Proso Millet Yield and Residue Mass following Direct Harvest with a Stripper-Header

W. Brien Henry, David C. Nielsen,* Merle F. Vigil, Francisco J. Calderón, and Mark S. West

ABSTRACT

Proso millet (*Panicum miliaceum* L.) (PM) is an important crop for dryland rotations in the central Great Plains. The crop is traditionally swathed before combining to promote uniform drying of the panicle and to minimize seed shattering losses. Direct harvesting of PM with a stripper-header would eliminate the swathing operation resulting in cost savings, and increased standing crop residues to enhance erosion protection, snow catch, and precipitation storage efficiency. This study was conducted to determine yield differences between conventionally swathed and stripper-header harvested PM and to compare PM residue mass and orientation following the two harvest techniques. The study was conducted over four growing seasons at Akron, CO. Proso millet was harvested either by swathing and then picking up the swath with a combine, or by direct harvesting with a stripper-header attached to the combine. Seed yields and moisture contents at harvest were not significantly different between treatments. About 20% more seed was found on the ground with the stripper-header harvest than with the conventionally swathed harvest, but the increased shattering resulted in only about 1% loss of the average final yield. Using a stripper-header resulted in both the standing residue mass and the silhouette area index following harvest to be four times greater than in conventionally swathed PM. A stripper-header can be used to successfully direct harvest PM thereby reducing harvest costs and increasing surface crop residues following harvest.

PROSO MILLET is well suited to the limited precipitation patterns and high summer temperatures of the central Great Plains (Anderson et al., 1986; Briggs and Shantz, 1913), and can either tolerate drought and intense heat or avoid those conditions by growing quickly to maturity (Baltensperger, 1996). Proso millet is used for human consumption in some Asian and African countries (Baltensperger, 1996), but most of the PM grown in the central Great Plains is used for birdseed. In this region PM is grown in rotation with winter wheat (*Triticum aestivum* L.) as an alternative to other summer crops such as corn (*Zea mays* L.), sunflower (*Helianthus annuus* L.), or grain sorghum (*Sorghum bicolor* L.) (Anderson et al., 1999; Nielsen et al., 1999; Shanahan et al., 1988).

Proso millet in the central Great Plains is generally planted the first week of June, although a very broad planting window is available due to PM's short growing season (Baltensperger, 1996). It grows throughout the summer months and is usually swathed in early to mid-September. Proso millet is swathed because the seeds do not mature or dry uniformly. Depending on the year, grain elevators will only accept PM seed at or below the 120 to 140 g kg^{-1} moisture range. Swathing PM promotes rapid drying and also limits the standing grain exposure to wind, rain, and hail and the potential yield loss attributable to seed shatter (Baltensperger et al., 1995a).

Wheat in this region has recently been harvested with a stripper-header (McMaster et al., 2000; Tado et al., 1998; Wilkins et al., 1996). A stripper-header, compared with a conventional cutter-bar header that cuts off the plant and seed head, is a large, rapidly-spinning drum with finger-like attachments that exclusively "strip" the grain from the head of the plant, leaving the stalk of the plant standing in the field. Advantages of this harvest technique include greater precipitation storage efficiency from taller residue that enhances snow catch and suppresses evaporation (Black and Siddoway, 1977; Nielsen, 1995; McMaster et al., 2000; Nielsen et al., 2005); reduced machinery wear from running less biomass through the combine; and shortened harvest period due to faster combine ground speeds. Additionally, the greater silhouette area index (SAI = stem height × diameter × population) resulting from taller standing stems following harvest reduces wind speed near the soil surface and thereby reduces wind erosion potential (Siddoway et al., 1965; Bilbro and Fryrear, 1994). These benefits would also apply to PM which sometimes leaves very little standing residue when conventionally harvested by swathing, especially following a dry growing season (Nielsen, unpublished data, 2005). Wind erosion problems and poor seedbed conditions for the following crop could be ameliorated by the additional standing millet residue left following a stripper-header harvest (Hagen and Armbrust, 1994; Hagen, 1996; McMaster et al., 2000).

Because of rising fuel costs, producers are concerned with the added expense of the swathing operation. Benefits of stripper-

W. B. Henry, USDA-ARS Corn Host Resistance Research Unit, Dorman 117, Box 9555, Mississippi State, MS 39762; D.C. Nielsen, M.F. Vigil, and F.J. Calderón, USDA-ARS Central Great Plains Research Station, 40335 County Road GG, Akron, CO 80720; M.S. West, USDA-ARS-NPA, Natural Resources Research Center, Building D, Suite 320, Fort Collins, CO 80526.
Received 7 Aug. 2007. *Corresponding author (david.nielsen@ars.usda.gov).

Published in Agron. J. 100:580–584 (2008).
doi:10.2134/agronj2007.0268
Copyright © 2008 by the American Society of Agronomy, 677 South Segoe Road, Madison, WI 53711. All rights reserved. No part of this periodical may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the publisher.

Abbrevations: PM, proso millet; SAI, silhouette area index.

header harvest would include the elimination of the swathing operation and associated fuel expenses, off-setting the large investment cost of the stripper-header by using it on crops in addition to wheat, and an increase in standing residue that could catch snow and increase soil water recharge for subsequent crops (Nielsen, 1998). With these potential advantages in mind, the objectives of this study were to (i) compare grain yield of conventionally swathed and stripper-header harvested PM and (ii) compare PM residue mass and orientation following the two harvest techniques.

MATERIALS AND METHODS

Field experiments were conducted at the USDA-ARS Central Great Plains Research Station (40°09′ N, 103°09′ W, 1383 m elevation above sea level) located near Akron, CO, during the summers of 2003 through 2006. The soil type was a Weld silt loam (fine, smectitic, mesic Aridic Argiustolls). Large plots were established in existing PM fields. Plot size was maximized based on the uniformity of the PM stand available. Plot sizes were 0.03, 0.09, 0.07, and 0.14 ha for 2003 to 2006, respectively. Half of each plot was harvested conventionally using a swather with a cutter-bar header and the other half by direct harvest with a stripper-header. There were three replications of each harvest treatment in 2003 and four replications in the other years. Treatments were randomized throughout the field. Planting and harvest dates are given in Table 1. Standard agronomic practices were used in the management of the PM crop with respect to planting date, population, fertility, and weed control. Weed control was a preplant glyphosate (Roundup Ultra, Monsanto Co., St. Louis, MO) N-(phosphonomethyl) glycine burn-down in all years, followed by 2,4-D amine (Helena Chemical Co., Collierville, TN) (Dimethylamine salt of 2,4-Dichlorophenoxyacetic acid) post-emergence (in 2003, 2005, and 2006); 2,4-D amine plus carfentrazone (Aim, FMC Corp., Agricultural Products Group, Philadelphia, PA) (Carfentrazone-ethyl) post-emergence was used in 2004. Weed control was considered adequate.

Plant Material

Proso millet cultivars were Sunup (Nelson, 1990) for 2003 to 2005 and Huntsman (Baltensperger et al., 1995b) in 2006. These varieties are releases from the University of Nebraska PM breeding program and generally have larger seeds, greater uniformity in maturity, less seed shatter, greater height, and less susceptibility to lodging than other PM releases from the program. Each of these traits improves the probability of successful harvest with a stripper-header.

Grain Harvest

For conventional harvest, a Hesston 8200 swather equipped with a 4.9 m draper header (Hesston Swather, AGCO Corp., Duluth, GA) was used to cut and windrow the PM. On average, the PM was swathed approximately 1 wk before the combine pickup of the swath. Stripper-header harvest date was 6 to 35 d later than combining of the swath depending on environmental conditions in a given year. A John Deere 9400 combine (Deere & Co., Moline, IL) with a John Deere pickup head was used to harvest the PM. The same combine with a Shelbourne Reynolds CX 54 stripper-header (Shelbourne Reynolds, Colby, KS) was used to direct harvest the PM. The entire plot area was harvested, and the harvested grain was weighed with a weigh wagon. Grain yields are reported at 120 g kg^{-1} moisture content.

Table 1. Dates of planting, swathing, swath pickup, and stripper-header harvest of proso millet at Akron, CO (2003–2006).

Operation	2003	2004	2005	2006
Planting	23 June	15 June	12 June	17 June
Swathing	09 Sept.	24 Sept.	09 Sept.	12 Sept.
Swath pickup	16 Sept.	29 Sept.	13 Sept.	19 Sept.
Stripper-header harvest	22 Sept.	18 Oct.	20 Sept.	24 Oct.

Combine settings for the cylinder speed, concave clearance, fan speed, chaffer setting, sieves, and extension were all the same regardless of combine header used. The ground speed was 5.6 km h^{-1} for the conventional harvest and 9.7 km h^{-1} for the stripper-header harvest. The settings specific to the stripper-header were stripper drum speed of 500 rpm and cowling setting of green (up).

Seed moisture content, stem height, stem diameter, standing residue mass following harvest, residue mass on the ground following harvest, seeds on the ground before harvest, and seeds on the ground following harvest were also collected. Standing residue mass and residue mass on the ground were measured in 8 to 10 0.3 by 0.3 m areas randomly selected throughout each plot. Seeds on the ground were counted before and after harvest in 8 to 10 0.15 by 0.15 m areas in each plot. Stripper-header plots were measured before and after harvest, while conventionally harvested plots were measured before swathing and after swath pickup. Stem height and diameter were measured on 10 consecutive plants from a randomly selected area within each plot. Stem diameter was measured with a micrometer approximately 4 to 6 cm above the ground in all plots of both harvest treatments. The diameter of the standing stems of the stripper-header treatments was also measured on the upper third of the stem, approximately 30 cm above the soil surface. Number of stems was counted in a 1 m length of row randomly selected in each plot. Silhouette area index was calculated as stem height × diameter × population. The residue characteristics and mass and the seeds on ground data were only collected in one replication in 2003.

Statistical Analyses

Field treatments were arranged in a completely randomized design for each experiment (i.e., year). Experiment and replication within experiment and treatment were treated as random effects. All data were fit to the linear mixed model $y_{ijk} = E_i + \tau_j + R_k(E\tau_{ij}) + \varepsilon_{ijk}$ using SAS PROC MIXED (SAS Institute, 2005) where E_i is the effect of the ith experiment ($i = 1,..,4$), τ_j is the effect of the jth harvesting technique ($j = 1,2$), $(R_k(E\tau_{ij})$ is the effect of the kth replication within each experiment and year combination ($k = 1,...,3$ for the 2003 experiment but $k = 1,...,4$ for all others). This mixed model was fit to assess effects of harvest technique on the responses (y_{ijk}) of yield, moisture content, seed shatter, residue mass, and SAI.

RESULTS

Yields averaged across years were similar regardless of harvest technique ($P = 0.66$) (Fig. 1). Averaged over the 4 yr of the study, conventionally harvested PM yielded 2061 kg ha^{-1} and stripper-harvested PM yielded 1969 kg ha^{-1}. Delaying

Table 2. Precipitation and wind conditions in the time interval between swathing and stripper-header harvest of proso millet at Akron, CO (2003–2006).

Weather parameter	2003	2004	2005	2006
Precipitation, mm	1	22	trace	36
No. of days with precipitation	2	7	1	6
No. of days with daily average wind speed greater than 5 m s^{-1}	0	2	0	10
No. of days with maximum wind gust >13 m s^{-1}	3	4	2	9

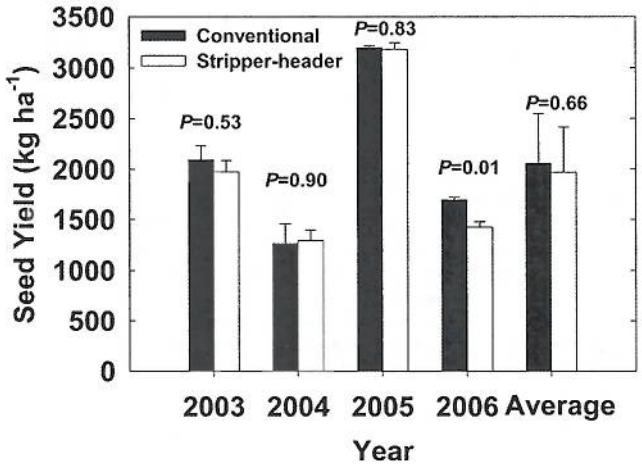

Fig. 1. Proso millet seed yields from conventionally swathed and stripper-header harvested treatments at Akron, CO, 2003–2006. Error bars represent the standard error of the mean (SEM). *P* values are probability that the null hypothesis (no difference between harvest methods) is true.

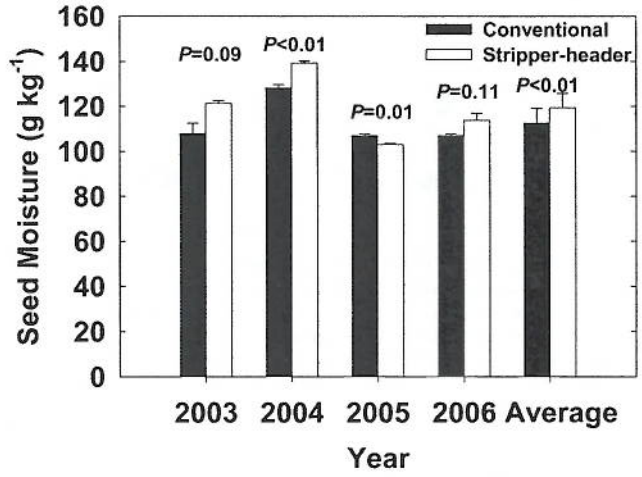

Fig. 2. Proso millet seed moisture content at harvest from conventionally swathed and stripper-header harvested treatments at Akron, CO, 2003–2006. Error bars represent the standard error of the mean (SEM). *P* values are probability that the null hypothesis (no difference between harvest methods) is true.

harvest and allowing the PM grain to dry standing in the field so that the stripper-header could be used for direct harvest did not result in detrimental yield losses when averaged across the 4 yr of the study. While there was no difference in harvest technique averaged over years, there was a yield difference due to harvest technique in 2006, with a 16% (268 kg ha^{-1}) lower yield obtained with the stripper-header harvest. Environmental conditions in 2006 were not conducive to harvesting PM with a stripper-header without a yield loss (Table 2). A total of 42 d passed between swathing the conventional treatments and harvesting the stripper-header treatments with 35 d between pickup and direct stripper-header harvest. During this time, six separate rainfall events resulted in 36 mm of precipitation. In addition to the rainfall, the standing PM experienced 10 d with daily average wind speed greater than 5 m s^{-1} and 9 d with a maximum recorded wind gusts greater than 13 m s^{-1}.

A major concern with harvesting PM with a stripper-header is that the seeds will not mature and dry sufficiently without the swathing operation. Moisture content of the PM seed varied from 103 to 139 g kg^{-1} (Fig. 2), with the greatest moisture content in 2004 and the driest in 2005. Stripper-header-harvested PM had higher seed moisture content in 2004, and lower seed moisture content in 2005. Although not statistically significant, seed moisture was higher for the stripper-header treatments in 2003 and 2006. However, the difference in seed moisture content due to harvest technique is of little practical consequence as the generally greater seed moisture content from the stripper-header harvest would not prohibit on-farm storage or acceptance of seed by commercial grain elevators. All PM seed moisture contents, regardless of harvest technique, were within the range that grain elevators would accept in all 4 yr of this study. Additionally, there were no differences in PM test weight or seed color due to harvest technique that would influence the marketability of the crop (data not shown).

Another concern with stripper-header harvesting of PM is that the increased standing time required for direct harvest of PM would result in greater seed shatter from wind, rain, birds, snow, and the action of the rotating stripper-header drum. This did not appear to be a major problem throughout the 4 yr of this study as yields from the two harvest techniques were different only in 2006 and were the same when averaged over the 4 yr of the study (Fig. 1). The yield advantage for conventionally harvested millet in 2006 was 268 kg ha^{-1}. These results may not be representative of harvest technique effects on all cultivars of PM as the shatter-resistant cultivars used in this study were specifically selected to maximize the success of direct harvest with a stripper-header.

As anticipated, more seeds were on the ground following stripper-header harvest than following combining of the picked-up swath (20% averaged over the 4 yr) (Fig. 3), although the increase was significant in only 2 of the 4 yr. The increased yield loss due to shatter from the stripper-header harvest averaged about 20 kg ha^{-1} over the 4 yr, a relatively small amount that did not significantly affect yield. With these data we were not able to specifically attribute this slight increase in seeds on the ground to the increased period of time that the PM was standing in the field before harvest or to the actual process of the stripper-header harvesting. In 2005 there were 31% more seeds on the ground following stripper-header harvest than following combining of the picked-up swath. In this year the increase in seeds on the ground was most likely primarily attributable to the stripper-header as there were only 6 d between swath pickup and stripper-header harvest with essentially no precipitation and not very windy conditions in that interval (Table 2).

Because of the importance of crop residues to successful dryland crop production in the central Great Plains (Nielsen et al., 2005), residue mass remaining in the field following the

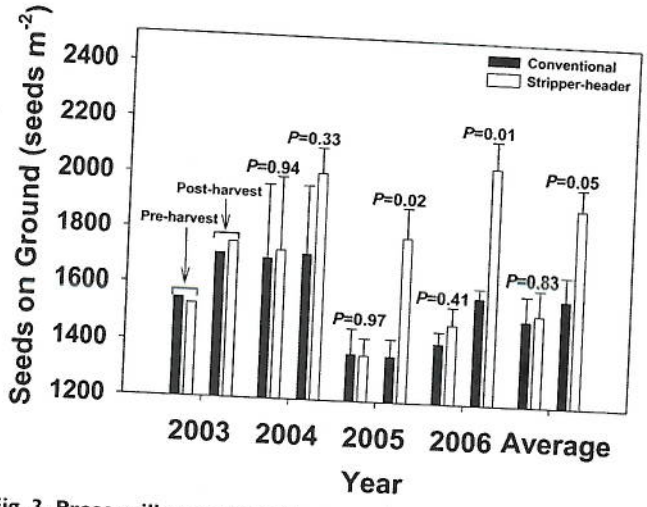

Fig. 3. Proso millet seeds on the ground before and after harvest (left and right pairs of bars, respectively, in each pair) from conventionally swathed and stripper-header harvested treatments at Akron, CO, 2003–2006. Error bars represent the standard error of the mean (SEM). Replicated values were not available in 2003 from which to calculate standard error bars. *P* values are probability that the null hypothesis (no difference between harvest methods) is true.

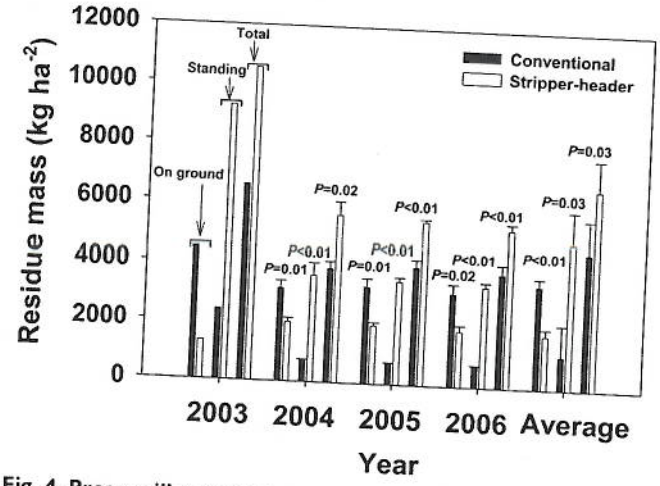

Fig. 4. Proso millet residue mass on the ground, standing, and total mass (left, center, and right pairs of bars, respectively, in each year group) from conventionally swathed and stripper-header harvested treatments at Akron, CO, 2003–2006. Error bars represent the standard error of the mean (SEM). Replicated values were not available in 2003 from which to calculate standard error bars. *P* values are probability that the null hypothesis (no difference between harvest methods) is true.

PM crop is a concern to producers. In all 4 yr total residue mass remaining after harvest was greater with the stripper-header harvest method (average 6728 vs. 4647 kg ha^{-1}) (Fig. 4). About 31% of the total residue mass from the conventionally harvested PM was apparently blown away by wind during the 7- to 10-d period between harvest and residue mass measurements (assuming the stripper-header harvested residue did not lose any residue mass due to taller standing residue). Wind movement of post-harvest residue can present a problem to the producer, as either the residue is leaving the field, or it is unevenly distributed throughout the field leading to potential wind erosion and emergence problems for the following crop.

Figure 4 also demonstrates the reversal in the relationship between the mass of standing residue and the mass of residue on the ground that occurs when changing from conventional to stripper-header harvest. Averaged over the 4 yr, 69% of the total residue mass was on the ground following conventional harvest, while the stripper-header harvest left 69% of the total residue mass standing. Even more important than standing residue mass is the residue SAI. Silhouette area index was greater in stripper-header harvested PM than in conventionally harvested PM in every year due to the increased stem height left by the stripper-header (Fig. 5). Silhouette area index of stripper-header harvested PM was much lower in 2003 than the other 3 yr due primarily to shorter stem height. Average silhouette area index was four times greater (0.08 vs. 0.32 m^2 m^{-2}) in the stripper-header harvested PM than in the conventionally swathed PM.

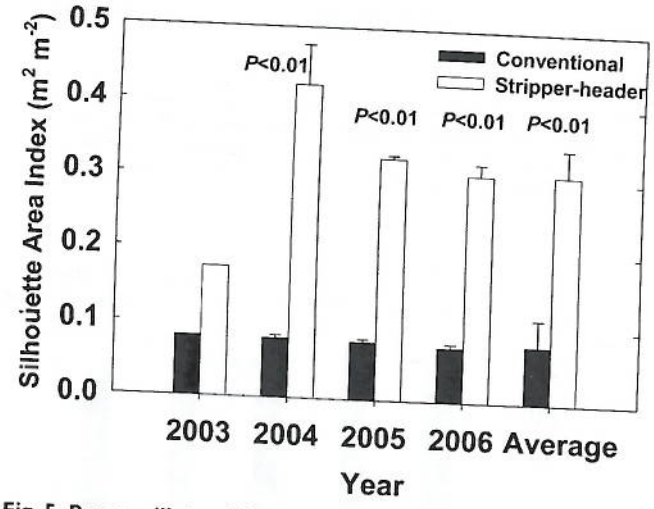

Fig. 5. Proso millet residue silhouette area index from conventionally swathed and stripper-header harvested treatments at Akron, CO, 2003–2006. Error bars represent the standard error of the mean (SEM). Replicated values were not available in 2003 from which to calculate standard error bars. *P* values are probability that the null hypothesis (no difference between harvest methods) is true.

DISCUSSION

Because yield and profitability are primary concerns in production agriculture, farmers must decide whether the cost of the swathing operation to harvest PM is justified. Over the past 9 yr, custom swathing operations in the central Great Plains have ranged from about \$10 ha^{-1} to \$45 ha^{-1}, averaging about \$25 ha^{-1} (Jeff Tranel, Colorado State University Cooperative Extension, personal communication, 2007; Tranel et al., 2007). The results of the current study showed that PM yield averaged over 4 yr was not different between the two harvest methods, and therefore the swathing operation and its cost could be eliminated, especially if a farmer had already invested in a stripper-header for his wheat harvest. On the other hand, producers in the Central Great Plains region are generally risk-averse and a swathing operation is seen by many as "insurance" to get the crop into a position that is, for the most part, protected from the elements. Many farmers consider PM to be a low input crop and would be willing to consider eliminating a swathing operation, particularly with the rising cost of diesel fuel.

The four growing seasons during which this study was conducted were relatively dry. Drier summer and fall conditions would seem to favor a successful harvest with a stripper-header. A producer has to take into consideration many factors to make an informed decision about harvest management practices.

Additional studies should be conducted over a range of environments to further determine applicability of direct stripper-header harvest of PM. The cultivars used in the current study (Sunup and Huntsman) are commonly grown in northeastern Colorado and western Nebraska, but future studies should be conducted with additional PM cultivars to determine those that are best suited to direct stripper-header harvest.

Although seed moisture content did not prohibit us from successfully harvesting the plots with a stripper-header, we should also consider that these plots, although relatively large, were still research plots located on-station. Because of the location we were able to closely observe the moisture content of the PM seed. If a farmer were harvesting an entire field, especially one with varying slope and/or PM maturity, or a location far from his main farming operation, monitoring the seed moisture content could be a challenge for the producer making it difficult to judge when to harvest the crop with a stripper-header.

During none of the 4 yr of this study did we experience an early snowfall, which is a potential problem if the PM has yet to be harvested. A wet snowfall could cause lodging or breakage of the panicle resulting in yield loss. However, the probability of receiving snow during the typical period between swathing for conventional harvest and stripper-header harvest (17 Sept.–7 Oct.) is low (3 of the last 15 yr had snow events in that period).

It is unknown how well a stripper-header would be able to harvest lodged PM. Previous studies have shown somewhat poor harvesting of lodged rice (*Oryza sativa* L.) (Kalsirisilp and Singh, 2001), but good harvesting of lodged barley (*Hordeum vulgare* L.) (Tado et al., 1998). Local producers in northeastern Colorado have reported very good harvesting of lodged winter wheat with a stripper-header (Jared Anderson, Servi-Tech, Inc., Haxtun, CO, personal communication, 2007). If future studies show that lodged PM is harvestable with a stripper-header, farmers may be less fearful of delaying PM harvest to allow for direct harvest with a stripper header.

The relatively dry growing season conditions during the course of this study resulted in average to below average yields, which leads us to consider the following: if the growing season has been dry and there is a below average PM crop in the field, is it worth investing the money, fuel, and time in a swathing operation, especially with rising fuel costs? This is a question that producers have found themselves asking the past several years, especially with respect to a traditionally low input crop like PM.

Another concern, particularly given dry conditions and thin stands, is leaving behind very little residue after a PM crop. Wind erosion following PM harvest can be a problem for many PM producers. Not only is there a risk of topsoil loss, but establishing a crop the next year may be extremely difficult without sufficient residue and soil moisture. The four-times greater silhouette area index measured in the current study should lead to greater snow catch and soil water recharge over-winter, greater off-season precipitation storage efficiency, greater soil erosion protection, and reduced weed densities.

In conclusion, direct harvest of PM with a stripper-header eliminates the swathing operation and associated expenses. As with any new management practice, there are risks associated with direct harvest of PM with a stripper-header, such as an early fall snow causing major problems with crop lodging, broken panicles, and shatter losses. Data from this 4-yr study suggest that if a producer is able to closely monitor his PM crop and harvest in a timely manner, a stripper-header could offer possibilities for lower input costs without losing yield and greater standing residue cover to enhance precipitation storage efficiency and erosion protection.

ACKNOWLEDGMENTS

The authors thank Paul Campbell, Brandie Bellefeuille, and Kristin Kraich for assistance with data collection and analysis; Ken Fetzer, Delbert Koch, and Gene Uhler for plot preparation; and Tom Nightengale and Dr. David Baltensperger for insight and advice.

REFERENCES

Anderson, R.L., R.A. Bowman, D.C. Nielsen, M.F. Vigil, R.M. Aiken, and J.G. Benjamin. 1999. Alternative crop rotations for the central Great Plains. J. Prod. Agric. 12:95–99.

Anderson, R.L., J.F. Shanahan, and B.W. Greb. 1986. Effect of tillage systems on proso millet production. Agron. J. 78:589–592.

Baltensperger, D.D. 1996. Foxtail and proso millet. p. 182–190. *In* J. Janick (ed.) Progress in new crops. Am. Soc. Hortic. Sci., Alexandria, VA.

Baltensperger, D., D. Lyon, R. Anderson, T. Holman, C. Stymiest, J. Shanahan, L. Nelson, K. DeBoer, G. Hein, and J. Krall. 1995a. Producing and marketing proso millet in the High Plains. Coop. Ext. Fact Sheet EC95-137-C. Univ. of Nebraska, Lincoln.

Baltensperger, D.D., L.A. Nelson, G.E. Frickel, and R.L. Anderson. 1995b. Registration of 'Hunstman' proso millet. Crop Sci. 35:941.

Bilbro, J.D., and D.W. Fryrear. 1994. Wind erosion losses as related to plant silhouette and soil cover. Agron. J. 86:550–553.

Black, A.L., and F.H. Siddoway. 1977. Winter wheat recropping in dryland as affected by stubble height and nitrogen fertilization. Soil Sci. Soc. Am. J. 41:1186–1190.

Briggs, L.J., and H.L. Shantz. 1913. The water requirement of plants. I. Investigations in the Great Plains. USDA-BPI Bull. 285. Bureau Plant Industry, USDA, Washington, DC.

Hagen, L.J. 1996. Crop residue effects on aerodynamic processes and wind erosion. Theor. Appl. Climatol. 54:39–46.

Hagen, L.J., and D.V. Armbrust. 1994. Plant canopy effects on wind erosion saltation. Trans. ASAE 37:461–465.

Kalsirisilp, R., and G. Singh. 2001. Adoption of a stripper header for a Thai-made rice combine harvester. J. Agric. Eng. Res. 80:163–172.

McMaster, G.S., R.M. Aiken, and D.C. Nielsen. 2000. Optimizing wheat harvest cutting height for harvest efficiency and soil and water conservation. Agron. J. 92:1104–1108.

Nelson, L.A. 1990. Registration of 'Sunup' proso millet. Crop Sci. 30:746–747.

Nielsen, D.C. 1998. Snow catch and soil water recharge in standing sunflower residue. J. Prod. Agric. 11:476–480.

Nielsen, D.C., R.L. Anderson, R.A. Bowman, R.M. Aiken, M.F. Vigil, and J.G. Benjamin. 1999. Winter wheat and proso millet yield reduction due to sunflower in rotation. J. Prod. Agric. 12:193–197.

Nielsen, D.C., P.W. Unger, and P.R. Miller. 2005. Efficient water use in dryland cropping systems in the Great Plains. Agron. J. 97:364–372.

SAS Institute. 2005. SAS users' guide. v.9.1. SAS Inst., Cary, NC.

Shanahan, J.F., R.L. Anderson, and B.W. Greb. 1988. Productivity and water use of proso millet grown under three cropping rotations in the central Great Plains. Agron. J. 80:487–492.

Siddoway, F.H., W.S. Chepil, and D.V. Armbrust. 1965. Effect of kind, amount, and placement of residue on wind erosion control. Trans. ASAE 8:327–331.

Tado, C.J.M., P. Wacker, H.D. Kutzbach, and D.C. Suministrado. 1998. Development of stripper harvester: A review. J. Agric. Eng. Res. 71:103–112.

Tranel, J.E., R.L. Sharp, D.A. Kaan, and J. Deering. 2007. Custom rates for Colorado farms and ranches in 2006. Available at www.coopext.colostate.edu/ABM/abmcustrate06.pdf (accessed 25 June 2007; verified 30 Jan. 2008). Agriculture and Business Management, Colorado State Univ., Fort Collins.

Wilkins, D.E., C.L. Douglas, Jr., and J.L. Pikul, Jr. 1996. Header loss for Shelbourne Reynolds stripper-header harvesting of wheat. Appl. Eng. Agric. 12:159–162.