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Diversifying Soybean Production Risk Using Maturity Group and Planting Date

Wes Weeks[*,1], Michael Popp[1,2], Montserrat Salmeron[3] and Larry Purcell[3]

[*] Presenting author is graduate research assistant Wes Weeks
[1] Department of Agricultural Economics and Agribusiness, University of Arkansas
[2] Corresponding author is Dr. Michael Popp, Professor. Phone: 479-575-6838 E-mail: mpopp@uark.edu, 217 Agriculture Building, Fayetteville, AR 72701
[3] Department of Crop, Soil and Environmental Science, University of Arkansas where Dr. Montserrat Salmeron is a post doctoral research associate and Dr. Larry Purcell is Altheimer Chair for Soybean production research

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Wes Weeks[a], Michael P. Popp[a], Montserrat Salmeron[b] and Larry C. Purcell[b]

[a] University of Arkansas, Department of Agricultural Economics and Agribusiness
[b] University of Arkansas, Department of Crop, Soil, and Environmental Sciences

Introduction

- A long planting window for soybeans leads to a large range of planting date (PD) and soybean maturity (MG) choices. Soybean cultivars are grouped by MG to reflect different time requirements until harvest.
- Early planting often results in greater expected returns but increases return risk for producers (drought avoidance and early to market)
- Optimization of risk-return options can be pursued using portfolio theory where the cost of risk reduction associated with a producer moving from a return-maximizing MG × PD combination to a planting portfolio with less risk can be quantified by estimating an efficient frontier where returns are maximized subject to a given level of risk
- Data from planting date trials using soybean from MG III to VI across nine locations are used to show risk-return "tradeoffs" for MG and PD

Objectives

- Demonstrate production risk reduction by diversifying from the profit-maximizing MG × PD choice to a portfolio of several MG × PD
- Illustrate similarities and differences in risk-return tradeoffs across nine locations with variation in production environment

Data

- Seven locations in '12 and nine locations in '13 & '14
- Four cultivars per MG III, IV, V and VI at each location and each year
- Location latitudes ranged from 30.6°N to 38.9°N
- Four PD with two middle PD spaced as evenly as possible between earliest and latest PD typical PD for a particular location
- Soil water deficits calculated using weather data from each location, with soil-specific deficit thresholds trigger irrigation applied
- Seed yield, oil and protein concentration are tracked to measure quantity and quality of production in conjunction with a seasonally adjusted 10 yr avg soybean, soybean oil and meal prices.

Methods

- Using yield, harvest week, oil and protein concentration, irrigation amount and other production cost that did not vary by location, MG or PD, producer returns were estimated for approx. 7,250 plot obs.
- Sixteen MG × PD choices were aggregated across years by location (**A**)
- Possible portfolio risk among sixteen MG × PD choices was minimized using quadratic programing and an efficient frontier was mapped (**B**)
- A mid-variance point on the efficient frontier, V_{MID}, was solved for to compare risk reduction costs across location

Results & Discussion

- Observations reaching harvest maturity before the 37th week of the year received a premium based on seasonal price effect
- Early planting resulted in higher average producer risk

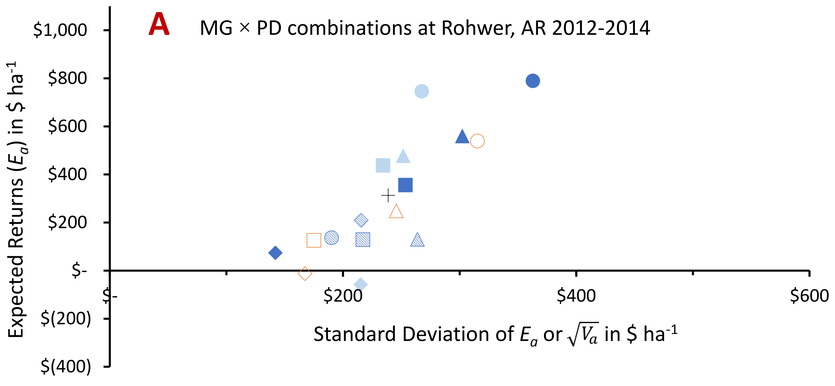
Rohwer, AR				Average Annual		Oil and Protein Premium or Discount		Expected Returns	
MG	PD	Yield (Mg ha^{-1})	Harvest Week	Irrigation (ha cm)	P_{Adj} ($ Mg^{-1})	($ Mg^{-1})	($ ha^{-1})	Avg. ($ ha^{-1})	Std. Dev. ($ ha^{-1})
III	PD1 3/29/12 4/26/13 4/21/14	5.0	32	32.0	$ 325.65	$ 16.77	$ 83	$ 746	$ 266
IV		5.2	34	34.0	$ 321.48	$ 16.29	$ 86	$ 790	$ 360
V		4.7	36	36.0	$ 317.55	$ 3.61	$ 17	$ 539	$ 296
VI		3.8	39	38.7	$ 298.60	$ (4.82)	$ (19)	$ 137	$ 189
III	PD2 4/24/12 5/20/13 5/19/14	4.3	35	34.8	$ 322.21	$ 16.66	$ 73	$ 478	$ 197
IV		4.6	36	35.6	$ 319.02	$ 14.69	$ 67	$ 560	$ 261
V		4.1	39	38.6	$ 300.67	$ (2.98)	$ (12)	$ 248	$ 241
VI		3.8	41	41.0	$ 296.62	$ (2.27)	$ (9)	$ 131	$ 256
III	PD3 5/15/12 6/10/13 6/5/14	4.3	37	36.6	$ 317.35	$ 15.34	$ 65	$ 438	$ 228
IV		4.2	38	38.0	$ 309.78	$ 8.59	$ 36	$ 356	$ 327
V		3.7	39	39.3	$ 300.21	$ (2.61)	$ (10)	$ 126	$ 194
VI		3.9	41	41.4	$ 289.33	$ (3.92)	$ (16)	$ 129	$ 205
III	PD4 6/26/12 6/28/13 6/30/14	2.9	39	39.0	$ 302.17	$ 4.45	$ 13	$ (58)	$ 197
IV		3.5	40	40.1	$ 291.44	$ 4.79	$ 17	$ 74	$ 166
V		3.3	42	41.5	$ 289.12	$ (4.73)	$ (16)	$ (13)	$ 182
VI		3.9	43	42.9	$ 301.50	$ (6.06)	$ (24)	$ 210	$ 224
	Average	4.1	38	38.1	$ 306.55	$ 4.97	$22	$ 306	$ 313

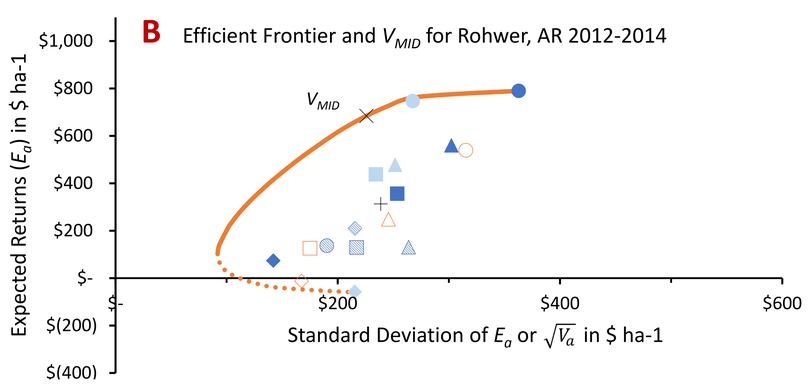
Location	Profit-maximizing MG × PD				Risk-minimizing MG × PD			
	MG	PD	E_a	$\sqrt{V_a}$	MG	PD	E_a	$\sqrt{V_a}$
Columbia, MO	III	2	$ 710	$ 208	VI	4	$(282)	$ 117
Portageville, MO	IV	1	**$ 504**	**$ 265**	VI	4	**$(160)**	**$ 148**
Milan, TN	IV	1	$ 602	$ 219	IV	4	$ 165	$ 116
Keiser, AR	IV	1	$ 447	$ 179	VI	2	$ 43	$ 126
Verona, MS	IV	1	$ 531	$ 205	VI	1	$ 305	$ 143
Rohwer, AR	IV	1	**$ 790**	**$ 363**	IV	4	**$ 74**	**$ 142**
St. Joseph, LA	IV	2	**$ 878**	**$ 286**	VI	4	**$ (3)**	**$ 170**
College St, TX	IV	1	$ 250	$ 220	V	3	$(287)	$ 111

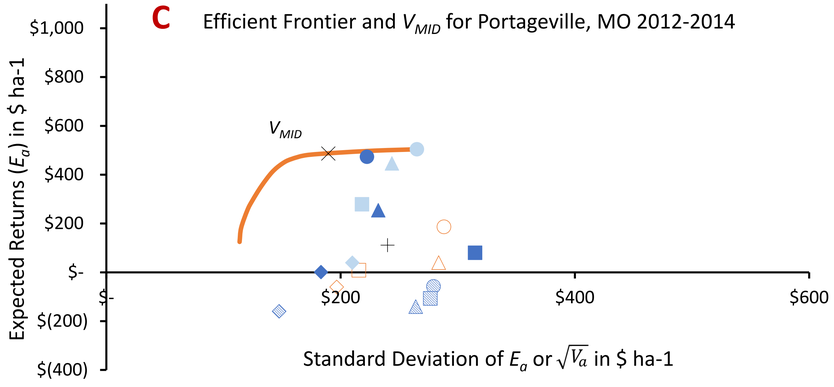
MG	III	IV	V	III	IV	V	III	IV	VI	Expected			
PD	1	1	1	2	2	2	3	3	3	Returns (E_a)		Risk (V_{MID})	
Location	% of land allocated to a MG × PD choice									($ ha^{-1})	% Δ	($ ha^{-1})	% Δ
Columbia, MO	-	23	-	56	19	-	2	-	-	$ 592	-16.6	$ 149	-28.7
Portageville, MO (**C**)	40	54	-	6	-	-	-	-	-	$ 488	**-3.5**	$ 189	**-28.6**
Milan, TN	15	58	27	-	-	-	-	-	-	$ 548	-8.9	$ 136	-38.0
Keiser, AR	14	58	28	-	-	-	-	-	-	$ 406	-9.1	$ 116	-35.0
Verona, MS	2	51	8	30	-	-	9	-	-	$ 479	-9.7	$ 129	-37.1
Rohwer, AR	56	16	-	-	15	-	13	-	-	$ 684	-13.4	$ 226	-37.3
St. Joseph, LA (**D**)	-	-	12	-	26	2	26	29	5	**$ 689**	-21.5	**$ 172**	-40.0
College St, TX	-	10	-	54	11	-	25	-	-	$ 286	-12.9	$ 150	-40.2

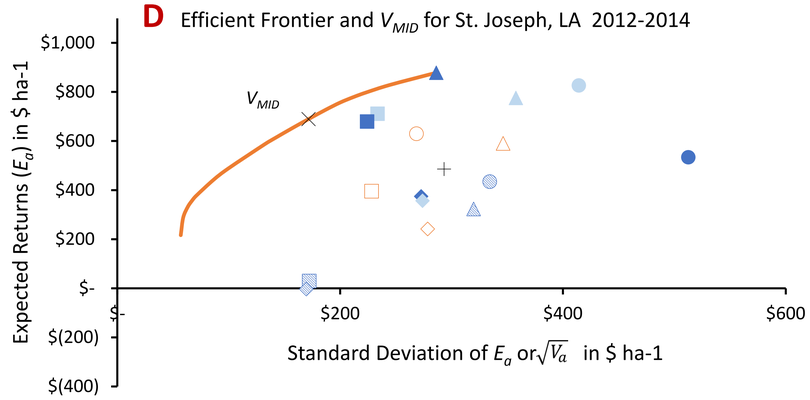
- For the most part, early-planted MG III and IV were more profitable and had higher average oil and protein premia than later-planted combinations of later maturing MG
- Selecting two to six different MG × PD to reduce risk could result in a substantial reduction of risk at relatively lower cost than choosing a less risk single MG × PD choice

Samples of MG × PD Choices in Risk-Return Space Along with Efficient Frontiers across Select Environments









Legend

Efficient Frontier	E Minimizing Frontier	PD1 MG III	PD 1 MG IV
PD 1 MG V	PD 1 MG VI	PD 2 MG III	PD 2 MG IV
PD 2 MG V	PD 2 MG VI	PD 3 MG III	PD 3 MG IV
PD 3 MG V	PD 3 MG VI	PD 4 MG III	PD 4 MG IV
PD 4 MG V	PD 4 MG VI	Vmid	Average E & V

Future Work

- Interactive decision tool utilizing simulated data with multiple constraints to make recommendations across a greater range of choices
- Include effects of seed grade on MG × PD choice

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