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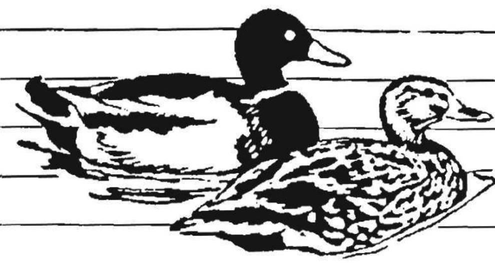

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New Rice Harvest Technique May Reduce Food for Wintering Waterfowl

Rice seed left in fields after harvest is a critical winter food for migratory waterfowl in California's Sacramento Valley. The few remaining wetlands in the valley cannot supply all of the required food resources. Rice is particularly important for northern pintails (*Anas acuta*), American wigeon (*A. americana*), mallards (*A. platyrhynchos*), wintering geese, and other waterfowl species. Pheasants (*Phasianus colchicus*), sandhill cranes (*Grus canadensis*), mourning doves (*Zenaida macruora*), red-winged black birds (*Agelaius phoeniceus*), and other seed-eating birds also feed in harvested rice fields.

Our field studies in the mid-1980's showed an average of 388 kg/ha of rice left after harvest in Sacramento rice fields. This rice was potentially available for waterfowl and other birds to consume. In 1990, a new type of harvester was introduced to the Sacramento Valley that employs a stripper header attached to the combine harvester as a replacement for the conventional cutter-bar header. Harvest with stripper headers is faster than with conventional headers and is a relatively inexpensive innovation. Use of stripper headers will likely increase over time, and our field sampling in 1993 indicates strippers may leave less rice in harvested fields than do conventional methods.

Harvest Methods Compared

Forward speed of conventional harvesters is approximately 1.6 kph. The header cuts the rice plant stems, creating stubble, and pulls the seed heads and cut straw into the machine for processing. Threshing components separate the seeds from the panicles, the seeds are retained, and straw is carried through and out the back to fall on the ground. Individual seeds in this straw and seeds still attached to incompletely processed seed heads become waste rice available for feeding waterfowl. Additional waste rice results from shatter as the machine passes through the fields and impacts adjacent rice plants.

A harvester with a stripper header attached operates at speeds up to 12.8 kph (normal range, 3.2 to 6.4 kph). The cutter-bar header is replaced with a stripper header that consists of a rotor with hundreds of stripping teeth attached. The rotor revolves at 300-1,000 rpm and strips the seeds from the seed heads and sweeps them into the harvester for storage until off-loaded. Thus, the machine does not process cut straw, markedly increasing harvest rates. Seed is still lost out the back of the machine, some seed is retained by panicles after stripping, and shatter still occurs.

Sampling Techniques Repeated From 1985 to 1986

In fall 1985, we sampled two plots in each of 111 conventionally cut fields. We sampled eight plots in each of 15 fields in 1986, reducing time and personnel requirements while retaining similar precision. In fall 1993, we repeated methodology from 1986, and sampled eight plots in each of 17 stripped fields. Selection of fields was not random because the number of strippers in use was limited, but each of the 17 fields was harvested with a different stripper by a different harvester operator. All strippers were identical (Shelbourne-Reynolds Engineering Limited, England) but were mounted on a variety of brands and models of harvesters. We placed 0.3 × 5.5-m plots randomly within fields and oriented them perpendicular to the direction of harvester travel, as in 1985-86. We collected samples with wet-dry vacuums powered by portable generators. Samples were threshed, cleaned, hand-separated, and the seeds dried and weighed.

In 1985, we obtained estimates from 22 of the plots on the amount of rice remaining on the ground versus that in the straw on top of the stubble. We multiplied these percentages by total loss to obtain kg/ha of rice in the straw and on the ground. We obtained similar estimates (rice retained on seed heads after stripping) for all plots (n = 136) in 1993. We calculated field estimates for rice losses in 1986 to compare with 1993 data, but we did not do so for 1985 because two plots per field (in 1985) is not sufficient to derive accurate or precise field estimates.

Unable to sample conventionally harvested fields as controls in 1993, we compared 1993 results with our 1985-86 data and similar data from the Rice Objective Yield Survey through 1989 (U.S. Department of Agriculture [USDA], program terminated 1989). The USDA data were not significantly different from ours for 1985-86 ($P > 0.05$) and are reliable measures of conventional harvest loss. Contacts with agricultural interests and rice growers convinced us that no important changes to conventional harvest had been made since 1989 that would have measurably altered the amount of harvest losses. In spite of this assurance, the lack of a true control measurement for 1993 requires prudent interpretation of results.

Stripper Harvest Seems to Be More Efficient

The total amount of rice left after stripper harvest averaged 344 kg/ha (Table) compared with the pooled mean of 388 kg/ha for conventionally harvested fields in 1985 and 1986. Comparative USDA means were 375, 394, 368, 627, and 468 kg/ha for 1985 through 1989, respectively. Thus, conventional harvest losses (rice available for waterfowl) increased at least through 1989. Harvest losses may have been higher still in 1993 because average yield was 9,320 kg/ha in 1993 compared with 7,885-8,750 kg/ha from 1985 to 1989 (California Agricultural Statistics Service), and losses tend to correlate with yield. For example, yields are up to 50% less in the Southeast than in California and harvest losses have ranged from only 140 to 225 kg/ha. Therefore, use of 1985-89 values to compare with stripper results seems reasonable.

The 344 kg/ha in stripped fields was not statistically different ($t = 1.42$, df = 475, $P > 0.05$) from the 388 kg/ha found in 1985-86. An average of about 290 kg/ha was left on the ground with both harvest techniques, but the stripper left less seed in the straw (52 kg/ha or 15% of total) than did the conventional harvester (97 kg/ha or 25% of total; $t = 2.18$, df = 156, $P < 0.05$; Table). Thus, the stripper left about half as much rice within the straw as did conventional harvest; variation around the larger ground average masked this difference when comparing overall means.

Fig. 1. Percent of sample plots in kg/ha class intervals (midpoint given on X axis) in conventionally harvested (1985-86 pooled) and stripped (1993) rice fields in the Sacramento Valley, California.

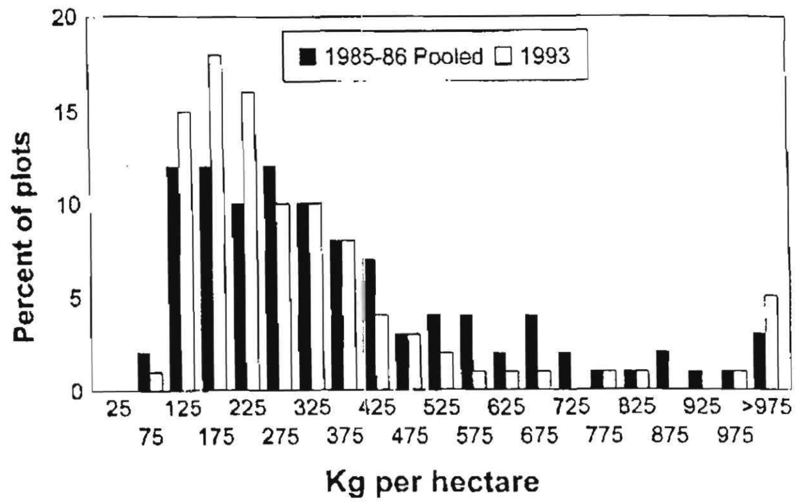
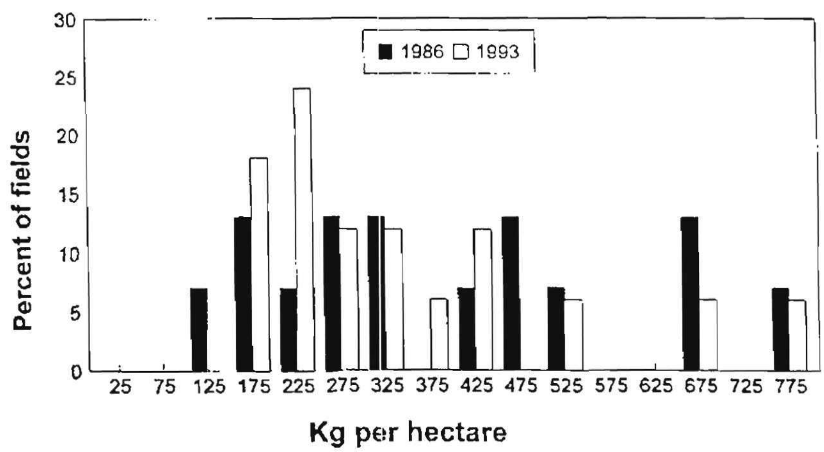


Fig. 2. Percent of sample fields in kg/ha class intervals (midpoint given on X axis) in conventionally harvested (1986) and stripped (1993) rice fields in the Sacramento Valley, California.



The frequency distribution of plot results was not normally distributed (Fig. 1) and chi-square statistics confirm that the distribution in 1985-86 was different from that in 1993. For example, 51% of individual sample plots had <250 kg/ha of rice in stripped fields but only 36% did in conventionally cut fields (Fig. 1; $\chi^2 = 18.28$, df = 4, $P < 0.01$). Similarly, 42% of stripped fields had <250 kg/ha compared with 27% of conventional fields (1986 data only), but sample sizes were small and results were not significant ($\chi^2 = 0.62$, df = 1, $P > 0.05$; Fig. 2). Thus, the probability of waterfowl locating productive foraging areas within fields, but probably not between fields, would be less in regions dominated by stripper harvest. Relative foraging efficiency of waterfowl in rice fields harvested by the two methods is not known, but straw left standing after stripping may deter waterfowl use.

Harvest Efficiency Will Improve

Stripper harvest is a new technology, and harvester operators are still learning the best way to use the new machine. We saw evidence of poor stripper control in some fields in excessive amounts of rice on the ground and missed areas in the field. As practical knowledge of stripper use improves and the proportion of competent harvester operators increases, harvest efficiency will increase. Given the practical economic benefits of strippers, speed and low cost, we expect their use to rise markedly in the years ahead, although we cannot estimate the ultimate extent of its use. Our studies should be repeated in 3-5 years when this technology and its operational use matures. Concurrent controls in conventionally harvested fields will be required for comparison with stripper harvest results then.

Our results also have implications for waste rice availability to waterfowl in Arkansas, Texas, Louisiana, and other rice growing regions in waterfowl wintering range because stripper use is increasing there as well. Also, stripper headers are used to harvest wheat and barley. If harvest efficiency of these grains is improved with the stripper in major waterfowl use areas, waterfowl foraging opportunities in these fields may be affected.

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Table. Weight of rice (kg/ha) in conventionally harvested (1985-86 pooled) and stripped (1993) rice fields in the Sacramento Valley, California.

	kg/ha			
Year	Ground	Straw	Total	Number of plots
1985-86 pooled	291	97 (25%)**	388	341
1993	292	52 (15%)	344	136

** Percentage, obtained in 1985 with 22 ground versus straw comparisons, was applied to the total to yield kg/ha for 1985-86 pooled estimate.