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ASSESSING QUANTITATIVE AND QUALITATIVE LOSSES IN RICE POST-PRODUCTION SYSTEMS

by

Z. Toquero, C. Maránan, L. Ebron and B. Duff

Paper prepared for presentation at an FAO Workshop on Post-Harvest Rice Losses, Alor Star, Malaysia

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AGRICULTURAL ENGINEERING DEPARTMENT
THE INTERNATIONAL RICE RESEARCH INSTITUTE
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Working Papers

The Department of Agricultural Engineering at the International Rice Research Institute has undertaken a series of empirical studies designed to examine and assess the economic and technical characteristics of the rice post-production industry in the Philippines and other countries of Southeast Asia. As a part of this project, the department is issuing a series of preliminary working papers reporting the results of studies of selected aspects of the post-production industry. The papers listed below represent those which have been issued to date.

74-02 AE Zenaida Toquero and Bart Duff, "Survey of Post-Production Practices Among Rice Farmers in Central Luzon", IRRI Saturday Seminar, September 1974.

75-02 AE Zenaida Toquero, Bart Duff, Tessa A. Lacsina and Yujiro Hayami, "Estimating the Elasticities of Home Consumption and Marketable Surplus for a Subsistence Crop: Rice in the Philippines", IRRI Department of Agricultural Engineering, February 20. Also published in the American Journal of Agricultural Economics, November 1975. A forthcoming issue of the Philippine Economic Journal also contains this paper.

75-03 AE Zenaida Toquero, "A Survey of Rice Milling Practices in Central Luzon", IRRI Department of Agricultural Engineering, August 1975.

75-04 AE Bart Duff and Zenaida Toquero, "Factors Affecting the Efficiency of Mechanization in Farm Level Post-Production Systems", paper prepared for presentation at a Workshop on Farm Tenure and Mechanization, UPLB Center for Policy and Development Studies, July 1975.

76-02 AE Zenaida Toquero and Bart Duff, "A Profile of the Rice Post-Production Industry in Camarines Sur", paper prepared for presentation at a Regional Workshop on Rice Post-Production Technology sponsored by the National Grains Authority, National Food and Agriculture Council, Bicol River Basin Council, University of the Philippines at Los Baños, February 5 - 7, 1976, Naga City, Philippines.

76-03 AE Zenaida Toquero, Celerina Maranan, Leonarda Ebron and Bart Duff, "An Empirical Assessment of Alternate Field-Level Rice Post-Production Systems in Nueva Ecija, Philippines. A Progress Report", IRRI Department of Agricultural Engineering, June 1976.

ASSESSING QUANTITATIVE AND QUALITATIVE LOSSES IN RICE POST-PRODUCTION SYSTEMS[1/]

by

Z. Toquero, C. Maranan, L. Ebron and B. Duff*

Introduction

There is a general consensus that the major source of expanded output in land-short countries must either be increased cropping intensity, higher yields or a combination of these components. Higher and less variable yields appear to harbor the greatest potential for short and medium-term increases in total production, although higher yields and increased intensity are not mutually exclusive options.

When focusing on the yield component as a source of increased output, we need to know at what point yield is measured. While field yield accurately reflects the realized biological potential of the rice plant, it may not represent the economic return to the farmer or the quantity ultimately available for consumption. Evaluating the latter requires knowledge of post-production and marketing systems and the efficiencies of these systems.

Current interest in post-production related activities is partially the result of the increased yields possible from the modern varieties. Losses which were formerly small in absolute terms, tend to expand proportionately with increased farm level yields making their magnitude and value more significant than in the past. In addition, there has been increased interest in the potential (and possibly low-cost) increases in output available through use of improved post-production systems. Lastly, the conditions necessary to achieve higher cropping intensities may require significant modification in existing harvesting, handling, threshing and drying operations to allow timely "turnaround" intervals between crops.

Unfortunately, much of the conjecture surrounding projected gains from reduced losses and improved cropping efficiency attributed to "modernized" post-production operations is not supported by empirical

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[1/]We would like to acknowledge the assistance of the Dept. of Agricultural Process Engineering and Technology, University of the Philippines at Los Baños, the National Grains Authority, Government of the Philippines, the Staff of the Bicol River Basin Development Program and the United States Agency for International Development for assistance in conducting the trials described in this report.

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evidence. Lack of information which identifies and quantifies the sources and characteristics of improvements in these operations is particularly acute at the field and village level where paddy is grown and large quantities are retained for consumption.

While there are obviously several economic and technical factors which affect post-production losses (including the variety grown, weather, and availability of labor), we attempt in this paper to pinpoint the sources and levels of grain loss in rice post-production systems which can be alleviated through introduction of improved techniques, management, economic policies or institutional innovations.

Review of Past Research

Beginning in 1973, IRRI initiated work to investigate the magnitude and nature of field grain losses in paddy production. A field study undertaken to assess harvest losses (Samson & Duff, 1973) indicated significant differences in loss levels when comparing a) varieties, b) wet and dry seasons, and c) moisture content at the time of harvest. In a related series of experimental trials at IRRI, losses ascribable to handling, bundling, stacking and field-drying were also investigated. Total paddy losses approximated 1 to 3 percent for the harvest operation and 2 to 7 percent for intermediate handling steps.

In an attempt to assess the qualitative changes resulting from these operations, total milled and head rice recoveries were recorded for both the harvesting and experimental handling trials. Significant decreases in both total and head rice were observed due to delays in the time of harvest with the greatest change being recorded between head rice recovery and moisture content at the time of harvest.

In 1973-74, a comprehensive survey of rice milling and field level operations was undertaken (Toquero & Duff, 1975). One hundred and eighty rice mills and approximately 600 farmers were surveyed in three regions of the Philippines. These surveys were designed to inventory existing rice post-production operations. The preliminary results have been summarized in a number of working papers issued by the IRRI Engineering Department and listed in the attached bibliography.

Based on the results of the foregoing research, a series of pilot area trials were planned and implemented to assess the impact of alternative systems of technology at both the farm and rice mill level. Sites for evaluating field and farm level operations were located in four villages of Central Luzon and three villages in the Bicol River Basin area. The preliminary findings from these systems trials are the subject of this report.

Objectives

The major objectives of the study are: a) to develop a suitable research methodology to determine the nature and characteristics of

grain loss at the farm and mill level, b) to inventory and assess technical efficiency in traditional and improved farm and mill level post-production systems, c) to examine the economics of traditional and improved systems, and d) to determine the institutional factors constraining use of improved techniques and systems.

The Methodology of Farm Level Trials

Four systems involving alternative combinations of technology and management were utilized in the farm level trials (Fig. 1). Harvesting in all four systems was carried out with the use of scythe or sickle.

System I exemplifies the traditional technology commonly used by farmers. Threshing was entirely a manual operation with the operator using either a threshing frame ("hampasan"), flail, stick or manual treading. Threshed paddy is sun-dried prior to storage or milling. System I acted as a control against which the results from other systems were compared.

Improved technology was used in System IV in which paddy was mechanically threshed with the axial-flow thresher and subsequently dried in a twin-bed batch dryer.

Systems II and III combine elements of traditional and improved systems in the threshing and drying operations. In System II, threshing was also performed manually, but a twin-bed batch dryer was used to remove moisture prior to storage. In System III, the mechanical thresher was utilized immediately following harvest, although the paddy was sun-dried.

Systems I and IV have a minimum paddy requirement of 1.75 tons each to permit replicated commercial milling tests. Systems II and III require a minimum of 1.0 ton each. Depending on the minimum requirement per system, one or more paddy fields were used for each system treatment. When more than one field was required, every attempt was made to ensure that a uniform variety and planting dates were employed.

The area of the field(s) selected for each system was carefully measured and recorded. Farm maps were also prepared as guides in planning and scheduling farm operations.

Crop-cut samples were taken for each system to measure the potential yield at the field level. To obtain actual area yields, plots were measured and the grain from each was weighed following threshing and again following drying. All yield and weight measurements were corrected for moisture content and impurities. To determine the quality of paddy and milled rice, 750g samples were taken following each operation in each system and later dried, milled and analyzed in the laboratory.

Quantitative losses were measured at each stage in the post-production operations. Harvesting loss was determined using a 2 sq m sample frame. Following harvest, paddy was bundled and stacked and grain that had either fallen on the ground or remained unharvested within the sample area were handpicked and weighed. This process was replicated two or more times per plot depending on the total area involved in a given system. To measure stacking losses, harvested materials were placed on canvas sheets provided to farmer cooperators. Following the stacking operation, grain remaining on the sheets was weighed. Losses incurred using the traditional system of threshing were determined by weighing the paddy recovered by gleaners or "mambabarog" (people re-threshing the paddy). For mechanical threshing, canvas mats were used to recover and measure paddy discharged onto the ground.

Records were kept of the labor employed for each operation within individual systems, the costs incurred to perform each operation and the total and elapsed times required to complete an entire sequence of operations. In addition, the quantitative and qualitative measurements necessary to impute relative benefits and costs for each system were also compiled.

In addition to the field level operational trials, concurrent interviews are being conducted among sample farmer-members of associations in the three pilot areas of the Bicol Region. These interviews are designed to examine farmers' post-production practices, attitudes and preferences toward use of alternative milling and processing technologies, problems and suggested improvements and paddy production and disposal.

Acquisition of Equipment

The threshers and dryers used in the pilot trials were purchased through a project fund and sold to the farmers' association selected for the field trials. An Equipment Purchase Agreement was signed by the President of the Association, the Manager of the Area Marketing Cooperative (AMC) and a representative from the cooperating agency through which the project was being implemented. In the Central Luzon pilot trials, the project was implemented in cooperation with the Integrated Development Project for Nueva Ecija (IDP/NE). In the Bicol Region, the research is being done in cooperation with the Bicol River Basin Development Program (BRBDP). Under the terms of the purchase agreement, the government agency (IDP/NE in Nueva Ecija and BRBDP in Bicol) sells the equipment (one thresher and one twin-bed batch dryer) to the farmers' association. The machines are amortized over a period of not more than five years with 8 percent interest charged on the unpaid balance. Payment is obtained from fees charged from members and other users of the equipment. The agreement further states that 40 percent of the gross income from the equipment is to be used for yearly amortization and 60 percent is to be retained by the association to defray labor, fuel and maintenance costs.

Results and Discussion

Field trials were completed at four villages in Central Luzon during the 1975 wet season and were continued through the 1976 dry season. Four to six farmer-members of each village association were chosen to participate (Table 1). The association purchased and operated the axial-flow threshers and twin-bed batch dryers, kept records and acted as marketing agent. Another three villages are presently being evaluated in the Bicol Region.

Labor Requirements

Detailed labor records were kept of the man-hours used in each operation under each level of technology. Man-hour requirements refer to the net time devoted to each operation and exclude snack and rest periods.

Figure 2 shows the relative percent distribution of labor between traditional and improved systems by operation as well as for the total system.

Harvesting. Harvesting, which includes cutting, gathering, bundling, and stacking required the greatest manpower input. Harvesting was one of the major constraining operations in the post-production process as indicated by an earlier farm level survey.[1/] The survey also indicated that a rapid harvest had little correlation with a farmer's desire to plant a subsequent crop. Generally, farmers in the area who harvest their paddy early tend to wait and plant with their neighbors to protect their crop from rat infestations and other pest problems. Timeliness in harvest operations reflects the farmer's awareness of the relationship between delays and increased losses.

In handling operations, the mechanical system required twice (2x) as much labor as the traditional system (Table 2). Examination of the data showed that paddy for mechanical threshing had to be moved to the dikes or roadside to make it accessible to the thresher. Moreover, large stacks were required to effectively utilize the equipment.

Threshing. Threshing is the separation of the grain from the stalk. In System I (traditional), threshing also included cleaning or winnowing to separate the grain from immature kernels and foreign materials. The mechanical thresher reduced overall labor requirements by 70 percent on a per hectare basis. The reduction is slightly higher on a per ton basis because the thresher also tends to improve grain yields.

[1/] Duff, B. and Z. Toquero, 1975. "Factors Affecting the Efficiency of Mechanization in Farm Level Post-Production Systems, IRRI Saturday Seminar Paper, August.

In addition to improved yields, farmers also appeared to prefer the mechanical thresher because of its high degree of availability (timeliness) and the ease of monitoring the threshing and distribution of the final product. In contrast to traditional methods which offer considerable opportunity for pilferage by those performing the threshing operation, mechanized threshing effectively consolidates control of the threshing operation.

The mechanical thresher used in the trials has the technical capability to thresh high moisture paddy, a feature which proved particularly useful when combined with mechanical drying. A major limitation of the thresher is its high initial cost and lack of field mobility during the wet season harvest. The machine did not eliminate the need for repeated intermediate handling, a major cause of grain loss.

Drying. The labor required for drying includes the handling of threshed paddy in preparation for drying, management of drying system and the collection and bagging of dried materials. Use of mechanical dryers reduced the amount of labor required for drying by 50 percent on both a per hectare and per ton basis. In contrast to the higher yields obtained with the introduction of the mechanical thresher, use of the mechanical dryer did not improve output compared to traditional methods, particularly when used in combination with traditional harvesting-threshing techniques. The dryer did, however, demonstrate an improvement in grain quality as measured by head rice recoveries. Dryer performance appears to be somewhat better when used in combination with the mechanical thresher. This is not a conclusive observation, however, since performance can partially be ascribed to the lower field losses from mechanical threshing rather than reduced drying losses.

Quantitative Grain Loss

Harvesting loss was based on the quantity of grain recovered during the interval from harvesting up to stacking. The improved system incurred lower harvesting but higher stacking losses compared to the traditional system (Table 3). These differences were partially a result of stack size. Under the traditional system, paddy is stacked in small bundles in the field while paddy intended for mechanical threshing is immediately hauled and stacked in larger bundles along the levees or roadside to facilitate access to the thresher. This practice is especially prevalent during the wet season harvest when the field is soft and muddy making it impossible for the thresher to negotiate the field.

Data from the Central Luzon trials show that grain losses from manual threshing were three times (3x) greater than for those systems using the mechanical thresher. The results from Bicol gave a different pattern because manual threshing was performed on a cement threshing floor. All grain recovered after the threshing operation was considered part of the threshing yield. Moreover, traditional threshing in Bicol

is a combination of treading and use of flail or stick. The threshing operation is somewhat more complete compared to the "hampasan" method (beating paddy against a threshing frame) practiced in Central Luzon.

Table 4 illustrates the relationship between elapsed time from harvest through drying and resulting grain yield.[1] In general, grain loss increased as the interval between the harvest and threshing operations lengthened. During this period, grain remains unthreshed or undried or both. More significant, however, are the yield differences observed between traditional systems and those using either one or both improved methods of threshing and drying. Using a dryer in System II increased grain yield by 12 percent over System I. Similar increases in yield were found in System III using the mechanical thresher. System IV which employed both the thresher and dryer in sequence, produced the greatest increase in output. A high degree of variability was observed from each system, largely because of the difficulty in controlling all factors that affect the performance of the systems. Rain after harvest but before threshing often damaged the grain that was stacked or bundled in the field. Subsequent operations could do little to rectify these effects. Better scheduling of operations for all systems would have reduced losses by cutting the time interval between harvesting and drying.

Qualitative Grain Loss

Differences in grain quality from each post-production system are shown in Table 5. Although overall milled rice recovery increased only 4 to 6 percent using the improved system, the percentage of broken, fermented, discolored and immature grains was significantly reduced, particularly in those systems using the grain dryer. An inverse relationship was also observed between elapsed time from harvest to final drying and percentage head rice recovery (compare Tables 4 and 5). A total elapsed time of 4 days from harvest to final drying resulted in a 77 percent head rice recovery (as exhibited by manual threshing and sun-drying). In contrast, systems with a total elapsed time of two days or less (mechanical threshing and drying or a combination of mechanical threshing and sun-drying) gave a 90 to 91 percent head rice recovery. These results were obtained through laboratory milling analysis. Current milling tests include passing the output of field level systems through a number of alternative commercial milling systems.

Distribution System

An examination of the paddy marketing system following the field level post-production operations partially explains why mechanical dryers

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[1] Analysis was based on samples from 51 fields.

are not attractive to farmers. Figure 3 shows the distribution of paddy among recipients following harvest. Of the 60 percent retained by a tenant-operator, 25 percent is sold and 32 percent is stored for home consumption. Figure 4 pinpoints the location within the post-production distributive system where drying takes place. For tenant farmers, 52 percent of the paddy is sold or distributed before it is dried. The remainder is not sufficient inducement for an individual farmer to own and operate a dryer. While the bulk of paddy is sun-dried at the farm level and retained for household consumption, a significant share enters the market prior to drying and is dried at rice mills or warehouses.

Comparative Costs

A series of cost estimates for traditional and improved post-production systems were computed for each village included in the Central Luzon trials. Items included in the analysis were observed labor, fuel and maintenance, and fixed investment requirements. These are expressed in $/t to incorporate the loss differentials between alternate systems. No attempt was made to ascribe increased value to improvements in quality that resulted from use of the mechanical systems, although this would accentuate the differences.

Two methods of estimating costs were considered in the analysis. One was based on a contractual harvesting-threshing fee paid in kind. The second was calculated using an imputed wage rate of $0.14/h (₱1/h) for actual labor.

In the Central Luzon pilot trials, both harvesting and threshing activities utilized hired or exchange labor from the village itself or from neighboring communities. Compensation for labor is usually in kind and harvesting and threshing are considered a joint operation. In the cost estimate, the harvester-thresher's fee was 1/6 of the gross production.[1] For the traditional system, the harvesting-threshing fee amounted to $23.80/t (Fig. 5). With the axial-flow thresher (including the man-hour requirement for harvesting and threshing[2]), costs were reduced by 60 percent to $14.30/t.

Inspite of the high contractual fee for harvesting and threshing, farmers in the study area were still willing to pay the fee plus the added cost for using the thresher. According to the farmers, the harvester-thresher's fee ensures that the field is cleared immediately following harvest, a major problem under the traditional system where threshing was carried out in the field and straw disposal is a problem.

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[1] Average production was 77 bags per hectare or 3.85 tons.

[2] Harvesting utilized an average of 43 m-h/t and manual threshing, 40 m-h/t.

With mechanical threshers, paddy is hauled and stacked along levees or roads where it is accessible to the equipment. Immediately following threshing, straw is either spread along the dike, scattered in the road or burned.

The improved drying system incurred a total cost of $4.40/t, $3.97 of which was for the operation of the batch dryer. In contrast, sun-drying incurred only the cost of labor. Because most farmers in the area did not sun-dry their paddy to the recommended 14 percent moisture content, a serious underestimation of total labor hours was observed in this process. In fact, most farmers sell their paddy immediately following threshing without the benefit of drying. To prevent this error in future trials, all paddy included in the field trial will be purchased and dried to a uniform moisture level as a condition of sale.

The total expenditure per ton in the traditional system was almost twice that of the improved post-production system.

Mill Level Trials

The mill level demonstration and applied research trials are confined to the Bicol area. UPLB[1/] is providing manpower, supervision and testing facilities for the implementation of these trials. As in the case of the field level pilot trials, a number of alternative systems are under evaluation (Table 6). With the exception of the IRRI-improved steel huller ("kiskisan"), all mills included in the trials are commercial units operating in the Bicol Region. While the focus of these studies is the village mill, an assessment of selected commercial level disc-cone and rubber roll-type mills are also included for comparative purposes.

There are four stages in the mill level trials. The first involves a technical assessment of seven milling systems. To reduce experimental error, a 35 ton, homogenous paddy sample was procured, threshed and dried under controlled conditions. The sample was then segregated into lot sizes large enough for replicated test runs through each milling system. Before each test, the milling degree was established using government specifications for second class milled rice. Rice mill operators were asked to calibrate their system to this standard. This procedure partially eliminates bias attributable to differences in the degree of milling. In the trial runs, the initial sample was used to: a) purge the system, b) charge the machine, c) calibrate the mill to a desired milling degree, and d) assess the condition of the mill before conducting the performance test. Samples of paddy, milled rice, bran and other by-products were gathered during each trial run for later laboratory analysis (Table 7).

[1/] Dept. of Agricultural Process Engineering and Technology, Institute of Agricultural Engineering and Technology, University of the Philippines at Los Baños.

In the second stage of the milling trials, paddy from each of the field level systems mentioned earlier is subjected to a series of similar trials. These tests are confined to the disc-cone ("cono") and steel huller ("kiskisan") mills commonly used by farmer-cooperators in the study area. The objective of the latter tests is to assess the effects of pre-milling field level harvesting, threshing, handling and drying techniques on milling performance.

A third phase of the mill-level analysis is to monitor a selected number of operating rice mills over a one-year period. During this phase of the study, paddy and milled rice samples will be obtained periodically. Records indicating the volume of paddy procured and processed will also be maintained. Monitoring will be confined primarily to village level rice mills, although there will be a range of mill types included to permit comparative analysis.

Finally, a mill level survey involving 45 kiskisan mills and 12 cono mills located throughout the Bicol River Basin area will be undertaken to assess their technical, economic and social viability. In addition, users and non-users of the sample mills will be interviewed to determine their attitudes, preferences, problems and recommendations regarding improvements in milling and processing technologies.

Comparative Milling Tests

Because disc-cone and steel-huller mills are the two most popular milling technologies in the Bicol area, the evaluation team was able to assess four mills within each of these categories. However, because other milling techniques are not commonly used in the area, only one mill was tested for the five remaining milling systems (see Table 6).

Results from the commercial milling tests showed the highest total milling recoveries for mills using rubber-roll hullers. Disc-cone and steel hullers followed in that order. This finding is based on the mean performance of each mill type. Close examination of total milling recoveries for two cone-type units showed recoveries of 71 and 70 percent which were slightly higher than was obtained from the rubber-roll hullers (Table 8). A similar condition was also noted for one steel huller which had a total milling recovery of 67 percent which is comparable to the output obtained from the cone-type mills.

Systems employing multipass milling (as exemplified by one Satake and the cone-type units) obtained higher head rice recoveries -- ranging from 72 to 78 percent -- compared to systems using single pass milling (as exemplified by the steel huller and the stone disc-steel huller combination). The difference in head rice recovery in multipass milling can be attributed to the fact that grains are subjected to less pressure during the whitening process and removal of the bran. In single-pass

milling, the grain is under high pressure with concurrently higher temperatures which results in excessive breakage. Moreover, single-pass mills do not have paddy separators, allowing unhulled paddy to mix with brown rice during the whitening process. The mixture of unhulled paddy and brown rice increases frictional forces in the whitening process resulting in further breakage.

Among the six alternative milling technologies tested, the steel-huller mill gave the lower total and head rice recovery. However, when the steel-huller is used as a whitener in combination with a rubber-roll or stone-disc huller, significantly higher total and head rice recoveries were obtained.

To gauge the performance of the commercial mills included in the technical assessment stage of the trials, a series of laboratory milling tests were conducted on the same paddy samples used in the commercial milling tests. The preliminary results showed that the Satake rubber-roll huller produced milling rates comparable to those obtained in the laboratory.

Concluding Remarks

The major objectives of the field level trials appear to have been met. We have been able to estimate the degree and nature of grain loss in several components of the rice post-production system. There is need for further replication of the trials to verify the reliability of the methodology and to investigate factors other than technology which affect the efficiency of these operations. Considerably more work is required at the mill level to assess comparative milling performance and to quantify the utility of milling services by location, size and type of service provided.

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Table 1. Characteristics of five villages included in the post-production pilot trials, Philippines, 1975-76.

Location	Season	Cooperators (no.)	Plots (no.)	Average area (sq m/plot)	Yield[a/] (t/ha)	Variety
Soledad, Sta. Rosa, Nueva Ecija	Wet	5	80	771.4	3.3	IR20 IR26 IR1529 IR1561
Malapit, San Isidro, Nueva Ecija	Wet	6	46	1423.2	3.6	IR26 IR30 IR579 IR1529 IR1561
Polilio, Cabanatuan, Nueva Ecija	Dry	4	42	1242.3	3.1	IR26 IR30 C4-63G
Sta. Cruz, Zaragosa, Nueva Ecija	Dry	5	22	1350.27	3.6	IR747 IR30 IR20
Poblacion, Libon, Albay	Wet	3	25	1269.67	b/	C4-63G BPI 76
Total/average		23	215	1211.36	3.3	

a/ Final paddy weight after drying and adjusting for purity at 14% moisture.

b/ Still being analyzed.

Table 2. Comparative labor requirement between alternative post-production systems by operation, Central Luzon, 1975-76.

Operation	Labor requirement (m-h)			
	Per hectare		Per ton	
	Traditional	Improved	Traditional	Improved
Harvesting	108	97	35	31
Handling	37	83	11	27
bundling	17	24	5	9
hauling	13	34	4	9
stacking	7	25	2	9
Threshing	122	36	39	11
threshing	72	31	23	10
cleaning	33		11	
bagging	9		3	
hauling	8	5	2	1
Drying	20	10	7	3
spreading	9		2	
stirring	1		1	
collecting/bagging	9		3	
weighing	1		1	
loading		2		1
unloading		4		1
weighing		4		1
All Operations	28[illegible]	226	92	72

Table 3. Grain loss incurred in harvesting and threshing operations, Central Luzon and Bicol Region, 1975-76.

Item	Harvesting[1/]		Threshing[2/]	Total
	Harvesting	Stacking		
	percent			
Central Luzon				
Traditional	3.16	0.12	6.82	10.10
Improved	2.14	0.14	2.07	4.35
Bicol[3/]				
Traditional	3.75	[4/]	0.93	4.68
Improved	2.03	1.85	2.18	6.06
Mean (ave. of 2 areas)				
Traditional	3.35	0.12	5.74	9.21
Improved	2.26	0.74	2.12	5.12

[1/] Based on the amount of paddy recovered in the field immediately following harvest from 32 fields.

[2/] Based on the quantity recovered by gleaners ("mambabarog") in the traditional system as reported by 10 farmers for 24 fields. For mechanical threshing, losses include blower loss and straw loss as reported by 13 farmers for 27 fields.

[3/] Data was taken from results of completed field trial in Libon, Albay.

[4/] No stacking loss was noted in the Bicol area because paddy was immediately threshed following harvest with no intermediate stacking operation.

Table 4. Relationships between elapsed time from harvesting to drying and grain yield for alternative post-production systems, Central Luzon, 1975-76.

Item	Post-production systems			
	Manual thresh and sun dry	Manual thresh and mechanical dry	Mechanical thresh and sun dry	Mechanical thresh and dry
Elapsed time by operation (days)				
harvest to thresh	1	1	0	0
thresh to dry	1	0	2	2
harvest to dry	4	1	2	2
Yield per hectare (t/ha)				
harvesting	3.3	4.1	4.9	3.9
threshing	2.9	3.6	4.8	3.8
drying	2.5	3.6	4.2	3.5

Table 5. Quality characteristics for milled rice from alternative post-production systems, 51 paddy samples, 16 plots, Central Luzon, 1975.

System	Elapsed period (harvest to dry)	Quality characteristics			
		Head rice	Broken rice	Milling recovery	
				Brown rice	Milled rice
	days			percent	
Manual thresh and sun dry	4	77.4	20.2	63.0	59.3
Manual thresh and mechanical dry	1	84.5	14.1	67.4	63.4
Mechanical thresh and sun dry	2	90.6	8.8	70.5	65.6
Mechanical thresh and dry	2	89.9	9.2	68.4	64.4

Table 6. Alternative milling systems.

Systems	Pre-cleaning	Hulling	Husk aspiration	Whitening	Refining
I[1/]	None	Engelberg	Air trap	Engelberg	Leather polisher
II[2/]	Scalper-sieve	Stone-disc	Air trap	Cone	Leather polisher
III[3/]	Scalper-sieve	Rubber roll	Aspirator	Abrasive friction	Leather polisher
IV[4/]	None	Rubber roll	Air trap	Kiskisan	None
V[5/]	Sieve	Stone-disc	Air trap	Kiskisan	None
VI[6/]	None	Rubber roll	Aspirator	Friction	None
VII[7/]	None	Engelberg	Air trap	Engelberg	None

[1/] One pass system (local Engelberg).

[2/] Conventional cono type rice mill.

[3/] Japanese multipass rice mill (Satake).

[4/] Rubber roll huller-Engelberg whitener rice mill (BRBC proposed mill).

[5/] Stone-disc huller-Engelberg whitener rice mill.

[6/] One pass Japanese rice mill (Kyowa).

[7/] IRRI improved Engelberg.

Table 7. Measurements performed in each milling system.

Operation	Measurements
Pre-cleaning	Moisture content, crack ratio, dockage, weight/1000 grains
Hulling	Brown rice, broken, dimensions, hardness
Husk aspiration	Loss in sound grains, loss in immature grains
Whitening	Head grains, broken grains, brewer's rice, dimensions, milling degree

Table 8. Preliminary results from commercial and laboratory milling tests for six alternative milling technologies in the Bicol River Basin Area, 1976.

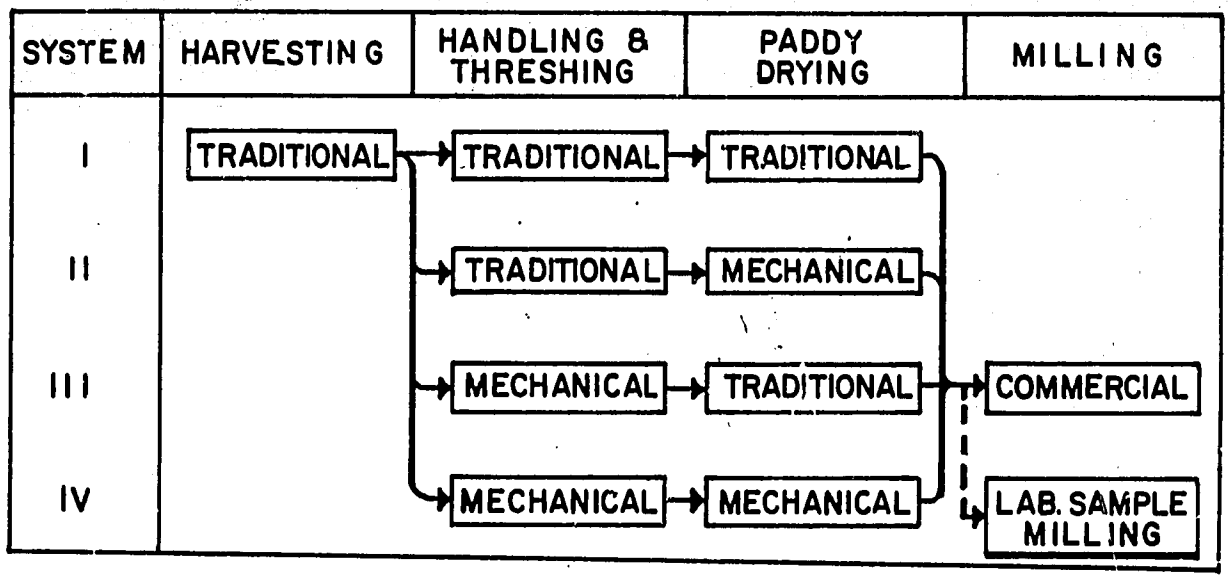
Milling System	Actual capacity (kgs/hr)	Commercial milling[1/]				Laboratory milling			
		Milling recovery	Head rice	Broken rice	Brewer's rice	Milling recovery	Head rice	Broken rice	Brewer's rice
		percent							
Rubber roll single pass (Kyowa)	225	69.75	60.55	38.50	0.95	72.65	82.94	14.97	2.09
Rubber roll multipass (Satake)	4200	69.43	77.71	21.94	0.35	71.33	80.00	17.25	2.75
Rubber roll kiskisan combination	300	68.47	59.05	40.50	0.45	71.31	86.07	11.50	2.43
Cono (ave.)[2/]	630	68.36	74.55	24.61	0.84	70.90	80.22	17.37	2.41
a. Libmanan RM	800	71.10	72.91	26.17	0.82	73.10	84.35	14.00	1.65
b. Concina RM	600	69.90	72.32	26.45	1.23	71.12	79.44	18.16	2.40
c. Gonzales RM	900	67.88	78.45	21.03	0.42	70.06	80.46	16.69	2.85
d. Nazarrea RM	225	64.56	74.52	24.78	0.70	69.33	76.62	20.63	2.75
Stone disc kiskisan combination	444	65.56	53.68	43.63	2.69	68.80	80.00	17.67	2.33
Kiskisan (ave.)[2/]	380	64.50	29.18	68.86	2.06	72.29	81.19	16.45	2.36
a. Torres RM	585	66.70	26.60	67.37	2.41	72.11	83.19	14.79	2.02
b. Olaño RM	270	65.09	38.23	77.00	1.67	70.87	82.32	15.42	2.26
c. Dycoco RM	410	63.26	21.75	60.08	1.25	72.12	80.70	16.45	2.88
d. Ruta RM	240	62.93	30.12	70.99	2.47	74.06	78.56	19.13	2.31

[1/] Tests for each milling system were replicated four times (4x).

[2/] These are mills selected within the pilot areas of the farm level demonstration and applied research trials.

PILOT PROJECT

FARM LEVEL POST PRODUCTION SYSTEMS



MEASUREMENTS (for each system)

o Crop cut samples o Paddy samples o Moisture content	o Post threshing output o Paddy samples o Moisture content	o Post drying output o Paddy samples o Moisture content	o Total rice o Head rice o By products

Fig. 1 Farm level post-production systems.

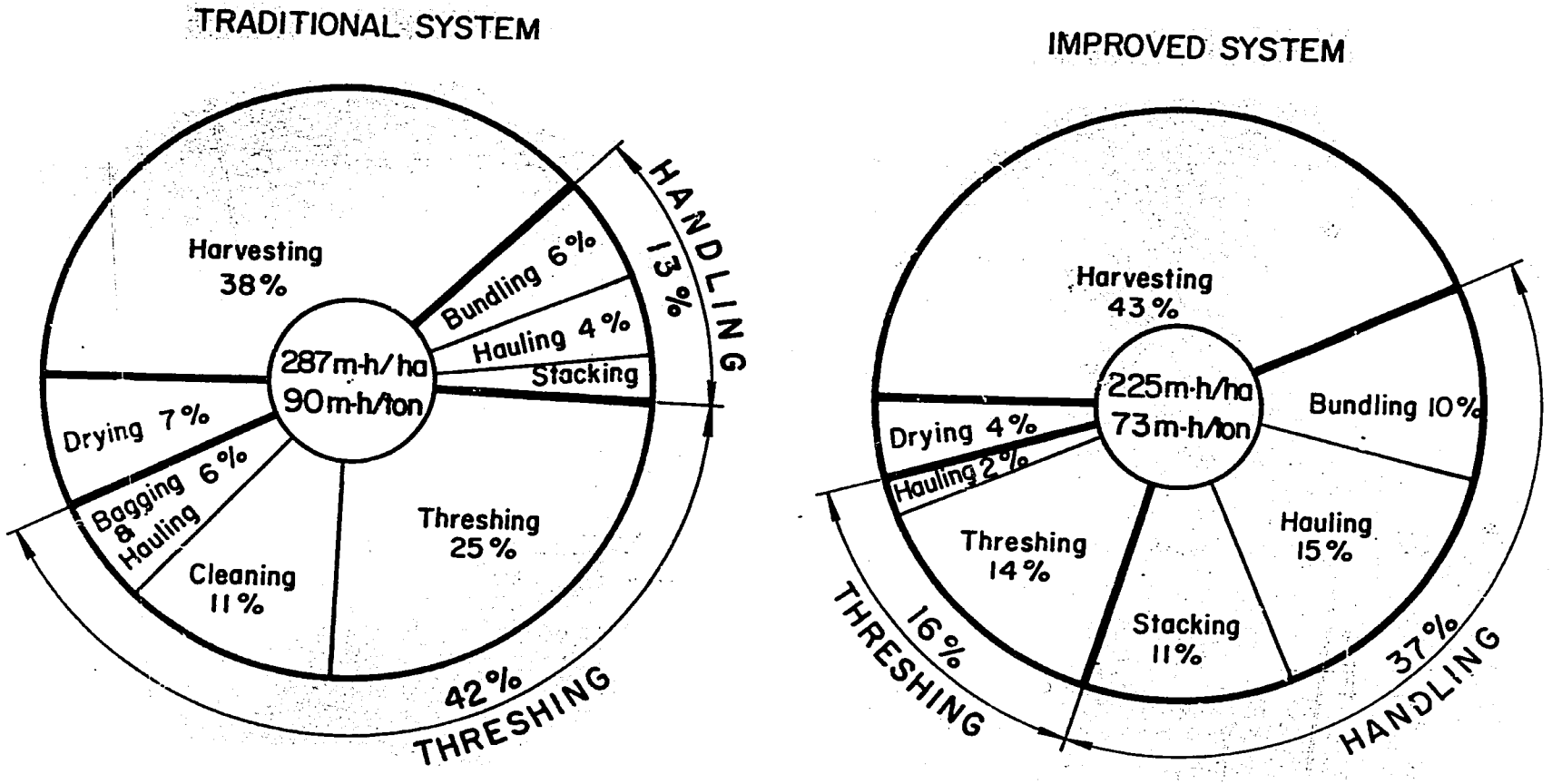


Fig. 2 Comparative labor use for traditional and improved post-production systems. Central Luzon, 1975-1976.

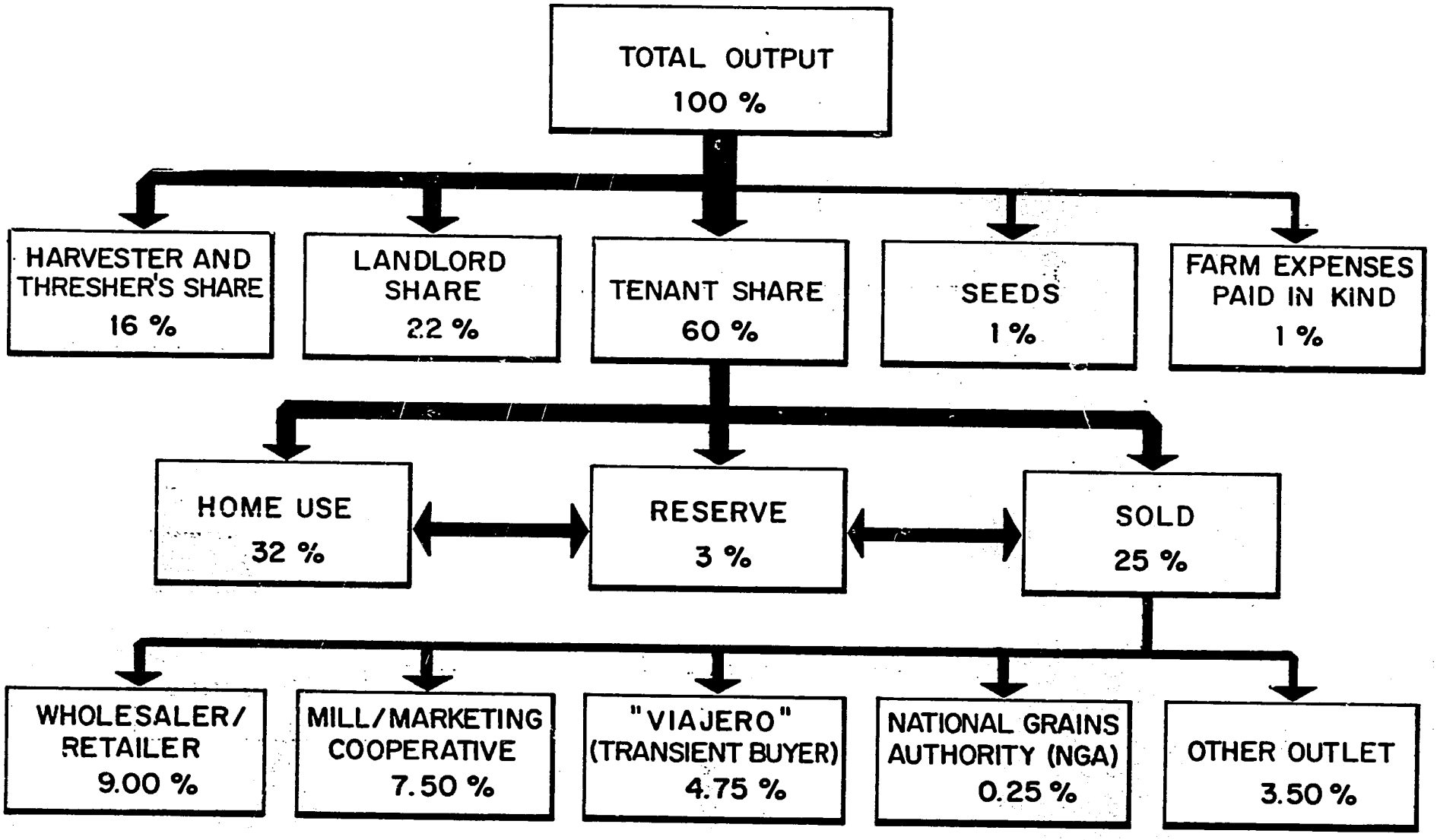


Fig. 3 Production and disposal of paddy by a tenant-operator, Central Luzon, 1974 – 1975

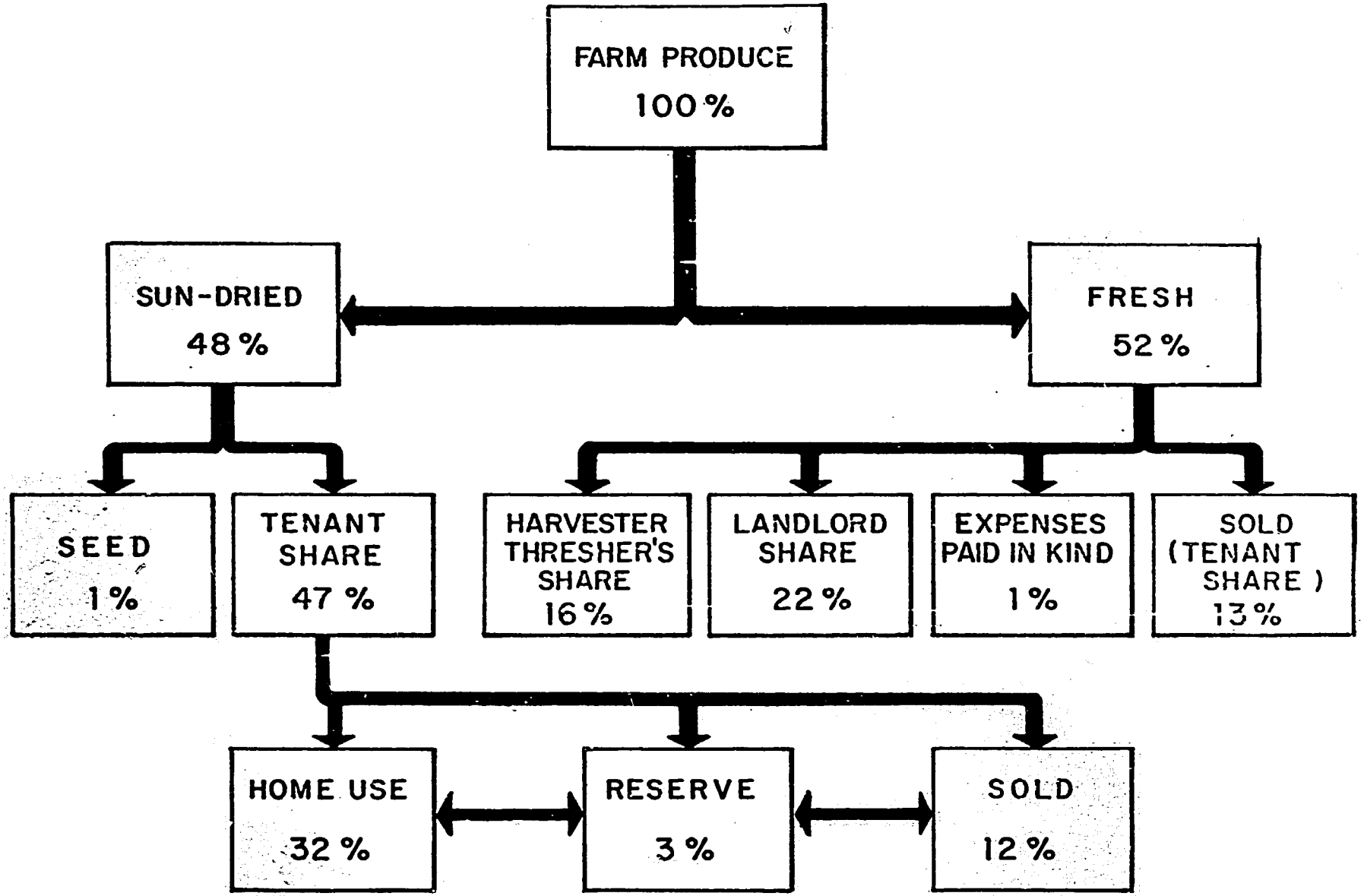


Fig. 4 Flow of paddy harvest in fresh and dried form, Central Luzon, 1974-'75

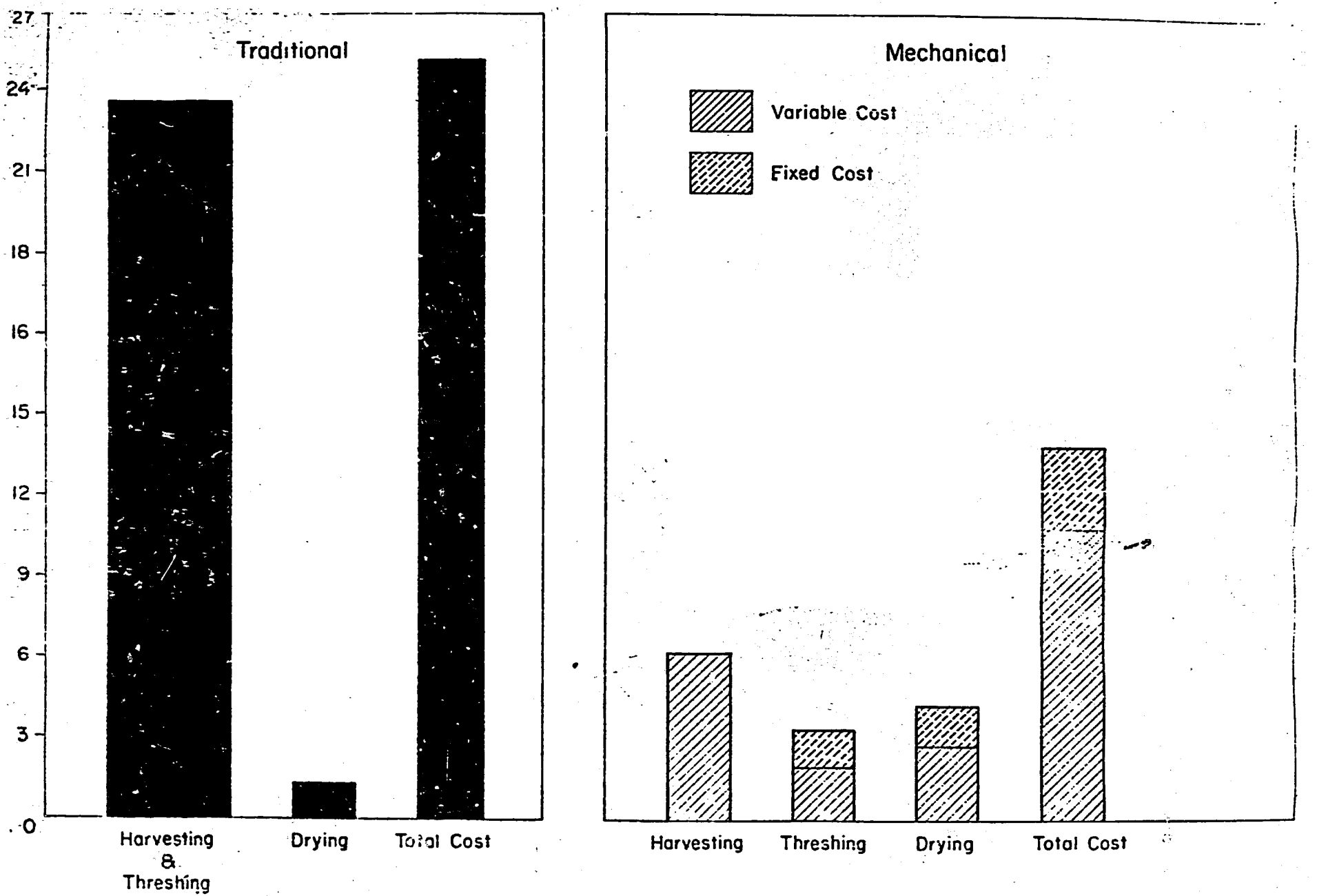


Fig. 5a. Cost estimate (based on contractual harvesting and threshing fee) for alternate post-production systems, Nueva Ecija, 1975-76.

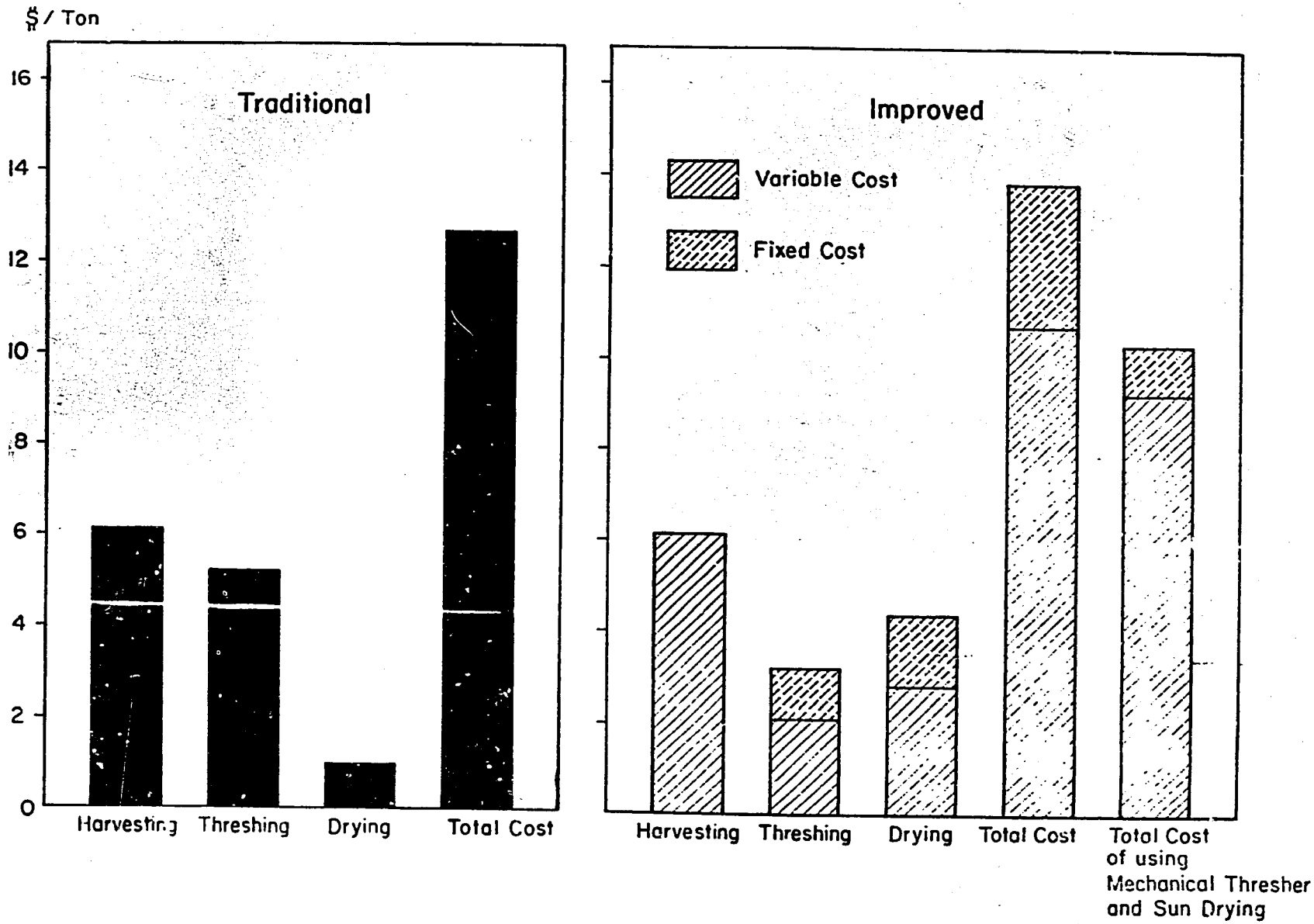
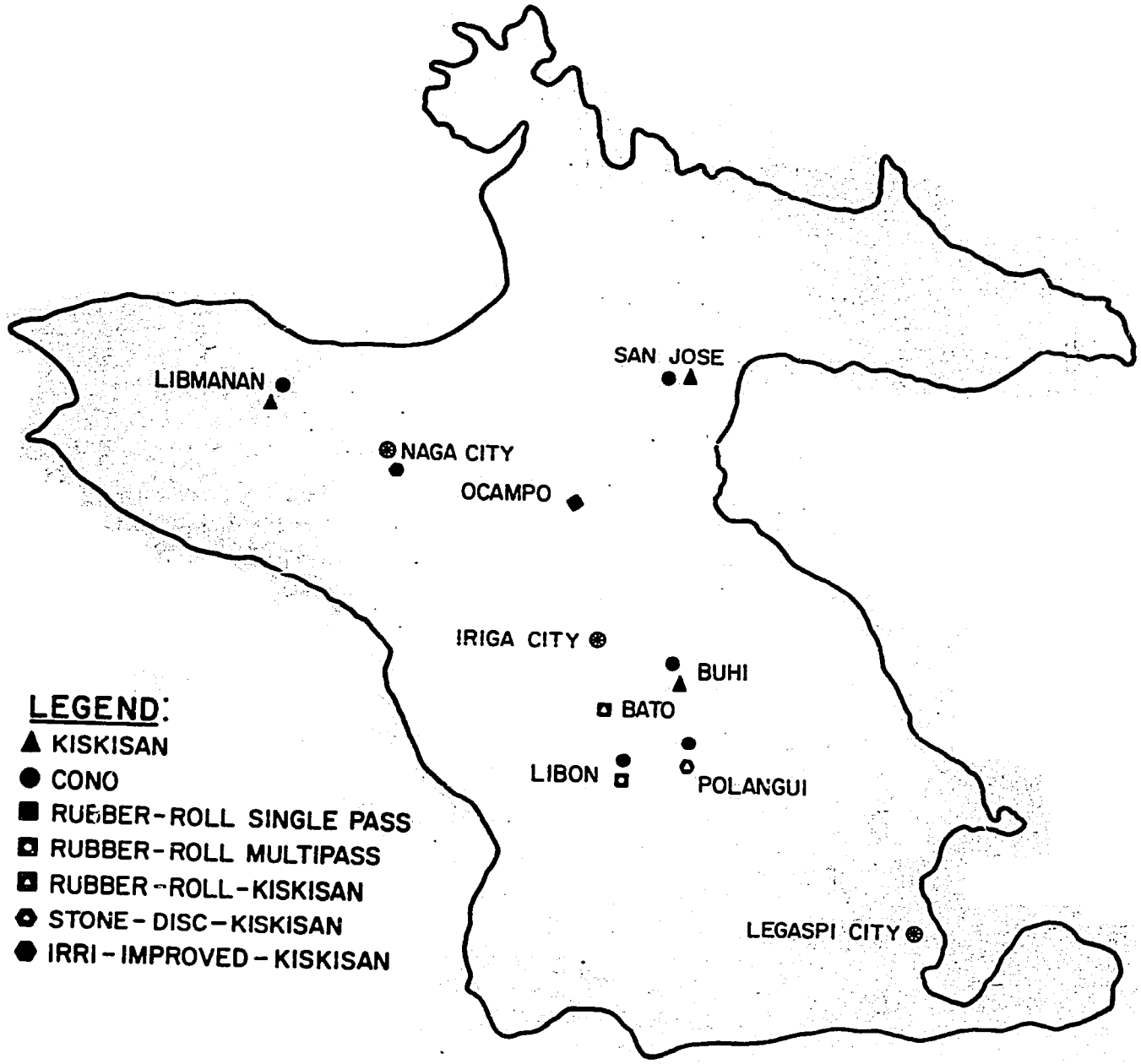
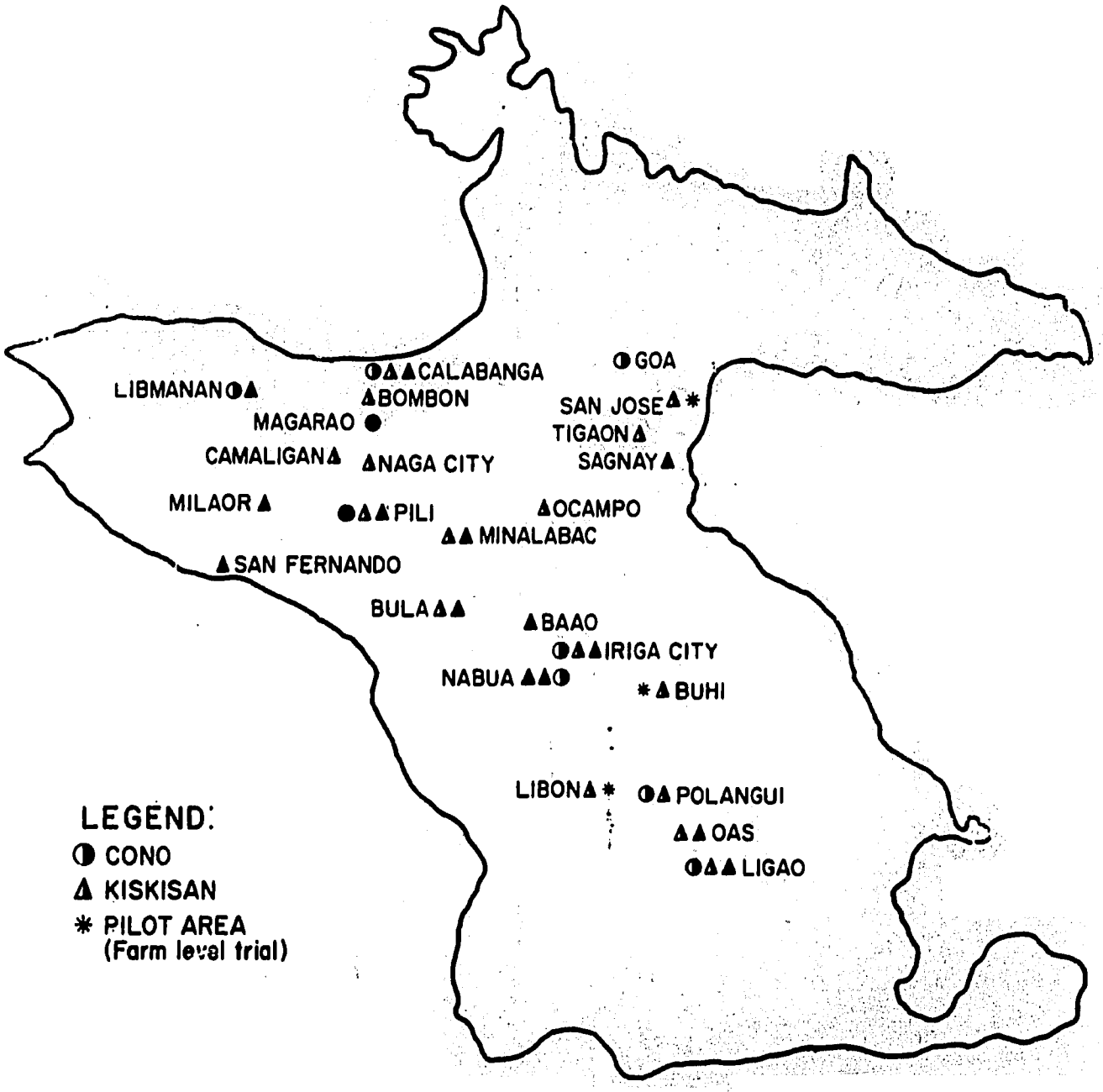


Fig. 5b Cost estimate for alternate post-production systems, Nueva Ecija, 1975-76.

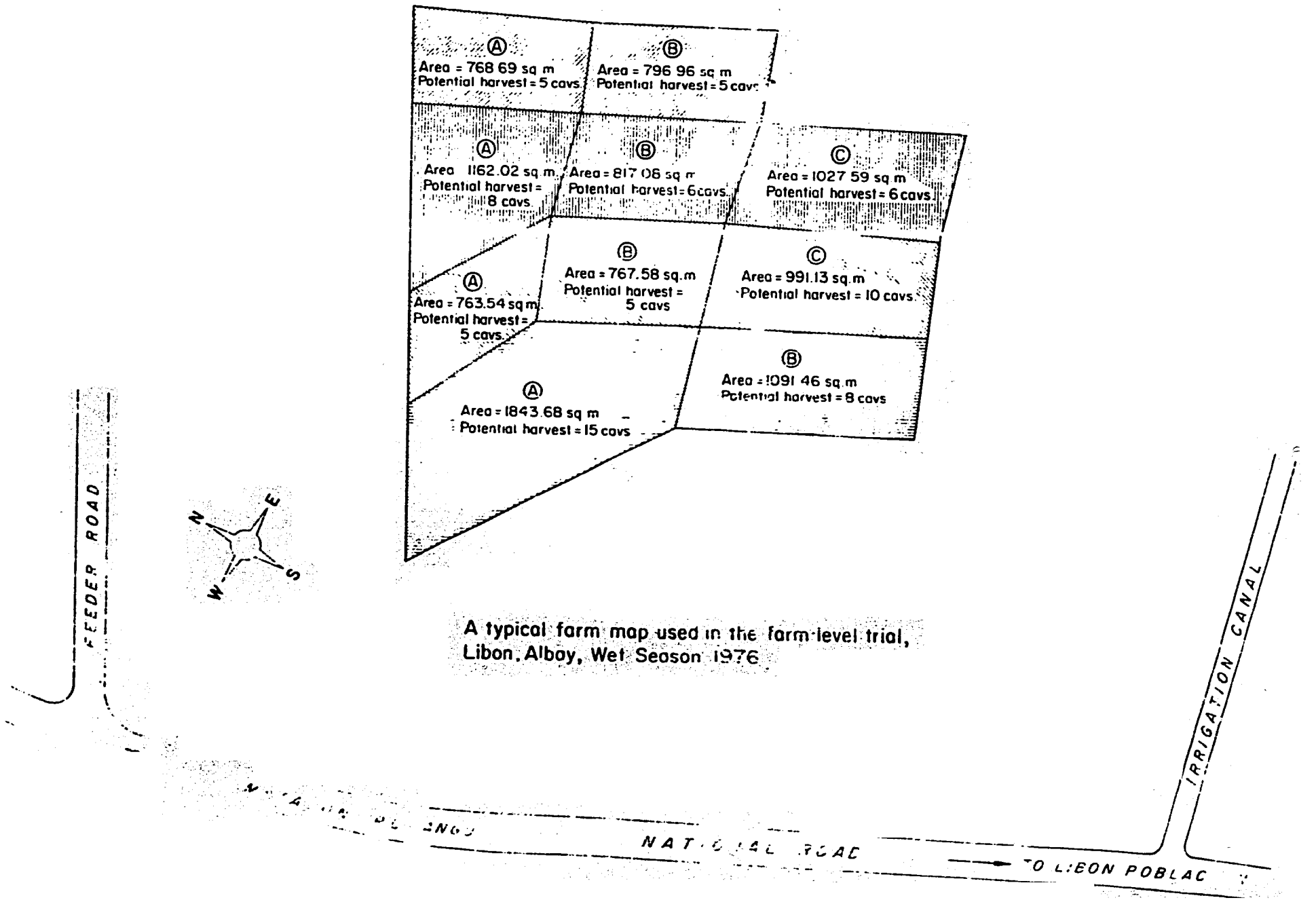


Map showing the location of seven alternative milling technologies included in the technical assessment and monitoring activities, Bicol River Basin, 1976.



Map showing the areas included in the farm and mill level survey, Bicol River Basin, 1976.

Date of harvest = Nov. 14 1976
Variety = C - 4



A typical farm map used in the farm-level trial, Libon, Albay, Wet Season 1976