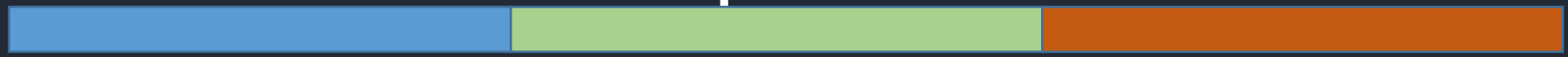
An Economic Analysis to Determine the Feasibility of Groundwater Supplementation from the Dockum Aquifer



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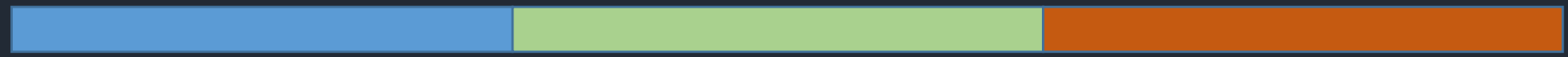
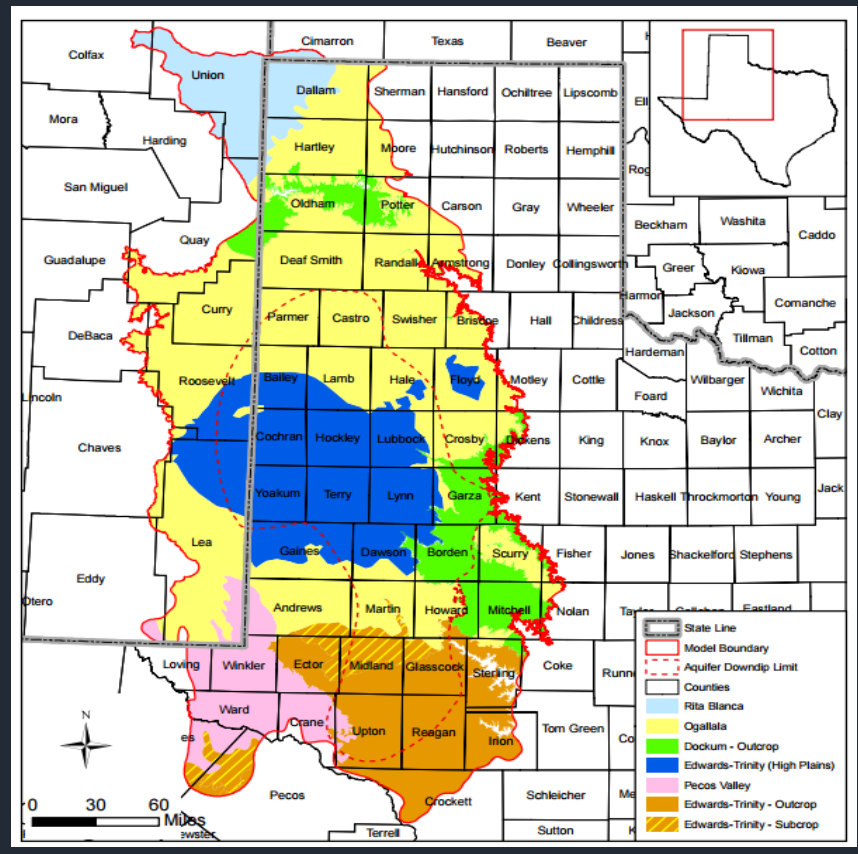
Introduction



Background

- Dockum has been identified as a possible source of irrigation water
- HPWD is drilling exploratory wells
- Aquifer Characteristics
  - Deep pumping depths-2000 feet
  - Poor water quality (1,000 mg/l to 60,000 mg/l)
  - Well yields (0.5 to 2,500 gpm)
  - No recharge
- Deaf Smith has the most volume and best water

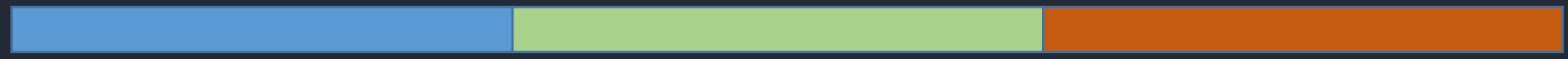


Research Objective

- To perform an economic analysis to determine the benefits associated with supplemental pumping from the Dockum via a non-linear optimization model

- Results will provide an estimation of the optimal amount of water withdrawals from the Ogallala, producer net returns, and optimal crop choice

Methods and Procedures



The Modeling Process

Hydrologic

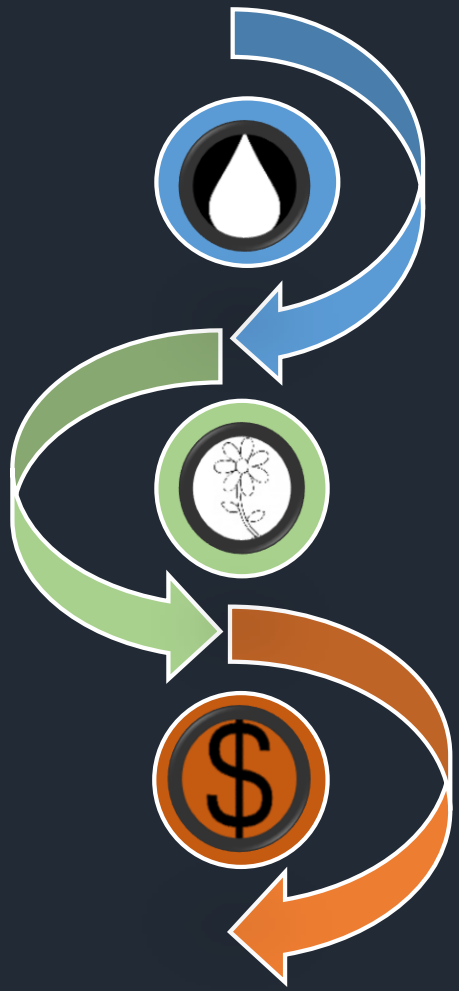
Includes variables such as saturated thickness, aquifer depth, specific yield

Agronomic

Incorporates crop production functions

Economic

Maximizes NPV of Net Returns



General Modeling Results

- Baseline Model- Represents the status quo position without water policy intervention or Dockum supplementation
- Constrained Model – Added Dockum with incorporated Blending constraints.
- Forecasted out 50 years

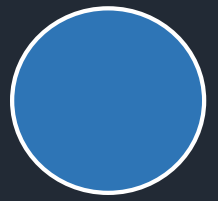
Data

County Characteristics	**Deaf Smith**
Irrigated Acres	148,412
Dryland	188,991
Total Cultivated Acres	337,403
Irrigated Crop Allocation (acres)	
Corn	33,358
Cotton	14,275
Sorghum	14,848
Wheat	56,223
Dryland Crop Allocation (acres)	
Cotton	2,926
Sorghum	30,234
Wheat	129,015
Average Dryland Yields	
Cotton (lb)	489
Sorghum (lb)	1,792
Wheat (bu)	20

Hydrologic Characteristics

Ogallala Characteristics	
Saturated Thickness	64
Specific Yield	0.15
Recharge	1.03
Average Well Yield (GPM)	191
Pumping Lift (ft)	223
Pumping Season (hours)	2,000

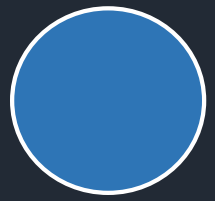
Dockum Characteristics	
Average Well Yield (GPM)	500
Transmissivity (m2/day)	92.90
Storage Coefficient	.000075
Screened Interval (feet)	785-908
Calculated Drawdown	168
Calculated Pumping Lift	769



Water Quality

Designation	TDS (ppm)
Fresh Water	<500
Slightly Brackish	500-1,000
Brackish	1,000-2,000
Moderately Saline	2,000-5,000
Saline	5,000-10,000
Highly Saline	10,000-35,000
Brine	>35,000

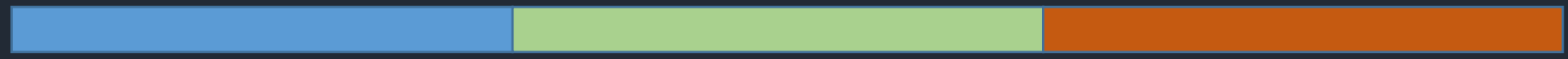
Source: Hillel (2000)



Pumping Cost

Lift (feet)	Cost/ac in	Cost/ac ft
200	$5.00	$60.00
500	$11.41	$136.90
700	$15.65	$187.80
900	$19.89	$238.68

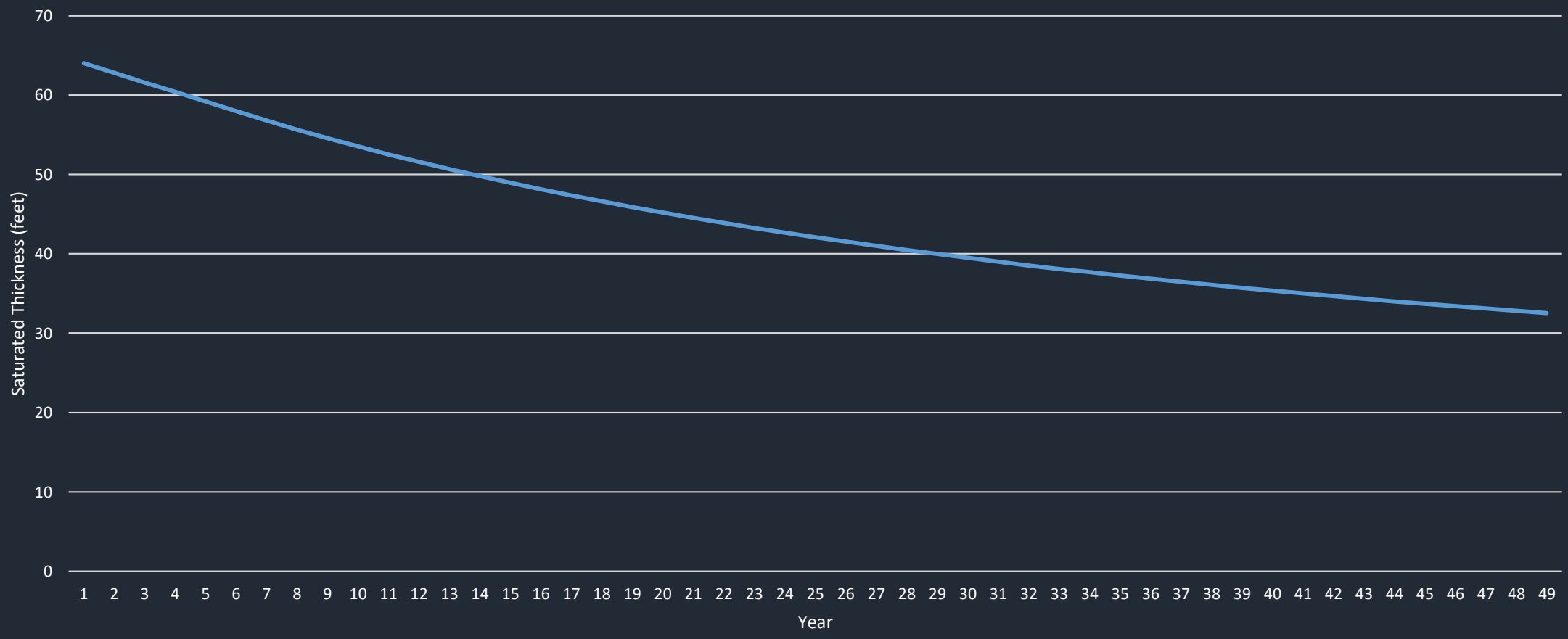
Results



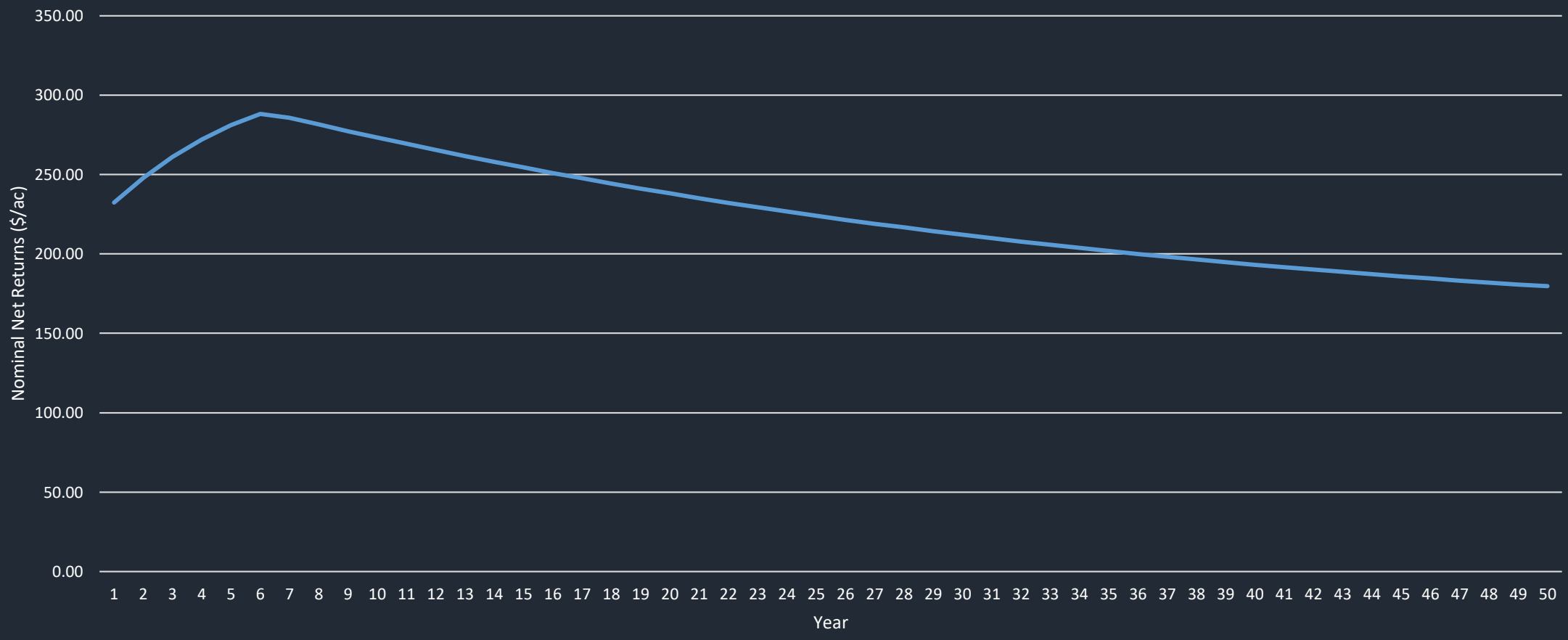
Baseline

Baseline	Year 10	Year 20	Year 30	Year 40	Year 50
Saturated Thickness (Ogallala) Year 1=64 feet	54	45	39	35	32
Net Revenue Year 1=$232/ac	$273	$238	$212	$193	$180
Irrigated Crop Percentage Year 1=44%	38%	25%	18%	14%	12%

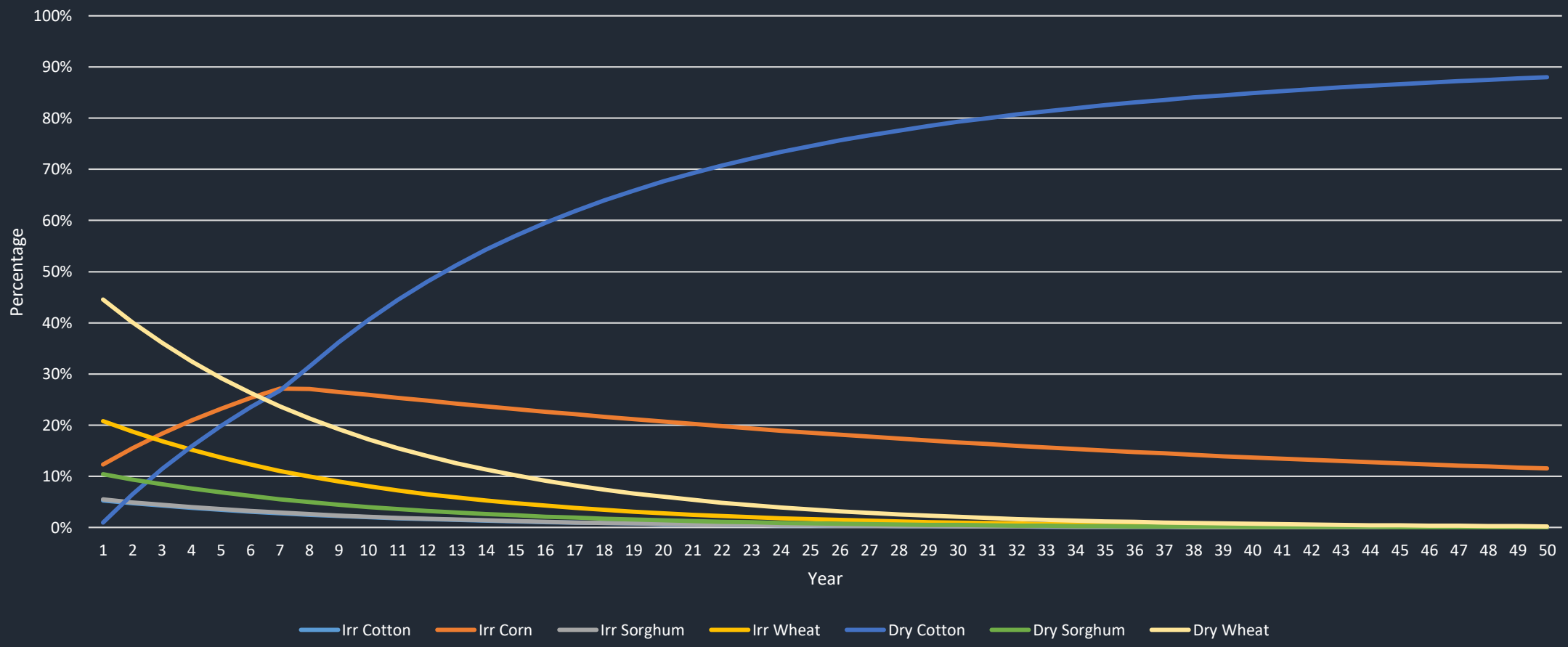
Baseline Saturated Thickness (Ogallala)



Baseline Net Returns



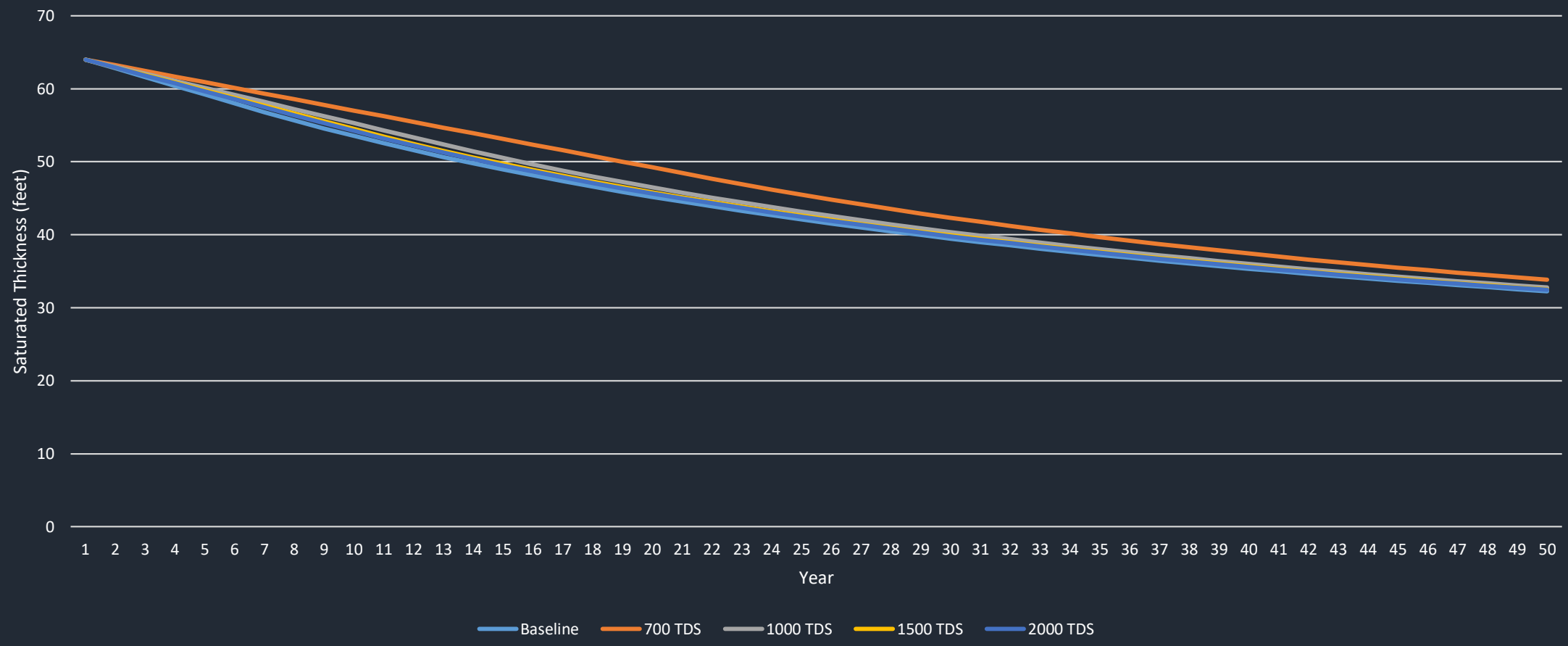
Baseline Crop Mix



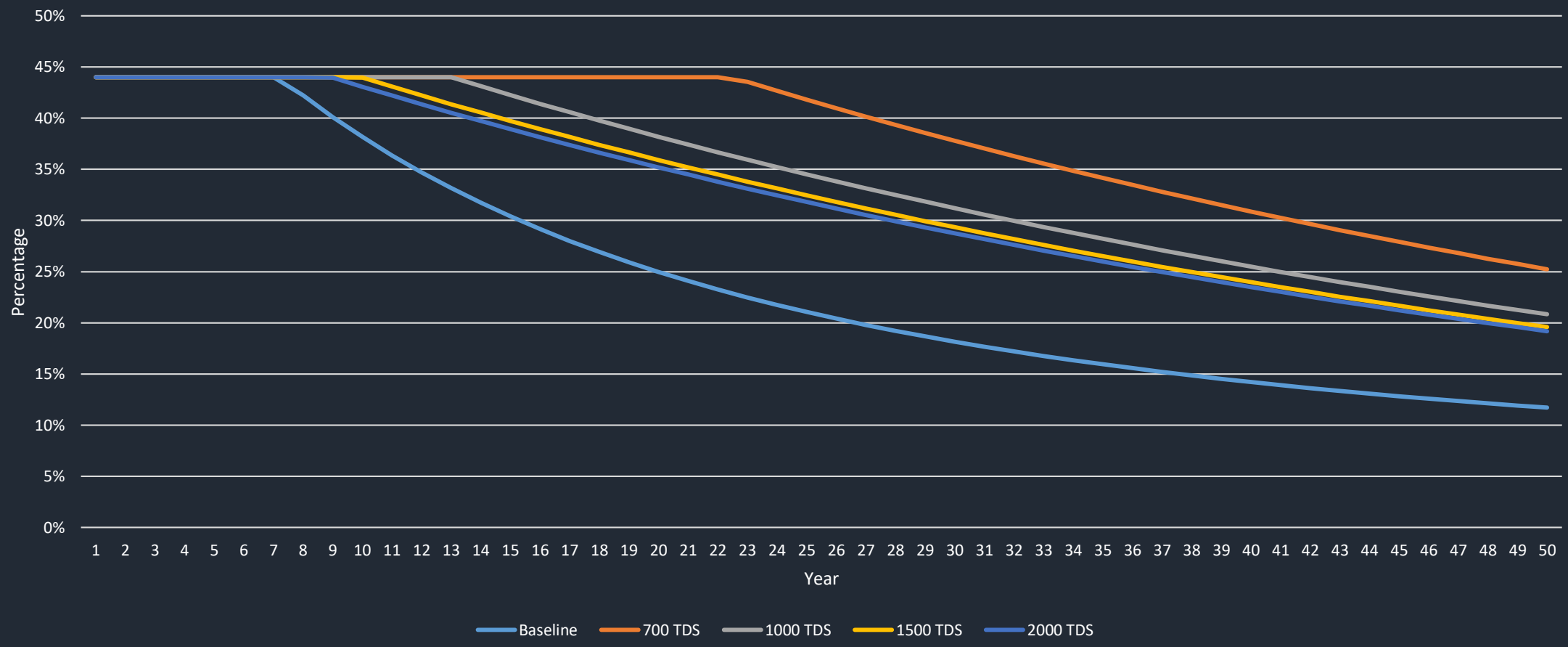
Scenario Results at Various Blending Rates

TDS 700	Year 10	Year 20	Year 30	Year 40	Year 50
Saturated Thickness (Ogallala) Year 1=64 feet	57	49	42	37	34
Net Revenue Year 1=$174/ac	$201	$222	$196	$174	$162
Irrigated Crop Percentage Year 1=44%	44%	44%	38%	31%	25%
TDS 1,000					
Saturated Thickness (Ogallala) Year 1=64 feet	55	47	40	36	33
Net Revenue Year 1=$191/ac	$215	$192	$166	$152	$145
Irrigated Crop Percentage Year 1=44%	44%	38%	31%	25%	21%
TDS 1,500					
Saturated Thickness (Ogallala) Year 1=64 feet	54	46	40	36	33
Net Revenue Year 1=$198/ac	$220	$180	$158	$146	$140
Irrigated Crop Percentage Year 1=44%	44%	36%	29%	24%	20%
TDS 2,000					
Saturated Thickness (Ogallala) Year 1=64 feet	54	46	40	36	32
Net Revenue Year 1=$201/ac	$215	$177	$155	$144	$139
Irrigated Crop Percentage Year 1=44%	43%	35%	29%	23%	19%

Comparison of Saturated Thickness (Ogallala)



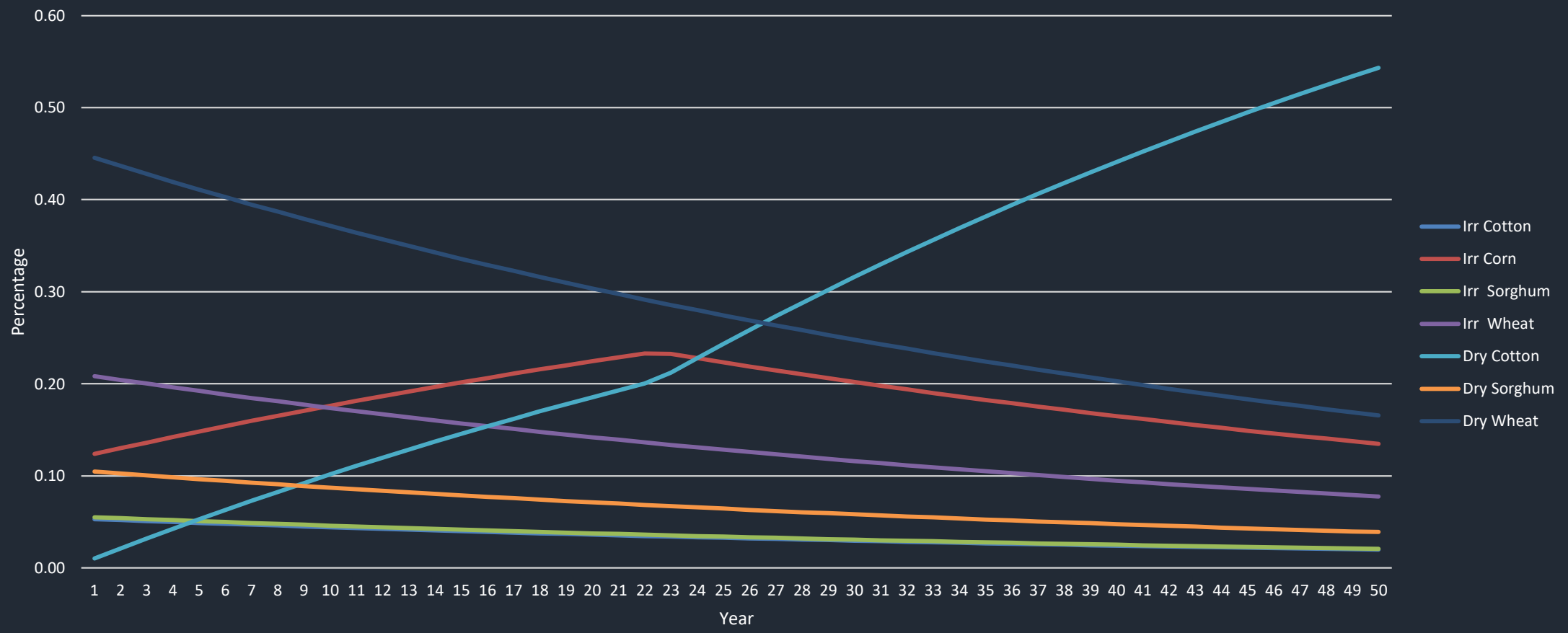
Comparison of Irrigated Crop Percentages



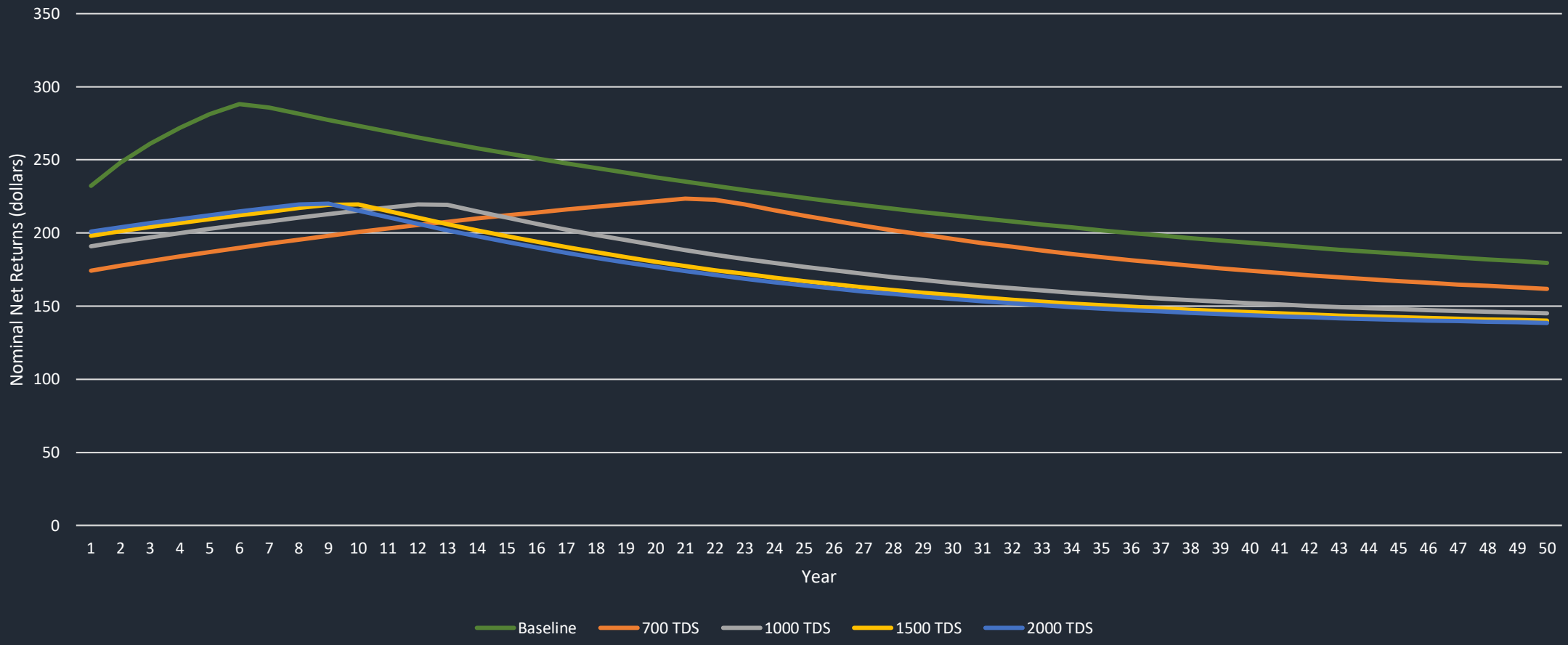
Comparison of Water Applied

Baseline	Ogallala	Dockum
Cotton	16.75	N/A
Corn	24.69	N/A
Sorghum	13.20	N/A
Wheat	11.19	N/A
Scenario 2 – TDS 700		
Cotton	12.09	6.05
Corn	17.60	8.80
Sorghum	10.03	5.02
Wheat	8.59	4.29
Scenario 2 – TDS 1,000		
Cotton	14.42	2.88
Corn	21.14	4.23
Sorghum	11.61	2.32
Wheat	9.88	1.98
Scenario 2 – TDS 1,500		
Cotton	15.44	1.54
Corn	22.71	2.27
Sorghum	12.28	1.23
Wheat	10.43	1.04
Scenario 2 – TDS 2,000		
Cotton	15.82	1.05
Corn	23.29	1.55
Sorghum	12.53	0.84
Wheat	10.63	0.71

Projected Crop Mix with TDS of 700 ppm



Comparison of Net Returns



Comparison of NPV

TDS	NPV NR	Ending Saturated Thickness	Ending Crop Percentage
Baseline	$6,341	32.26	11.72%
700	$5,175	33.83	25.23%
1000	$4,976	32.76	20.83%
1500	$4,876	32.51	19.59%
2000	$4,838	32.44	19.19%

Limitations

"All models are wrong, but some are useful"

- Quadratic production functions were assumed to be identical for the Ogallala and Dockum
- Maintenance costs of both irrigation systems did not reflect well deterioration
- This analysis assumes no water treatment technology implementation to improve water quality
- Crop production and irrigation requirements are based on average annual weather patterns and did not include climate or drought predictions

Conclusions

- The 50/50 management policy was shown to have no impact
- Pumping from the Dockum can be used for supplemental irrigation
- Deep pumping depths of the Dockum may make it financially challenging to producers
- Higher value, salt tolerant crops to maximize Dockum water

Questions and Discussion