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THIRD AUTUMN WORKSHOP ON MATHEMATICAL ECOLOGY

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"Rice ecosystems in Asia"

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These are preliminary lecture notes, intended only for distribution to participants.

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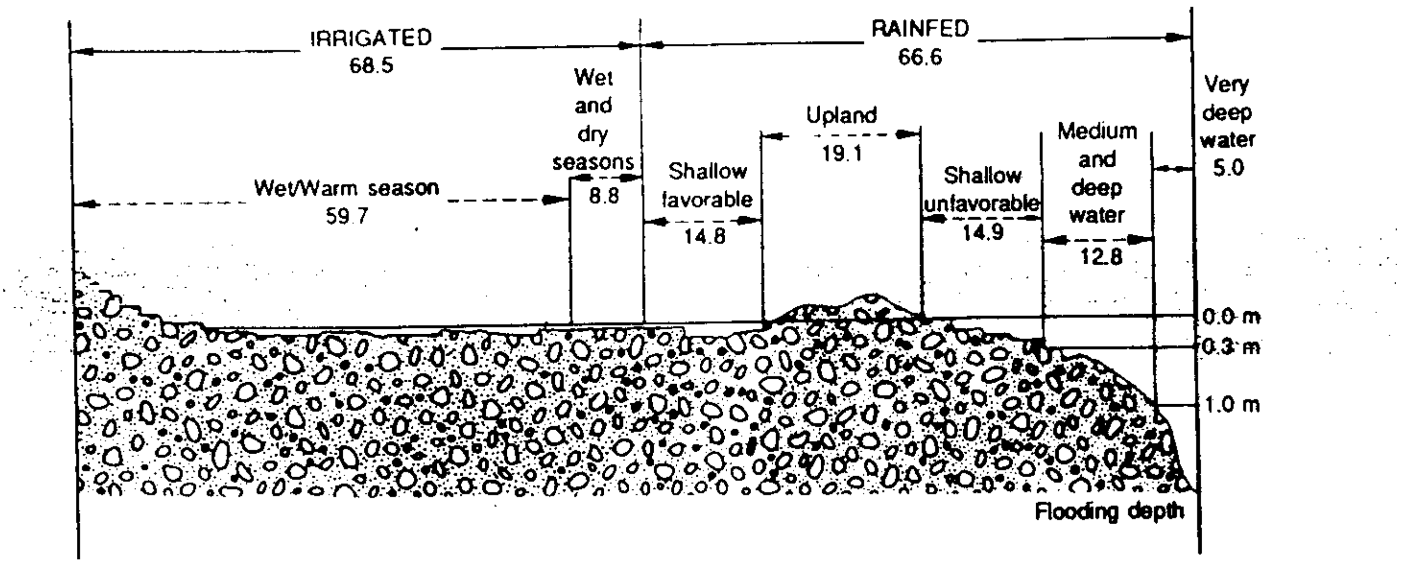
FIGURE 1 Terraced rice fields in Asia



3. Relative areas of the world's riceland by water regime (million ha). Horizontal extent of each class is approximately proportional to the area. Terminology follows that of Khush (1984).

Table 3. The distribution of rice agroecosystems between major regions.

Agroecosystem	Area (%)			
	East Asia	S/SE Asia	West Africa	Latin America
Irrigated	>95	33	11	47
Rainfed lowland	–	35	15	–
Upland	–	13	54	53
Deepwater	–	12	13	–
Tidal wetland	–	5	–	–

– = negligible to nonexistent.

Table 1. Irrigated rice area in South and Southeast Asia.

Country	Irrigated rice area (thousand ha)	
	Wet season	Dry season
Island and peninsula countries		
Malaysia	266	220
Philippines	892	622
Sri Lanka	294	182
Indonesia	3,274	1,920
Major river delta countries		
Bangladesh	170	987
Burma	780	115
Kampuchea	214	–
Laos	67	9
Thailand	866	320
Vietnam	1,326	894
Continental diversified grain countries		
India[a]	10,065	2,263
Central	1,590	0
East	3,317	581
North	1,350	0
South	3,808	1,682
Nepal	261	0
Pakistan	1,710	–
Total	20,185	7,532

[a]Only the major rice-growing states of India are represented as follows: Central India: Madhya Pradesh, Uttar Pradesh; East India: Assam, Bihar, Orissa, West Bengal; North India: Haryana, Himachal Pradesh, Jammu, Kashmir, Punjab; South India: Andhra Pradesh, Karnataka, Kerala, Tamil Nadu.

Table 3.2 Soil Orders: Comprehensive Classification System (USDA) (Adapted from USDA 1975)

Order	Key Profile Characteristics
Entisols	Recent soils; little or no change from parent material
Inceptisols	Light colored subsoils; weak soil development
Mollisols	Soft, deep, dark soils; high base status of surface horizon
Alfisols	Subsoil horizon of accumulated clay; high base saturation; high in weatherable minerals .
Ultisols	Subsoil horizon of accumulated clay; low base saturation; few or no weatherable minerals
Oxisols	Uniform textured; friable profile high in oxides of iron and aluminum with kaolin clay; no weatherable minerals, low cation exchange capacity
Vertisols	Dark soils; high in montmorillonitic clay, prone to shrink and swell; high cation exchange capacity
Aridisols	Mineral soils of dry regions with either calcium carbonate or salt accumulation
Spodosols	Strong brown subsoil underlying a gray to brown surface horizon; strongly acid
Histosols	Soils with more than 30% organic matter to a depth of 40 cm

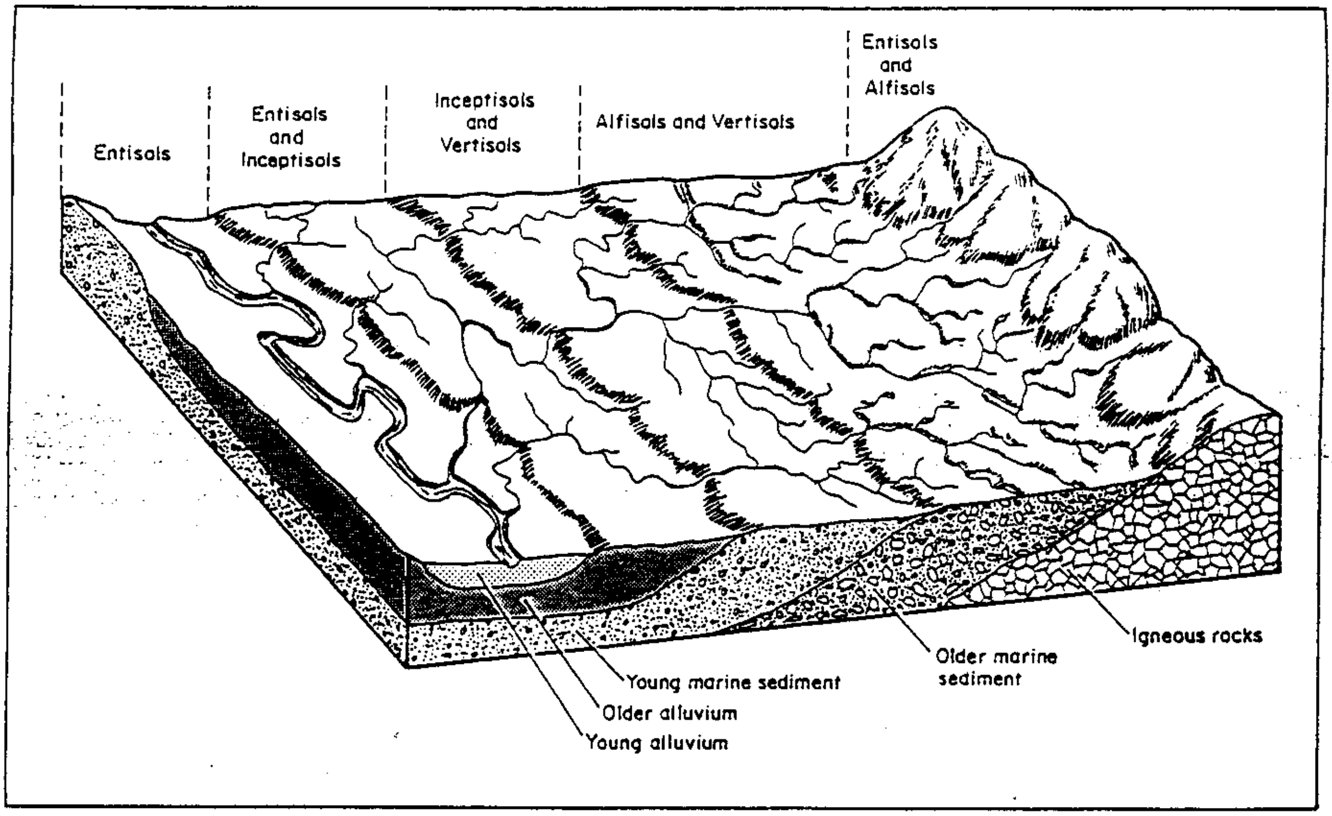


Figure 3.5 Paddy soilscapes on a broad river valley in the Philippines. (From Raymundo 1978)

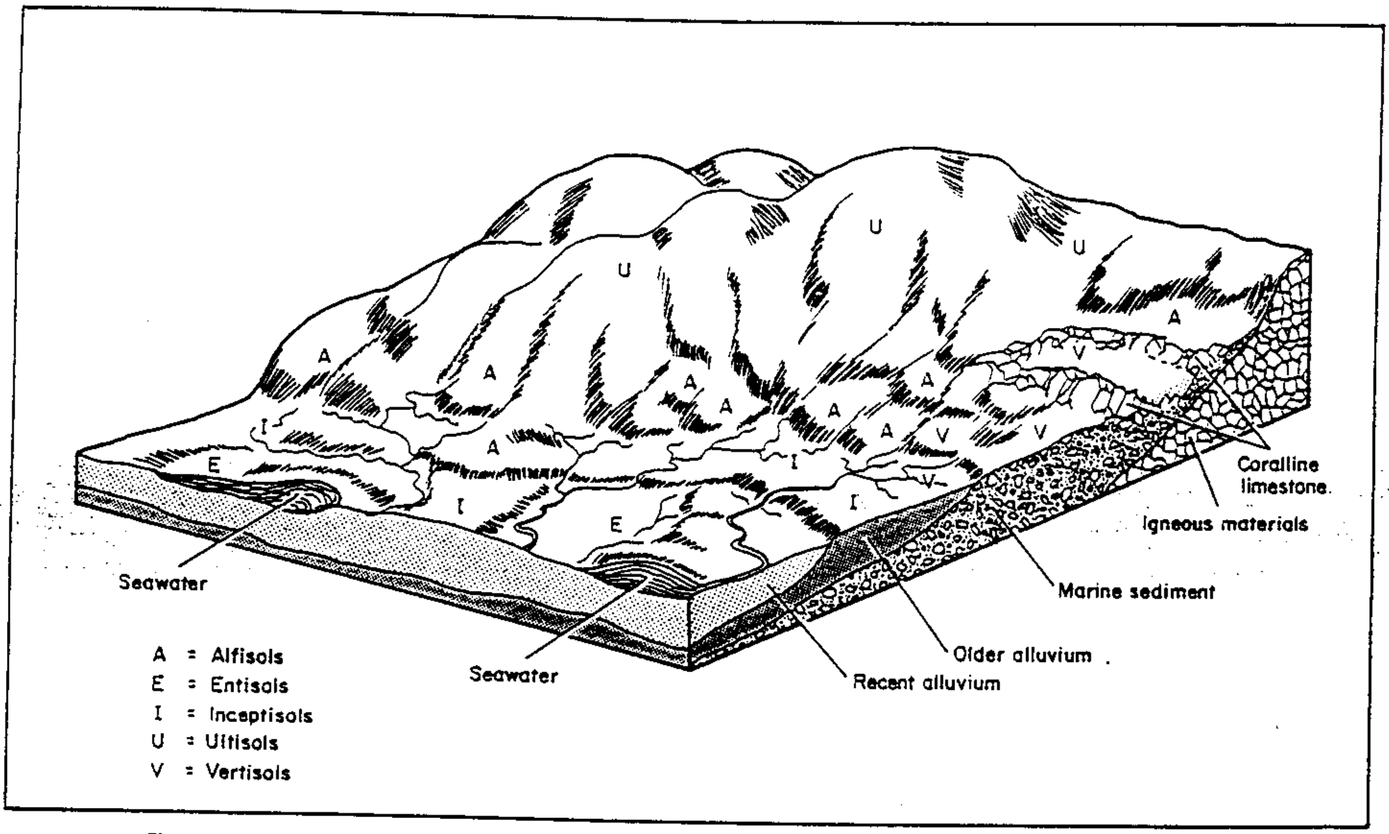


Figure 3.4 Paddy soilscapes on a coastal plain physiography in the Philippines. (From Raymundo 1978)

Table 2. Important vectors of malaria and Japanese encephalitis breeding in ricefields.

Species	Region/Country[a]	Other major breeding habitats
	Malaria	
Anopheles aconitus Donitz	Oriental	Lakes, ponds, swamps, impoundments
A. albimanus Wiedemann	Central and South America, Mexico	Lakes, ponds, swamps, impoundments, pools
A. campestris Reid	Malaysia, Thailand	Canals, swamps, ponds, pools, ditches
A. culicifacies Giles	Middle East, Oriental	Canals, borrow pits, ponds, rivers, streams, pools
A. darlingi Root	South America	Canals, reservoirs, ponds, swamps, pools, stream margins
A. donaldi Reid	Southeast Asia	Swamps, marshes, bogs
A. fluviatilis James	Middle East, China, Southeast Asia	Canals, wells, ponds, streams, ditches
A. funestus Giles	Africa	Swamps, ponds, ditches, lake margins, streams
A. gambiae s.l.	Africa, Yemen	Canals, borrow pits, pools, ditches
A. hyrcanus Pallas	Central and North Asia, Hungary, Japan, Mediterranean	Ponds, swamps
A. lesteri Baisas & Hu	China, W. Pacific	Ponds, swamps, lakes
A. maculatus Theo	Oriental	Streams, seepages, springs
A. pharoensis Theo	North Africa, Middle East	Reservoirs, lakes, swamps
A. philippinensis Ludlow	Southeast Asia	impoundments, borrow pits, slow rivers, lakes, swamps
A. pulcherrimus Theo	Middle East, Southeast Asia	Swamps, ponds
A. sergentii Theo	Mediterranean, Middle East	Streams, seepages, borrow pits, irrigation ditches
	Japanese encephalitis	
Culex tritaeniorhynchus Giles	Oriental, Africa	Marshes, ponds, pools, ditches, streams, cesspools
C. vishnui Theo. (*syn. annulus* Theo.)	Oriental	Swamps, ditches, rain pools, ponds
C. gelidus Theo	Oriental	Marshes, ponds, pools, streams
C. fuscocephala Theo	Oriental	Rain pools, ditches, marshes

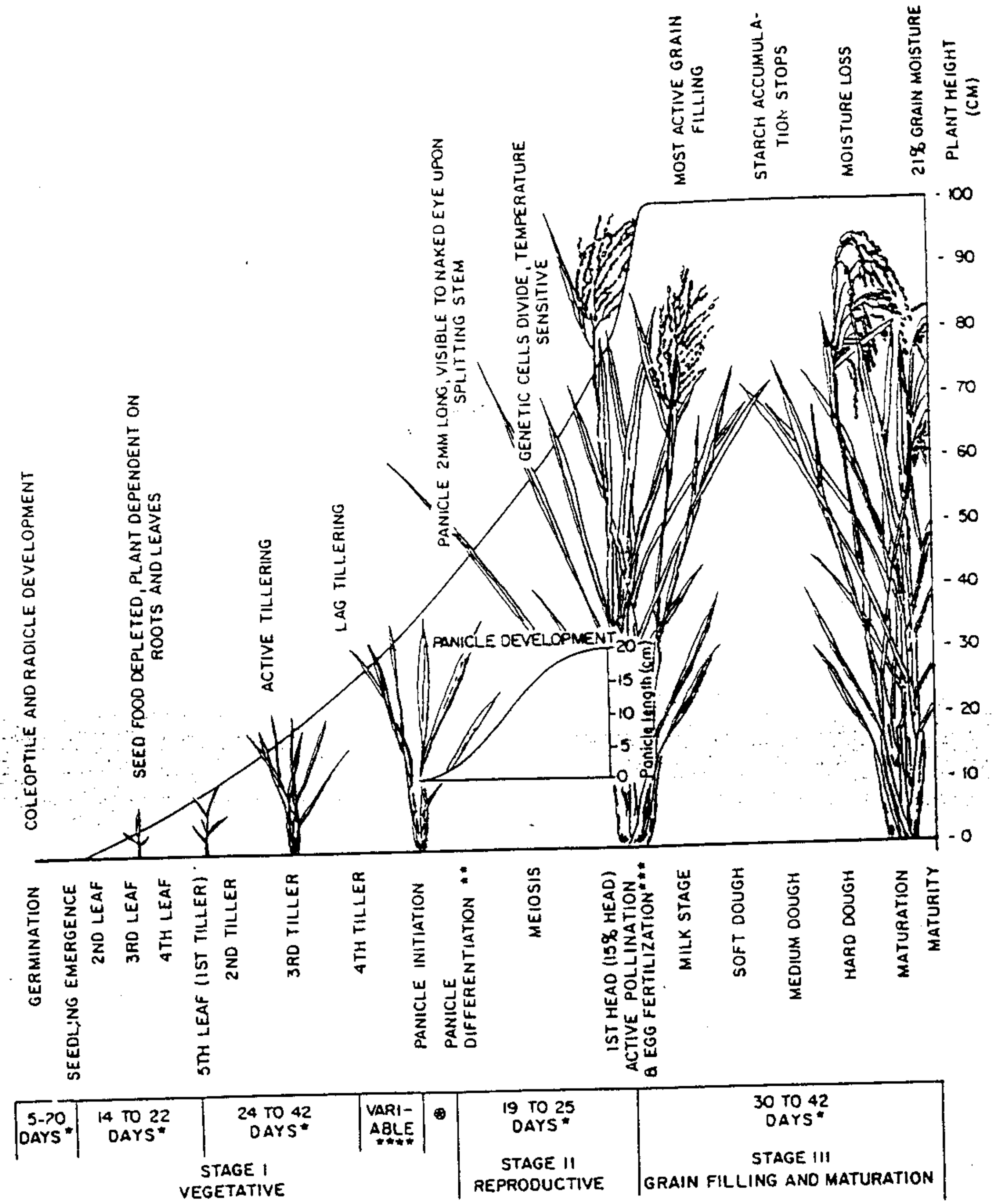
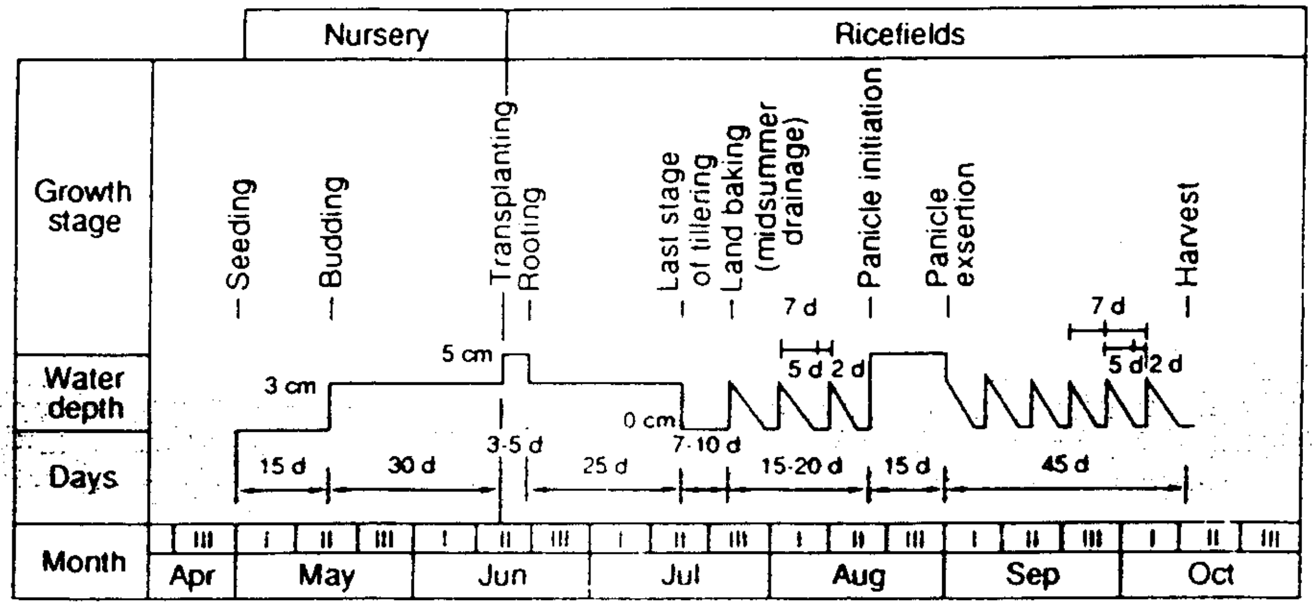
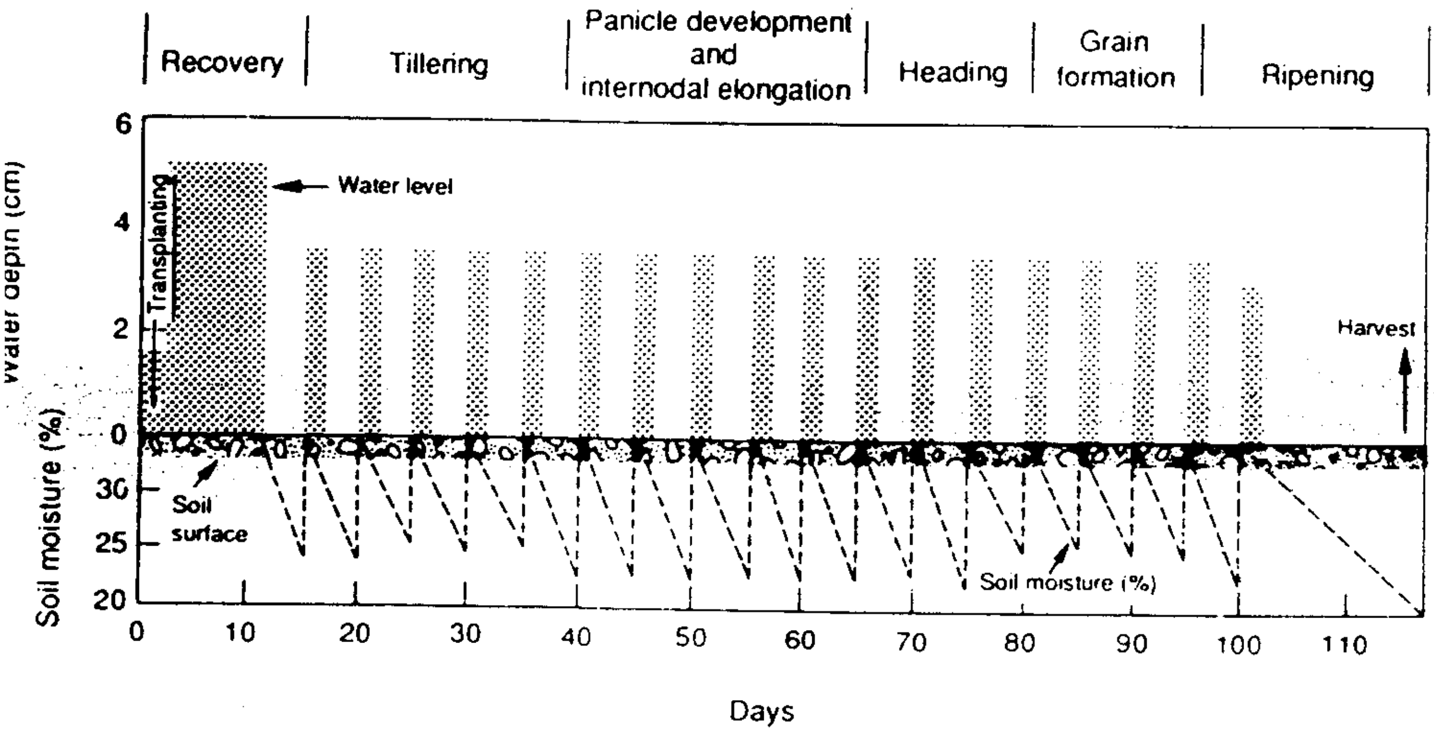


Figure 5.13 Development stages of the rice plant. (From Stansel 1975) ⊛ 3–5 days. *Under warm conditions use the lower number of days and for cool conditions use the larger number of days. **The reproductive stage begins with panicle differentiation, which can be seen only by splitting the stem lengthwise. At this stage 30% of the main culms sampled have a panicle 2 mm or longer. ***Stage III begins when 50% of the florets are pollinated. ****Variable time—0–25 days (dependent upon variety).



1. Ricefield cropping calendar, Tangko Commune, Shandong, China.



1. Diagram of wet-irrigation method from transplanting (day 0) to harvest in rice cultivation in Henan Province, China (modified from Ge et al 1981).

TABLE 1
Relationship between Malaria Morbidity and the Area of Rice Fields in Kaifeng, Henan Province

Year	Area of rice fields (ha)	Malaria morbidity per 100,000 inhabitants
1966	546	86.73
1967	1588	102.82
1968	1826	421.77
1969	2654	1994.79
1970	4669	3191.16
1971	2941	1680.80
1972	3398	1511.11
1973	4660	958.51
Introduction "wet irrigation" practice		
1974	5135	1944.18
1975	5749	564.28
1976	6107	547.99
1977	5075	415.65
1978	4349	310.27
1979	3813	166.16
1980	3504	105.50

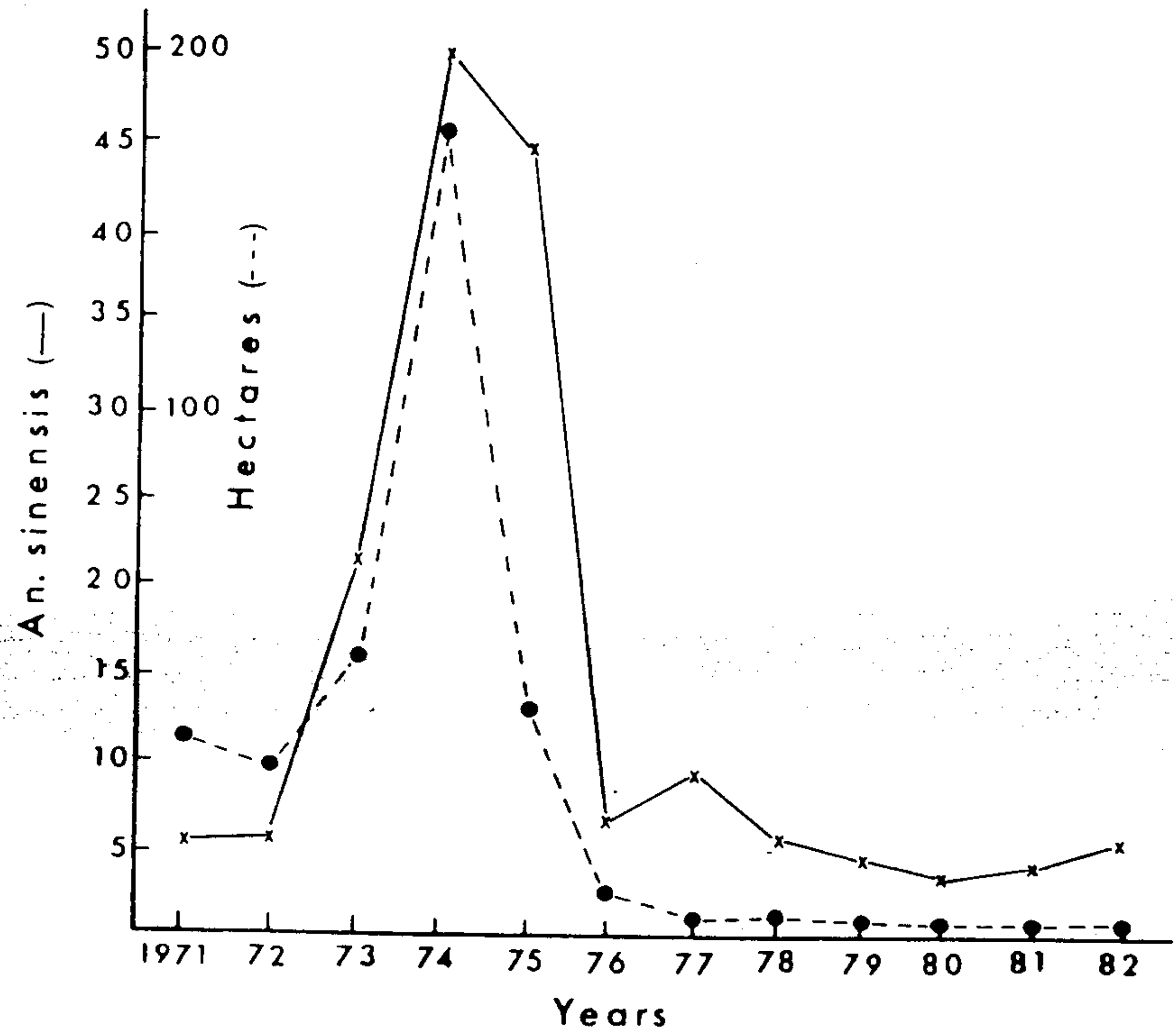
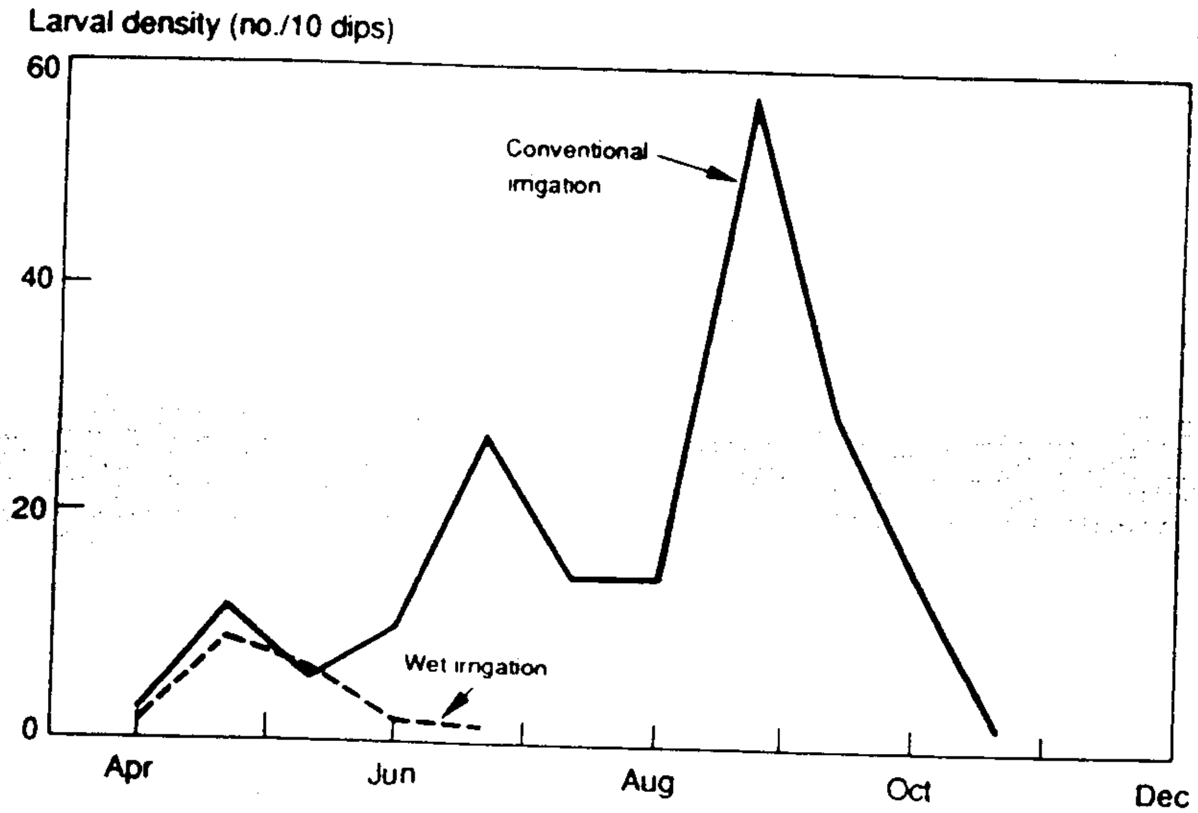


FIGURE 3. Relationship between mean number of *An. sinensis* adults (–) caught on an ox (2 hours) and the hectarage of rice fields (---) in Guantang commune, Luyi County, Henan Province, China.

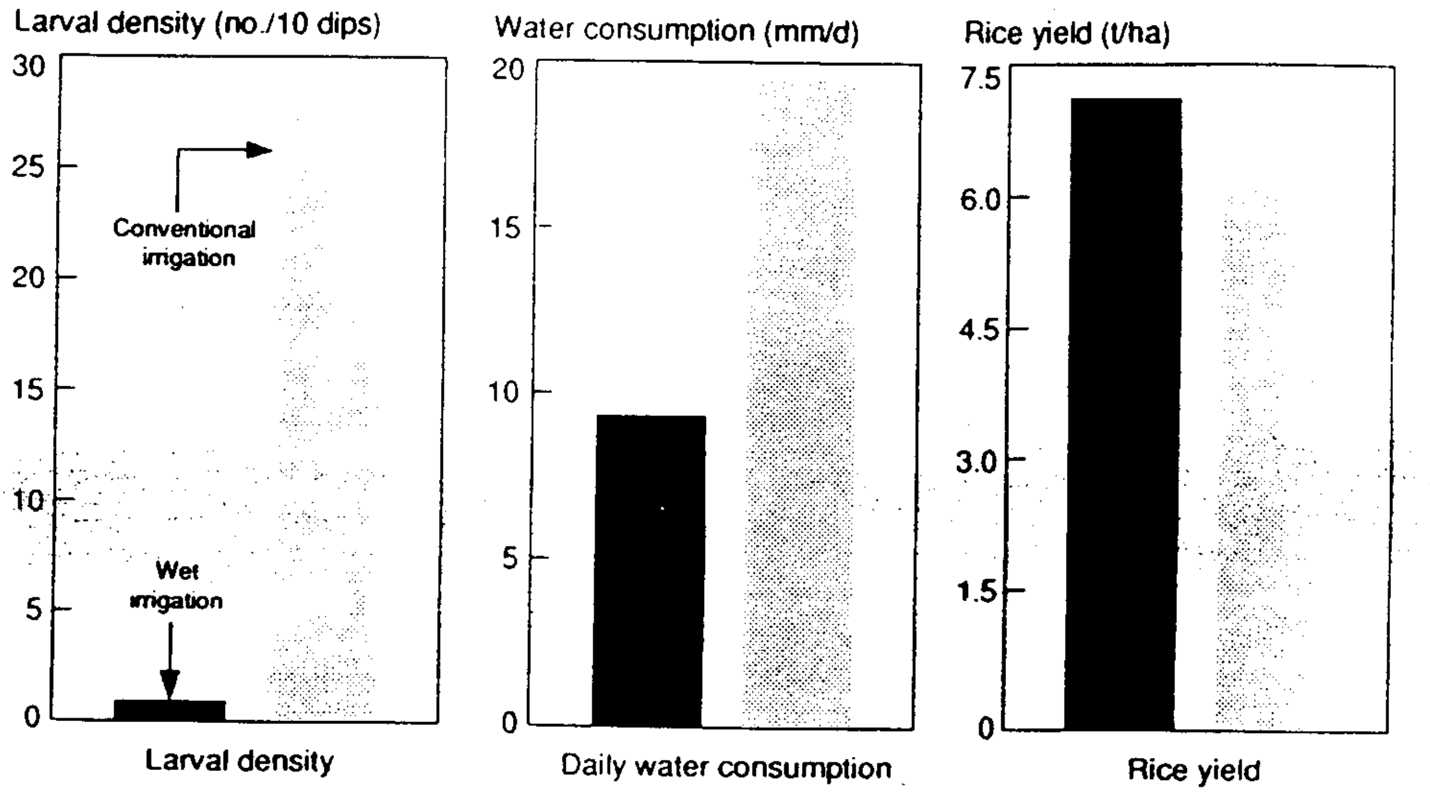
Table 1. Larval composition in ricefields in China.

Locality	Total larvae collected (no.)	Number of larvae of different species collected and percentage of total					
		A. sinensis		*C. tritaeniorynchus*		Others	
		No.	%	No.	%	No.	%
Quanzhou, Guangxi (Jun 1983)	480	105	21.9	375	78.1		
Tongbai, Henan (Jul-Aug 1984)	1381	960	69.5	99	7.2	322	23.3
Cili, Hunan (Jul-Aug 1984)	8266	2,848	34.5	5,317	64.4	101	1.2
Danyang, Jiangsu (Jul-Aug 1985)	1995	994	49.8	1,001	50.2		
Wanza, Jiangxi (Jul-Aug 1985)	481	413	85.9	68	14.1		
Shenyang, Liaoning (Jul-Aug 1984)	361	228	63.2	116	32.1		
Yongning, Ningxia (Aug-Sep 1973)	1524	8	0.5	6	0.39	1,510[a]	99.1
Zhongwei, Ningxia (Aug-Sep 1982)	3702	885	23.9	1,564	42.2	1,013	27.4
Yuci, Shangxi (Jul-Aug 1984)	212	50	23.6	76	35.8	96	45.3
Chengdu, Sichuan (Jul-Aug 1985)	975	485	49.7	490	50.3		

[a] 82.3% of the larvae were *Culex modestus*, ferocious biter



. Comparison of larval densities of *A. sinensis* and *C. tritaeniorhynchus* in wet-irrigated and onventionally irrigated fields (modified from Ge et al 1981).



Comparison of larval density, crop yields, and water consumption in wet-irrigated and conntionally irrigated ricefields (after Ge et al 1981).

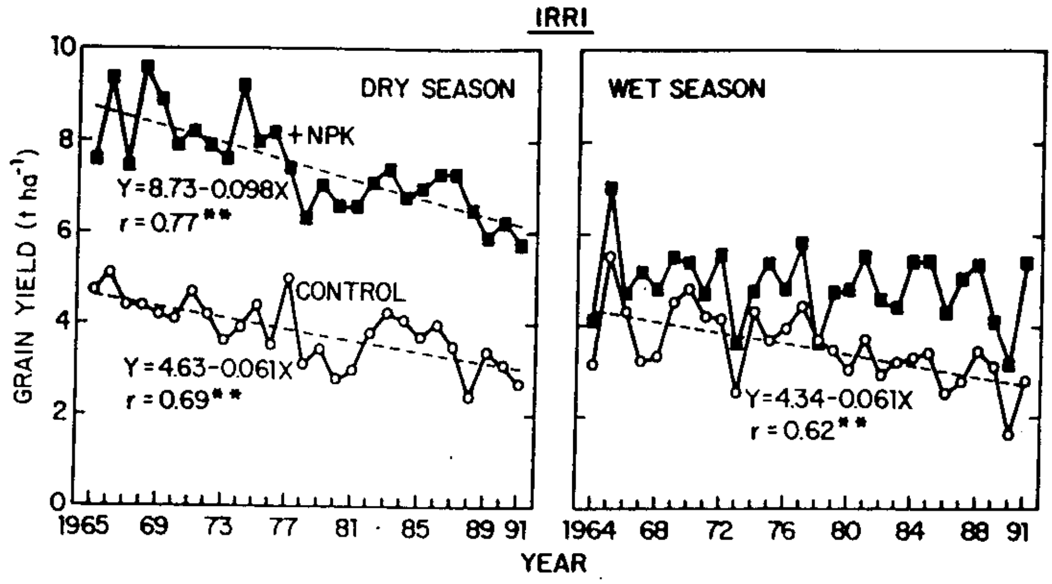


Figure 5.6 Yield trends of the highest yielding variety in the Long-Term Fertility Experiment conducted at the IRRI Research Farm in Laguna Province, Philippines since 1964 in treatments that receive complete nitrogen (N), phosphorus (P), and potassium (K) inputs in each crop cycle (+ NPK), and in the control treatment without fertilizer- nutrient inputs

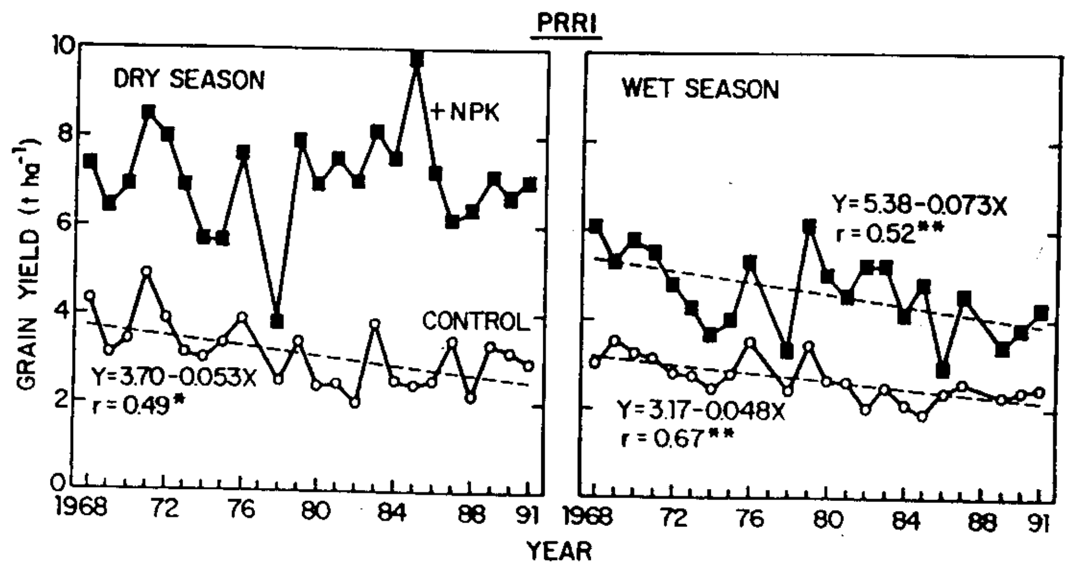
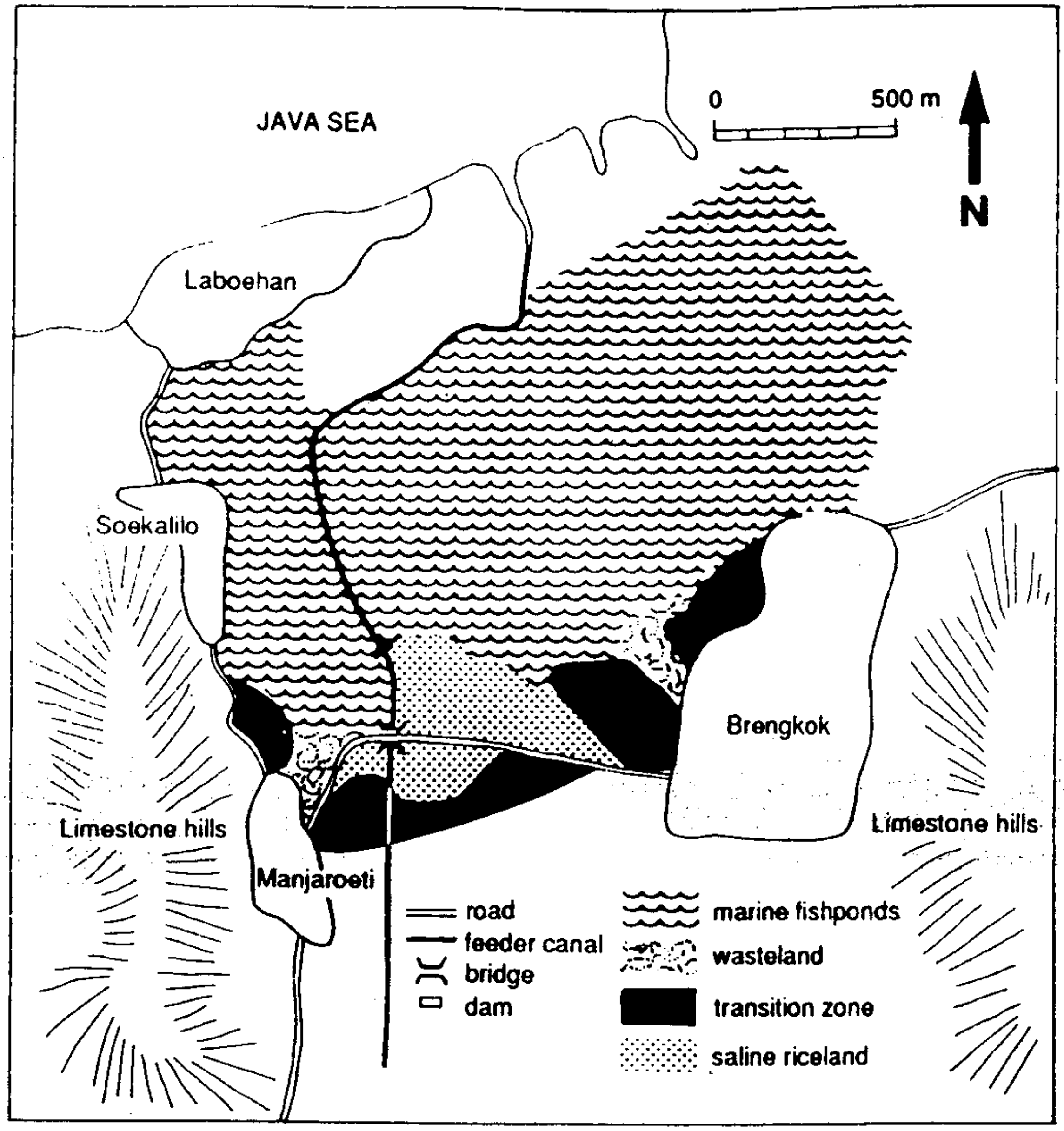


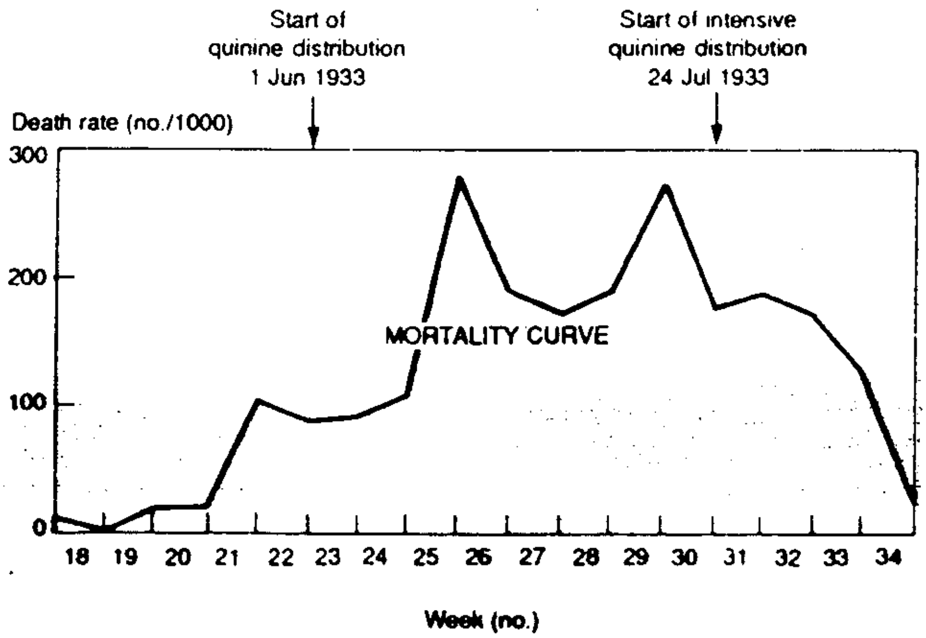
Figure 5.7 Yield trends of the highest yielding variety in the Long-Term Fertility Experiment conducted at the PhilRice Research Station in Central Luzon, Philippines since 1968 in treatments that receive complete nitrogen (N), Phosphorus (P), and potassium (K) inputs in each crop cycle (+ NPK), and in the control treatment without fertilizer-nutrient inputs



2. Potential breeding sites for *A. ludlowi* near the village of Brengkok, East Java, Indonesia, 1933.

Table 2. Results of *Anopheline* mosquito collection and dissection in Brengkok, East Java, Dutch East Indies, July-August 1933.

	Anophelines collected (no.)			Anophelines infected (no.)			
	From cowshed in 1 night	From houses (24 Jul-21 Aug)	Total	Anophelines dissected (no.)	Stomach	Salivary gland	Total
A. subpictus	43	971	1014	964	–	–	–
A. ludlowi	–	157	157	146	44	36	68
A. aconitus	1	1	2	2	–	–	–



1. Mortality curve during a malaria epidemic in the village of Brengkok, East Java, Indonesia, in the 1933 wet season.

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EDITORIAL

Malaria, where now?

The concept of the "magic bullet" has been with us a long time and far too much thinking about infectious diseases tends to be in military terms—battles, wars, and campaigns to be won (or lost), weapons and ammunition to be used (or abused). For some of the parasitic and protozoal infections there is another soldiering metaphor, the lowering of sights. The idea that malaria might be eradicated was quietly abandoned almost 30 years ago. The word now is "control", but with the plasmodium proving to be every bit as ingenious as the molecular parasitologists who pay it such attention, even control is still far off.

For a time it seemed that the search for a vaccine against malaria was getting somewhere. Earlier this year, a Cochrane Collaboration meta-analysis of five trials of SPf66, the vaccine associated with the pioneer work of M E Patarroyo, concluded that, with a first episode of clinical malaria as an endpoint, vaccine efficacy was 27%(99% CI 13-38%). Not a great result for an immunisation but hopeful. At that time three further randomised trials were in progress, two in South America and one, reported in this week's *Lancet* (p 701), from Thailand, where this vaccine has been found ineffective in Karen children. A repeat meta-analysis with these data in it will show a considerable lowering of confidence. Bad news, then, at least for this vaccine approach.

Bad news elsewhere too. By the end of 1996 no pharmaceutical company will have a significant antimalarial drug discovery programme. No major new class of antimalarial compounds has emerged clinically in recent years after the synthetic artemisinin derivatives. Co-artemether and atovaquone plus proguanil hold promise but when basic research comes up with really new ideas (and there are some in phase I or II) how will they now be taken forward to the market? The US "orphan drug" tax concession was renewed last month, and this is something for all countries to look at. The Steering Committee on Drugs for Malaria (CHEMAL-TDR) remains committed to drug development. Joint ventures with pharmaceutical companies, the fostering of drug development by malarious countries, and the seeking of guarantees on future sales all deserve exploration. Meanwhile, antimalarial resistance continues to spread and questions over the safety of some drugs await resolution.

We might seem to be losing this "war". But is it really a war? Malaria, business travellers and tourists apart, is a disease of poverty. In countries where the disease is endemic, malaria has adapted to the population and people accept malaria as a fact of life, along with other misadventures. Those more fortunately placed must never forget that this disease kills over 2 million every year. Even so, the peoples of the endemic regions may not see malaria as an enemy in military terms, and research should reflect that.

"High profile" projects must not be abandoned, for breakthroughs can only come from patient inquiry into the biology of *Plasmodium* spp and their vectors. The change needed is to raise the profile (ie, the perceived importance and the standing) of lower-technology approaches. Good trials have lately been published on treated bed-nets, for example, and the evidence there ought to be sufficient to encourage international aid donors to back more operational research. Checks on the absence of stagnant water is another approach by which people can be encouraged to help themselves in an affordable way. Of course, simple algorithms to treat presumptive malaria are less than ideal, but this approach can be improved; the dreaded complications of malaria can be investigated clinically; and progress towards control can still be made by applying better what we know already.

The Lancet