

INCREASED PROTEIN YIELD AND SILAGE QUALITY THROUGH INTERCROPPING CORN-SOYBEAN



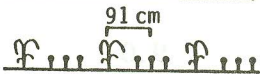




*Stephen J. Herbert & Daniel H. Putnam
Department of Plant & Soil Sciences
University of Massachusetts*

*Mary I. Poos
Department of Veterinary
& Animal Sciences
University of Massachusetts*

When soybean was introduced into the United States in the early part of this century, intercropping was already an accepted agronomic practice, tracing back to the American Indian methods of planting corn, beans and squash in varying combinations. Several experiment stations at this time reported increased yields when corn was planted with soybean for silage although others reported only mixed results. However, there was less interest shown in legume-corn intercropped mixtures, as corn yields showed big increases with the introduction of hybrid corn, mechanization and greater use of fertilizer. Also there were higher yields of soybean in monoculture, through the use of improved agronomic practices.

Advantages to intercropping two necessary crops still exist in terms of land use efficiency and have been demonstrated in numerous studies. We see the practice of intercropping corn-soybean for silage as a method of increasing homegrown protein without sacrificing dry matter production.

In the 1980 experiment several different planting combinations of corn (Cornell 281) and soybean (Harsoy, a maturity group II soybean) were established (Fig. 1).





PLANTING PATTERNS	CORN:SOYBEAN	TOTAL YIELDS	% SOYBEAN IN SILAGE
1. 	0:100	26.2 c	100.0
2. 	100:0	57.8 a	0.0
3. 	50:50	53.2 ab	17.8
4. 	67:33	54.3 ab	12.1
5. 	50:50	47.3 b	24.2
6. 	Corn:Soybean in same row	56.0 a	6.3
7. 	Soybean between corn rows	58.2 a	3.8

[§] Silage yield (70% moisture) tonnes per hectare (multiply by 0.446 for ton/acre).

Figure 1. 1980 planting patterns and silage yields of intercropped corn-soybean.

In corn monoculture rows were spaced 36 inches (91 cm) apart. Soybean rows in monoculture were 12 inches apart. In intercropped planting patterns, treatments were based upon the 36 inch corn row spacing either in a replacement series where one corn row was replaced by three soybean rows or in other combinations as shown in treatments 6 and 7 of Figure 1. The plots were sown May 23, 1980. Prior to planting plots were fertilized with 120 lb N-P₂O₅-K₂O per acre. Weed control was achieved by using a pre-emergence application of linuron (Lorox) and alachlor (Lasso).

Silage yields and percentage soybean in the silage were similar to corn grown alone for all intercropped planting patterns except treatment 5 (Fig. 1). Soybean grown alone gave an unacceptable yield. Percentage soybean in the intercropped silage varied according to the proportion of the cropped area planted to soybean and the intimacy of the planting pattern of corn and soybean (Fig. 1). Percent protein of the silage and protein yield per acre were both improved by intercropping (Fig. 2). Replacing alternate rows of corn with three rows of soybean spaced 12 inches apart yielded 25% more protein per acre than silage from corn grown alone.

PLANTING PATTERNS	DRY MATTER*	% CRUDE PROTEIN	PROTEIN*
1. 	7.9	19.7	1.55
2. 	17.1	8.1	1.39
3. 	16.0	10.9	1.74
4. 	16.3	9.0	1.47

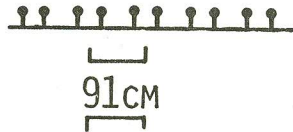



* tonnes per hectare (multiply by 0.446 for ton/acre)

Figure 2. 1980 dry matter and protein yields.

In 1981 two intercropped planting patterns of corn and soybean were compared to corn alone and soybean alone. The test crops were Cornell 281 corn and Williams maturity group III soybean. Corn row width was 91 cm (36 inches) and two rows of soybeans, 14 inches apart were centered at 36 inch centers as shown in Figure 3. Individual corn rows in the intercropped combination were replaced by these two soybean rows. In one intercropped pattern alternate rows of corn were replaced with two soybean rows and in the other every third row of corn was replaced with two soybean rows. Plant density was varied in each corn row as shown in Figure 1. In corn monoculture these densities corresponded to 20,000, 30,000 and 40,000 plants per acre. Soybean plant density was held constant at 160,000 plants per acre.

PLANTING PATTERNS


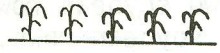
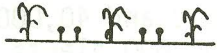

DENSITY (SEEDS PER METER OF ROW)

		SOYBEAN 36 (DOUBLE ROW) = 395,000 PLT/HA					
		LOW		MEDIUM		HIGH	
		CORN	SOY	CORN	SOY	CORN	SOY
							
		4.5*	-	6.7	-	9.0	-
		4.5	36	6.7	36	9.0	36
		4.5	36	6.7	36	9.0	36

* Monoculture corn densities:
 Low - 49,400 plants/hectare
 Medium - 74,130 plants/hectare
 High - 98,840 plants/hectare
 (multiply by 0.405 for plants per acre)

Figure 3. 1981 planting patterns and plant densities of intercropped corn-soybean.

Silage yields are shown in Figure 4, together with the % soybean in the silage. These yields are also illustrated with the components of corn stover and ears and soybean in Figure 5. In monoculture corn silage yield varied little with density averaging 27.6 ton per acre (61.8 tonnes per hectare). In the alternate row corn-soybean intercropped planting pattern total silage yield increased with corn plant density and was similar to the corn alone silage yield only when corn rows were planted to the high density corn alone rate. The response in the planting pattern where every third row of corn was replaced by soybean further shows that a high density or proportion of corn is necessary to maintain silage yield similar to corn alone. However, both high density and proportion of corn reduced soybean yield and contribution to the silage.

PLANTING PATTERNS	SILAGE YIELDS [§]					
	23.5					
	CORN DENSITY					
	LOW	% SOY†	MED.	% SOY	HIGH	% SOY
1. 						
2. 	60.8	0	62.7	0	62.0	0
3. 	47.1	23.4	54.7	20.1	59.6	14.3
4. 	52.6	13.4	61.1	8.7	61.1	8.1

† % soybean in silage

Pattern linear**

Density linear**

Pattern x Density*

§ Silage yield (70% moisture) tonnes per hectare (multiply by 0.446 for ton/acre).

Figure 4. 1981 silage yields of intercropped corn-soybean.

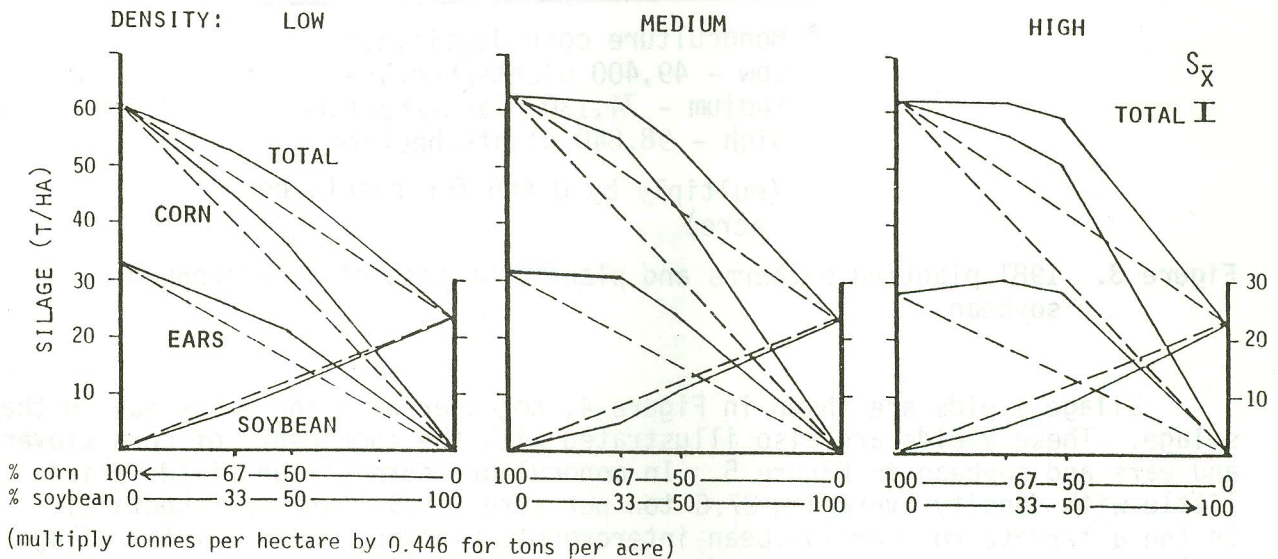





Figure 5. 1981 corn and soybean contribution to yield.

Even so as in 1980, percentage protein in the silage and protein yield were increased in the intercropped silage compared to corn silage (Fig. 6).

PLANTING PATTERN	CRUDE PROTEIN (DRY BASIS)					
	% CP	18.85	CP YIELD		1324 kg/ha	
CORN DENSITY:	LOW		MEDIUM		HIGH	
	% CP	CP YIELD	% CP	CP YIELD	% CP	CP YIELD
	8.3	1517	7.7	1456	7.8	1446
	10.1	1431	10.2	1666	9.3	1661
	10.0	1569	8.8	1608	8.9	1620

% Crude Protein: Density linear** Pattern linear** Den x Pattern*

CP Yield: soybean vs. others* corn alone vs. intercropped*

(multiply kg/ha by 0.892 for lb/acre)

Figure 6. 1981 crude protein yields.

Silage quality from intercropping was further improved by intercropping since the corn component had a higher ear:stover ratio than corn grown alone (Table 1). Also while there was a decline in ear:stover ratio in corn grown alone as plant density was increased the ear:stover ratio of corn in intercropping was maintained with increasing corn plant density. This occurred because in intercropping, comparing intercropped corn rows with monocropped rows, ear weight was reduced a lesser amount and ear number increased with increasing corn plant density (Table 2).

These relationships also held true in an adjoining experiment, where both corn and soybean plant densities were varied. In this experiment we used a systematic design where corn in alternate rows had plant density varied from 4 to 15 plants per meter² (16,000 to 61,000 plants per acre if corn were grown in monoculture) within the row and soybean plant density was varied between alternate corn rows from 15 to 85 plants per meter² (61,000 to 344,000 plants per acre if soybeans were grown in monoculture). The response surface of silage yield is shown in Figure 7. Intercropped silage yield peaked at 30 ton per acre (67 tonne per hectare) and was affected most by corn plant density. Soybean plant density had little influence on silage yield except at lower corn plant densities but here total silage yields were much lower than at higher corn plant densities.

In 1982 we are further testing planting patterns and corn plant density relationships, and if yields and quality are acceptable after this growing season we expect to be able to recommend this practice to farmers in 1983 as a means of producing more protein and better quality silage on the home farm.

Table 1. Percentage ears in silage of corn and intercropped corn-soybean.

Corn Density	Corn Alone		67% Corn/33% Soybean		50% Corn/50% Soybean	
	% of Corn	% of Total	% of Corn	% of Total	% of Corn	% of Total
Low	55	55	54	47	57	44
Medium	51	51	54	50	54	43
High	45	45	54	49	56	48

% of Corn: Density linear* Pattern linear**

% of Total: Pattern linear** Pattern x Density**

Table 2. Influence of planting pattern and intercropping on ear weight and number.

Corn Density	Corn Alone		67% Corn/33% Soy		50% Corn/50% Soy	
	g/ear	ears/m ²	g/ear	ears/m ² †	g/ear	ears/m ² †
Low	163¶	6.2§	157	7.1	156	8.0
Medium	121	7.9	148	9.2	171	8.3
High	91	9.4	131	10.3	138	12.5

† comparing intercropped corn rows with monocropped rows

¶ Density linear** Pattern linear** Density x Pattern**

§ Density linear* Pattern linear*

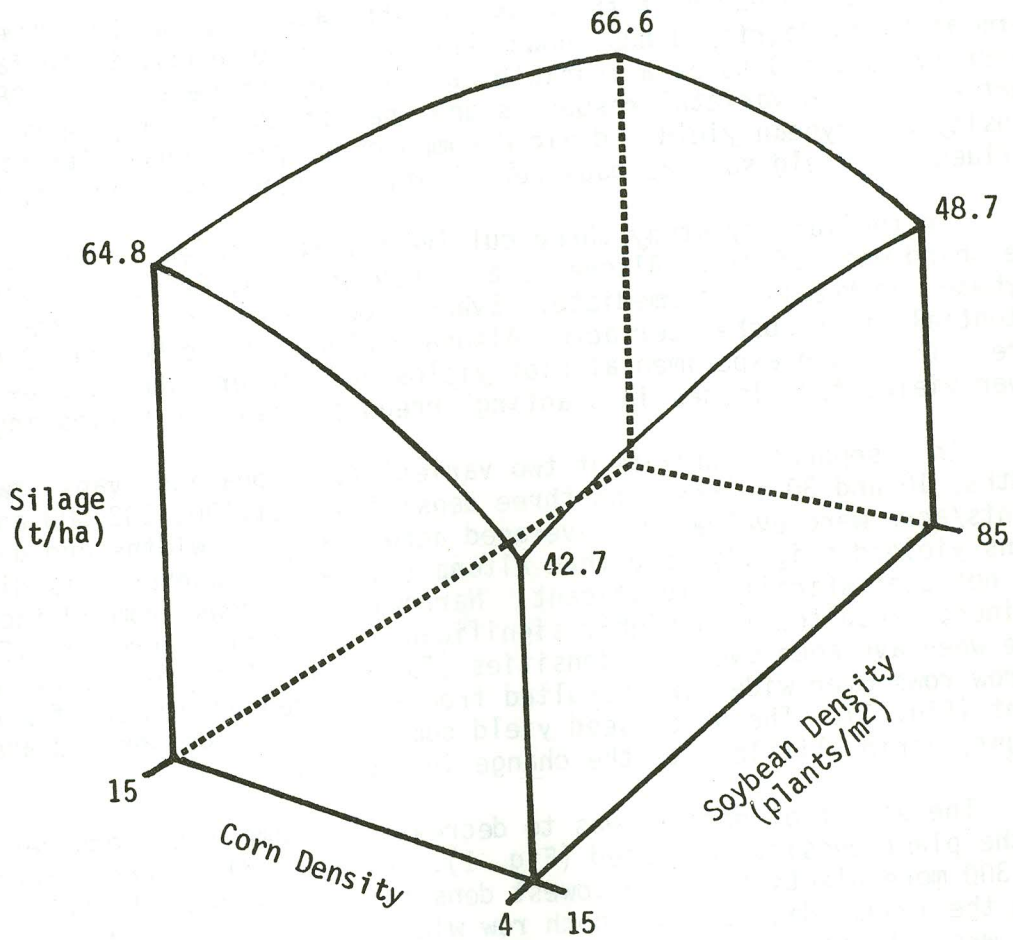


Figure 7. Silage yield response surface as influenced by varying corn and soybean plant densities. (Multiply tonnes per acre by 0.446 for tons per acre.)