Effect of Harvest Management and Nurse Crop on Production of Five Small-Seeded Legumes

Selection of annual legume species and harvest management, and the decision to use a nurse crop, will depend upon the producer's objectives.

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Continuous cropping of cereal grains depletes soil of nitrogen. In order to maintain production, this nitrogen must be replaced by either chemical or biological means. While fertilizer N is a relatively cheap and efficient means of replenishment, many producers are re-examining old cropping practices that include the use of green manure crops.

Small-seeded annual and perennial legumes included in cereal grain rotations can provide residual N for subsequent cereal grain crops as well as hay and pasture for livestock. Registration of pesticides for these legumes, particularly new introductions, is very difficult. For this reason, researchers at the Northwestern Agricultural Research Center and the Western Agricultural Research Center conducted studies to determine the feasibility of establishing several small-seeded legumes without the use of herbicides.

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Materials and Methods

Five small-seeded legumes — 'Bigbee' and 'Multicut' berseem clovers (*Trifolium alexandrinum* L.), 'Arrow' and 'Nitro' alfalfas (*Medicago sativa* L.), and 'Maral Shaftal' clover (*Trifolium resupinatum* L.) — were established with and without 'Monida' spring oats (*Avena sativa* L.) at Kalispell, Montana in a Creston silt loam soil and at Corvallis, Montana in a Burnt Fork sandy loam soil in 1989. The legumes were harvested two, three and four times during the growing season. The experimental design was a split plot with four replications. Harvest managements were assigned as main plots with nurse crop (with or without oats) stripped within harvest managements. Legumes were randomly assigned within nurse crop.

Nurseries were established on April 21 at Kalispell and on May 1 at Corvallis. Legumes inoculated with appropriate *Rhizobia spp* were seeded at 50 seeds per linear foot (approximately 10 lb/acre) in four rows spaced one foot apart. Three rows of Monida oats were seeded in between legume rows at 12 seeds per linear foot (approximately 36 lb/acre).

Herbicides were not used at either location. Weeds within the plots were allowed to compete with the oats and legumes. Major weed species at Kalispell were field pennycress (*Thlaspi arvense* L.) and shepherdspurse (*Capsella bursa-pastoris* (L.) Medik) and at Corvallis were green foxtail (*Setaria viridis* (L.) Beauv.), storksbill (*Erodium cicutarium* (L.) L'Her. ex Ait.) and lambsquarters (*Chenopodium album* L.). Phosphorus (P) was applied at 30 lb/acre at Kalispell and at 60 lb/acre at Corvallis. No nitrogen was applied at either site. Precipitation from September 1, 1988 through August 31, 1989 was 23.4 inches at Kalispell and 13.5 inches at Corvallis. Two inches of supplemental water were sprinkler-applied at Kalispell and 27 inches were sprinkler-applied at Corvallis.

Harvest dates at Kalispell were July 18 and Sept. 26 for the two-harvest treatment; June 30, August 15 and Sept. 26 for the three-harvest treatment; and June 14, July 18, August 15 and Sept. 26 for the four-harvest treatment. Harvest dates at Corvallis were July 20 and Oct. 1 for the two-harvest treatment; July 6, August 22 and Oct. 1 for the three-harvest treatment; and June 21, July 21, August 21 and Oct. 1 for the four-harvest treatment. At each harvest, subsamples were obtained for dry weight and quality analyses. Protein content was determined by the total Kjeldahl nitrogen method.

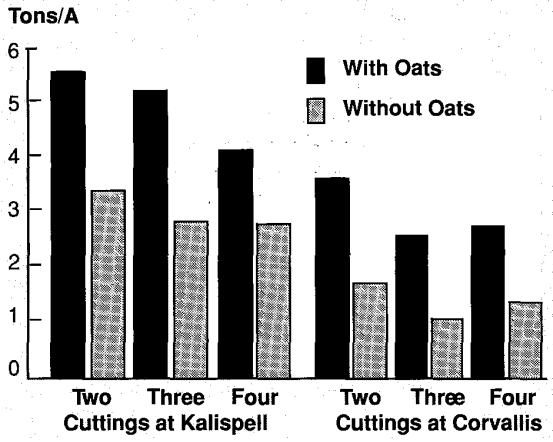
Results and Discussion

Dry Matter and Protein Production.

Forage production was greater for legume-oat mixtures than for pure legumes at each location regardless of harvest management (Figure 1). At Kalispell, the addition of oats to the legumes increased yield from 50 to 90 percent depending upon harvest management. Although forage yields at Corvallis were considerably lower than those at Kalispell, the addition of oats doubled yields for each harvest management. Generally, forage yields were higher for the two-harvest management treatment than for the three- and four-harvest treatments. At each location, oat contribution to forage yield was greatest in the first two harvests. Very little oat regrowth occurred in the third or fourth harvests.

Protein analyses were obtained for all legumes for each harvest, but only for oats grown with Maral Shaftal clover and Nitro alfalfa for the first two harvests. Oat yields in the third and fourth harvests were negligible; not worth considering.

Figure 1:
Effect of Harvest Management and Nurse Crop on Total Dry Matter Yield per Acre of Legumes and Oats at Kalispell and Corvallis in 1989*



*Average of Nitro Alfalfa and Maral Shaftal Clover.
LSD (0.05) = 0.82 at Kalispell and 0.87 at Corvallis

As with dry matter production, total protein yields were increased when oats were planted with legumes at Kalispell (Figure 2). Even though protein percentages of oats were lower than legumes, total protein yield (percent protein x dry matter production) was greater for oat-legume mixtures because of the high dry matter contribution of the oats. Oat protein varied from 10 to 25 percent while legume protein varied from 14 to 29 percent. Generally, oat protein would not be this high, because forage oats are usually harvested at the soft dough stage. When harvested in the vegetative to flowering stage, oat protein can be as high as 25 percent. With protein concentrations this high, the producer must be very cautious about nitrate poisoning and should test the oats before haying or grazing.

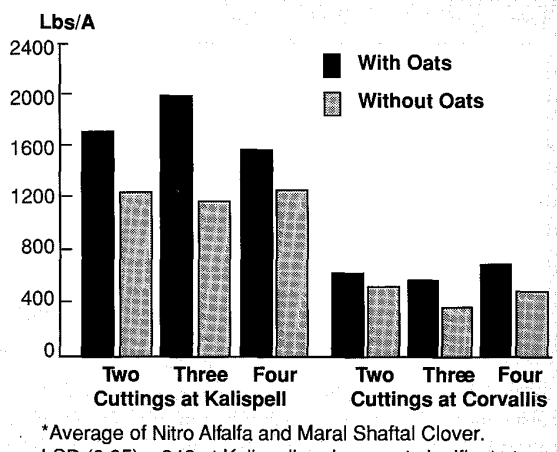
The greatest total protein yield per acre was produced for the three-harvest treatment with no difference between the two- and four-harvest treatments at Kalispell. Protein yields at Corvallis were much lower than those at Kalispell. Harvest management and nurse crop did not affect protein yields at Corvallis.

Legume Production

Our major interest was establishing the small-seeded legumes because they reduce the need for N fertilizer and can provide residual N for subsequent small grain crops. Effects of harvest management and species on legume yield with and without the oat nurse crop at each location are presented in Figures 3 through 6.

At Kalispell, without the use of a nurse crop, total legume yields ranged from 1.75 to over four

Figure 2:
Effect of Harvest Management and Nurse Crop on Total Protein Yield Per Acre of Legumes and Oats at Kalispell and Corvallis 1989*



*Average of Nitro Alfalfa and Maral Shaftal Clover.
LSD (0.05) = 348 at Kalispell and was not significnt at Corvallis

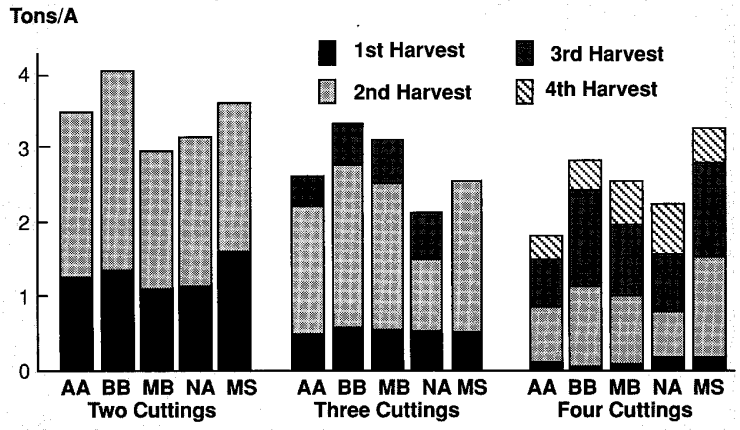
tons/acre (Figure 3). Harvesting twice resulted in the most legume yield for Arrow alfalfa and Bigbee berseem clover. Differences in legume production were not as great under the three-harvest management system. Maral Shaftal clover and the berseem clovers were better adapted to the four-harvest management than the alfalfas, particularly Arrow. Nitro alfalfa (non-hardy variety) was better adapted to multiple harvests than Arrow alfalfa (hardy variety). Generally, legume yields were reduced when seeded with the oat nurse crop at Kalispell (Figures 3 & 4).

Maral Shaftal clover was more competitive with the oats than all other legumes when harvested twice (Figure 4). Nitro alfalfa was superior under the three-harvest management and Nitro and Maral Shaftal clover were superior under the four-harvest management.

At Corvallis, without the oat nurse crop, legume yields of Multicut berseem clover and Maral Shaftal clover were greater than legume yields of Nitro alfalfa and Arrow alfalfa under a two-harvest management system (Figure 5). Legume yields under the three-harvest system were similar, while under the four-harvest system, Nitro alfalfa and Maral Shaftal clover tended to be superior to other legumes.

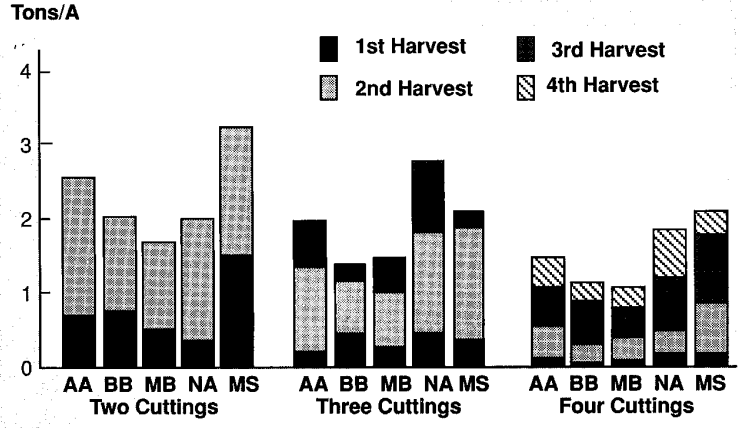
Seeding with an oat nurse crop generally reduced legume yield at Corvallis as at Kalispell (Figures 4 & 6). Maral Shaftal clover was more competitive with oats than other legumes under the two-harvest management and was superior to all legumes except Nitro alfalfa under the three-harvest management (Figure 6). Under all harvest managements, Nitro alfalfa was superior to Arrow alfalfa.

Figure 3:
Effect of Harvest Management and Species on Legume Yield at Kalispell 1989 (*without* oat nurse crop)



AA = Arrow alfalfa; BB = Bigbee Berseem Clover; MB = Multicut Berseem Clover; NA = Nitro Alfalfa; MS = Maral Shaftal Clover. LSD (0.05) for all possible comparisons among total yields = 0.67.

Figure 4:
Effect of Harvest Management and Species on Legume Yield at Kalispell 1989 (*with* oat nurse crop)



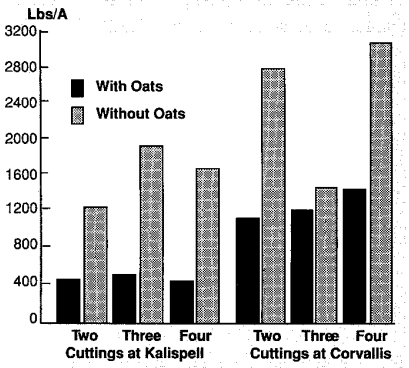
AA = Arrow alfalfa; BB = Bigbee Berseem Clover; MB = Multicut Berseem Clover; NA = Nitro Alfalfa; MS = Maral Shaftal Clover. LSD (0.05) for all possible comparisons among total yields = 0.92 (P = 0.07)

Weed Competition

Using the oat nurse crop reduced weed competition for all harvest managements at Kalispell and for the two- and four-harvest managements at Corvallis (Figure 7). Harvest management did not affect weed yield at either location when oats were seeded with the legumes.

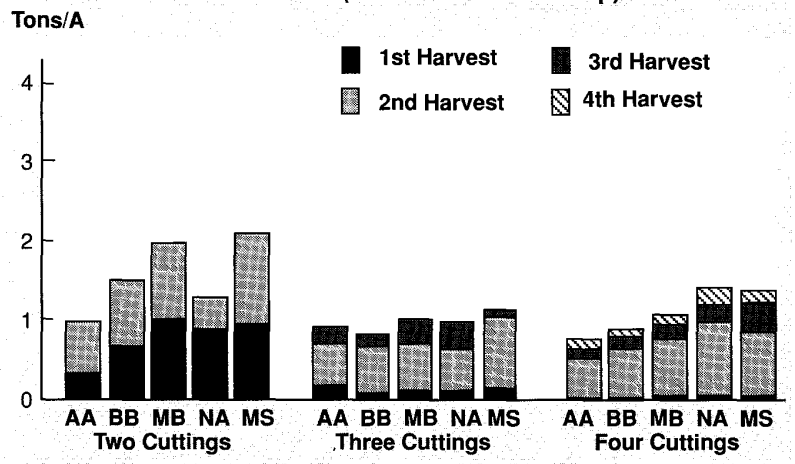
Generally, weed competition was more severe at Corvallis than at

Figure 7: Effect of Harvest Management and Nurse Crop on Weed Yield at Kalispell and Corvallis 1989*



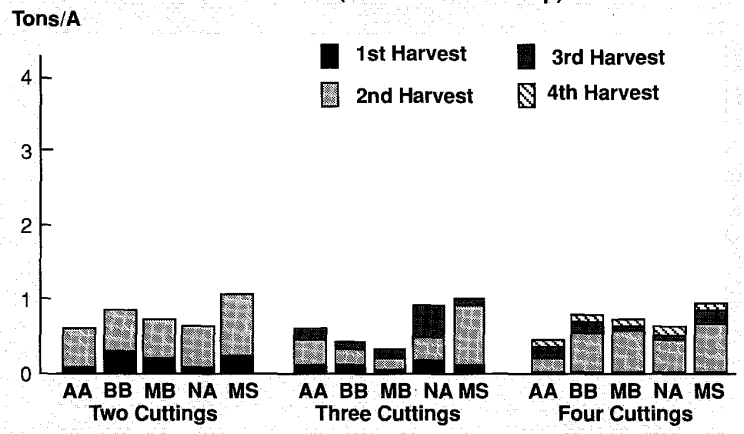
*Averaged across legumes. LSD (0.05) was not significant at Kalispell or on the harvests with oats at Corvallis, but was 631 at Corvallis without oats.

Figure 5:
Effect of Harvest Management and Species on Legume Yield at Corvallis 1989 (*without* oat nurse crop)



AA = Arrow alfalfa; BB = Bigbee Berseem Clover; MB = Multicut Berseem Clover; NA = Nitro Alfalfa; MS = Maral Shaftal Clover. LSD (0.05) for all possible comparisons among total yields = 0.52 (P = 0.08)

Figure 6:
Effect of Harvest Management and Species on Legume Yield at Corvallis 1989 (*with* oat nurse crop)



AA = Arrow alfalfa; BB = Bigbee Berseem Clover; MB = Multicut Berseem Clover; NA = Nitro Alfalfa; MS = Maral Shaftal Clover. LSD (0.05) for all possible comparisons among total yields = 0.35

Kalispell which could explain the lower legume and oat yields at Corvallis.

Conclusions

Selection of annual legume species and harvest management, and the decision to use a nurse crop will depend upon the producer's objectives. If the producer's objectives are to maximize annual legume production, then every effort should be made to favor legume growth. This would mean not using the nurse crop and would result in more weeds being harvested, particularly in the first harvest.

If, on the other hand, the producer's goals are to grow as much dry matter forage and protein as possible, then they should seed the legumes with a nurse crop. Fall regrowth of legumes under either system can be managed for green manure to produce nitrogen for the following years' cereal grain crop.

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