Agricultural Cost of Maintaining Playa Lake Hydroperiod to Preserve Playa Lake Ecosystems in the Texas High Plains

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What are playas?
Shallow depressional recharge wetlands each existing in its own watershed.
Average Playa Area is 6.3-ha (15.5 acres) and 87% of all Playas are less than 12-ha in Southern Great Plains.

In Texas 98% of all Playas are located on Private property.

90% of the 25,000 Playas in the Southern Great Plains have been destroyed.
ROLES OF PLAYAS IN THE SOUTHERN HIGH PLAINS

(1) Natural Flood Control
(2) Wildlife Habitat
(3) Conservation of Native Plants
(4) Aquifer Recharge
(5) Recreation and Aesthetic
WHAT MAKES A PLAYA A PLAYA?

Just because a playa depression exists and water collects does not mean that the playa remains!

Agricultural land use practices have decreased playa hydro-period and biological diversity
Agricultural Conversion of a Playa

A Non-Functioning Playa
Agricultural Land Use Practices Cause Playas to Fill with Sediment
Cumulative Amphibian Richness - 2004

Fig. 6. Total number of amphibian species observed in grassland and cropland playas in the Southern High Plains in 2004.
Playa Loss is a Classic Externality

Environmental Damage Costs

Index of Agricultural Operations
Agricultural Policy-Environmental eXtender Model (APEX)
Flow Chart of Physical, Biologic, and Economic Data Used in Management Practice Cost-Effectiveness Analysis

- Playa Watershed Parameters
  - Soil Types
  - Slopes
  - Crop Field Geometry
  - Playa Characteristics
  - Water Routing

- Agricultural Land Management Scenario

- Weather Data
  - Daily precipitation
  - Daily Max Temperature
  - Daily Min Temperature
  - Wind Velocity

- APEX Simulation

- Playa Response
  - Hydroperiod
  - Sedimentation Levels
  - Average Volumes

- Agronomic Response
  - Crop Yield
  - Water Use
  - Idled Land

- BMP Cost-Effectiveness

- TCES Budget Data Per-acre Cost
Illustrative Playa Watershed Design

Primary Field
237.73 ha (624.24 ac)
232.50 ha (611.33 ac)

Marginal Field 1
(7.5 Ha (18.53 ac))

Marginal Field 2
(7.5 Ha (18.53 ac))

WSA:
259 Ha (640 ac)

Playa
6.27 Ha
15.5 Ac
Meter Depth

Filter strip
50 Meters
5.23 Ha
(12.92 Ac)
Average Yearly Playa Wet Days: May 1 – August 31

100 50-year Simulations
Average Yearly Playa Wet Days: May 1 – August 31

Average May-August Wet Days:
Cotton, Wheat, and Range on **Amarillo Soil**

Average May-August Wet Days:
Cotton, Wheat, and Range on **Pullman Soil**
Average Yearly Playa Wet Days
Less Variable than May1-August 31
100 50-year Simulations
Number Average Yearly Playa Wet Days

*Less Variable* than May1-August 31

Average Yearly Total Wet Days:
Cotton, Wheat, and Range on **Amarillo Soil**

Average Yearly Total Wet Days:
Cotton, Wheat, and Range on **Pullman Soil**
Why are Wet Days Lost?

Average End-of-Year
Playa Storage Capacity

100 50-year Simulations
Average End-of-Year Playa Storage Capacity

Average End-of-Year Playa Water Storage Capacity:
Cotton, Wheat, and Range on Amarillo Soil

Average End-of-Year Playa Water Storage Capacity:
Cotton, Wheat, and Range on Pullman Soil
Average Yearly Playa Stored Water Volume per Wet Day: May 1 – August 31 100 50-year Simulations
Average Yearly Playa Stored Water Volume per Wet Day: May 1 – August 31

Average May-August Stored Water per Wet Day:
Cotton, Wheat, and Range on Amarillo Soil

Average May-August Stored Water per Wet Day:
Cotton, Wheat, and Range on Pullman Soil
Controlling Agricultural Impacts

Buffer Filter Strip Effectiveness in protecting Number of Playa Wet Days between May 1–August 31:
Buffer Filter Strip Effectiveness

Number of Playa Wet Days: Cotton

Average Number May-August Playa Wet Days: 50 Meter Buffer vs No Buffer Strip
Cotton grown on Amarillo Soil

Average Number May-August Playa Wet Days: 50 Meter Buffer vs No Buffer Strip
Cotton grown on Pullman Soil
Buffer Filter Strip Effectiveness
Number of Playa Wet Days: Wheat

Average Number May-August Playa Wet Days:
50 Meter Buffer vs No Buffer Strip
Winter Wheat grown on Amarillo Soil

Average Number May-August Playa Wet Days:
50 Meter Buffer vs No Buffer Strip
Winter Wheat grown on Pullman Soil
Controlling Agricultural Impacts

Effectiveness of Buffer Filter Strips in protecting Initial Playa Water Storage Capacity:
Buffer Filter Strip Effectiveness
End-of-Year Storage Capacity: Cotton

Average Playa End-of-Year Water Storage Capacity:
50 Meter Buffer vs No Buffer Strip
Cotton Grown on Amarillo Soil

Average Playa End-of-Year Water Storage Capacity:
50 Meter Buffer vs No Buffer Strip
Cotton Grown on Pullman Soil
Buffer Filter Strip Effectiveness
End-of-Year Storage Capacity: Wheat

Average Playa End-of-Year Water Storage Capacity:
50 Meter Buffer vs No Buffer Strip
Winter Wheat Grown on Amarillo Soil

Average Playa End-of-Year Water Storage Capacity:
50 Meter Buffer vs No Buffer Strip
Winter Wheat Grown on Pullman Soil
Controlling Agricultural Impacts

Effectiveness of Buffer Filter Strips in protecting Average Playa Stored Water Volume per Wet Day:
May 1–August 31:
Buffer Filter Strip Effectiveness
Stored Water Volume/Wet Day: Cotton

Average May-August Stored Water Volume per Wet Day:
50 Meter Buffer vs No Buffer Strip
Cotton Grown on Amarillo Soil

Average May-August Stored Water Volume per Wet Day:
50 Meter Buffer vs No Buffer Strip
Cotton Grown on Pullman Soil
Buffer Filter Strip Effectiveness
Stored Water Volume/Wet Day: Wheat

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Average May-August Stored Water Volume per Wet Day:
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Winter Wheat Grown on Pullman Soil
Impact of Furrow Dikes
Yield and Erosion Impacts
Cotton
Furrow Dike Cotton Yield Impacts

Annual Average per Acre Cotton Yield:
Amarillo Soil, Furrow Diking versus no Furrow Diking

Annual Average per Acre Cotton Yield:
Pullman Soil, Furrow Diking versus no Furrow Diking
Control Practice Comparisons
Number of Playa Wet Days: Cotton

Average May-August Wet Days: Cotton with and without Buffers and Diking on Amarillo Soil

Average Annual May-August Wet Days: Cotton with and without Buffers and Diking on Pullman Soil
Control Practice Comparisons

Year-End Storage Capacity: Cotton

Average Yearly Playa Water Storage Capacity: Cotton with and without Buffers and Diking on Amarillo Soil

Average Yearly Playa Water Storage Capacity: Cotton with and without Buffers and Diking on Pullman Soil
Control Practice Comparisons
Water Volume per Wet Day: Cotton

Average May-August Stored Water per Wet Day: Cotton with and without Buffers and Diking on Amarillo Soil

Average May-August Stored Water per Wet Day: Cotton with and without Buffers and Diking on Pullman Soil
Average Simulated Yearly Cotton Yield Difference With Buffer Strip

Yearly Average Per Acre Cotton Yield by Field:
Pullman Soil, No Buffer Strip, No Furrow Diking

Yearly Average Per Acre Cotton Yield by Field:
Pullman Soil, Buffer Strip, No Furrow Diking
### Annual Producer Per Acre Cost of Buffer Strip By Crop, Price Scenario, and Soil Type Excluding Establishment Cost ($65.00)

<table>
<thead>
<tr>
<th>Price Scenario</th>
<th>Crop</th>
<th>Amarillo Soil</th>
<th>Pullman Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Base to Buffer</td>
<td>Diking to Buffer (No Dike)</td>
</tr>
<tr>
<td>Mkt Price + LDP</td>
<td>Cotton</td>
<td>-18.87</td>
<td>392.37</td>
</tr>
<tr>
<td>Mkt Price + All GP's</td>
<td>Cotton</td>
<td>179.72</td>
<td>874.95</td>
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<tr>
<td>Mkt Price + LDP</td>
<td>W Wheat</td>
<td>29.85</td>
<td></td>
</tr>
<tr>
<td>Mkt Price + All GP's</td>
<td>W Wheat</td>
<td>130.83</td>
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</tr>
</tbody>
</table>
### Annual Producer Per Acre Cost of Buffer Strip By Crop, Price Scenario, and Soil Type Excluding Establishment Cost ($65.00): No Buffer Yield Effect

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<tr>
<th>Price Scenario</th>
<th>Crop</th>
<th>Amarillo Soil Base to Buffer</th>
<th>Diking to Buffer (No Dike)</th>
<th>Diking to Buffer (w/Dike)</th>
<th>Pullman Soil Base to Buffer</th>
<th>Diking to Buffer (No Dike)</th>
<th>Diking to Buffer (w/Dike)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mkt Price + LDP</td>
<td>Cotton</td>
<td>-126.22</td>
<td>285.02</td>
<td>-111.24</td>
<td>-151.95</td>
<td>428.12</td>
<td>-133.10</td>
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<tr>
<td>Mkt Price + All GP's</td>
<td>Cotton</td>
<td>25.56</td>
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<td>-10.26</td>
<td>927.24</td>
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<tr>
<td>Mkt Price + LDP</td>
<td>W Wheat</td>
<td>-75.59</td>
<td>-</td>
<td>-77.29</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mkt Price + All GP's</td>
<td>W Wheat</td>
<td>-26.41</td>
<td>-</td>
<td>-28.80</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tbody>
</table>
Summary and Conclusions

1. Agricultural land use practices reduce the (1) number of playa wet days, (2) volume of stored water per wet day, (3) and increase playa sedimentation rates relative to pristine range conditions.

2. Buffer filter strips more effectively reduce sedimentation rates on silty-clay Pullman soil than sandy Amarillo Soil.

3. Cotton production has a larger adverse affect on playas than wheat production.

4. Furrow diking increases on-farm returns which increases producer opportunity cost of installing buffer strips.

5. Government price support programs increase producer opportunity cost of installing buffer strips.
Summary and Conclusions

6. Additional work needs to be done to more fully calibrate APEX to Texas High Plains land use practices.

7. Need to correlate the number of wet days to an eco-system quality index

8. Identify critical environmental threshold levels

9. Establish minimum environmental safety standards

10. Account for stochastic weather in establishing minimum environmental safety standards.