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POST HARVEST LOSSES OF RICE IN THE DOMINICAN REPUBLIC

by

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Abstract

A national survey of post-harvest losses of rice was conducted in the Dominican Republic during the period March - November 1979. Quantitative and qualitative losses during harvesting, milling and storage of rice were studied and an attempt was made to assess their economic value. Recorded losses due to inefficient harvesting and threshing practices totalled 18.1 per cent. At the rice mills significant breakage of grains occurred when sundried rice was milled. It was estimated that millers using this drying method were losing, on average, 9.75 per cent of the value of the product because of the lower grade obtained. The milling process itself appeared to cause no significant losses of quantity or quality. An average weight loss of 0.35 per cent, recorded during storage at government warehouses, was attributable mainly to spillage and handling. No insect losses were observed. The loss during storage is small, but the total annual loss is estimated to be 680 metric tons.

Resumé

Durant la période de mars à novembre 1979, une enquête a été menée en République Dominicaine en ce qui concerne les pertes de riz intervenues poste-récolte. Les pertes quantitatives et qualitatives s'étant produites durant les opérations de récolte, de moulinage et d'entreposage du riz ont été étudiées et il a été tenté d'évaluer leur valeur économique. Les pertes enregistrées par suite à des méthodes inefficaces de récolte et de battage se sont élevées à 18.1%. Dans les moulins, un bris significatif des grains est intervenu lorsque le riz ayant été séché au soleil était décortiqué. Il a été estimé que les minotiers utilisant cette méthode de séchage subissaient des pertes, en moyenne, de 9.75% de la valeur de produit par suite de la qualité inférieure obtenue. Le processus de moulinage soi-même ne semblait pas être à l'origine d'aucune perte significative au niveau de la qualité ou de la quantité. Une perte de poids moyenne de 0.35% enregistrée pendant l'entreposage dans des entrepôts d'Etat fut principalement attribuée à des déversements et aux opérations de manutention. Il n'a été observé aucune perte dues aux insectes. La perte intervenant lors de l'entreposage est faible, mais la perte annuelle globale est estimée à 680 tonnes métriques.

Resumen

Un estudio a nivel nacional sobre las pérdidas posteriores a la cosecha fue llevado a cabo en la República Dominicana durante el período de marzo a noviembre dt 1979. Se analizaron las pérdidas cuantitativas y cualitativas durante la recogida, descascarillado y almacenaje de arroz, y se intentó determinar su valor en el aspecto económico. Las pérdidas registradas atribuidas a unos métodos ineficaces de recogida y trillado correspondieron a un 18.1%. En los molinos de arroz, se producia una rotura considerable de granos cuando se descascarillaba el arroz secado al sol. Se calculó que los molineros que utilazaban este método de secado perdian, en téminos generales, un 9.75% del valor total del producto debido a la baja calidad de grano obtenido. El proceso de descascarillado en sí no parecía originar pérdidas considerables referentes a la cantidad o a la calidad. Una pérdida de peso media de un 0.35%, registrada durante el almacenaje en silos del gobierno, fue atribuida principalmente a derrames y al manejo inadecuado. No se detectaron pérdidas debidas a insectos. Las pérdidas registradas durante el almacenaje son pequeñas, pero la pérdida global anual se calcula en 680 toneladas métricas.

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Introduction

This study originated from a proposal presented at the Seminar on the Reduction of Post-Harvest Losses organised by the Interamerical Institute for Agricultural Sciences (IICA) in the Dominican Republic in August 1977 (Adams and Tejada, 1977). Preliminary investigations began in March 1979 and the main study was conducted during the period June to October of the same year. The study concentrated on establishing the losses occurring in the main (Spring) rice crop of 1979 at the three principal points of the rice post-harvest system; namely harvesting, milling and storage. In addition to quantitative food losses, qualitative changes were considered and an assessment was made of the economic value that the rice losses represent to participants in the marketing system.

Total production in the Dominican Republic approaches 180,000 metric tons of milled rice annually and on average an additional 33,500 metric tons is imported, although there was no deficit in 1979. Most is harvested and threshed by hand but combine harvesters are common particularly in the major rice producing areas.

The threshed rice (paddy) is bagged and transported directly to the mills, of which there are approximately 130 with a total milling capacity of 137 tons per hour. It is estimated that less than 5 per cent of the total production is retained at the farm level. Paddy received at the mills is usually kept for periods of up to two months especially when the mills purchase in excess of their drying and handling capacity. Most paddy is dried using mechanical driers at the mills although in the South Western Region about half is sun-dried. All milled rice is transported by road to government warehouses operated by the Price Stabilisation Institute (INESPRE). INESPRE establishes a fixed farm price for paddy, based on 20 per cent moisture content and 5 per cent impurities, and a fixed price to mills based on grade according to INESPRE standards. The price to wholesalers is also based on the grade of rice. Furthermore INESPRE establishes a weekly maximum quota of milled rice to be purchased by wholesalers in order to stabilize the flow of rice to consumers. A minor proportion of the rice may be sold directly to retailers or consumers.

Methods used to assess losses

The methodology employed to evaluate post harvest losses in this study was based on that compiled by Harris and Lindblad (1978).

A total of 77 farms, 8 mills and 5 INESPRE warehouses were selected within the three principal rice producing regions of the country. Farms were selected at random from data provided by the local agricultural department officials. Rice mills, stratified by milling capacity, were selected at random from official lists and the warehouses were selected at random from INESPRE lists.

Harvesting losses

Losses in the field were assessed by comparing the potential yield from randomly selected plots, each four metres square and carefully hand harvested, with the actual yields from traditionally harvested plots of a similar size. For combine harvesting the comparison was made with actual yields from plots approximately 16 metres square, i.e. the width of the cutting head times the distance travelled. On the farms where harvesting and threshing were done by hand the panicles threshed by the farmer were gathered after threshing so that the amount of paddy remaining on the straw could be calculated. All samples were weighed in the laboratory and the percentage moisture content and impurities measured. The samples were also dried and milled under laboratory conditions in order to compare the quality of white rice obtained from the 'potential yield' and 'actual yield' samples.

Losses at mills

Limited laboratory resources restricted the study of losses at the rice mills to two stages, both of which relate to grain breakage rather than actual material loss; firstly the extent of breakage caused to grain during mechanical drying and sun-drying; secondly, the overall breakage occurring during the milling process.

Samples were taken immediately before and after drying, and before and after milling. For mechanical dryers, six subsamples were collected, prior to drying, at 10-15 minute intervals as the drier was loaded; yielding a final wet grain sample of approximately one kilogram. The dry grain samples were collected at similar intervals during unloading of the dryer. For sundried grain, samples of approximately 1 kg were made up from sub-samples drawn at random from the drying floor before and after drying.

The wet samples were dried in a laboratory tray drier, which circulated air at a temperature of 34°C - 35°C for 18 hours. They were then permitted to cool and stabilize for 48 hours before laboratory milling. These samples and the dry grain samples from the factory or drying floor were milled to determine the total white rice yields and the whole grain content of each sample.

In the milling process, samples were taken immediately before and after the complete milling operation. This was not necessarily the same grain that had been evaluated in the drying process. The samples were laboratory milled and the resultant white rice was analyzed for whole grain content and compared with the results of the factory milled samples.

Losses in warehousing

In order to study the losses at the INESPRE warehouses, bags of milled rice were selected at random from incoming consignments. Samples of approximately ½ kg were taken with a sack probe from each bag, which was then weighed and marked for later identification. The selected bags were otherwise handled normally, being routinely weighed and then placed in the stack with other bags from the consignment. The bag weight, position in the stack and date of receipt were recorded. Subsequently, as bags were removed from the warehouse, the date of delivery and weight of each selected bag were recorded. After weighing, a further sample of ½ kg was collected from each selected bag. The moisture content and standard volume weight of each sample were determined in the laboratory.

Results

Harvesting losses

The results of twelve farms had to be omitted from the final analysis because the field meaurements of yields were incomplete. The final loss estimates are therefore based on results from 65 sample farms. Of these, 44 (68 per cent of the sample) were harvested manually and the remainder by combine harvester. Eleven different varieties of paddy were sampled and three distinct traditional methods of hand threshing were identified.

The total losses at harvesting, i.e. the differences between the actual and potential yields, are summarised in Table 1 which shows groupings by region, by farm size, by method of harvesting and threshing and by variety.

Table 1 Harvesting losses, per cent potential yield, for 65 farms

Grouping	Number of farms	Percentage losses Mean	Standard Deviation
By region:			
Central-Northeast	37	17.41	12.86
Northwest	18	21.58	14.36
Southwest	10	14.25	10.39
By size (tarea):			
1-50	31	18.24	13.26
51-100	16	24.82	13.46
101+	17	12.27	9.33
By harvest method:			
Manual	44	20.32	12.74
Mechanized	21	13.37	12.54
By hand-threshing method:			
Stick	23	19.52	11.91
Platform	17	22.01	14.56
Drum	14	17.72	11.31
By variety:			
Juma-57	11	20.30	16.06
Isa-21	5	15.51	9.16
Tanioka	12	17.81	13.06
Ir-6	2	20.03	8.19
Mingolo	18	20.04	14.64
Juma-58	10	16.14	10.85
J.P.	1	15.99	- -
Cica-4	2	6.96	6.60
Ir-5	1	34.32	- -
Tono Brea	2	16.72	13.20
Juma-1	1	0.47	- -
Overall:	65	18.08	13.00

* 1 Tarea = 1/16 Hectare

The mean percentage loss for the sample was 18.08 with a standard deviation of 13.00. Statistical analysis of these results showed that the difference between manual and mechanised harvesting methods was significant at $p = 0.05$ and the difference between medium size farms and the largest farms was significant at $p = 0.01$.

The results suggest that larger farms are more efficient than smaller farms. This was not, however, supported by correlations of farm size, as a continuous variable, either with yield or with percentage losses for which the correlation coefficients, respectively, were 0.0699 and 0.0797. Therefore, the significant difference between the two farm size groups seems to be due to the fact that larger farms are also mechanized.

Of the 20 per cent average loss on manually harvested farms approximately 7 per cent could be attributed to grain remaining on the panicles after threshing. The remaining 13 per cent was attributed to other causes such as grain shedding during harvesting and handling and the scattering of grain during threshing.

The average loss overall per farm was 1083 kg/ha which means that, at the INESPRE announced price for paddy, in 1979, of RD$ 22.00/100kg the farmers in the survey were losing an average of RD$238.26/ha. The aggregate earnings lost by the rice growers in the country were estimated to be RD$12,956,970 in that year. (RD$1.00 = US $ 1.00).

As a measure of quality loss in the grain leaving the farms, the potential and actual yields of whole-grain milled rice were compared. The difference was small, with 58.7 per cent mean whole-grain content in the potential yield sample and 56.9 per cent in the actual harvest sample. Thus, in this study, there was very little physical quality loss in the rice during the harvesting, threshing and handling stages before it left the farm.

Losses at mills

Of the 8 mills examined, observations were made at 7 mills during the drying process, and at 6 mills during the actual process of milling. Five mills provided information on both the drying and milling stages. In the drying stage, samples were taken from 10 vertical driers, one cylindrical drier, and 3 sundrying operations. Four driers were oil fired; the remainder burned rice husks.

Table 2 Observed quality losses during drying and milling

	Number of observations	Whole grains per cent				Mean loss %	INESPRE Rice grade obtained
		At factory		At laboratory			
		Mean	S.D.	Mean	S.D.		
Drying							
Oil Fired	4	77.75	5.25	84.93	4.89	7.18	1
Husk Fired	7	76.29	8.72	81.61	4.40	5.32	1
Sun Dried	3	62.43	5.64	78.07	1.88	15.64	3
Overall	14	73.74	9.19	81 80	4.61	8.06	2
Milling	6	74.55	8.26	76.88	10.00	2.33	

Table 2 summarises the results of these observations. The average reduction in whole-grain content during drying (8.1 per cent) represents a reduction in grade and a loss of revenue to the factory operators of RD$1.00 per 100 lbs (0.45kg) of white rice produced.

The mean losses for oil fired and husk fired driers, which have identical machinery, were not significantly different. Highest losses were noted where the mechanical drying was carried out too rapidly. Substantial grain breakage resulted from sundrying, causing a mean loss (15.6 per cent) in whole grains that was significantly higher, at $p = 0.05$, than the losses from mechanical drying. The three sun-dried samples averaged only 62.4 per cent whole grain content, equivalent to INESPRE grade 3, which represents a financial loss of 9.75 per cent of the value of the product to the millers using sun-drying.

The difference (2.3 per cent) between the whole grain contents for factory milled rice and laboratory milled rice was not statistically significant.

Storage losses

The final estimate is based upon data from 4 warehouses because the results for one warehouse were incomplete. The warehouses had capacities ranging from 680 to 900 metric tons and observations were recorded on 103 bags of white rice as they entered and left the warehouses. The estimates of overall storage loss are presented in Table 3. For individual bags, 69 lost weight, while 34 bags showed weight gains. The losses are very small, but the average loss is statistically significant at $p = 0.05$.

Table 3 Losses of milled rice (dry weight) in storage

Warehouse	Number of bags sampled	Days in storage (Average)	Mean dry weight equivalent (1bs)*		Mean loss %
			Received	Dispatched	
1	30	50	108.98	108.84	0.11
2	30	11	109.22	109.04	0.17
3	20	13	108.68	108.84	(-0.14)
4	23	22	107.85	106.44	1.31
Overall	103	25	108.74 SD 0.84	108.36 SD 1.75	0.35

* 1lb = approximately 0.45 kg

Rice is delivered to INESPRE warehouses in woven polypropylene sacks and at intake every bag is spear sampled. The resulting damage to the sacks leads to excessive spillage during subsequent handling and it is likely that this spillage is the major source of the storage loss. No losses attributable to insect activity were detectable by volume - weight measurements. Little or no rodent activity was observed during the sampling period.

Discussion

The results of the study indicate that rice grown in the Dominican Republic loses 18.1 per cent of the white rice equivalent before it leaves the farm and a further 0.35 per cent during storage. The amount reaching the wholesaler may be further reduced since further losses in handling, which could not be measured in this study, are likely to occur during the milling process. However, the results of the investigation, when related to national production, indicate total post-production losses of rice in the Dominican Republic of approximately 35,000 tons per year.

Serious losses occur at the farm level particularly when the crop is harvested and threshed by hand. During the drying process, at the rice mills, significant losses of quality can occur especially if paddy is dried too quickly by mechanical driers or when it is sundried. Low, yet reduceable, losses were recorded in INESPRE warehouses even though the storage period was abnormally short. The relief operations which followed the hurricane disaster of August 1979 necessitated the rapid turnover of rice stocks. Under normal circumstances rice may be stored for 3-6 months and losses can be expected to be higher than those recorded here.

Spillage during handling has been identified as an important source of storage loss. However rice spillage is periodically collected and either returned to bags or distributed among workers. In the latter case, the loss is not recovered by INESPRE and this situation can lead to greater spillage. On an annual basis, spillage represents a cost to INESPRE operations estimated at RD$312, 135 per year.

Long term objectives for loss reduction programmes in the Dominican Republic should focus on the reduction of losses at the farm level and during drying. Losses in threshing are reduceable by the introduction of improved (mechanical) threshing techniques, but only if the social consequences of such a change are found to be acceptable. The Institute of Agriculture (ISA) in Santiago has constructed a minature portable thresher following the plans of the model developed by the International Rice Research Institute (IRRI). The results of field tests may demonstrate the benefit of introducing such a machine, if losses due to spilage and scattering can be reduced and if breakage of the rice grain can be prevented. It is possible that such powered machines may prove to be too expensive for most farmers and a simpler, pedal operated thresher may be more acceptable. The successful adoption of such a machine by farmers will necessarily depend upon proven efficiency and effective extension activity.

The results reported here (Table 2) indicate that significant improvements in the whole-grain content of milled rice might be achieved by machine drying in place of sundrying, provided that the machine drying is not too rapid.

Grain drying at the farm level is rare and since there is very little farm storage capacity the wet paddy must be moved to the mills as soon as possible after harvest or be lost. Consequently the millers are often faced with the problem of drying large quantities of wet grain. Some mills limit their intake to match the drying/milling capacity, thereby avoiding serious loss themselves, but there is a pressure on the millers to dry the grain as quickly as possible by increasing drier temperatures or alternatively by sundrying. INESPRE is in a position to relieve the problem to some extent by hiring out the drying facilities at its silo installations and this is being given serious consideration.

At present INESPRE is able to purchase more than enough grade 1 and grade 2 rice and this has led INESPRE to consider raising its quality standards to limit still further the percentage of broken grains in the finished product. INESPRE now purchases limited amounts of a 'select' grade from rice mills on a quota basis. This means that millers must take greater care, especially during drying of paddy, to ensure the production of the superior grade of milled rice.

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A more extensive account of the work reported here is to be published by IICA, Santo Domingo, Dominican Republic.

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