Cover Crops Interseeded into Corn or Soybeans: A Meta-analysis

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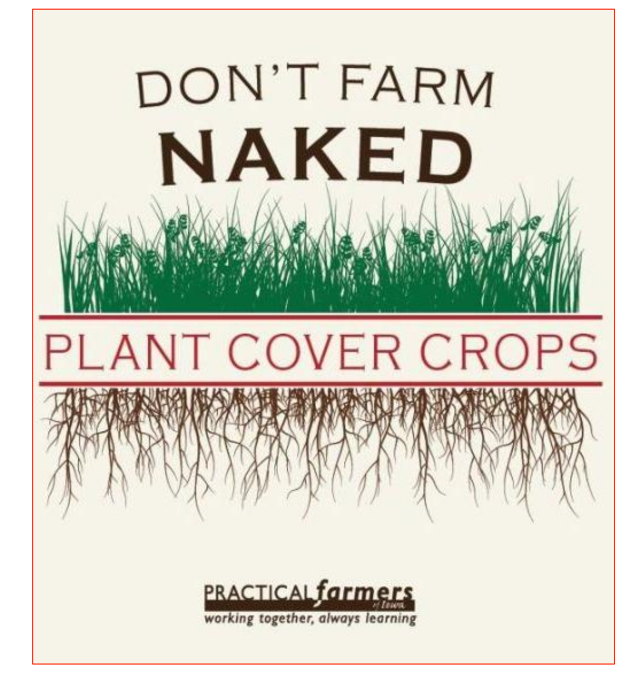
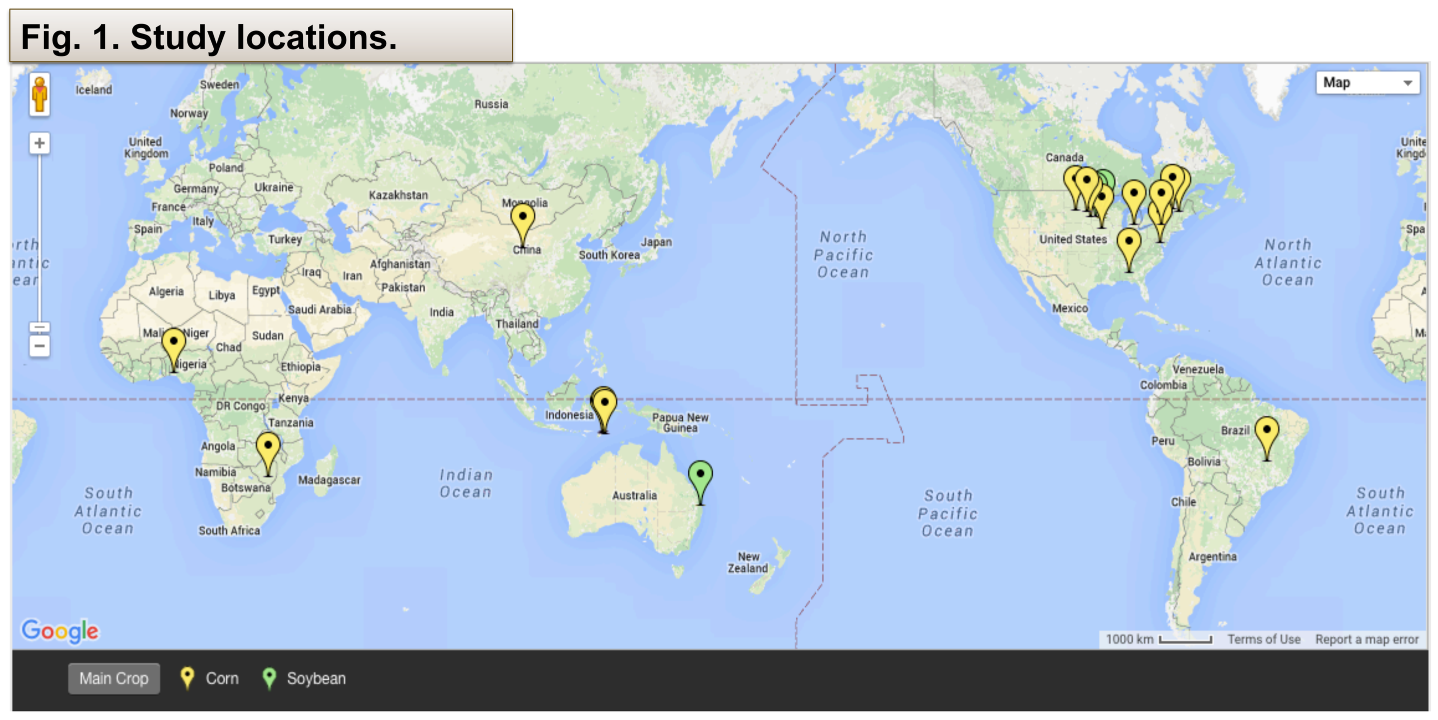


Background: Corn and soybean farmers have increased their acres planted to cover crops over the last six years (SARE 2015). Many use cover crops to reduce soil erosion, scavenge nitrogen and dissolved phosphorus, and improve soil health. Many farmers who have used cover crops for two to three years and have experienced less than desirable plant stands are testing seeding alternatives. Farmers have begun experimenting with seeding cover crops within 95 days of main crop planting. At the beginning of this project the USDA-Risk Management Agency discouraged the seeding of cover crops earlier than physiological maturity of the main crop or later than 95 days after planting (DAP). This meta-analysis reviewed published, peer-reviewed literature to determine the effect on corn or soybean yield and cover crop biomass performance when cover crops were seeded within 95 DAP main crop.

Methods:

- Key search terms: "interseeding cover crops," "cover crops at V6 seeding," "overseeded cover crops," and "intercropping cover crops" were used to conduct a search of primary research using Google scholar and the reference section of individual papers.
- Data from peer-reviewed publications was used if **i) corn or soybean harvested for grain was the main crop; ii) cover crops were seeded within 95 DAP main crop; iii) cover crop species and planting date, and main crop yield was available**.
- Studies that evaluated a cover crop planted more than 95 DAP main crop were excluded.
- Thirty-five percent of the experimental designs were either split-plot or randomized complete block design, 20% were completely randomized and 10% were other. When reported, replications ranged from three to eight.
- Data from 14 publications met the initial criteria to be included in the meta-analysis. Soybean was the main crop in two studies and corn was the main crop in 12 studies.
- Studies were conducted on four continents with the majority occurring in the North America **(Fig. 1)**.

Fig. 1. Study locations.



Yield response variable and analysis: A response variable for main crop yield was calculated: **Yield (with cover crop) ÷ Yield (without cover crop)**. This response ratio was used by Miguez and Bollero (2005) in a meta-analysis about corn yield response to winter cover crops. The yield response variable was tested for normality. Data was not normally distributed and therefore was log transformed for analysis. Only cover crop planting date effect on corn and soybean yield response variables and performance of cover crop species when interseeded are reported. Other variables tested but not reported included: cover crop species, cover crop type (legume, grass, mixture and other broadleaf), nitrogen fertilizer rate, weed control, and total cover crop biomass production. Many studies did not report numerical data for all variables across all studies. When reported cover crop treatments that failed to establish or measured zero were removed.

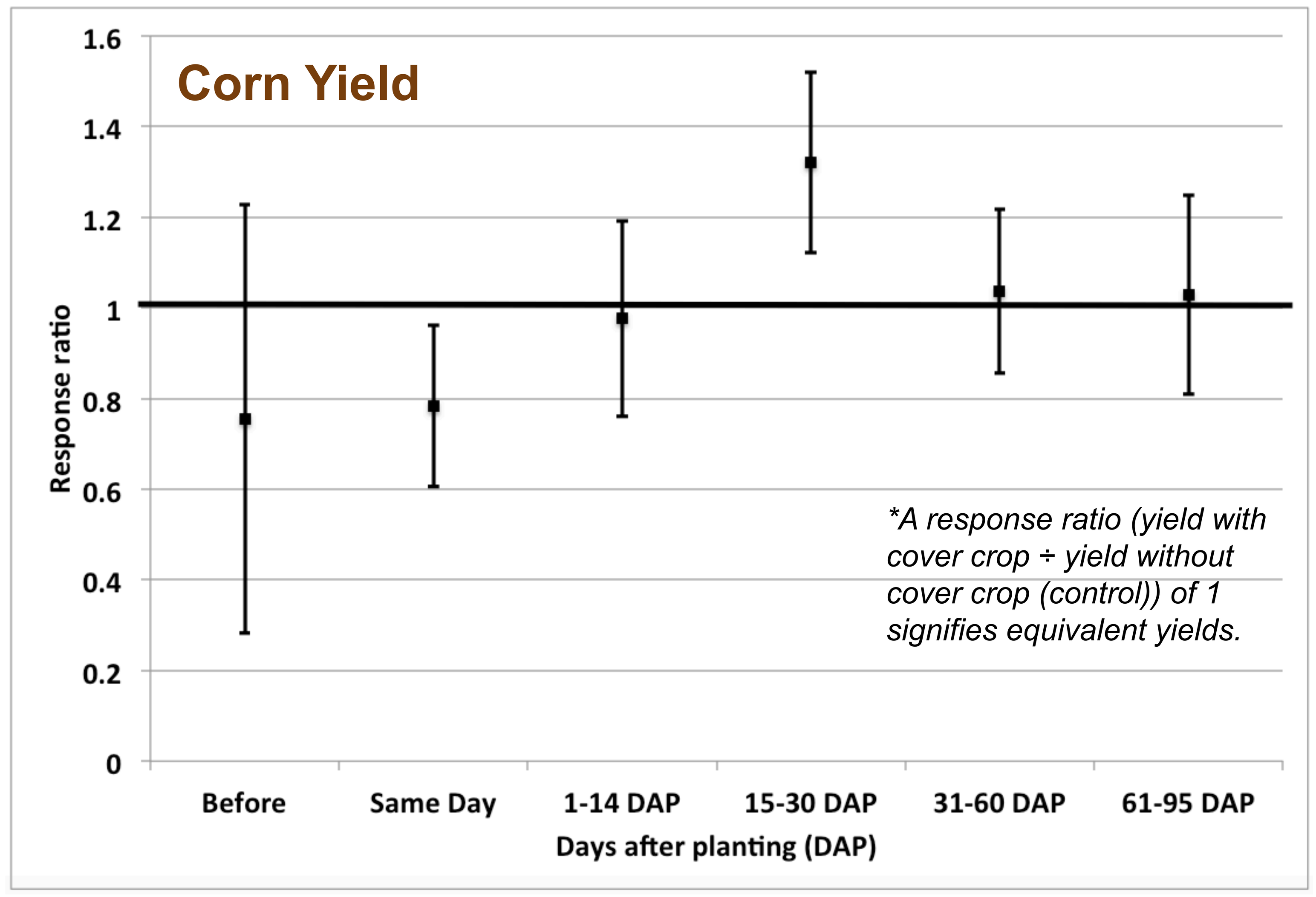


Fig. 2. Mean corn response ratio [corn yield with cover crops/corn yield without cover crops] and 95% confidence interval (vertical bars) for cover crops seeded at various days after planting (DAP).

Interseeded cover crop effect on corn yield: Cover crop planting date significantly affected corn yield (p=0.0002) **(Fig. 2)**. Cover crops seeded 15-30 DAP corn, yielded 112% to 151% of the control. When seeded within 1-14 DAP, 31-60 DAP, and 61-95 DAP, corn yield was mostly neutral but ranged from 76% to 125% of the control. Cover crops seeded the same day as planting ranged from 60% to 96% of the control; Planted before was more variable ranging from 28% to 122% of the control.

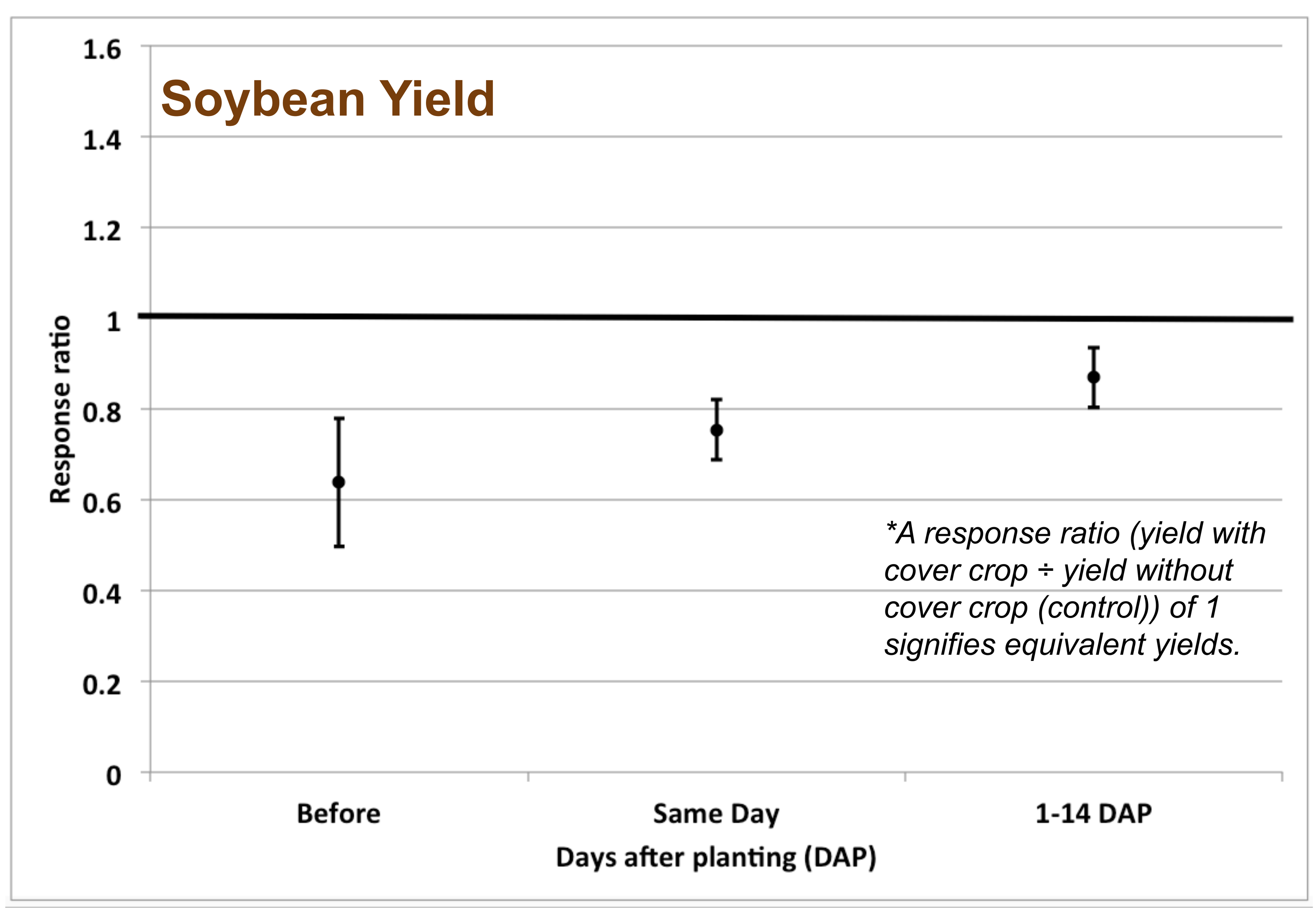


Fig. 3. Mean soybean response ratio [soybean yield with cover crops/soybean yield without cover crops] and 95% confidence interval (vertical bars) cover crops seeded at various days after planting (DAP).

Interseeded cover crop effect on soybean yield: Soybean yield was negatively affected across all cover crop planting dates significantly (p=0.0072) **(Fig. 3)**. Planting cover crops within 1-14 DAP soybean had the least negative affect on yield. Cover crops planted before were 49% to 77% of the control; Planted the same day ranged 69% to 82% of the control; and 1-14 DAP were 80% to 94% of the control. In Chen et al., (2006) alfalfa, perennial ryegrass and red clover were established the same day and 1-14 DAP soybean. Aboveground cover crop biomass was not reported. In Tsay et al., (1988) cassava planted 15 days **before** soybean averaged 12,972 kg/ha aboveground biomass and likely explains the significantly lowered yields.

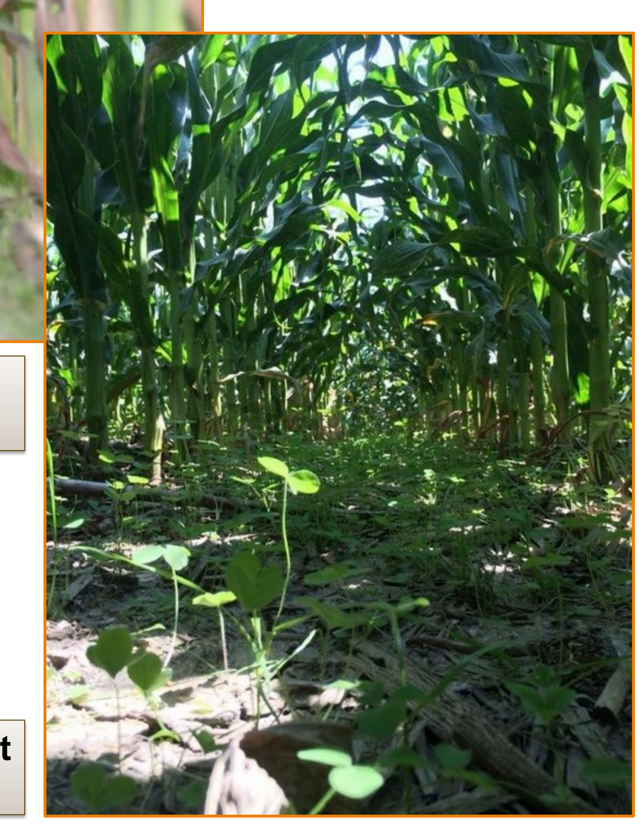
Cover crops interseeded into corn at various planting dates.

	Before	Same Day	1-14 DAP	15-30 DAP	31-60 DAP	61-95 DAP
	kg/ha					
Alfalfa	-	-	N/A	-	789.50	-
Alsike clover	-	-	-	-	N/A	-
Berseem clover	-	-	N/A	-	-	-
Birdsfoot trefoil	-	-	-	-	N/A	-
Brachiaria grass	-	-	6131.90	-	-	679.54
Cassava	-	N/A	-	-	-	-
Cereal rye	-	-	N/A	-	-	2233.50
Cowpea	-	N/A	-	-	N/A	-
Cowpea + Sunn hemp	-	-	-	N/A	-	-
Crimson clover	-	-	N/A	-	-	-
Crimson clover + Lentil + Winter wheat	-	-	-	-	75.33	85.90
Field pea	1723.64	-	-	-	N/A	-
Hairy vetch	-	-	N/A	-	500.00	827.00
Jack bean	-	N/A	-	N/A	N/A	-
Medic	-	936.67	813.33	320.00	95.00	-
Mucuna	-	N/A	-	5890.49	N/A	-
Perennial ryegrass	-	-	-	-	1995.00	2054.00
Persian clover	-	-	N/A	-	-	-
Pigeon pea	-	-	8783.04	-	-	1284.31
Red clover	-	-	-	-	1400.50	221.00
Red clover + Cereal rye	-	-	-	-	2223.00	-
Red clover + Perennial ryegrass	-	-	-	-	2104.00	-
Soybean	-	452.50	-	-	-	-
Strawberry clover	-	-	N/A	-	-	-
Subterranean clover	-	-	N/A	-	-	-
Sword bean	-	N/A	-	N/A	N/A	-
White clover + Ryegrass	-	-	N/A	-	-	-
Yellow sweetclover	-	-	N/A	-	1898.00	-

Table 1. Cover crops species interseeded into corn and aboveground biomass yield (kg/ha) at various DAP. "N/A" refers to aboveground biomass not reported and "–" refers to planting date not evaluated.

Cover crop species performance in corn: Aboveground cover crop biomass was significantly different across planting dates (p=0.001). Mucuna and pigeon pea yielded significantly more aboveground biomass than soybean, medic or the mixture of crimson clover + lentil + winter wheat. Measured aboveground biomass at each planting date is reported in **Table 1** for reference. In Scott et al., (1987) buckwheat and Austrian winter pea failed to establish so were excluded from the analysis.

Annual ryegrass interseeded into corn June 2015 in northwest IA. Picture taken July 2015.



Clover interseeded into corn 2014 in northeast IA. Photo credit Loran Steinlage.

List of ublications used for the meta-analysis:
•Abdin, O., B.E. Coulman, D. Cloutier, M.A. Faris, X. Zhou, and D.L. Smith. 1998. Yield and yield components of corn interseeded with cover crops. Agron. J. 90:63-68.
•Allen, J. R. and Obura, R. K. 1983. Yield of corn, cowpea, and soybean under different intercropping systems. Agron. J. 75: 1005-1009
•Baldé, Alpha Bocar, et al. "Agronomic performance of no-tillage relay intercropping with maize under smallholder conditions in Central Brazil." Field Crops Research 124.2 (2011): 240-251.
•Bich, Alex D., et al. "Corn Yield Is Not Reduced by Mid-Season Establishment of Cover Crops in Northern Great Plains Environments." Crop Management13.1 (2014).
•Chen, Senyu, et al. "Effect of cover crops alfalfa, red clover, and perennial ryegrass on soybean cyst nematode population and soybean and corn yields in Minnesota." *Crop science* 46.5 (2006): 1890-1897.
•Chui, J.A.N. and Shibles, R.M., 1984. Influence of spatial arrangements of maize on performance of an associated soybean intercrop. Field Crops Res., 8: 187-198.
•Correia, Marcos Vidal, et al. "Maize-mucuna (Mucuna pruriens (L.) DC) relay intercropping in the lowland tropics of Timor-Leste." Field Crops Research 156 (2014): 272-280.
•Ezumah, H.C. and Lawson, T.L., 1990. Cassava and maize intercropping systems - the effects of varieties and plant populations. J. Agron. Crop Sci., 164: 334-342.
•Jeranyama, P., Hesterman, O.B., Waddington, S.R., Harwoood, R.R., 2000. Relay-intercropping of sunhemp and cowpea into a smallholder maize system in Zimbabwe. Agron. J. 92, 239-244.
•Jeranyama, P., O.B. Hesterman, and C.C. Sheaffer. 1998. Medic planting date effect on dry matter and nitrogen accumulation when clear-seeded or intercropped with corn. Agron. J. 90:616-622.
•Mao, Lili, et al. "Yield advantage and water saving in maize/pea intercrop."Field Crops Research 138 (2012): 11-20.
•Scott, T. W., Mt. Pleasant, J., Burt, R. F. and Otis, D. J. 1987. Contributions of ground cover, dry matter and nitrogen from intercrops and cover crops in a corn polyculture system. Agron. J. 79: 792-798.
•Tsay, J.S., Fukai, S. and Wilson, G.L., 1988. Intercropping cassava with soybean cultivars of varying maturities. Field Crops Res., 19: 211-225.
•Weil, R.R. and McFadden, M.E., 1991. Fertility and weed stress effects on performance of maize/soybean intercrop. Agron. J., 83: 717-721.