.) Bacterial wilt (*Pseudomonas solanacearum*)
4	Armyworm (*Spodoptera* spp.)

Main Source Sukarami Research Institute for Food Crops.

Table 24 Cucumber pest ranking in the dry irrigated zone

Rank	Pest
1	Cucumber mosaic virus Leaf-eating beetle (unspecified) Angular leaf spot (*Pseudomonas syringae*) Downy mildew (*Pseudoperonospora cubensis*)
2	Root-knot nematode (*Meloidogyne* spp.) Damping off (*Sclerotium rolfsii, Pythium* spp.) Powdery mildew (*Sphaerotheca fuliginea*) Anthracnose (*Colletotrichum lagenarium*)

Table 25 Carrot pest ranking in the sub-montane, wet and dry irrigated zones

Rank	Pest
1	Root-knot nematode (*Meloidogyne incognita, M. javanica*) Leaf spot (*Alternaria* sp.)

Table 26 Eggplant pest ranking in the dry irrigated zone

Rank	Pest
1	Bacterial wilt (*Pseudomonas solanacearum*)
2	*Phomopsis* sp. Leaf-eating beetle (unidentified) Fruit borer? (*Leucinodes orbonalis*)
3	Bug (unspecified) Mite (unspecified) Root-knot nematode (*Meloidogyne* spp.) Anthracnose (unspecified)

Table 27 French, snap and kidney bean pest ranking in the sub-montane and dry irrigated zones

Rank	Pest
1	Bean fly (*Ophiomyia phaseoli*) Rust (*Uromyces vignae*) Anthracnose (*Colletotrichum lindemuthianum*)
2	Cowpea aphid-borne mosaic virus Groundnut aphid (*Aphis craccivora* – also vector – cowpea aphid-borne mosaic virus)
3	Cercospora leaf spot (*Cercospora* spp.) Bean fly (*Agromyza* sp.) Root-knot nematode (*Meloidogyne incognita, M. javanica*)
4	Armyworm (*Spodoptera litura*)

Table 28 Yardlong bean* pest ranking in the wet and dry irrigated zones

Rank	Pest
1	Armyworm (*Spodoptera litura*)
2	Anthracnose (*Colletotrichum lindemuthianum*) Bean fly (*Ophiomyia phaseoli, Agromyza* sp.) Groundnut aphid (*Aphis craccivora*) Cowpea aphid-borne mosaic virus Cercospora leaf spot (*Cercospora* spp.)
3	Pod sucking bug (*Riptortus linearis, Nezara viridula, Piezodorus hybneri*) Bacterial spot (*Xanthomonas* sp.) Witches broom Pod borer (*Maruca testulalis*)

**Vigna unguiculata* sub. sp. *sesquipedalis*.

Table 29 Cabbage pest ranking

Rank	Pest	Rank	Pest
Sub-montane zone		**Wet and dry irrigated zones**	
1	Diamond-back moth (*Plutella xylostella*) Cabbage moth (*Crocidolomia binotalis*) Clubroot (*Plasmodiophora brassicae*)	1	Diamond-back moth (*Plutella xylostella*)
2	Root-knot nematode (*Meloidogyne incognita, M. javanica*) Black rot and leaf scald (*Xanthomonas campestris* pv. *campestris*) Downy mildew (*Peronospora parasitica*) Powdery mildew (*Sphaerotheca fuliginea*) Bacterial soft rot (*Erwinia carotovora*)	2	Cabbage moth (*Crocidolomia binotalis*)
3	Damping off (*Rhizoctonia solani*)	3	Clubroot (*Plasmodiophora brassicae*) Downy mildew (*Peronospora parasitica*) Alternaria spot (*Alternaria brassicae, A. brassicicola*)
		4	Bacterial soft rot (*Erwinia carotovora*) Cutworm (*Agrotis ipsilon*) Black rot and leaf scald (*Xanthomonas campestris* pv. *campestris*) Damping off (*Rhizoctonia solani*)

Table 30 Tomato pest ranking

Rank	Pest	Rank	Pest
Sub-montane zone		**Dry irrigated zone**	
1	Late blight (*Phytophthora infestans*) Bacterial wilt (*Pseudomonas solanacearum*)	1	Fruit borer (*Helicoverpa armigera*)
2	Fruit borer (*Helicoverpa armigera*) Root-knot nematode (*Meloidogyne incognita, M. javanica*)	2	Bacterial wilt (*Pseudomonas solanacearum*)
		3	Early blight (*Alternaria solani*) Late blight (higher elevation) (*Phytophthora infestans*) Root-knot nematode (*Meloidogyne* spp.) Cucumber mosaic virus (and other viruses)
		4	Cutworm (*Agrotis ipsilon*) Scab? (*Cladosporium* sp.)
		5	Cercospora leaf spot (*Cercospora* sp.) Bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*) Fusarium wilt (*Fusarium oxysporum* f. sp. *lycopersici*)

Table 31 Sweet potato pest ranking

Rank	Pest	Rank	Pest
Sub-montane zone		**Wet zone**	
1	Scab (*Elsinoe batatas*)	1	Sweet potato weevil (*Cylas formicarius*)
2	Sweet potato weevil (*Cylas formicarius*)	2	Scab (*Elsinoe batatas*?, *Streptomyces ipomeae*?)
		3	Little leaf mycoplasma Viruses (unidentified)
		4	Sweet potato borer (*Omphisa anastomosalis*) Sweet potato beetle (*Aspidomorpha punctum*)
		5	Root-knot nematode (*Meloidogyne incognita, M. javanica*)

Table 32 Cotton pest ranking in the dry unirrigated zone

Rank	Pest
1	Cotton jassid (*Amrasca biguttula*)
2	Bollworm (*Helicoverpa armigera*)
3	Spiny bollworm (*Earias vittella*)
4	Pink bollworm (*Pectinophora gossypiella*)
5	Cotton aphid (*Aphis gossypii*)
6	Armyworm (*Spodoptera litura*) Cotton stainer (*Dysdercus cingulatus*) *Botryodiplodia* (*phaseoli? theobromae?*) Bacterial blight (*Xanthomonas campestris* pv. *malvacearum*?)

Table 33 Sugar cane pest ranking

Rank	Pest	Rank	Pest
Wet zone		**Dry irrigated zone**	
1	Top borer (*Scirpophaga nivella*) Sugar cane stalk borer (*Chilo sacchariphagus*) Ratoon stunting disease (*Clavibacter xyli*) Sugar cane mosaic virus Sugar cane smut (*Ustilago scitaminea*)	1	Top borer (*Scirpophaga nivella*) Ratoon stunting disease (*Clavibacter xyli*) Smut (*Ustilago scitaminea*) Sugar cane mosaic virus
2	*Leucopholis* sp. *Ceratovacuna lanigera* Stalk borer (*Chilo auricilius*) Rat (*Rattus argentiventer*) Leaf scald (*Xanthomonas albilineans*) Leaf scorch (*Stagonospora sacchari*) Pokkah boeng (*Fusarium moniliforme*)	2	Sugar cane stalk borer (*Chilo sacchariphagus*) Stalk borer (*Chilo auricilius*) Rat (*Rattus argentiventer*) Leaf scald (*Xanthomonas albilineans*)
3	*Phragmataecia castaneae* *Tetramoera schistaceana* Yellow spot (*Mycovellosiella koepkii*) Root-knot nematode (*Meloidogyne incognita, M. javanica*) Root-lesion nematode (*Pratylenchus* spp.)	3	*Ceratovacuna lanigera*
4	Bandicoot rat (*Bandicota indica*) Wild pig (*Sus* spp.) *Bacteriosis* sp. Rust (*Puccinia kuehnii*)	4	*Bacteriosis* sp. *Tetramoera schistaceana*

Table 34 Cashew pest ranking in the dry unirrigated zone

Rank	Pest
1	Leaf-eating caterpillar (*Cricula trifenestrata*)
2	Tea mosquito-bug (*Helopeltis* spp.) Fruit borer (*Nephopteryx* sp.) Bacterial wilt (*Pseudomonas solanacearum*)
3	Die-back complex (*Botryodiplodia* sp., *Pythium* sp., *Fusarium* sp., *Pestalotia* sp., *Gloeosporium* sp.) Longhorn beetle (*Plocaederus ferrugineus*) Leaf miner (*Acrocercops syngramma*) Mango borer (*Rhytidodera simulans*) *Hypatima haligramma*

Table 35 Pepper pest ranking in the wet zone

Rank	Pest
1	Foot rot (*Phytophthora palmivora*)
2	Yellow disease* (complex of *Radopholus similis, Meloidogyne incognita* and *Fusarium* sp.) Stalk borer (*Lophobaris piperis*)
3	Stunted growth Lace bug (*Diconocoris hewitti*)*
4	Coreid bug (*Dasynus piperis*)
5	Leaf spot (*Colletotrichum piperis*) Thread blight (*Pellicularia koleroga*) *Mehteria hemidoxa* Mealybug (*Planococcus* sp.) Citrus aphid (*Toxoptera* spp.) Termites (*Microtermes* spp.)

*Not found in Lampung Province, where black pepper is produced.

Table 36 Tea pest ranking in the sub-montane zone

Rank	Pest
1	Tea mosquito bug (*Helopeltis antonii, H. theivora*)
2	Mite (*Brevipalpus phoenicis, Polyphagotarsonemus latus*) Blister blight (*Exobasidium vexans*)
3	Root rots as a group*: brick-red disease (*Poria hypolateritia*) wine-red root disease (*Ganoderma pseudoferreum*) (found at lower altitude) Armillaria root disease (*Armillaria mellea*) split canker or shoestring rot (*Armillaria fuscipes*)
4	Root-knot nematode (*Meloidogyne incognita*)
5	Root-lesion nematode (*Pratylenchus loosi*) Leaf roller (*Cydia leucostoma*0 Tea tortrix (*Homona coffearia*)

**Poria hypolateritia* and *Ganoderma pseudoferreum* are the two worst root rots.

Table 37 Coffee pest ranking

Rank	Pest	Rank	Pest
Sub-montane zone		**Wet zone**	
1	Coffee berry borer (*Hypothenemus hampei*)	1	Coffee berry borer (*Hypothenemus hampei*)
2	Root-lesion nematode (*Pratylenchus coffeae*)* Rust (*Hemileia vastatrix*)*	2	Root-lesion nematode (*Pratylenchus coffeae*)
3	Twig borer (*Xyleborus* sp.) Root rot (*Phellinus noxius*) Citrus mealybug (*Planococcus citri*) Coffee mealybug (*Planococcus lilacinus*)	3	Twig borer (*Xyleborus* sp.) Root rot (*Phellinus noxius*) Citrus mealybug (*Planococcus citri*) Coffee mealybug (*Planococcus lilacinus*)
4	Pink disease (*Corticium salmonicolor*)* Stemborer (*Zeuzera coffeae*)* Root-knot nematode (*Meloidogyne incognita, M. javanica*)	4	Rust (*Hemileia vastatrix*) Pink disease (*Corticium salmonicolor*) Stem borer (*Zeuzera coffeae*) Root-knot nematode (*Meloidogyne incognita, M. javanica*)
5	Soft green scale (*Coccus* spp.)*	5	Soft green scale (*Coccus* spp.)

*Major pest of arabica coffee.

Table 38 Cocoa pest ranking in the wet zone

Rank	Pest
1	Tea mosquito-bug (*Helopeltis antonii, H. theivora*)
2	Pod rot (*Phytophthora palmivora*)
3	Stemborer (*Zeuzera coffeae*) Vascular streak die-back (*Oncobasidium theobromae*)* Pod borer (*Conopomorpha cramerella*)† Looper (*Hyposidra talaca*) Citrus mealybug (*Planococcus citri*) Anthracnose (*Colletotrichum gloeosporioides*)‡
4	Pink disease (*Corticium salmonicolor*)
5	Root rot (*Phellinus noxius*)

*Second rank in South Sulawesi and North Maluku.
†First rank in North Maluku.
‡Second rank in East Java.

Table 39 Oil palm pest ranking in the wet zone

Rank	Pest
1	Nettle caterpillars and bagworms as a group nettle caterpillar (*Setothosea asigna, Setora nitens, Darna trima*) bagworm (*Mahasena corbetti, Metisa plana*) Rat (*Rattus tiomanicus, R. diardii*)
2	Root rot (*Ganoderma boninense, Rigidoporus microporus*)
3	Pig (*Sus* spp.)
4	Bunch rot (*Marasmius palmivorus*) Rhinoceros beetle (*Oryctes rhinoceros*) Curvularia leaf spot (*Curvularia eragrostidis*) Anthracnose (*Colletotrichum gloeosporioides*)
5	Early leaf disease (*Botryodiplodia* spp., *Glomerella* sp.) Elephant (*Elephas indicus*)

Table 40 Clove pest ranking in the wet zone*

Rank	Pest
1	Sumatra disease (*Pseudomonas syzygii*) – Sumatra and Java (vector – *Hindola fulva* in Sumatra, *H. striata* in Java)
2	Leaf blight (*Phyllosticta* sp., *Guignardia heveae*)
3	Leaf fall (*Pestalotia* sp., *Colletotrichum* sp.) – particularly North Sulawesi Die-back (*Rhizoctonia* sp., *Rosellinia* sp., *Phoma* sp., *Diplodia* sp.) Ring borer (*Hexamitodera semivelutina*) Stemborer (*Nothopeus* sp.)
4	Leaf rot (*Cylindrocladium quinqueseptatum*) Leaf spot (*Coniella castaneicola*) Arthriticus bug (*Arthriticus eugeniae*) Pestalotiopsis leaf rot (*Pestalotiopsis versicolor*) Anthracnose (*Colletotrichum gloeosporioides*) Twig borer (*Xyleborus* spp.)
5	White root (*Fomes* sp.) Thread blight (*Pellicularia koleroga*) Algal leaf spot (*Cephaleuros virescens*) Downy mildew (*Capnodium* sp.) Red root (*Ganoderma pseudoferreum*)

*Cloves are also grown in the sub-montane zone. No information was obtained on the difference in the pest situation between the two zones.

Table 41 Coconut pest ranking

Rank	Pest
Wet zone	
1	Foot rot (*Phytophthora palmivora*)
2	Leaf-eating bush-cricket (*Sexava nubila*) Leaf-eating caterpillar (*Hidari irava*) Coconut leaf skeletonizer (*Artona catoxantha*) Leaf-eating caterpillar (*Tirathaba* spp.)
3	Natuna wilt (unknown aetiology) Batrachedra caterpillar (*Batrachedra* sp.) Squirrel Pig (*Sus* spp.) Rat (*Rattus* spp.) Rhinoceros beetle (*Oryctes rhinoceros*)
4	Stem bleeding (*Ceratocystis paradoxa, Thieldaviopsis paradoxa*) Coconut leaf diseases as a group: grey leaf spot (*Pestalotiopsis palmarum*) Age < 1 year Drechslera leaf spot (*Drechslera incurvata*) Age < 1 year Curvularia leaf spot (*Curvularia eragrostidis*) Age < 1 year petiole break (*Anthostonella cylindrospora*) Lasmeniella leaf spot (*Lasmeniella cocoes*) Fusarium leaf rot (*Fusarium moniliforme* var. *intermedium*)
5	Basal stem rot (*Ganoderma* sp.) Thread blight (*Corticium* sp.) Leaf pest (*Chalcocelis* spp., *Parasa* spp.) Nettle caterpillar (*Setothosea* sp., *Setora* sp.)

Rank	Pest
Dry unirrigated zone	
1	Rhinoceros beetle (*Oryctes rhinoceros*)
2	Coconut whitefly (*Aleurodicus destructor*) Coconut hispid (*Brontispa* sp.) Black hispid (*Plesispa* sp.) Batrachedra caterpillar (*Batrachedra* sp.)
3	Leaf-eating bush-crickets – particularly Moluccas and North Sulawesi (*Sexava* spp.) Coconut leaf skeletonizer – particularly Moluccas and North Sulawesi (*Artona catoxantha*) Leaf-eating caterpillar – particularly Moluccas and North Sulawesi (*Hidari irava*)
4	Leaf-eating caterpillar (*Tirathaba* spp.)
5	Squirrels Pig (*Sus* spp.) Rat (*Rattus* spp.) Leaf pests (*Chalcocelis* spp., *Parasa* spp.) Nettle caterpillar (*Setothosea* spp., *Setora* spp.)

Table 42 Sago pest ranking in the wet zone

Rank	Pest
1	Red palm weevil (*Rhynchophorus ferrugineus*) Leaf-eating bush-cricket (*Sexava nubila*)

Table 43 Rubber pest ranking in the wet zone (estates and smallholders combined)

Rank	Pest
1	White root rot (*Rigidoporus lignosus*)
2	Anthracnose (*Colletotrichum gloeosporioides*)
3	Secondary leaf fall (*Oidium heveae, Corynespora cassiicola*)
4	Pink disease (*Corticium salmonicolor*) Panel mouldy rot (*Ceratocystis fimbriata*) Root rot (*Ganoderma pseudoferreum, G. philippi*) Pig (*Sus* spp.)
5	Termite (*Macrotermes gilvus*) Bark necrosis (*Botryodiplodia* sp., *Fusarium* sp.) Foot rot (*Phytophthora palmivora*)
6	Eye spot (*Drechslera hevea*) *Ustulina maxima* Algal leaf disease (*Cephaleuros mycoidis*) Root rot (*Phellinus noxius*)

Table 44 Citrus pest ranking in the sub-montane, wet, and dry unirrigated zones

Rank	Pest
1	Citrus greening disease (vector *Diaphorina citri*)
2	Diplodia gummosis and die-back (*Botryodiplodia theobromae*)
3	Foot rot or gummosis (*Phytophthora nicotianae* var. *parasitica*)
4	Tristeza virus
5	Citrus aphid (*Toxoptera aurantii, T. citricidus* – both vectors of Tristeza virus, but *T. aurantii* is inefficient)
6	*Prays endocarpa*
7	Citrus leaf miner (*Phyllocnistis citrella*)

No information was obtained about differences in the pest situation between the zones.

Table 45 Banana pest ranking in the sub-montane, wet and dry unirrigated zones

Rank	Pest
1	Banana weevil (*Cosmopolites sordidus*)
2	Sigatoka (*Mycosphaerella musicola*)
3	Panama disease (*Fusarium oxysporum* f. sp. *cubense*)
4	Fruit fly (*Bactrocera* spp. near *dorsalis*)
5	Bunchy top virus (West Java) Blood disease (*Xanthomonas campestris* pv. *celebensis*) (Sulawesi, similar disease in West Java)

No information was obtained about possible differences in the pest situation between the zones.

Table 46 Pest ranking of the tropical fruits, durian, rambutan, guava and salak, in the wet zone

Fruit	Rank	Pest
Durian	1	Fruit fly (*Drosophila lurida*)
	2	Pink disease (*Corticium salmonicolor*)
Rambutan	1	Coffee mealybug (*Planococcus lilacinus*)
	2	*Nectria* sp.
Guava	1	Fruit fly (*Bactrocera* spp. near *dorsalis*)
	2	*Carea angulata*
	3	*Trabala vishnou*
	4	*Cephaleuros* sp.
Salak	1	*Fusarium* sp.

Table 47 Pineapple and avocado pest ranking in the sub-montane, wet and dry unirrigated zones

Fruit	Rank	Pest
Pineapple	1	Fruit rot (*Thielaviopsis paradoxa*)
	2	Pineapple wilt disease (vector – pineapple mealybug, *Dysmicoccus brevipes*)
Avocado	1	Bark feeder (*Squamura maculata*)
	2	Anthracnose (*Colletotrichum gloeosporioides, Leleum ustilaginoides*)

No information was obtained about possible differences in the pest situation between these zones.

Table 48 Pawpaw pest ranking in the wet zone

Rank	Pest
1	Anthracnose (*Colletotrichum gloeosporioides*)
2	Soft green scale (*Coccus viridis*)

In the tables of pest ranking by zone it has been assumed that 10% of the pawpaw is in the dry unirrigated zone, with no changes in the disease situation.

Table 49 Mango pest ranking in the dry unirrigated zone

Rank	Pest
1	Leafhopper (*Idioccopus clypealis, I. niveosparsus*)
2	Fruit fly (*Bactrocera* spp. near *dorsalis*)
3	*Pseudomonas mangiferae*

Table 50 Apple pest ranking in the sub-montane zone

Rank	Pest
1	Pink disease (*Corticium salmonicolor*)
2	Apple aphid (*Aphis pomi*)

Table 51 Relative importance of non-weed pests* in Indonesia as a whole and their importance ranking in each zone

			Importance ranking Zones‡			
Score†	Pest	Crops attacked	1	2	3	4
153	Rat (*Rattus* spp., particularly *Rattus argentiventer*)	Rice, oil palm, sugar cane, maize, cassava, soyabean, groundnut, coconut, mung bean, sweet potato	4	1	1	1
131	Stemborer (*Scirpophaga innotata, S. incertulas, Chilo suppressalis, Sesamia inferens*)	Rice	5	2	2	2
113	Bacterial leaf blight (*Xanthomonas campestris* pv. *oryzae*)	Rice	2	2	–	2
101	Brown planthopper (*Nilaparvata lugens*)	Rice	–	3	5	2
98	Armyworm (*Spodoptera litura, S. exigua*)	Soyabean, shallot, chilli, garlic, mung bean, kidney bean, yardlong bean, rice, maize, tobacco, cassava, cotton, groundnut	2	5	2	2
90	Bacterial wilt (*Pseudomonas solanacearum*)	Potato, tomato, cassava, groundnut, chilli, tobacco, ginger, cashew, egg-plant	4	4	3	5
90	Tungro virus	Rice	7	4	4	3

Table 51 – *continued*

Score†	Pest	Crops attacked	Importance ranking Zones 1	2	3	4
88	Root-knot nematode (mostly *Meloidogyne incognita, M. javanica*)	Coffee, tea, cabbage, potato, sweet potato, tomato, kidney bean, sugar cane, tobacco, chilli, cucumber, carrot, eggplant	1	4	5	5
88	Rice bug (*Leptocorisa* spp., mostly *L. oratorius* and *L. acuta*)	Rice	5	5	2	3
86	Rice blast (*Pyricularia oryzae*)	Rice	1	4	2	–
82	Red spider mite (*Tetranychus urticae*)	Cassava, taro	–	3	3	–
79	Narrow brown leaf spot (*Cercospora oryzae*)	Rice	–	4	5	4
78	*Thrips parvispinus*	Garlic, shallot, chilli	6	5	3	4
78	Pod borer (*Etiella zinckenella*)	Soyabean, groundnut, mung bean	4	5	3	5
77	Seedling fly (*Atherigona* spp.)	Dryland rice, maize	4	4	3	–
77	Pod sucking bug (*Riptortus linearis, Nezara viridula, Piezodorus hybneri*)	Soyabean, mung bean, yardlong bean, rice	4	5	2	6
76	Berry borer (*Hypothenemus hampei*)	Coffee	1	3	–	–
76	Sheath blight (*Rhizoctonia solani*)	Rice	6	4	–	3
76	*Phytophthora palmivora*	Pepper, coconut, cocoa, rubber	–	2	–	–
71	Oriental fruit fly (*Bactrocera* spp. near *dorsalis*)	Banana, guava, mango, chilli	5	5	3	6
70	Citrus greening (CVPD)	Citrus	1	5	3	–
69	Sumatra disease (*Pseudomonas syzygii*)	Clove	5	3	–	–
68	Groundnut rust with leaf spot (*Puccinia arachidis* with *Cercospora* spp.)	Groundnut	5	5	4	6
66	Anthracnose (*Colletotrichum gloeosporioides*)	Rubber, clove, oil palm, pawpaw, cocoa, citrus, nutmeg	7	3	7	–
66	*Cercosporidium henningsii*	Cassava	–	4	4	–
65	Bean fly (*Ophiomyia phaseoli*)	Soyabean, groundnut, mung bean, yardlong bean, French, snap and kidney bean	4	6	3	5
63	White root disease (*Rigidiporous lignosus*)	Rubber	–	3	–	–
63	Purple blotch (*Alternaria porri*)	Shallot, garlic	4	5	–	4
63	Banana weevil (*Cosmopolites sordidus*)	Banana	3	5	4	–
62	Diamond-back moth (*Plutella xylostella*)	Cabbage	2	5	–	5
62	Root-lesion nematode (*Pratylenchus coffeae*)	Coffee	2	4	–	–
60	Pink disease (*Corticium salmonicolor*)	Rubber, coffee, durian, cocoa	3	4	–	–
60	Pig (*Sus* spp.)	Rubber, coconut, oil palm, sugar cane, groundnut, maize, other annual crops near forest, particularly in transmigration areas	5	4	7	–
60	Soyabean rust (*Phakopsora pachyrhizi*)	Soyabean	5	6	4	5
58	Chilli viruses	Chilli	6	6	5	4

Table 51 – *continued*

Score†	Pest	Crops attacked	Importance ranking Zones 1	2	3	4
58	Sweet potato weevil (*Cylas formicarius*)	Sweet potato	6	5	6	6
58	Java downy mildew (*Peronosclerospora maydis*)	Maize	–	5	4	7
57	Sheath rot (*Sarocladium oryzae*)	Rice	7	5	–	4
57	Sigatoka (*Mycosphaerella musicola*)	Banana	4	5	5	–
55	Gall midge (*Orseolia oryzae*)	Rice	–	5	–	4
54	Leaf blight (*Phylosticta* sp., *Guignardia heveae*)	Clove	6	4	–	–
53	Rhinoceros beetle (*Oryctes rhinoceros*)	Coconut, oil palm	–	5	4	–
51	Groundnut viruses	Groundnut	5	6	5	6
50	Nettle caterpillar and bagworm (*Setothosea asigna, Setora nitens, Darna trima, Mahasena corbetti, Metisa plana*)	Oil palm (*Setothosea* and *Setora* spp., also coconut pests)	–	4	–	–
50	Yellow tea mite (*Polyphagotarsonemus latus*)	Tea, chilli	5	6	5	6
49	Tea mosquito-bug (*Helopeltis antonii, H. theivora*)	Tea, cocoa	2	5	–	–
49	Bacterial blight (*Xanthomonas campestris* pv. *manihotis*)	Cassava	–	5	5	–
47	Twig borer (*Xyleborus* sp.)	Coffee, clove	3	5	–	–
47	Root rot (*Phellinus noxius*)	Coffee, cocoa, rubber	3	5	–	–
47	Citrus mealybug (*Planococcus citri*)	Coffee, cocoa	3	5	–	–
47	Coffee mealybug (*Planococcus lilacinus*)	Coffee	3	5	–	–
47	Sugar cane top borer (*Scirpophaga nivella*)	Sugar cane	–	6	–	3
47	Ratoon stunting disease (*Clavibacter xyli*)	Sugar cane	–	6	–	3
47	Sugar cane mosaic virus	Sugar cane	–	6	–	3
47	Sugar cane smut (*Ustilago scitaminea*)	Sugar cane	–	6	–	3
46	*Botryodiplodia theobromae*	Citrus (rubber – species of *Botryodiplodia* uncertain)	3	6	5	–
46	Soyabean viruses	Soyabean	5	7	3	6
45	Cabbage moth (*Crocidolomia binotalis*)	Cabbage	2	6	–	6
45	Clubroot (*Plasmodiophora brassicae*)	Cabbage	2	6	–	6
45	Leaf-eating bush-cricket (*Sexava nubila*)	Coconut, sago	–	5	6	–
45	Leaf-eating caterpillar (*Hidari irava*)	Coconut	–	5	6	–
45	Coconut leaf skeletonizer (*Artona catoxantha*)	Coconut	–	5	6	–
45	Brown spot (*Drechslera oryzae*)	Dryland rice	–	6	3	–
43	Leaf scald (*Xanthomonas albilineans*)	Sugar cane	–	6	–	4
43	Sugar cane stalk borer (*Chilo saccariphagus*)	Sugar cane	–	6	–	4

Table 51 – *continued*

Score†	Pest	Crops attacked	Importance ranking Zones 1	2	3	4
43	Stalk borer (*Chilo auricilius*)	Sugar cane	–	6	–	4
42	Earworm or fruit borer (*Helicoverpa armigera*)	Maize, soyabean, tobacco, tomato, cotton, pigeon pea, sorghum	5	–	2	5
42	Leaf-eating caterpillar (*Tirathaba* spp.)	Coconut	–	5	7	–

*The relative importance of weed pests in Indonesia as a whole is shown in Table 64.
†Derived from Tables 2, 6–9. Scores are calculated from pest ranks and the values of zonal crop production as described on page 11.
‡1=sub-montane zone
2=wet zone
3=dry unirrigated zone
4=dry irrigated zone

Table 52 The relative importance of non-weed rice pests in Indonesia

Pest	Score*
Rats (*Rattus* spp.)	685
Stemborer (various species)	585
Bacterial leaf blight (*Xanthomonas campestris* pv. *oryzae*)	531
Brown planthopper (*Nilaparvata lugens*)	461
Tungro virus	380
Sheath blight (*Rhizoctonia solani*)	362
Rice bug (*Leptocorisa* spp.)	348
Narrow brown leaf spot (*Cercospora oryzae*)	346
Rice blast (*Pyricularia oryzae*)	321
Sheath rot (*Sarocladium oryzae*)	267
Gall midge (*Orseolia oryzae*)	262
Seedling fly (*Atherigona exigua*)	216
Brown spot (*Drechslera oryzae*)	157
Leaf scald (*Rhyncosporium oryzae*)	142
Leaf folder (*Cnaphalocrocis medinalis*)	136
Grain discoloration (*Drechslera* sp., *Cercospora* sp., *Fusarium* sp.)	122
Armyworm (*Spodoptera* spp.)	109
Birds	81
Mole cricket (*Gryllotalpa orientalis*)	81
False smut (*Ustilaginoidea virens*)	61
Foot rot or bakanae (*Gibberella fujikuroi*)	61
Pig (*Sus* spp.)	61
Black bug (*Scotinophara* spp.)	61
Grassy stunt and ragged stunt viruses	54
Bacterial leaf streak (*Xanthomonas campestris* pv. *oryzicola*)	30
Stink bug (*Nezara* spp.)	28
Whorl maggot (*Hydrellia philippina*)	25
Caseworm (*Parapoynx stagnalis*)	25

*Derived from Tables 10-13. Intermediate scores are allocated to pest ranks as follows:

Rank	Score
1	7
2	6
3	5
4	4
5	3
6	2
7	1

These are then multiplied by the percentage of the national rice crop in each zone (see Table 3) to give scores for each zone. The zonal scores are added to give the scores in the table.

Table 53 Comparison of rice pest ranking in Table 51* with that in Table 52†

Score	Pest	Score	Pest
Table 51	*Ranking*	*Table 52*	*Ranking‡*
153	Rat (*Rattus* spp.)	685	Rat (*Rattus* spp.)
131	Stemborer (various species)	585	Stemborer (various species)
113	Bacterial leaf blight (*Xanthomonas campestris* pv. *oryzae*	531	Bacterial leaf blight (*Xanthomonas campestris* pv. *oryzae*)
101	Brown planthopper (*Nilaparvata lugens*)	461	Brown planthopper (*Nilaparvata lugens*)
90	Tungro virus	380	Tungro virus
88	Rice bug (*Leptocorisa* spp.)	362	Sheath blight (*Rhizoctonia solani*)
86	Rice blast (*Pyricularia oryzae*)	348	Rice bug (*Leptocorisa* spp.)
79	Narrow brown leaf spot (*Cercospora oryzae*)	346	Narrow brown leaf spot (*Cercospora oryzae*)
76	Sheath blight (*Rhizoctonia solani*)	321	Rice blast (*Pyricularia oryzae*)
57	Sheath rot (*Sarocladium oryzae*)	267	Sheath rot (*Sarocladium oryzae*)
55	Gall midge (*Orseolia oryzae*)	262	Gall midge (*Orseolia oryzae*)
45	Brown spot (*Drechslera oryzae*)	157	Brown spot (*Drechslera oryzae*)

*Derived from Tables 6–9 giving pest ranking by zone across all crops.
†Derived from Tables 10–13 giving rice pest ranking by zone.
‡Seedling fly is omitted because it is also a pest of maize. Pests with scores less than that of brown spot are also omitted.

Table 54 Rice pest ranking for Southeast Asia* (all ecosystems)

Rank	Pest
1	Rats (mostly *Rattus* spp.)
2	Tungro virus (vector-*Nephotettix virescens, N. nigropictus*) Brown planthopper (*Nilaparvata lugens*) Stemborer (various species) Rice blast (*Pyricularia oryzae*)
3	Gall midge (*Orseolia oryzae*) Sheath blight (*Rhizoctonia solani*) Brown spot (*Drechslera oryzae*)
4	Rice bug (*Leptocorisa oratius*) Birds (various species)
5	Hispa (*Dicladispa armigera*) Bacterial leaf blight (*Xanthomonas campestris* pv. *oryzae*) Leaf folder (*Cnaphalocrocis medinalis*)
6	Golden apple snail (*Pomacea canaliculata*) – Philippines Ufra disease (*Ditylenchus angustus* nematode)

Source: IRRI respondents, principally P. S. Teng, K. L. Heong and, for insects only, Z. R. Khan. No revision of the assessment has been made in the light of the later assessment of pest ranking in Indonesia made by the author.
*Myanmar (Burma), Thailand, Vietnam, Cambodia, Laos, Malaysia, Indonesia, Philippines.

Table 55 Relative importance of weeds in irrigated and rainfed rice

Rank	Weed
1	*Echinochloa crusgalli* *Monochoria vaginalis*
2	*Paspalum distichum* *Cyperus difformis* *Fimbristylis littoralis* *Leptochloa chinensis* *Cyperus iria* *Scirpus juncoides*
3	*Echinochloa colona* *Spenochloa zeylanica* *Salvinia molesta* *Paspalum paspaloides* *Scirpus maritimus* *Scirpus lateriflorus* *Jussae* spp.

The tabulated order within ranks represents a tentative order of importance within the rank.

Table 56 Relative importance of weeds in dryland rice*

Rank	Weed
1	*Cyperus rotundus* *Echinochloa colona* *Eleusine indica* *Digitaria sanguinalis* and/or† *D.ciliaris*
2	*Ageratum conyzoides* *Imperata cylindrica* *Borreria alata* *Cynodon dactylon*
3	*Croton hirtus* *Amaranthus spinosus* *Portulaca oleraceae* *Phyllanthus niruri* *Mimosa invisa* *Digitaria mida*

The tabulated order within ranks represents a tentative order of importance within the rank.
*The dryland rice weeds are also important in maize, soyabean and groundnuts. In these crops *D.ciliaris, E.colona, C.rotundus* and *B.alata* are particularly important; in groundnuts *P.oleraceae* is also very important.
†There may be some confusion between these two species of *Digitaria*.

Table 57 Relative importance of weeds in deepwater rice

Rank	Weed
1	*Paspalum paspaloides*
2	*Isachne globosa*
3	*Panicum repens*

Source: personal communication from Dr Soekisman, SEAMEO-BIOTROP, Bogor, Indonesia (November 1990).

Table 58 Weeds of tidal swamp rice

Brachiaria paspaloides
Paspalum distichum
Leersia hexandra
Fimbristylis littoralis
Cyperus iria
Eleocharis sp.

Source: Bangun, P. and Wiroatmodjo, J. (1986). Dominant weeds and their control in Indonesian food crops. In *Symposium in Weed Science*, BIOTROP Publication No. 24.
The tabulated order does not indicate order of importance.

Table 59 Relative importance of weeds in cassava, sweet potato, taro and pineapple

Rank	Weed
1	*Imperata cylindrica* *Cyperus rotundus* *Ageratum conyzoides*
2	*Eupatorium odoratum* *Clidemia hirta* *Croton hirtus* *Melastoma malabathricum*

Source: personal communication from Dr Soekisman, SEAMEO-BIOTROP, Bogor, Indonesia (November 1990).

Table 60 Major weeds of potato, cabbage and tomato

	Potato	Cabbage	Tomato
Galinsoga parviflora	**	**	**
Portulaca oleraceae	**	**	**
Drymaria cordata	*	**	**
Polygonum nepalense	*	**	**
Cynodon dactylon	*	*	**

Source: Sastrosiswojo (1990).
**Important.
* Less important.

Table 61 The most frequently found important weeds of vegetables that propagate by seed in the highlands of Java

Galinsoga parviflora
Polygonum nepalense
Eleusine indica
Digitaria ciliaris
Drymaria cordata
Drymaria villosa

Source: Everaats, A.P. (1981) *Weeds of Vegetables in the Highlands of Java*. Jakarta: Horticultural Research Institute, Pasarminggu.
The tabulated order does not indicate order of importance.

Table 62 Relative importance of weeds in perennial estate and industrial crops*

Rank	Weed	Crops infested
1	*Imperata cylindrica*	ROC† and others
	Other grasses as a group:	
	Ischaemum timorense, I.rugosum	ROC and others
	Ottochloa sp.	ROC and others
	Paspalum conjugatum	ROC, tea, cocoa and others
	Brachiaria mutica	Coconut in North Sulawesi
2	*Chromolaena odorata*	ROC, coffee, cocoa
	Borreria alata	Rubber (particularly West Kalimantan), tea, cocoa, coffee
	Mikania micrantha	ROC, coffee: competes with cover crop as well as main crop
3	*Cyperus rotundus, C.kyllingia*	Robusta coffee; some in tea and cocoa
	Lantana camera	
	Mimosa invisa	Sometimes used as cover crop, but interferes with operations
	Mimosa pudica	As above
	Melastoma malabathricum	Rubber
4	*Ageratum conyzoides*	ROC, tea, cocoa
	Panicum sp.	ROC, *P. repens* in tea
	Setoria plicata	Robusta coffee, cocoa
	Centatheca lappacea	ROC (South Sumatra)
	Themeda argueus	ROC
	Themeda villosus	ROC (Kalimantan)
	Clidemia hirta	ROC
	Clibadium surinamense	ROC
	Tetracera sp.	ROC
	Gleichenia linearis	Rubber (Riau, West Kalimantan and South Sumatra)
	Ottochloa nodusa	Rubber

*Rubber, coffee, oil palm, clove, coconut, pepper, tea, nutmeg, cocoa.
†ROC = Rubber, oil palm, coconut.

Table 63 Relative importance of weeds in sugar cane in Java*

Irrigated		Unirrigated	
Rank	Weed	Rank	Weed
1	*Cyperus rotundus* *Cynodon dactylon* *Echinochloa colona*	1	*Echinochloa colona*
2	*Leptochloa chinensis* *Brachiaria repans* *Polytrias amaura*	2	*Digitaria ciliaris*
3	*Heliotropium indicum* *Fimbristylis miliac*	3	*Cyperus rotundus*

Source: personal communication from Dr Boedijino Wiroatmodjo, Indonesian Sugar Research Institute, Pasuaran (December 1990).
*In 1987 Java produced 86% of Indonesian sugar cane production.

Table 64 Relative importance of weeds in Indonesia as a whole

Rank	Weed	Crops infested
1	*Imperata cylindrica*	Perennial estate and industrial crops, dryland rice, cassava, sweet potato, taro, pineapple, maize, soyabean, groundnut, uncultivated potential areas for dryland crops, durian, citrus
	Echinochloa crusgalli	Irrigated and rainfed rice
	Monochoria vaginalis	Irrigated and rainfed rice
2	*Paspalum distichum*	Irrigated and rainfed rice
	Paspalum conjugatum	Perennial estate and industrial crops, citrus, mango, durian
	Cyperus difformis	Irrigated and rainfed rice
	Cyperus iria	Irrigated and rainfed rice
	Cyperus rotundus	Dryland rice, maize, soyabean, groundnut, cassava, Robusta coffee, tea, cocoa, citrus, mango, shallot, garlic, cabbage, sugar cane
	Marsilea crenata	Irrigated and rainfed rice
	Fimbristylis littoralis	Irrigated and rainfed rice, irrigated sugar cane
	Leptochloa chinensis	Irrigated and rainfed rice, irrigated sugar cane
	Scirpus juncoides	Irrigated and rainfed rice
	Echinochloa colona	Dryland rice, maize, soyabean, groundnut, irrigated and rainfed rice, shallot, garlic, sugar cane
	Eleusine indica	Dryland rice, maize, soyabean, groundnut, cabbage
	Digitaria sanguinalis, D. ciliaris	Dryland rice, maize, soyabean, groundnut, mango
	Cynodon dactylon	Dryland rice, maize, soyabean, groundnut, tea, shallot, garlic, cabbage, irrigated sugar cane
	Ageratum conyzoides	Dryland rice, maize, soyabean, groundnut, cassava, cabbage
	Borreria alata	Dryland rice, maize, soyabean, groundnut, rubber, tea, cocoa, coffee
	Chromolaena odorata	Rubber, oil palm, coconut, coffee, cocoa
	Mikania micrantha	Rubber, oil palm, coconut, coffee
	Ischaemum timorense, I. rugosum	Perennial estate and industrial crops; *I. timorense* also in direct seeded rainfed or irrigated rice

Source: analysis of Tables 55-63.

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Appendices

APPENDIX 1: INSTITUTIONS AND PERSONS CONSULTED

International Rice Research Institute (IRRI)
- Dr K. L. Heong, Head, Entomology Division
- Dr R. C. Saxena, Entomologist
- Dr Z. R. Khan, Entomologist
- Dr G. R. Quick, Head, Agricultural Engineering Division (also gave information on rodents)
- Dr N. K. Awadhwal, Agricultural Engineer
- Dr H. Koganezawa, Virologist
- Dr P. S. Teng, Co-ordinator Integrated Pest Management (Pathologist)
- Dr L. Villaneura, Nematologist
- Dr J. M. Bonman, Pathologist
- Ms N. Vera Cruz, Pathologist
- Dr M. Arraudeau, Upland Rice Programme Leader
- Dr R. Chavez, Weed Scientist
- Dr P. L. Pingali, Agricultural Economist

Indonesia

National Estate Crop Plant Protection Project
- Mr D. Laycock, Weed Scientist

Centre for Policy and Implementation Studies
- Dr C. P. A. Bennett, Tree Crop Specialist

Centre for Agro-economic Research
- Dr B. Hutabarat, Agricultural Economist
- Mr V. T. Manurung, Agricultural Economist
- Mr Hermanto, Agricultural Economist

Badan Koordinasi Survey Dan Pemetaan Nasional (BAKOSURTANAL)
- Mr Wirawan

Directorate of Food Crop Protection
- Mr M. Rais, Sub-Director, Pest Observation and Forecasting
- Mr Haryono, Pest Observation and Forecasting
- Mr Yusmin, Pest Observation and Forecasting
- Mr Gunardi, Pest Observation and Forecasting

Training and Development of Integrated Pest Management in Rice-based Cropping Systems Project
- Dr R. Dilts, Team Leader
- Mr H. Wibakti, Network Officer

Harvard Institute for International Development
- Dr W. Linser, Food Security Adviser

Directorate of Estate Crop Protection
- Dr Ir M. Soehardjan, Director

Directorate of Production Development for Horticulture
Dr A. P. Tjiptono, Sub-Director, Pest Management and Post Harvest
Ms A. Anwar, Vegetable Specialist
Mr P. Yuliani, Fruit Specialist

South-East Asian Regional Centre for Tropical Biology
Prof. H. S. S. Tjitrosomo, Director
Dr Soekisman, Weed Scientist

Agricultural University, Bogor Department of Plant Pests and Diseases
Dr A. Rauf, Head of Department (Entomologist)
Dr A. Toerngadi, Rat Specialist
Dr S. Mandang, Pathologist
Dr S. Satari, Pathologist
Dr S. Sosromarsono, Entomologist

Maros Research Institute for Food Crops
Dr A. Hasanuddin, Director (Pathologist)
Dr Ir Djafar Baco, Entomologist
Dr J. Tandiabang, Entomologist
Dr S. Rahamma, Pathologist
Dr W. Akib, Entomologist
Dr Zubachtirodin
Dr A. M. Usman

Food Crop Protection Centre, Maros, South Sulawesi
Ir Shagir Sama, Director

Research Co-ordinating Centre for Food Crops/Bogor Research Institute for Food Crops
Dr Ir J. Soejitno, Entomologist
Ir Rochman, Rodent and Wild Pig Specialist
Dr Mahmud, Pathologist
Dr P. Bangun, Weed Scientist
Dr Sutrisno, Entomologist
Dr B. Soegiarto, Entomologist
Dr E. Soenarjo (Provided checklist of scientific names of insect pests)

Bogor Research Institute for Estate Crops
Dr S. Wardojo, Director (Entomologist)
Dr P. Soekirman (Pathologist)
Dr D. Sudarmadji (Entomologist)
Ir B. Soepadmo (Pathologist)
Dr K. A. Mulyadi (Nematologist)
Dr Basuki (Weed Scientist)
Dr Sumaryono (Weed Scientist)
Dr A. Purwantara (Pathologist)

Lembang Horticultural Research Institute
Dr S. Sastrosiswojo, Research Co-ordinator (Entomologist)
Ir M. Suwandi, Agronomist
Dr Ir A. V. Vidjaja, Nematologist
Dr A. S. Duriat, Virologist
Ir Adi, Agricultural Economist
Ir J. S. Buurma, Agricultural Economist
Dr Ir G. J. H. Grubben, Team leader Dutch Technical Assistance Team (Agronomist)

Centre for Research and Development of Industrial Crops/Research Institute for Spices and Medicinal Crops
Dr A. Munaan, Entomologist
Dr D. Soetopo, Pathologist
Dr R. Balfas, Entomologist
Dr E. K. Rusansi, Entomologist (ranked cotton pests)
Dr A. Abdullah (ranked tobacco pests)

ICI Pesticides, Indonesia
Ir N. M. Holil, Entomologist

Indonesian Planters Association for Research and Development
Dr T. Subagyo, Weed Management Specialist

Jember Research Institute for Estate Crops (Coffee and Cocoa)
Dr Ir I. Hartana, Associate Director of Research
Mr Zaenudin

Sukamandi Research Institute for Food Crops
Dr A. M. Fagi, Director
Dr S. Kartaatmadja
Mr Yulianto

Sukarami Research Institute for Food Crops
Dr Z. Lamid, Research Co-ordinator

Research Institute for Estate Crops, Sembawa (Rubber)
Dr M. Sultoni Arifin, Director

Sungei Putih Research Institute for Estate Crops (Rubber)
Dr Ir Basuki, Director

Research Institute for Tea and Cinchona
Ir D. A. Sudarma, Director

Indonesian Sugar Research Institute, Pasuruan
Dr B. Wirioatmodjo, Associate Director of Agriculture Department

Medan Research Institute for Estate Crops (Oil palm)
Dr K. Pamin, Director

United Kingdom

Dr J. R. D. Wall, Natural Resources Institute, information on agro-climatic zones of Indonesia
Mr M. Milchard, Natural Resources Institute, spice crops
Mr A. Hone, Natural Resources Institute, information on production and prices of fruits and vegetables
Dr J. Bridge, Nematologist, CAB International Institute of Parasitology, St Albans
Dr T. Woodford, Entomologist, Scottish Crop Research Institute, Invergowrie
Dr C. J. Lomer, CAB International Institute of Biological Control, Ascot, information on Sumatra disease of cloves
Dr M. E. Irwin, visiting from Illinois University, USA, information on soyabean pests

APPENDIX 2 CALCULATION OF ZONAL CROP PRODUCTION VALUES

Introduction

Various sources were used for volume of national production and unit price of crops. Details are given below. The lack of a single source of information for all crops introduces the possibility of some comparability differences between data taken from different sources, e.g. between the prices of the three groups vegetables, fruits and other crops. For a few crops, mostly minor ones, for which data were lacking, the prices of crops with some similarity were used as a proxy.

For crops such as rubber, tea, coffee, coconut, oil palm, tobacco and sugar cane, which are processed shortly after harvest, it was not entirely clear from the sources how comparable the values for these crops were with those of crops marketed fresh or receiving simpler treatment such as shelling or husking. As production losses from pest attack are likely to increase the unit costs of

processing, inclusion in the crop value of some of the value added by processing is in fact appropriate for this study.

The basis for estimating the distribution of the total production value of each crop between zones is given in the main text (page 5). Table E gives the actual figures for volume, price and value used.

Table A Sources of production volume data

Crop	Source
Rice (unhusked) Maize (shelled) Cassava (fresh) Sweet potato Groundnut (shelled) Soyabean (shelled)	Food Crops Statistics Division (1988) *Agricultural survey : production of cereals in Indonesia 1987*. Jakarta : Central Bureau of Statistics. 1987 data.
Mung bean	Tantera D. M. (1988) Breeding for disease resistance in coarse grains and food legume crops of Indonesia. *Indonesian Agricultural Research and Development Journal*, **10** (4). Jakarta : Agency for Agricultural Research and Development. Table 1. 1987 data.
Tobacco Rubber Oil palm (oil and kernels) Coffee Tea Coconut Clove Pepper Cassiavera Cashew Cotton Kapok Sugar cane	Directorate General of Estate Crops (1989) *Indonesian estate crop statistics, 1984-1989*. Jakarta : Directorate General of Estate Crops. Table 2.1. For cotton, area rather than production volume was used (see source of price data for cotton). For sugar cane, the production data for sugar was used. 1987 data.
Chilli Shallot Yardlong bean/ cowpea Garlic Cucumber Cabbage Chinese cabbage Tomato Potato French, snap and kidney bean Eggplant Carrot Banana Citrus Pawpaw Mango Pineapple Avocado Salak Rambutan Durian Guava	Food Crops Statistics Division (1988) *Agricultural survey : production of vegetables and fruits in Indonesia*. Jakarta : Central Bureau of Statistics. 1988 data.
Apple	

Table B Sources of price data (all 1987)

Crop	Source
Rice (unhusked) Maize (shelled) Cassava (fresh) Sweet potato Groundnut (shelled) Soyabean (shelled) Tobacco Rubber Coffee Tea Copra Clove Pepper Cassiavera Potato Sugar cane	*Statistik harga konsumen dan harga perdagangan besar (October 1989). Statistik harga perdagangan besar beberapa provinsi di Indonesia.* Jakarta : Central Bureau of Statistics. For sugar cane, the data was for 'local refined sugar'. To allow for the costs of transport of cane and for milling and refining, the value of sugar cane production was assumed to be 60% of the value of the production of 'local refined sugar', 60% is the farmers' share of the proceeds of sugar production (Nataatmadja, H., 1986).
Mung bean	Assumed to be the same price as groundnut.
Nutmeg	Assumed to be the same price as pepper.
Cotton	No price statistics available, so value of production per hectare assumed to be the same as that of soyabean. Value of cotton production then equals: $\frac{\text{cotton area}}{\text{soyabean area}} \times$ value of soyabean production.
Cocoa	Producer price data not available. It was estimated as follows. From Table 2.5 in Directorate General of Estate Crops (1989) the mean export price for 1986, 1987, 1988 was calculated for cocoa, coffee and tea. Producer prices for coffee and tea were available (see above). The producer price of cocoa was assumed to bear the same relation to its export price as the relation of the producer prices of coffee and tea to their export prices. The prices were:

Crop	Mean export price 1986-88 (US$/t)	Producer price 1987 (Rp/kg)
Coffee	2152	2232
Tea	1306	1141
Cocoa	1566	n.a.

Producer price of cocoa estimated as:

$$0.5\left(\frac{1566 \times 2232}{2152} + \frac{1566 \times 1141}{1306}\right)$$

= 1496 Rp/kg.

Cashew	No price statistics available, so value of production per ha assumed to be the same as that of cocoa. Value of production of cashew then equals: $\frac{\text{cashew area}}{\text{cocoa area}} \times$ value of cocoa production
Palm oil and kernel	Producer price data not available. Following a similar estimation procedure to that used for cocoa, the producer prices of palm oil and kernel were assumed to bear the same relation to their export prices as the relation of the producer prices of coffee, tea and rubber to their export prices. The prices were:

Crop	Mean export price, 1986-88 (US$/t)	Producer price 1987 (Rp/kg)	Producer price divided by export price
Coffee	2152	2232	1.037
Tea	1306	1141	0.874
Rubber	906	702	0.775
Palm oil	289.9	n.a.	–
Palm kernel	183.9	n.a.	–
Mean			0.895

Table B—*continued*

Crop	Source
	The producer price of palm oil was estimated to be: 189.9 × 0.9 = 260.9 Rp/kg. The producer price of palm kernels was estimated to be: 183.9 × 0.9 = 165.5 Rp/kg.
Cabbage Chilli Tomato Eggplant Cucumber French and snap bean (assumed to include kidney bean)	Source A in Table C.
Potato	As described earlier, the potato producer price used in the study is Rp/kg 333, calculated from the provincial data in *Bagian statistik harga kronsumen dan harga perdagangan, October 1989*. This is similar to the potato producer price of Rp/kg 339 in source A in Table C.
Yardlong bean and kidney bean	Price assumed to be Rp/kg 358, the same as French and snap bean, source A in Table C.
Shallot, garlic, chinese cabbage, carrot	The prices of these crops were assumed to bear the same relation to their prices in source B as the price of cabbage in source A bears to its price in source B, i.e. a ratio of 1.75 (sources in Table C). The producer price estimates are Shallot 1.75 × 560 = 980 Rp/kg Garlic 1.75 × 1600 = 2800 Rp/kg Chinese cabbage 1.75 × 130 = 228 Rp/kg Carrot 1.75 × 130 = 228 Rp/kg
Citrus Pawpaw Avocado Mango Rambutan Durian Guava Banana Pineapple Salak Apple	Source A in Table D. The price of citrus was assumed to be the same as the price of orange. The prices of these crops were assumed to bear the same relation to their prices in source C as the price of pawpaw in source A bears to its price in source C, i.e. $\frac{232}{200}$ = 1.16 times their prices in source C (sources in Table D).

Table C Available data for vegetable prices and their sources*

Crop	Source A† 1987 prices (Rp/kg)	Source B‡ 1988 prices (Rp/kg)	Source C§ 1988 prices (Rp/kg)
Shallot	–	560	800
Garlic	–	1600	2500
Potato¶	339	230	350
Cabbage	211	120	100
Chinese cabbage	–	130	250
Carrot	607	130	250
Chilli	1115	580	1000
Tomato	320	230	400
Eggplant	165	130	–
Cucumber	281	130	250
Red bean	–	300	–
French and snap bean	358	–	–
Snap bean	–	200	–
Yardlong bean	–	200	–
Beans (all varieties)	–	–	200

* Available to the author from data collected during the study.
† Agro-industrial Statistics Division (1987) *Indicator of agriculture*. Jakarta: Central Bureau of Statistics.
‡ Personal communication from J. S. Buurma, agricultural economist at Lembang Horticultural Research Institute, based on data from the Central Bureau of Statistics.
§ Representative primary market price 1988, Vade Mekum 1, National Food Balance of Indonesia.
¶ Actual price used in the study was 333 Rp/kg calculated from the provincial data in *Bagian statistik harga konkuman dan harga perdagangan, October 1989*.

Table D Available data for fruit prices and their sources*

Crop	Source A† 1987 prices (Rp/kg)	Source C‡ 1988 prices (Rp/kg)
Avocado	–	400
Mango	825	500
Rambutan	–	500
Durian	–	1200
Orange	911	800
Guava	–	500
Pawpaw	232	200
Banana	579	200
Pineapple	–	200
Salak	–	500
Apple	–	1000

* Available to the author from data collected during the study.
† Agro-industrial Statistics Division (1987) *Indicator of agriculture*. Jakarta: Central Bureau of Statistics
‡ Representative primary market price, 1988, Vade Mekum 1, National Food Balance of Indonesia.

Table E Figures for price, production and value of crops in Indonesia used in the study (mostly 1987)*

Crop	Price (Rp/kg)	Production volume ('000 mt)	Production value (billion (10^9) Rp)
Rice (unhusked)	245	40078	9819
Cassava (fresh)	78	14356	1120
Maize (shelled)	183	5156	944
Coffee	2232	389	868
Rubber	702	1130	793
Soyabean (shelled)	615	1161	714
Coconut	334	2099	701
Sugar (local refined)	632	1744	1102
Sugar cane (0.6 × sugar value)	–	–	661
Groundnut (shelled)	1100	533	586
Banana	232	2308	535
Clove	7113	71	505
Chilli	1115	449	501
(Palm oil)	(261)	(1506)	(393)
(Palm kernel)	(166)	(319)	(53)
Oil palm	–	–	446
Citrus	911	445	405
Shallot	980	379	371
Tobacco	3208	113	363
Mango	580	532	309
Pepper	6158	49	302
Garlic	2800	96	269
Durian	1392	193	269
Mung bean	1100	235	259
Sweet potato	108	2013	217
(Cabbage)	(211)	(771)	(163)
(Chinese cabbage)	(228)	(231)	(53)
Cabbage plus Chinese cabbage		1002	215
Tea	1141	126	144
Potato	333	418	139
Rambutan	580	227	132
Guava			
Yardlong bean plus cowpea	358	297	106
Nutmeg	6158	15	92
Cucumber	281	307	86
Pineapple	232	358	83
Pawpaw	232	346	80
Salak	580	115	67
Tomato	320	192	61
Apple	1160	50	58
French, snap and kidney bean	358	156	56
Cassiavera	2057	27	56
Cashew	–	–	48
Cocoa	1496	26	39
Carrot	228	132	30
Avocado	464	63	29
Eggplant	165	165	27
Cotton	–	–	19
Kapok	–	–	14

* For details of sources and (for some crops) methods of estimation, see Tables A and B.

APPENDIX 3 FORMAT FOR SUGGESTED CHANGES IN PEST RANKINGS

NRI Bulletin No. 47 The relative importance of pre-harvest crop pests in Indonesia

1. Name and address of proposer.
2. Position held by proposer.
3. Brief summary of experience relevant to the pest and the cropping system zone.
4. Suggested change, mentioning zone, pest and crop. This can be the addition or deletion of a pest or a change in the ranking of a pest already listed, or a change in the crop it affects.
5. Amplifying remarks. Include whether the original assessment in the *Bulletin* is considered to have been incorrect, or if the change proposed is made as a result of a change in the actual pest situation. If the latter, indicate how this change has developed over time and any ideas on the cause.

   Give the reason for proposing a change in pest rankings. Give the proper reference for any literature suggesting the changed assessment.

   Send a suggested change to:

   Head of Pest and Vector Economics Section
   Natural Resources Institute
   Central Avenue
   Chatham Maritime
   Kent ME4 4TB
   United Kingdom

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