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9. ABSTRACT

To learn more about rice scientists and the professional environments in which they work, the International Rice Research Institute (IRRI) surveyed 41 rice breeders at 28 research centers in 10 Asian nations. Eighty-five percent of the breeders worked exclusively with rice. Almost all of them indicated remaining in rice breeding as one of two aspirations for what they would like to be doing in 10 years.

Half of the breeders held doctor of philosophy degrees; for 32% the master of science degree was the highest attained. Although 93% of the total bachelor's degrees were earned locally, 65% of the doctorates were earned from universities in highly developed nations. Sixty-two percent of the breeders had participated in the IRRI nondegree training program. About 10% had received academic degrees at the University of the Philippines at Los Baños through the IRRI degree training program.

When the scientists rated the adequacy of resource factors in their breeding programs, *personal freedom* was found to be the most adequate, followed by *availability of experimental land* and *availability and quality of field labor*. Rated as least adequate were *opportunities for specialized training or advanced education* and *transportation*. Noted as the most *important* to the success of a breeding program was *opportunities for specialized training or education for the people who work under me* followed by *the availability of suited genetic materials* and *personal freedom*.

Among environmental and biological conditions, diseases and insects were perceived by all breeders as the main factor that most seriously limits farmers' rice production. Next in importance were drought and injurious soils.

Farmers' rice-growing conditions, scientists' research efforts, and rice varieties released during the previous 5 years were compared. About 43% of the farmers' fields were thought to be irrigated, about 60% of the research efforts went to irrigated rice, and 57% of the newest varieties were suited to irrigated conditions. For rainfed lowland rice, the mean percentages were: 40% of farmers' fields, 22% of scientists' work, and 32% of newest varieties.

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RICE BREEDERS IN ASIA: A 10-COUNTRY SURVEY OF THEIR BACKGROUNDS, ATTITUDES, AND USE OF GENETIC MATERIALS[1]

ABSTRACT

To learn more about rice scientists and the professional environments in which they work, the International Rice Research Institute (IRRI) surveyed 41 rice breeders at 28 research centers in 10 Asian nations. Eighty-five percent of the breeders worked exclusively with rice. Almost all of them indicated remaining in rice breeding as one of two aspirations for what they would like to be doing in 10 years.

Half of the breeders held doctor of philosophy degrees; for 32% the master of science degree was the highest attained. Although 93% of the total bachelor's degrees were earned locally, 65% of the doctorates were earned from universities in highly developed nations. Sixty-two percent of the breeders had participated in the IRRI nondegree training program. About 10% had received academic degrees at the University of the Philippines at Los Baños through the IRRI degree training program.

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Among environmental and biological conditions, diseases and insects were perceived by all breeders as the main factor that most seriously limits farmers' rice production. Next in importance were drought and injurious soils.

Farmers' rice-growing conditions, scientists' research efforts, and rice varieties released during the previous 5 years were compared. About 43% of the farmers' fields were thought to be irrigated, about 60% of the research efforts went to irrigated rice, and 57% of the newest varieties were suited to irrigated conditions. For rainfed lowland rice, the mean percentages were: 40% of farmers' fields, 22% of scientists' work, and 32% of newest varieties.

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[1] by Thomas R. Hargrove, associate editor, International Rice Research Institute, Los Baños, Philippines. Submitted to the IRRI Research Paper Series Committee 24 November 1977.

During a 5-year period, 165 new varieties had been released for 29 areas. or slightly more than 1 variety/year; 78% were locally developed; the others were from IRRI.

In 27 advanced yield trials, 4,021 lines were being grown. About 60% of the lines were progeny of local crosses. Of the introduced lines, 60% came from crosses made at other research centers in the same countries; almost all of the others came from IRRI. The breeders had selected 3,791 advanced lines from 443 local crosses, an average of 8.6 lines/cross.

RICE BREEDERS IN ASIA: A 10-COUNTRY SURVEY OF THEIR BACKGROUNDS, ATTITUDES, AND USE OF GENETIC MATERIALS

The ultimate responsibility for the development of improved rice varieties and farming methods rests with agricultural scientists in the rice-growing nations. Only through their efforts can hunger be eliminated. Knowledge about the programs and problems of Asian scientists can help scientists at international research centers determine how best to allocate research, training, information, and genetic resources to deliver maximum returns from new rice technology.

Pino (1974) said that the international agricultural research centers alone cannot develop and disseminate the vast range of varieties and technology needed by the highly diverse rice-growing world. To have an impact in low-income countries, international researchers must collaborate with local agricultural scientists who can build on, complement, and extend generated knowledge, adapt it to a variety of local conditions, and correct dislocations that it may create.

Despite the importance of agricultural scientists in the developing nations, little is known about them or about the professional environments in which they work.

In late 1975 the International Rice Research Institute (IRRI) initiated research that included the study of the sociology of rice science in Asia. Because the study also monitored the flow of rice germplasm into the genetic crosses made in national rice improvement programs, rice breeders -- the scientists who largely control those hybridizations from which new farmer varieties are developed -- were chosen as the unit of analysis.

Forty-one rice breeders were interviewed at 28 agricultural experiment stations and universities in 10 Asian nations: Bangladesh, India, Indonesia Iran, Korea, Nepal, Pakistan, Philippines, Sri Lanka, and Thailand (Table 1)

Data on the ages, professional backgrounds, and aspirations of the breeders were collected. Also measured were the allocation of the scientists' professional time; their contact with other rice scientists, both within their countries and abroad; and the adequacy of resources in their programs.

Data were also collected on genetic and biologic factors such as the genetic backgrounds and sources of newest varieties and advanced breeding lines; and the breeders' perceptions of environmental and pest problems.

The project was partially funded by a grant from The Rockefeller Foundation.

Table 1. Stations surveyed and breeders interviewed in a 10-nation study of rice breeders, 1975.

Country	Stations surveyed (no.)	Breeders interviewed (no.)
Bangladesh	1	2
India	12	18
Indonesia	1	2
Iran	2	2
Korea	3	3
Nepal	1	1
Pakistan	2	5
Philippines	1	1
Sri Lanka	3	3
Thailand	2	4
Total	28	41

BACKGROUNDS OF THE RICE BREEDERS

The ages of the rice breeders ranged from 31 to 55 years and averaged about 42 years. Seventy percent of the breeders were between the ages of 37 and 47. All were male. More than half had agricultural backgrounds, and 95% of this group came from families that owned land (Table 2).

Professional experience and work allocation

The breeders surveyed had from 2 to 33 years of professional experience (excluding academic work) (Table 2). Twenty-six percent had 10 years of professional experience; 28% had 20 years or more. Eighty-five percent worked only with rice; the others worked with rice and other crops, including wheat, pulses, maize, and potatoes.

Each breeder indicated the percentages of his professional time spent in different aspects of rice work. About 68% of the breeders' work time was spent in research; about 56% of the total time was spent in breeding-related activities (crossing, selecting, evaluating experimental lines, etc.) (Fig. 1).

Professional aspirations

Twenty-two of the rice breeders were asked to indicate their first and second preferences for the type of work that they would like to be doing in 10 years, considering their educational backgrounds, experience, and career interests.

Ninety-one percent of the scientists indicated rice breeding as one of two preferences; 36% wanted to become administrators; and 23% opted for basic or fundamental research (Table 3).

Table 2. Background information on rice breeders at 27 agricultural experiment stations in 10 Asian nations, 1975.

Characteristic	Breeders	
	No.	Ave.
Age	40	41.9 yr.
Professional experience[a]	39	13.9 yr.
Background[b]		
Agricultural	20	53%
Nonagricultural	18	47%
Source of family's agricultural income[c]		
Owned land and rented all or part to tenants	8	40%
Owned and farmed their own land	11	55%
Rented farmland from landlord	1	5%
Worked as agricultural laborer	0	0%

[a] Excludes experience gained during academic training.

[b] If during each scientist's youth, more than half of his family's income came from agricultural sources, his background was considered agricultural.

[c] Refers only to the families of the 20 breeders from agricultural backgrounds.

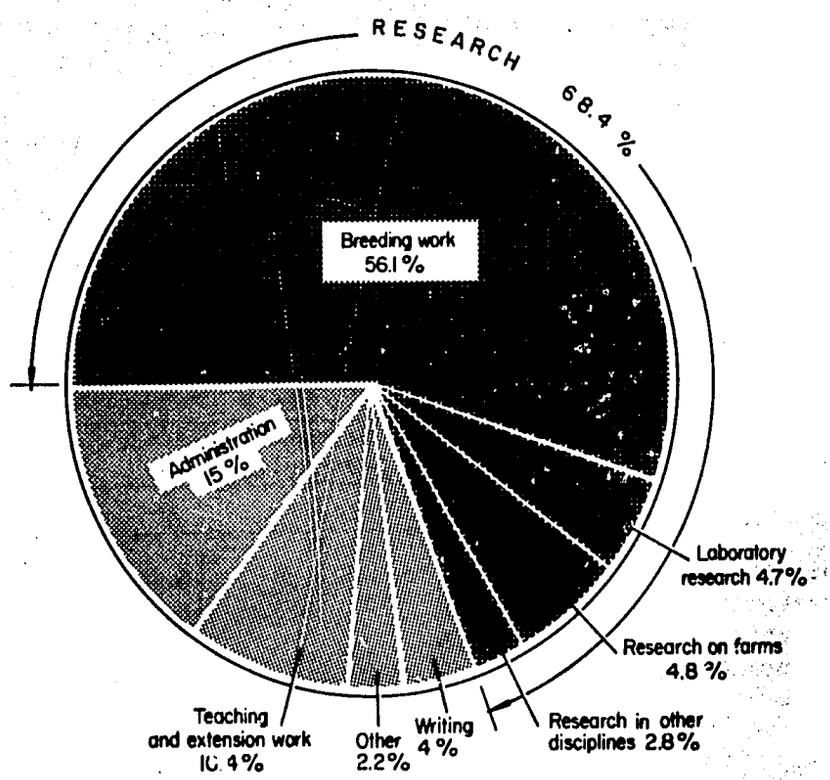

Fig. 1. How rice breeders allocate their professional time among different types of work. Thirty-eight scientists at 27 agricultural experiment stations and universities in 10 Asian nations, 1975.

Table 3. Types of work Asian rice breeders preferred to do in 10 years. Twenty-two breeders at 15 agricultural experiment stations and universities in 8 Asian nations, 1975.

Type of work	Breeders who rated type as 1st or 2nd preference	
	No.[a]	%
Plant breeding	20	91
Administrative position in agriculture	8	36
Fundamental or basic research	5	23
Teaching or training	3	14
Extension/demonstration work with farmers	3	14
Applied or adaptive research (other than plant breeding)	2	9
Farming	2	9

[a] One breeder indicated only one choice so the total number of preferences for this question is 43.

The breeders were also asked the types of organizations with which they preferred to work in 10 years. Seventy percent of the scientists indicated a preference for a government research organization, and 56% for a nonprofit international research organization (Table 4). (All of the breeders worked at national- or state-level research organizations or agricultural universities.)

Table 4. Types of organization in which Asian rice breeders preferred to work in 10 years. Twenty-three breeders at 16 agricultural experiment stations and universities in 8 Asian nations, 1975.

Type of organization	Breeders who rated type as 1st or 2nd preference	
	No.[a]	%
Government research organization	16	70.0
Nonprofit international research organization	13	56.0
Agricultural college or university	8	35.0
Private company, business, or industry	3	13.0
Government extension service	2	9.0
Farming	2	9.0
Other	1	0.4

[a] One breeder indicated only one choice, so the total number of preferences for this question is 45.

Travel

Seventy-six percent of the breeders had traveled outside their countries during the previous 5 years. Those who had traveled abroad had made a total of 80 international trips over the period -- or an average of almost 3 trips each (Table 5). Ten scientists had each made one trip abroad; seven, two trips each; four, three trips each; and eight, four or more trips each.

Ninety percent of the most recent trips abroad were made to IRRI and 10% to other countries. Forty-eight percent of the most recent trips were made primarily to attend a professional conference, 28% for further education or training.

Forty-two percent of the breeders indicated that an administrator within their own organization selected them to make their last trip abroad; 54% had received an invitation directly from another organization.

Table 5. International travel of Asian rice breeders. Thirty-eight breeders at 27 agricultural experiment stations and universities in 10 Asian countries, 1975.

International trips	Trips abroad	
	No.	%
Travel abroad[a]	29	76
Trips (av. no./breeder)	2.8[b]	
Destination of last travel		
IRRI	26	90
Other	3	10
Purpose of last travel[a]		
Professional conference	14	48
Education or training	8	28
Confer with professional colleagues	5	17
Acquire genetic materials	2	7
Basis of selection for travel[c]		
Selection by administrator	11	42
Direct invitation	14	54
Personal time and expense	0	0
Other	1	4

[a] During the past 5 years.

[b] Average number of trips computed for the 27 breeders who had traveled abroad during the past 5 years.

[c] Twenty-six respondents.

Education

Data on the educational background of 40 rice breeders were collected. Half of the breeders held a doctor of philosophy degree (Ph.D.); for 32% the master of science (M.S.) was the highest degree attained. Ninety-eight percent of the breeders had at least bachelor's degrees and 85% at least M.S. degrees (Table 6).

Ninety-three percent of the total bachelor's, diploma, and engineer's degrees were granted within the breeder's own country and 3%, in highly developed nations. But 65% of the Ph.D.'s were earned in highly developed countries (U.S., Canada, Europe, Japan, or Australia) (Fig. 2).

Table 6. The educational levels of 40 rice breeders at 27 agricultural experiment stations and universities in 10 Asian nations, 1975.

Academic degree	Scientists (%) for whom degree was the highest attained	Scientists (%) who hold degree
Ph. D.	50	50
M. S.	32	85
Engineer's[a/]	3	3
B. S.	12	98
Diploma[b/]	3	3

a/ B. S. plus 2 years.
b/ High school plus 2 years.

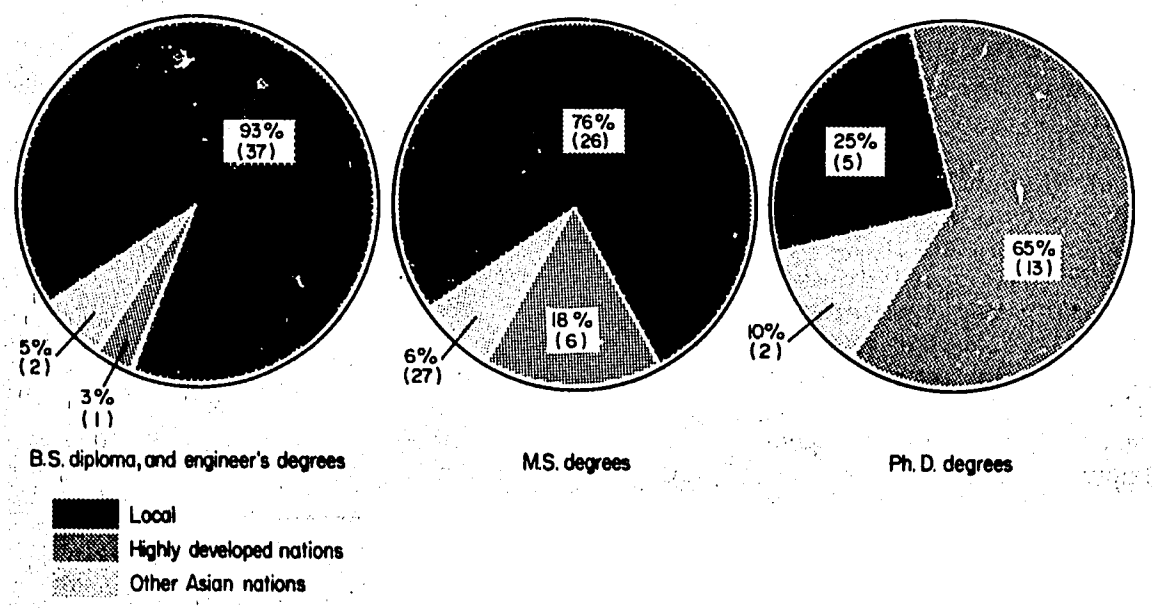

Fig. 2. Sources of academic degrees of Asian rice breeders. Forty scientists at 27 agricultural experiment stations and universities in 10 Asian nations, 1975.

Degree and nondegree training

Four breeders (all Ph.D) had participated in the IRRI degree training program. Two had received their doctorates at the University of the Philippines at Los Baños (UPLB) through a collaborative program with IRRI. The other two had received master's or bachelor's degrees at UPLB and then received doctorates in highly developed nations.

Seventy-six percent of the breeders had participated in nondegree training at IRRI or at other institutions (Table 7). Of those who had participated, 62% had been in the IRRI training program. Forty-three percent of those participants had attended only 1 course; 30%, 2 courses; and 10%, 3.

Table 7. Participation in nondegree training courses by Asian rice breeders. Thirty-eight scientists at 27 agricultural experiment stations and universities in 10 Asian nations, 1975.

Nondegree training courses	Participating breeders (no.)	(%)
Participated	29	76
Courses attended	1.73[a]	--
Place of training		
IRRI only	10	34
IRRI and elsewhere	8	28
Elsewhere only	11	38

[a] Average number of nondegree training courses each breeder participated in.

ADEQUACY AND IMPORTANCE OF RESOURCES

A plant breeder is essentially a *genetic architect*. His tools for building new rice varieties include such resources as experimental land, greenhouses, scientific information, and parent varieties with desired genetic traits.

The breeders were asked to rate the adequacy and the importance of 14 resource factors suggested by plant scientists from IRRI and from national programs in Asia. Each factor was considered important to rice breeding programs.

Scientists rated *personal freedom to incorporate new breeding materials, techniques, and ideas into the rice improvement program* as the most adequate, and *availability of genetic materials* as second most adequate. They also rated *availability of experimental land* and *availability and quality of field labor* as fairly adequate (Table 8).

Table 8. Ratings of adequacy and importance of resources that influence the work of rice breeders. Thirty-eight rice breeders at 27 agricultural experiment stations and universities in 10 Asian nations, 1975.

Resources	Mean rating of adequacy[a]	Importance score total[b]	Importance score index[c]
Opportunities for specialized training or advanced education for people who work under you	3.08	49	0.32
Availability of genetic materials with specific genetic characteristics	2.02	46	0.30
Personal freedom to incorporate new breeding materials, techniques, and ideas into the rice improvement program	1.63	45	0.30
Opportunities to have breeding lines thoroughly tested under diverse pest and environmental conditions	2.91	38	0.25
Financial support	3.00	37	0.24
Scientific information resources, such as journals, books and contact with other scientists, to use in your breeding program	2.83	32	0.21
Availability and quality of trained technical help	2.75	32	0.21
Opportunities for specialized training or advanced education	3.27	17	0.11
Opportunities to gain scientific recognition	3.13	15	0.10
Equipment and tools to use in experiments and breeding work	3.08	12	0.08
Opportunities for professional advancement	3.07	11	0.07
Availability of experimental land	2.11	7	0.05
Transportation	3.25	5	0.03
Availability and quality of labor	2.26	2	0.01
Other	3.43	10	0.07

[a] On a scale of from 1 to 5: 1 = very adequate at this station; 2 = adequate; 3 = intermediate; 4 = inadequate; 5 = very inadequate.

[b] Calculated by assigning a weight of 4 to each factor rated as first in importance by each breeder; 3 to each factor rated second; 2 to each rated third; and 1 to each factor rated fourth. Totals for each factor were then summed to get an index. Totals for each factor was 152 (if all 38 respondents had rated one factor as first in importance).

[c] Calculated by dividing total importance score by maximum possible score per factor (152). 1 = most important; 0 = least important.

Rated as least adequate among the factors were *opportunities for specialized training or advanced education* and *transportation*. *Other resources* were rated as least adequate by four individual breeders. Of those, *red tape* and *bureaucracy* were cited twice.

Each breeder was given a list of the resources that he had rated and was asked to rank the top four in terms of importance to the success of his breeding program. An importance score and an index were calculated.

Rated as most important was *opportunities for specialized training or advanced education for the people who work under you* (Table 8). Second most important was *availability of genetic materials*, followed by *personal freedom* (the factor that had the highest adequacy rating), and *opportunities to have breeding lines thoroughly tested under diverse pest and environmental conditions*.

Note that *opportunity to gain scientific recognition* and *opportunity for professional advancement* received low importance ratings.

ENVIRONMENTAL AND PEST PROBLEMS

Rice breeders and other scientists share the responsibility of developing improved varieties that can resist or tolerate adverse environmental or biological conditions such as diseases and insects, drought, cold temperatures, or injurious soils. The breeders' perceptions of various environmental stresses and of specific pests that limit yields on rice farmers' fields were surveyed. IRRI and national research organizations can use such data to help determine the areas in which rice scientists most need improved breeding materials and scientific information.

Each breeder ranked (in order of severity) the four most serious environmental or biological problems that limit farmers' rice yields within the area served by each experiment station. At stations where more than one rice breeder were interviewed, these data were collected for the major environmental subregions for which each breeder was responsible. The breeders also ranked specific pests in order of severity.

Environmental and biological stresses

Every breeder rated diseases and insects among his four major problem (Table 9). For all regions, diseases and insects received the highest mean severity rating -- 3.2 on a scale where 4 was the most serious problem and 1 the fourth most serious.

Drought was the second most important environmental problem. It was considered a major problem in 82% of the areas. It also received the second-highest mean rating of severity. Injurious soils were rated as a major constraint in 57% of the regions. The overall severity rating for injurious soils was 1.2; for the stations where problem soils were

considered a serious problem, 2.2. Excessive monsoon cloudiness was considered serious in 40% of the areas; floods in 38%. Cold temperature, rated as a problem in 29% of the areas, received a low overall severity rating of 0.7. But when calculated for only the stations where cold was a problem its severity rating (2.5) was high.

Waterlogged soils was an interesting problem. Also called *ill-drained soils* or *stagnant soils*, the term refers particularly to regions in the coastal areas of the Indian subcontinent where stagnant water up to 1 meter in depth stands throughout the monsoon season. Two breeders in India (6%) indicated waterlogged soils as a serious constraint under the category *other stresses* although it was not included in the list of environmental stresses. One breeder considered waterlogged soils the most serious constraint in his region.

Table 9. Rice breeders' perceptions of the biological and environmental stresses that most seriously limit rice production on farmers' fields within the areas served by their research centers. Thirty-five breeders at 28 agricultural experiment stations and universities in 10 Asian nations, 1975.

Biological-environmental factors	Mean severity rating[a]		Areas (%) where stress was rated as a major constraint[b]
	All stations	Stations where stress was a problem	
Diseases and insects	3.2	3.2	100
Drought	2.2	2.7	82
Injurious soils[c]	1.2	2.2	57
Excessive monsoon cloudiness	1.3	2.4	40
Floods	0.6	1.7	38
Cold temperature	0.7	2.5	29
Deep water[d]	0.4	2.6	15
Hot temperature	0.1	1.3	9
Waterlogged soils	0.1	2.5	6
Other stresses[e]	0.1	1.5	6

[a] On a scale of 1-4: 4 = most serious environmental or biological stress; 1 = fourth most serious. Calculated for all 35 areas and also for only those in which each factor was considered one of the region's four major problems.

[b] Percent of 35 rice breeders who rated each stress as one of four most serious problems limiting rice production on farmers' fields within the regions served by the experiment stations.

[c] Salinity, alkalinity, zinc deficiency, etc.

[d] Defined as *water that reaches about 50 cm (too deep for the new semidwarf varieties to grow) during the monsoon season.*

[e] Typhoons and weeds.

Diseases and insects

When the rice breeders ranked 14 major pests, they cited three diseases and three insects among the four most serious in from 30 to 60% of the regions.

The rice stem borer was considered a serious pest -- in 60% of the regions (Table 10). When calculated for all 35 regions in 10 countries, its severity rating (1.6) was one of the highest. But when calculated only for the stations where the stem borer was rated as one of the four most serious problems, the degree of severity (2.7) was fourth highest. That

Table 10. Rice breeders' perceptions of the specific insects and diseases that most seriously limit rice production on farmers' fields within the areas served by their research centers. Thirty-five rice breeders at 28 agricultural experiment stations and universities in 10 Asian nations, 1975.

Pest	Mean severity rating[a]		Regions (%) where pest was rated as a major constraint[b]
	All stations	Stations where pest was a problem	
Stem borer	1.6	2.7	60
Bacterial blight	1.6	2.8	57
Brown planthopper	1.1	2.5	46
Blast disease	1.4	3.2	43
Gall midge	1.1	3.0	37
Tungro virus	0.7	2.3	29
Sheath blight	0.3	2.0	17
Green leafhopper	0.2	2.0	9
Helminthosporium	0.1	1.0	9
Striped virus[c]	0.3	3.0	9
Grassy stunt virus	0.1	1.0	6
Sheath rot	0.1	2.0	6
Other insects[d]	0.7	2.1	34
Other diseases[e]	0.4	2.1	20

[a] On a scale of 1-4: 4 = most serious insect or disease pest; 1 = fourth most serious. Calculated for all 35 areas and for only those regions in which each factor was considered one of the four major pests.

[b] Percent of 35 breeders who rated each insect or disease as one of four most serious pests limiting rice production on farmers' fields within the regions served by the experiment station.

[c] Korea only.

[d] Includes one rating each for whitebacked planthopper, leaf roller, paddy bug, seedling fly, stink bug, army worm, gandhi bug, and two nonspecified insects.

[e] Includes one rating each for bacterial leaf streak, black smut, sheath virus, glume blotch, stem rot, and two nonspecified diseases.

may indicate that the stem borer limits yields across vast regions, but that other pests are usually more serious in individual regions.

Bacterial blight disease was another widespread pest. It was considered a major problem in 57% of the regions and it received an overall severity rating of 1.6. At the stations where it was a serious pest, bacterial blight received a rating of 2.8 -- higher than that received by the stem borer. Blast disease was cited as the fourth most common of the serious pests -- in 43% of the regions, and it received an overall severity rating of 1.4. At the stations where it was considered a major problem, however, it received the highest rating (3.2) among all pests (Table 10).

Grassy stunt virus disease was considered a major problem in only 6% of the regions while its vector, the brown planthopper, was cited in 46%. That may indicate that grassy stunt could become widespread and serious in the future.

COMPARISON OF FARMERS' CONDITIONS, SCIENTISTS' BREEDING EFFORTS, AND LATEST VARIETIES

The relevance of the rice breeders' research efforts in providing the types of varieties that farmers need was measured. Three questions about local rice-growing conditions were asked of 23 breeders at 22 research centers[2/] in 8 countries.

1. What percentage of the rice grown on farmers' fields within the area served by your experiment station is irrigated, rainfed-lowland, upland, and deep-water or floating rice?

2. What percentage of your professional time is spent in improvement of irrigated, rainfed-lowland, upland, and deep-water or floating rice?

3. What percentage of all varieties released by your station over the past 5 years is suited for each of the 4 rice-growing conditions?

To eliminate bias, the sequence of the three questions was dispersed in the questionnaire.

The breeders perceived 43% of the rice grown on farmers' fields as irrigated; the scientists spent 60% of their time working with irrigated rice; 57% of all varieties released at their stations during the previous 5 years were suitable for irrigated land (Table 11).

For rainfed rice the mean percentages were 40% for farmers' conditions; 22% for scientists' work time; and 32% for recent varieties.

The three factors matched fairly well for upland and deep-water or floating rice.

2/ At the one experiment station where two breeders were asked these questions, each was asked to respond to the questions for the major subregion for which he was responsible.

Table 11. A comparison of rice breeders' perceptions of the rice-growing conditions of farmers in the regions served by experiment stations; the mean percentages of research efforts that rice breeders devote to the same categories of rice-growing conditions; and the varieties released during the past 5 years. Twenty-three breeders for 23 regions served by 22 agricultural experiment stations and universities in 8 Asian nations, 1975.

Comparison	Rice-growing conditions (%)			
	Irrigated	Rainfed lowland	Upland	Deep-water or floating
Farmers' fields	43	40	12	5
Scientists' research efforts	60	22	14	4
Newest varieties[a]	57	32	10	2

[a] Released over the past 5 years.

NEWEST VARIETIES

The types of new rice varieties that were becoming available to Asian farmers were determined through a survey of breeders at 29 research centers in 10 countries. The breeders were asked about the varieties that had been released by their stations over the previous 5 years.

A total of 165 new varieties had been released by 27 of the experiment stations. Two stations had not released varieties during the time period. For all stations surveyed, the average number of released varieties was 5.7 or slightly more than 1 variety/year. For only the stations that had released varieties during the 5-year period, the average was 6.1 varieties/station.

Locally bred and IRRI varieties

Each breeder was asked how many of his newest varieties had been bred locally (within his country) and how many had come from IRRI. Breeders were also asked to identify the parents of all locally bred varieties.

Almost 80% of the varieties had been bred within the countries where they were released; 22% were developed at IRRI (Fig. 3).

IRRI progeny

Forty-two percent of the varieties were progeny of crosses involving an IRRI variety or line as a parent (Fig. 3). (Of the 120 *locally developed* varieties, 54% were IRRI progeny.) Sixty-four percent of the total sample were either progeny of IRRI rices or had been developed at IRRI. Many of the other varieties were progeny of Taichung Native 1 (TN1), which was

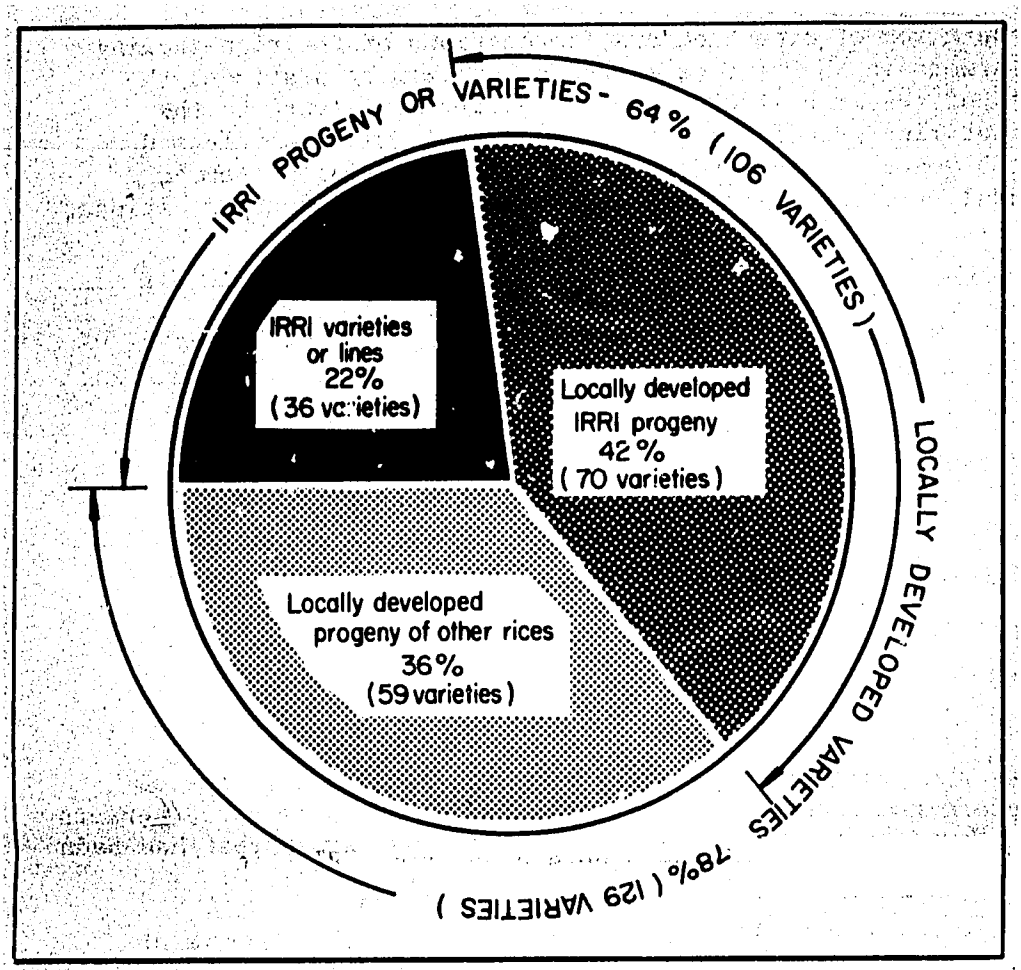

Fig. 3. Of 165 new varieties released for farmers in Asia over period, 64% were either progeny of IRRI rices or were IRRI varie experimental lines. Twenty-two percent of the rices were develo IRRI and 42% were progeny of local crosses involving an IRRI par One hundred and sixty-five newest varieties released from 1970 t at 29 agricultural experiment stations and universities in 10 Asian nations, 1975.

released in Taiwan in 1956. TN1 was the first tropical semidwarf plant type, and it became a prototype model for the architecture of IR8, released in 1967. TN1 was generally replaced on farmers' fields by IR8 and newer semidwarfs in the late 1960's.

ADVANCED BREEDING LINES

Plant breeders enter their best experimental rices -- those fixed lines (F_5 or F_6 generation) being evaluated for possible release as new farmer varieties -- in advanced yield trials. Because most of the future rice varieties in Asia will come from such advanced trials, information was collected on the types of plant materials included in them through a survey of the rice breeders in charge at 28 research centers in 10 countries.

Numbers and sources of lines

It was found that 4,163 advanced lines were being tested in 29 such trials at the 28 stations. A mean number of 144 lines/trial was found, with a range of from 12 to 630 lines/trial.

For most of the trials, the breeder in charge indicated how many of the advanced lines were developed at that station and how many came from outside sources (other breeding centers in that country, other countries, or IRRI). These data were collected on 4,021 of the breeding lines in 27 advanced yield trials in 9 countries.

Fifty-nine percent of the genetic material originated from local crosses made at the breeders' station; 41% originated outside of the stations (Fig. 4a).

Sources of introduced lines

The origin of 1,406 of the *introduced lines* (the advanced lines *not* from local crosses) in 17 advanced yield trials in 8 countries was determined Sixty percent of the introduced genetic material came from crosses made at other research centers within the same country as the surveyed experiment station: almost all of the others came from IRRI (Fig. 4b).

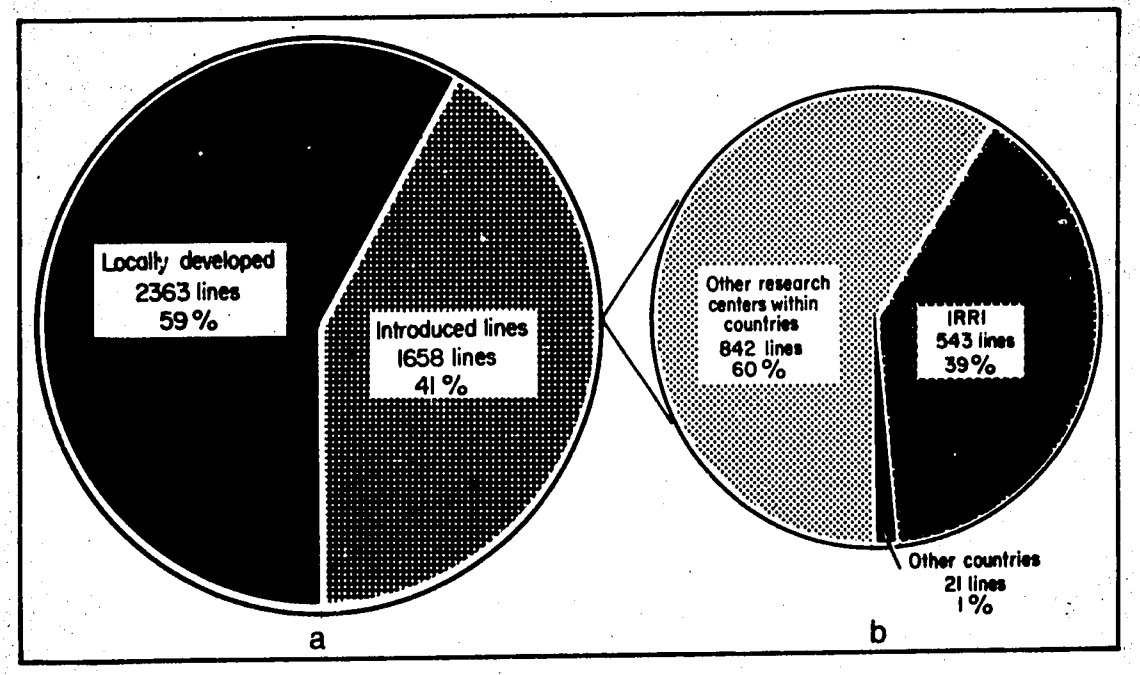

Fig. 4. Data were collected on 4,021 breeding lines of rice in advanced yield trials in Asia. 4a. Fifty-nine percent of the advanced lines originated from crosses made at the local research center while 41% originated from crosses made outside of the local centers. 4b. Of 1,406 introduced lines, 60% came from other research centers within the countries and 39% came from IRRI. From a survey of 4,021 advanced experimental lines of rice in 27 advanced yield trials in nine Asian nations, 1975.

Number of locally developed lines per cross

An attempt to further measure the genetic diversity of improved local lines was made by asking the breeders to indicate the number of crosses from which they selected 3,791 locally developed lines in 22 advanced trials at 20 research centers in 8 countries. The lines had been selected from 443 crosses -- an average of 8.6 advanced lines per cross.

BREEDING METHODS

The breeding methods that rice breeders used were surveyed at 24 research centers in 10 countries.

Sixty-eight percent of the breeders primarily used the pedigree method; 94% used the pedigree system in combination with other methods (Table 12). Although no breeder depended primarily on mutation breeding (chemical, radiation, or natural) in his program, 39% used mutation in combination with other methods.

Table 12. The breeding methods used by 31 rice breeders at 24 agricultural experiment stations and universities in 10 Asian countries, 1975.

Use of method	Breeders using											
	Pedigree		Backcross		Bulk		Mutation[a]		Combination		Others	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1st	21	68	2	6	1	3	0	0	6	19	1	3
2nd	3	10	10	32	9	29	3	10	3	10	1	3
3rd	3	10	5	16	5	16	4	13	5	16	5	16
4th	2	6	2	6	0	0	5	16	4	13	1	3
Use as one of several breeding systems	29	94	19	60	15	48	12	39	18	58	8	25

[a] Chemical radiation, or natural.

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