IMPLICATIONS OF TEMPERATURE-ACTIVATED POLYMER SEED COATING FOR CROP PRODUCTION IN THE NORTHERN CORN BELT

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ABSTRACT

The value of an innovative new seed technology is evaluated in a discrete stochastic programming framework for a representative farm in the northern Corn Belt. Temperature-activated polymer coated seed has the potential to increase net returns by reducing yield loss due to delayed planting and by increasing the use of longer season varieties. A biophysical simulation model was used to estimate the impact of polymer coated seed on corn and soybean yields and on field day availability for five planting periods, two crop varieties and two tillage systems on two different soils under varying weather conditions. Results show that polymer coated seed increases net returns in corn by $2.50-$3.65 per acre and in soybeans by $4.50-$9.70 per acre.

Keywords: mathematical programming, biophysical simulation, corn, soybean

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INTRODUCTION

A recent technological innovation has the potential to significantly change the risks faced by farmers in planting their crops. A temperature-activated polymer seed coating has been developed which delays the exposure of seed to the soil until the soil reaches a specific temperature. When the soil reaches the critical temperature, the coating allows the seed to be exposed to the soil, and germination can occur. Polymer coated seed has several potential uses. Dillon et al. (2001) investigated the potential value of polymer coated seed in variable rate planting date applications. The technology also has the potential to improve planting options in double cropping (McCoy et al., 2000).

Polymer coated seed has the potential to extend the planting window, reducing potential yield losses due to late planting and allowing equipment costs to be spread over more acres. Polymer coated seed also may allow producers to plant longer season varieties, increasing potential yields. These factors are particularly important on the northern edge of the Corn Belt, where a short growing season leads to significant yield reduction when seeding is delayed beyond the optimum period and where cool, wet spring conditions often hamper seeding operations. Cool, wet spring conditions are also a significant barrier to the adoption of no-till in the northern Corn Belt. The potential for polymer coated seed to reduce this barrier has generated considerable interest (Grooms, 2001). Initial field research has shown that the polymer coating may allow corn and soybeans to be planted as much as four weeks early without a reduction in yield (Gesch et al., 2001).

The primary objective of this analysis is to estimate the value of polymer coated seed in the northern Corn Belt. A secondary objective is to identify the potential for the new technology to lead to changes in cropping practices in this region.

ANALYTICAL METHOD

The analytical approach in this analysis is to formulate production decisions in a discrete stochastic programming (DSP) model for a representative farm in Stevens County, Minnesota. The farmer's objective is to maximize expected net returns given a production technology set and subject to uncertain weather conditions. The analysis proceeds as follows. First, crop production alternatives are defined and crop yields are estimated for production alternatives. Second, days available for field work are generated and used to derive estimates of stochastic parameters for the economic model. Third, the economic model for a representative farm is constructed and used to estimate the impact of polymer seed technology at the farm level.

Crop Production

Crop yields may be affected by weather conditions in the northern Corn Belt in several ways. Wet conditions in the spring may cause planting to be delayed, shortening the growing season and reducing crop yields. However, planting too early increases the risk of frost damage for early emerging crops, and prolonged cool, wet conditions after planting may cause seed to deteriorate in the soil. Temperature-activated polymer coated seed may allow earlier planting while reducing the risk that seed will deteriorate in the soil, and maximizing use of the growing season. However, if soil temperatures are warm early in the spring, polymer coated seed may not protect against frost damage to early emerging crops.

To capture these effects, the EPIC biophysical simulation model (Sharpley and Williams, 1990) was used to estimate the impact of polymer coated seed on corn and soybean yields under varying weather conditions. Yields were simulated for each crop with weekly planting dates ranging from April 3 to May 22 for corn (8 weeks) and from April 3 to June 5 for soybeans (10 weeks). Planting dates were entered in the model so that planting actually occurs as soon as the soil temperature reaches 50° F (10° C) after the entered date. This mimics the behavior of seed with a polymer coating that becomes permeable at 50° F. Yields were simulated for three different maturity classes for each crop denoted early, normal, and late. Yields were also simulated under two different tillage systems: conventional tillage (CT) and no-till (NT), and for two different soil types: Aastad clay loam and Parnell silty clay loam.

EPIC simulations relied on 51 years of historical daily weather observations from the University of Minnesota West Central Research and Outreach Center. Missing weather observations were replaced using values generated by EPIC. Although yield observations for the specific treatments were not available, simulated yield levels were compared against historical county average yields for Stevens County, Minnesota (USDA-NASS) for general consistency with observed yield levels and responses to weather variability. Simulated yields appeared to be consistent with historical yields.

Weekly crop yields were averaged for each of five 2-week periods to reduce the number of stages included in the DSP model to a tractable level. The five planting periods used in the DSP model were: March 31-April 13, April 14-28, April 29-May 12, May 13-26, and May 27-June 9.

Field Day Estimation

EPIC-simulated soil moisture and temperature values were also used to estimate the impact of varying weather conditions on field day availability. A modified version of the procedure described by Dillon et al. (1989) was used to determine field day availability. The criteria used to identify a nonworking day were: 1) if it rained 0.15 inches (0.38 cm) or more on a given day, that day was not considered a field day, 2) if soil moisture in the top 3.9 inches (10 cm) was greater than 80 percent of available water capacity for CT or greater than 90 percent of available water capacity for NT, that day was not considered a field day, and 3) if soil temperature was at or below 32° F (0° C) at any depth, that day was not considered a field day.

The total number of field days available for each 2-week planting period were treated as stochastic in the DSP model. Following Etyang et al. (1998), the farmer chooses planting activities based on the realization of available days in the current period plus the knowledge of the distributions, but not the realizations, of available days in future periods. The distributions were approximated by a 2-point Gaussian quadrature (GQ) estimate, which exactly matches the first three moments of the simulated distribution of available field days. The 2-point GQ estimate is used to retain as much information on the underlying distribution as possible with the fewest number of points. This is important to reduce the "curse of dimensionality" problem in the DSP model. With five planting periods there are $2^5 = 32$ states of nature in our model.

The distribution of available field days differed for the corn and soybean simulations, so the GQ estimates for each crop would provide different estimates of the states of nature. These could not be handled simultaneously in the DSP model. It was decided to use the distribution from the corn simulations only, which generally had the most limiting field day availability. Field day distributions also differed depending on tillage system and soil type. However, the tillage system decision is generally a longer term decision made for the entire farm, so only one tillage distribution is used for making within-season cropping decisions. Also, assuming both soil types occur in all fields, only one soil type distribution is relevant, with the most limiting soil type determining field day availability.

As Etyang et al. (1998) indicate, the distribution of available field days in one period may be related to the realized number of field days in previous periods. To allow for this possibility, the number of available field days in each period was regressed on the number of field days in preceding periods down to period one. Results from the regressions are given in Table 1. The number of field days available in period 5 (D_5) was not related to the number of field days in any previous period for any tillage system or soil type. The number of field days in period 4 (D_4) was not related to the number of field days in any previous periods for conventional tillage on either soil type, and the number of field days in period 3 (D_3) was not related to the number of field days in any previous periods for conventional tillage on an Aastad soil. The number of available field days in most other periods showed a positive significant relationship with the previous period indicating a tendency for conditions to persist. The results agree with the perception that available field days are more persistent early in the season when it is cool and takes longer for the soil to dry. Also, the results agree with the perception that available field days are more persistent under no-tillage than under conventional tillage, again because it takes longer for the soil to dry. The results for period 3 (D_3) under conventional tillage and on a Parnell soil were unusual, in that the coefficients for the previous two periods were both significant and the coefficient on the 2-period lagged coefficient was negative.

The states of nature for the DSP model were estimated from the distributions of available field days as a 2-point GQ approximation following the procedure outlined by Preckel and DeVuyst (1992). The estimates are given in Table 2. For the first period, there were two states of nature with the probabilities of the two states and the number of available field days in the two states estimated directly from the distribution of available field days. For subsequent periods the estimates of available field days and associated probabilities were obtained differently depending on whether the number of field days in the period were significantly related to the number of field days in previous periods. If the number of field days was significantly related to the number of field days in the previous period, the distribution of the residuals from the regression were used to estimate a 2-point distributions of the residuals. These points were then used in the regression equation along with the number of field days in the previous period to obtain estimates of the field days in the current period. For example, the number of days in period 2 on an Aastad soil under conventional tillage depends on the number of days in the previous period. Suppose the realization in period 1 was point 2, so there were 11.07 days available for field work. If the realization in period 2 was point 1, then the number of field days available in period 2 would be $D_2 = 2.393 + 0.745*(11.07) – 2.80 = 7.84$.

If the number of field days was not related to the number of field days in the previous period, the probability and field day estimates were estimated directly from the distribution of field days.

In some cases the 2-point GQ approximation produced negative estimates of available field days. To obtain 2-point estimates that were feasible, while retaining as much information on the observed distribution as possible, it was necessary to relax the condition that the 2-point distribution exactly match the first three moments of the sample. A simple optimization model was constructed to provide a 2-point estimate that exactly matched the first two moments of the original distribution, and minimized the absolute deviation from the third moment, while requiring the estimated number of field days to be nonnegative.

Economic Model

The representative farm was assumed to grow corn and soybeans in rotation, with 50 percent of the acres in corn and 50 percent of the acres in soybeans in any one year. The farm was assumed to have 625 acres (253 ha.) of cropland, which is the average size for cropland farms in Stevens County, Minnesota (USDA-NASS, 1997). The crops could be grown under either conventional tillage (CT) or no-till (NT). The effect of soil type on the potential use of polymer coated seed was analyzed by including two soil types that are commonly found in the area: Aastad clay loam and Parnell silty clay loam. The producer could choose from three different maturity classes for each crop: early, normal and late, and crops could be planted in any of five planting periods.

The economic model was formulated as a whole-farm discrete stochastic programming optimization model (Cocks, 1968). The DSP model was chosen over the chance-constrained programming model (Charnes and Cooper, 1958) because we were specifically interested in the effect of low probability events (i.e. available field days early in the season) on farm planting decisions. The farmer's objective is to maximize expected net returns given by:

$$(1)\quad Max \sum_{p}\sum_{n}\sum_{c}\sum_{s}\sum_{m} \mathrm{PROB}_{p,n}(\mathrm{PRICE}_{c}\mathrm{YIELD}_{p,c,s,m} - \mathrm{COST}_{p,c,s,m})\mathrm{X}_{p,n,c,s,m}$$

subject to:

field day availability constraint:

$$(2)\quad \sum_{c}\sum_{s}\sum_{m}(\mathrm{PREP}_{p,n}\mathrm{PREPLAB} + \mathrm{X}_{p,n,c,s,m}\mathrm{LAB}) \le \mathrm{FLDDAY}_{p,n}$$

time path soil constraint:

$$(3)\quad \sum_{p}\sum_{m}\mathrm{X}_{p,n,c,s,m} \le \mathrm{SOILAC}_{c,s} \quad \forall c, s, n$$

field preparation constraints:

$$(4)\quad \sum_{i=1}^{p}\mathrm{PREP}_{p,n,t} - \sum_{i=1}^{p}\sum_{c}\sum_{s}\sum_{m}\mathrm{X}_{i,n,c,s,m} \ge 0 \quad \forall n;\ p = 1, 2, \ldots, 5$$

soil constraints:

$$(5)\quad \sum_{c}\mathrm{SOILAC}_{c,s} \le \mathrm{SOILLIM}_{s} \quad \forall s$$

rotation constraints:

(6) $SOILAC_{1,s} = SOILAC_{2,s} \quad \forall s$

where

$X_{p,n,c,s,m}$ = acres production in period p and state n of crop c on soil type s crop maturity rating m

$PREP_{p,n}$ = acres of field preparation in period p and state n

$SOILAC_{c,s}$ = total acres of production of crop c on soil type s

FLDDAYp,n = number of field days available in period p and state n

$PROB_{p,n}$ = probability of state n in period p

$PRICE_{c}$ = price per bushel of crop c

$YIELD_{p,c,s,m}$ = expected yield of crop c planted in period p on soil type s with crop maturity rating m

$COST_{p,c,s,m}$ = per acre cost of production for crop c planted in period p on soil type s with crop maturity rating m

PREPLAB = days labor required per acre for field preparation work

LAB = days labor required per acre for planting

and indices denote:

p = time period (1 - 5)

n = state of nature (1 - 32)

c = crop (corn, soybeans)

s = soil type (Aastad, Parnell)

m = crop maturity rating (Early, Normal, Late)

Labor for field preparation and planting activities was limited by field day availability in periods 1-5 assuming 12 hours of labor could be used for field work for every available field day. A sixth period was added to the model without limits on field day availability to allow any field preparation and planting activities not completed in periods 1-5 to be completed. Crop yields for period 6 were the yields estimated from the final planting date for corn and soybeans, May 22 and June 5, respectively. No limits on available labor were imposed for any field activities after planting.

Costs of production were estimated using the functions in EPIC with equipment cost parameters based on Minnesota Extension Service cost estimates (Lazarus, 2001) No land, overhead, or management costs were included, assuming none of these would change with the availability of polymer coated seed. Crop prices were fixed at $1.98 per bushel for corn and $5.69 per bushel for soybeans, reflecting the average of the higher of the market year average costs from 1996-2000 for Minnesota (USDA-NASS) or the commodity loan rate for Stevens County, Minnesota.

The economic model was run separately for each tillage system. In addition, three different scenarios for soil types were considered: (1) 100 percent Aastad soil, (2) 100 percent Parnell soil, and (3) 50 percent Aastad and 50 percent Parnell soil. For the third scenario, costs and yield were specific to soil type, while field day availability depended on the Parnell soil, which was the most limiting soil type.

The value of polymer coated seed was estimated by running four different scenarios: (1) polymer coated seed available for both corn and soybeans, (2) polymer coated seed available for corn only, (3) polymer coated seed available for soybeans only, and (4) no polymer coated seed available. When polymer coated seed was not available, it was assumed that planting could not occur prior to period 3 (April 29) for corn and planting could not occur prior to period 4 (May 13) for soybeans. When polymer coated seed was available, it was assumed that planting could occur beginning in period 1 (March 31). The difference in net returns between the scenarios where polymer seed was available (scenarios 1, 2, and 3) and the scenario where polymer seed was not available (scenario 4) were used to estimate the value of polymer coated seed and to indicate the effect of polymer coated seed on crop production practices.

RESULTS AND DISCUSSION

Whole-farm expected net returns for each of the scenarios are given in Table 3. Highest expected net returns occurred on the Aastad soil under conventional tillage for each of the polymer seed scenarios. The largest increase in net returns due to the availability of polymer coated seed also occurred on the Aastad soil under CT, with expected net returns increasing $3,562 or 4.0% with the introduction of both corn and soybean polymer coated seed. A large part of this increase occurred with the introduction of soybean polymer coated seed alone with an increase of $2,942 over the no-polymer case. The lowest expected net returns occurred on the Parnell soil under NT. The smallest increase in net returns also occurred on the Parnell soil under NT, with expected net returns increasing $953 or 1.8% with the introduction of both corn and soybean polymer coated seed. Again the largest part of the increase occurred with the introduction of soybean polymer coated seed alone, with an increase of $769 over the no-polymer case.

The potential value of introducing both corn and soybean polymer coated seed is listed in Table 4. Values range from $3.41 per acre on the Parnell soil under NT to $7.18 per acre on the Aastad soil under CT. Table 4 also shows expected use of polymer coated seed when both corn and soybean polymer coated seed are available. As much as 79% of total corn and soybean acres would be expected to be planted using polymer coated seed on the Aastad soil under CT, with 61% of corn acres and 97% of soybean acres planted with polymer coated seed. Note, this represents an upper limit on the use of polymer coated seed when the price of the seed is zero. The acreage planted to polymer coated seed is directly related to the increase in field day availability the seed provides as long as the net returns to earlier planting are higher than the net returns under late planting. As a result, the 100% Parnell soil and the 50%Aastad/50% Parnell soil scenarios showed identical expected polymer seed use, since field day availability in each of these scenarios was determined by the Parnell soil.

Although whole-farm expected net returns increased under NT for all soil types, increases in net returns were greater under CT for each soil type. This higher increase in net returns under CT was due to both a higher value per acre of polymer coated seed planted and to a greater number of acres that could be planted using polymer coated seed. As a result, it appears unlikely that polymer coated seed will lead to greater use of NT.

Tables 5 and 6 show expected values and potential use of polymer coated seed when polymer coated corn seed and polymer coated soybean are introduced individually. This allows a valuation for each type of seed to be identified. The value of polymer coated corn seed ranged from $2.50 per acre for the Aastad soil under NT to $3.65 per acre for the 50% Aastad/ 50% Parnell soils under CT. Using a seeding rate of 30,000 seeds per acre these values range from $6.66 to $9.73 per 80,000 seed bag. Potential use of polymer coated corn seed was not largely affected by tillage system, with 40% of corn acres planted to polymer coated seed when available field days were determined by the Parnell soil and 60-61% of the corn acres planted to polymer coated seed when available field days were determined by the Aastad soil.

The value of polymer coated soybeans ranged from $4.50 per acre for the Parnell soil under NT to $9.70 per acre for the Aastad soil under CT. Using a seeding rate of 50 pounds per acre these values range from $5.40 per bushel to $11.63 per bushel. Tillage system did have an effect on the use of polymer coated soybean seed, with lower polymer coated soybean seed acreage under NT than under CT for both soil types. Note, a larger portion of the acreage was planted to polymer coated soybeans when only polymer coated soybean seed was available than when both polymer coated corn and soybean seed were available, since some of the early soybean plantings were displaced by early corn plantings.

A potential benefit of polymer coated seed is that it could lead producers to plant longer maturity varieties or avoid planting early maturity varieties. Tables 7 shows the effects of polymer coated seed on expected corn plantings by maturity rating. The most dramatic shift occurred on the Aastad soil under conventional tillage, where 61.4% of expected corn plantings shifted from normal maturity to late maturity varieties with the availability of polymer coated seed. Polymer coated seed led to a slight reduction in the use of early season corn varieties ranging from 0.3% to 2.1% for the other soil types and tillage systems. No late maturity corn varieties were planted under any other soil type or tillage system.

The effects of polymer coated seed on expected soybean plantings by maturity rating are shown in Table 8. The availability of polymer coated seed had no effect on the varieties of soybeans planted.

CONCLUSION

Temperature-activated polymer coated seed is a recent technology innovation that allows more flexible planting options for producers in the northern Corn Belt. Combining biophysical simulation with a discrete stochastic programming representative farm model, we have attempted to evaluate the potential value and use of this new technology.

Our analysis for a sample farm in Minnesota shows that temperature sensitive polymer coated seed could see significant use. Polymer coated seed can increase net returns primarily by reducing yield loss due to delayed planting, but also by increasing the use of longer season varieties. While per acre values were relatively small, ranging from $2.50 to $9.70 per acre, a substantial portion of the crop acreage could be planted with polymer coated seed. Expected use of polymer coated seed ranged from 45% to 79% of the total corn and soybean acres for our sample farm.

Although there has been early interest in the potential use of polymer coated seed in no-till systems, our analysis showed higher benefits to conventional tillage systems.

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Table 1. Regression of available field days on previous period(s) available field days

D_i Available Field Days in Period i	Conventional Tillage			No-Till	
	Intercept	D_{i-1} Coefficient	D_{i-2} Coefficient	Intercept	D_{i-1} Coefficient
			Aastad Soil		
D_2	2.393	0.745		2.060	0.619
D_3				3.464	0.525
D_4				6.711	0.314
			Parnell Soil		
D_2	1.399	0.729		1.111	0.638
D_3	5.648	0.680	-0.449	2.151	0.649
D_4				4.195	0.533

Table 2. Two-Point Gaussian quadrature (GQ) estimates of field day availability

		Point 1			Point 2		
		Probability	Days	Residual[b]	Probability	Days	Residual
Aastad Soil							
CT	Period 1	0.73	0.55		0.27	11.07	
	Period 2[a]	0.60		-2.80	0.40		4.28
	Period 3	0.33	7.22		0.67	12.28	
	Period 4	0.45	4.75		0.55	11.95	
	Period 5	0.26	4.81		0.74	12.19	
NT	Period 1	0.77	0.44		0.23	11.40	
	Period 2[a]	0.60		-2.33	0.40		3.56
	Period 3	0.59		-3.10	0.41		4.49
	Period 4	0.43		-3.89	0.57		2.92
	Period 5	0.36	5.76		0.64	12.10	
Parnell Soil							
CT	Period 1	0.80	0.24		0.20	11.75	
	Period 2[a]	0.80		-1.57	0.20		6.22
	Period 3	0.49		-4.12	0.51		3.88
	Period 4	0.38	4.55		0.62	11.89	
	Period 5	0.33	5.48		0.67	12.27	
NT	Period 1	0.83	0.33		0.17	11.66	
	Period 2[a]	0.80		-1.32	0.20		5.42
	Period 3[a]	0.76		-2.15	0.24		6.79
	Period 4	0.57		-3.31	0.43		4.38
	Period 5	0.46	3.40		0.54	11.41	

a Estimated using LP model to match first two moments instead of GQ.

b For field day estimates that depend on previous period available field days, GQ estimates are realizations of the regression residual which are used to calculate available field days with the regression equation.

Table 3. Whole farm expected net returns

Soil Type and Tillage System	Polymer Corn and Soybean Seed	Polymer Corn Seed Only	Polymer Soybean Seed Only	No Polymer Seed
100% Aastad CT	$76,915	$73,987	$76,305	$73,353
100% Parnell CT	$63,492	$61,701	$63,046	$61,255
50% Aastad/50% Parnell CT	$69,170	$67,237	$68,718	$66,781
100% Aastad NT	$67,370	$66,083	$67,013	$65,615
100% Parnell NT	$54,197	$53,593	$54,013	$53,243
50% Aastad/50% Parnell NT	$59,441	$58,707	$59,257	$58,305

Table 4. Potential value and use of polymer coated seed for both corn and soybeans

Soil Type and Tillage System	Value of Polymer Seed	Expected Polymer Seed Use: Both Corn and Soybeans	Corn Only	Soybeans Only
	--$/ac--	---percent of total planted acres---		
100% Aastad CT	$7.18	79%	61%	97%
100% Parnell CT	$6.56	55%	40%	69%
50% Aastad/50% Parnell CT	$7.00	55%	40%	69%
100% Aastad NT	$4.24	66%	60%	72%
100% Parnell NT	$3.41	45%	40%	49%
50% Aastad/50% Parnell NT	$4.06	45%	40%	49%

Table 5. Potential value and use of polymer coated seed for corn

Soil Type and Tillage System	Value of Polymer Seed		Polymer Seed Acres
	--$/ac--	--$/bag--	-% of total-
100% Aastad CT	$3.31	$8.82	61%
100% Parnell CT	$3.57	$9.53	40%
50% Aastad/50% Parnell CT	$3.65	$9.73	40%
100% Aastad NT	$2.50	$6.66	60%
100% Parnell NT	$2.77	$7.39	40%
50% Aastad/50% Parnell NT	$3.18	$8.49	40%

Table 6. Potential value and use of polymer coated seed for soybeans

Soil Type and Tillage System	Value of Polymer Seed		Polymer Seed Acres
	--$/ac--	--$/bu--	-% of total-
100% Aastad CT	$9.70	$11.63	97%
100% Parnell CT	$8.30	$9.95	69%
50% Aastad/50% Parnell CT	$8.97	$10.76	69%
100% Aastad NT	$5.86	$7.03	76%
100% Parnell NT	$4.50	$5.40	55%
50% Aastad/50% Parnell NT	$5.57	$6.68	55%

Table 7. Distribution of Expected Corn Planting by Maturity Rating

	Polymer Seed			No Polymer Seed		
Soil Type and Tillage System	Early	Normal	Late	Early	Normal	Late
100% Aastad CT	0.0%	38.6%	61.4%	0.0%	100.0%	0.0%
100% Parnell CT	18.8%	81.2%	0.0%	21.1%	78.9%	0.0%
50% Aastad/50% Parnell CT	18.8%	81.2%	0.0%	21.1%	78.9%	0.0%
100% Aastad NT	8.8%	91.2%	0.0%	10.4%	89.6%	0.0%
100% Parnell NT	25.8%	74.2%	0.0%	28.9%	71.1%	0.0%
50% Aastad/50% Parnell NT	25.8%	74.2%	0.0%	28.9%	71.1%	0.0%

Table 8. Distribution of Expected Soybean Planting by Maturity Rating

	Polymer Seed			No Polymer Seed		
Soil Type and Tillage System	Early	Normal	Late	Early	Normal	Late
100% Aastad CT	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%
100% Parnell CT	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%
50% Aastad/50% Parnell CT	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%
100% Aastad NT	0.5%	99.5%	0.0%	0.5%	99.5%	0.0%
100% Parnell NT	20.6%	79.4%	0.0%	20.6%	79.4%	0.0%
50% Aastad/50% Parnell NT	20.6%	79.4%	0.0%	20.6%	79.4%	0.0%