Abstract
Since Eagle Ford Shale developed in late 2008, the huge potential has led to over 1000 wells drilled in the Eagle Ford Shale in 2010 with increasing trend. It is in oil companies’ interest to predict well performance. The decline curve analysis (DCA) for well performance prediction based on production history is the most widely used method due to the data availability that only the production data is required for analysis. This study adopts Arp’s calculation to analyze oil wells that produced in Frio and Zavala counties in Texas. In facing the characteristics of quickly decline in shale wells, this study explored a new analysis method by multistage production data analysis. That is, the prediction is based on the production during multiple six-month period instead of the whole production period. All the single wells producing from the Eagle Ford Shale over one year (21 leases) were analyzed. Completion and production data are collected from the online database. This study aims to predict field performance from oil shale wells and propose a new method for forecasting shale well performance.

Introduction
Eagle Ford Shale, in a long time, used to be considered only as the source rock of Austin Chalk, however it was developed since 2009. Now it is the most active shale gas play in the world. The Zavala and Frio counties that we are going to analyze, lying on the northeast of Eagle Ford Shale, belong to the Maverick Basin, is in the oil window. The interesting field is BRISCOE RANCH, which has a total 59 leases in Zavala and 51 leases in Frio, containing all wells newly completed in the Eagle Ford Shale formation. This study contains all the leases (21 leases) with single well in the Zavala and Frio counties in Texas.

For conventional reservoirs, well production goes through three period: production increases, becomes steady and finally declines. Decline curve analysis (DCA) is used to forecast production in the field which is in the decline period. However, the shale (unconventional) reservoirs meet the decline stage at the early time when the well was produced, due to the extremely low permeability and porosity.

Arp’s (1945-1956) first presented a comprehensive set of line equations defining exponential (b=0), hyperbolic (0<b<1) and harmonic (b=1) decline curves.

\[ D = -\frac{dq}{dt} = Kq^b \]

Research Objectives
• Acquire proprietary fluid data of the Eagle Ford shale through Railroad Commission of Texas online database.
• Predict field performance from the Eagle Ford shale in Frio and Zavala counties in Texas.
• Propose a new prediction method by multistage analysis for shale well performance.

Methodology
• Arp’s equations
  1) Exponential decline: \( b=0 \)
  \[ q_i = q_0 e^{-kt} \]
  \[ N_i = \frac{q_i - q_0}{k} \]
  \[ b=0 \]

  2) Hyperbolic decline: \( 0 < b < 1 \)
  \[ q_i = \frac{q_0}{(1 + bt)^{1/b}} \]
  \[ N_i = \frac{q_i}{1 + (b/t)^{1/b}} \]
  \[ b=1 \]

  3) Harmonic decline: \( b=1 \)
  \[ q_i = \frac{q_0}{1 + bt} \]
  \[ N_i = \frac{q_i}{b} \ln(1 + bt) \]

Case Study

Historical Match Data

<table>
<thead>
<tr>
<th>Well name</th>
<th>Time to reach decline period (months)</th>
<th>Decline Rate (6-12 month)</th>
<th>Decline Rate (12-18 month)</th>
<th>Decline Rate (24-30 month)</th>
<th>Decline Rate (general)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frio_15404</td>
<td>2</td>
<td>348.288</td>
<td>355.84</td>
<td>0.0401</td>
<td>0.4433</td>
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<td>Frio_15508</td>
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<td>2.739</td>
<td>654.358</td>
<td>0.0532</td>
<td>248.98</td>
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<tr>
<td>Frio_15608</td>
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<td>1.602</td>
<td>350.389</td>
<td>0.1135</td>
<td>0.0967</td>
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<tr>
<td>Frio_1592</td>
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<td>821.852</td>
<td>0.0407</td>
<td>-</td>
<td>0.257</td>
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<td>Zavala_1541</td>
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<td>0.087</td>
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<td>0.0071</td>
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<tr>
<td>Zavala_15485</td>
<td>5</td>
<td>0.4634</td>
<td>0.0441</td>
<td>0.0491</td>
<td>0.9631</td>
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<tr>
<td>Zavala_15772</td>
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<td>0.1708</td>
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<td>0.0721</td>
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<td>Zavala_15792</td>
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<td>160.32</td>
<td>0.1058</td>
<td>0.0442</td>
<td>468.768</td>
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<td>Zavala_15424</td>
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<td>0.2336</td>
<td>0.3309</td>
<td>-</td>
<td>0.2959</td>
</tr>
</tbody>
</table>

Results
According to the analyzing data, several results are achieved:
1. For 8 wells in Frio County, all wells reached to the Decline Period within 2 months; for 13 wells in Zavala County, the time to reach Decline Period ranged from 1 month to 5 months, the mean value was 4.
2. Most of the wells reached the highest decline rate at the beginning of the first production year and turned to a smooth curve; whereas, a few wells didn’t show a significant change with time, such as Zavala_1845, Zalava_15424.
3. Forecasting was based on 10 years with end rate of 0.1 bbl/day. The final rate was varied from 17,2665 to 0.0928 bbl/day, the average value was 7.3142 bbl/day, and the average EUR was 95.545.

Intermediate Conclusions and future Work
• Oil wells in Frio County went to the Decline period rapidly but wells in Zavala County need more time; the decline rate varied significant with time in Frio County but not in Zavala. These differences may due to the difference in geologic factor or fracture scale (e.g. Wells in Frio have an average depth for 7083.75, however wells in Zavala show an average depth of $5146.92\ ft$).
• With 10 years forecast, the final rate and Estimated Ultimate reserves are relative low.
• In the future, more models will be applied to Decline Curve Analysis. The differences between Frio and Zavala counties need further investigation.

Acknowledgement
We greatly appreciate to the funding support from the Eagle Ford Center for Research, Education, and Outreach (EFCREO) in TAMUK.