



Landsat Science Team / December 2012
**Integrating Field-Level Biophysical Metrics
Derived from Landsat Science Products into a
National Agricultural Data Warehouse**

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USDA Risk Management Agency

Office of Compliance

Strategic Data Acquisition & Analysis (SDAA)

USDA **RMA**
Risk Management Agency



Project Team



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About RMA & Crop Insurance



Risk Management Agency Overview



- Mission: To promote, support, and regulate sound risk management solutions to preserve and strengthen the economic stability of America's agricultural producers
- Operate and manage the Federal Crop Insurance programs
- For crop year 2011, RMA managed about \$114-billion worth of insurance liability with \$10.77-billion in indemnities
- RMA web site: <http://www.rma.usda.gov/>

	2010	2011	2012 (so far)
Liability	\$78 Billion	\$114 Billion	\$117 Billion
Acres Insured	256.2 Million	266 Million	282 Million
Total Premium	\$7.6 Billion	\$11.95 Billion	\$11 Billion
Indemnity (Claims Paid So Far)	\$4.2 Billion	\$10.83 Billion	\$7.1 Billion
Loss Ratio	.56	.91	.64

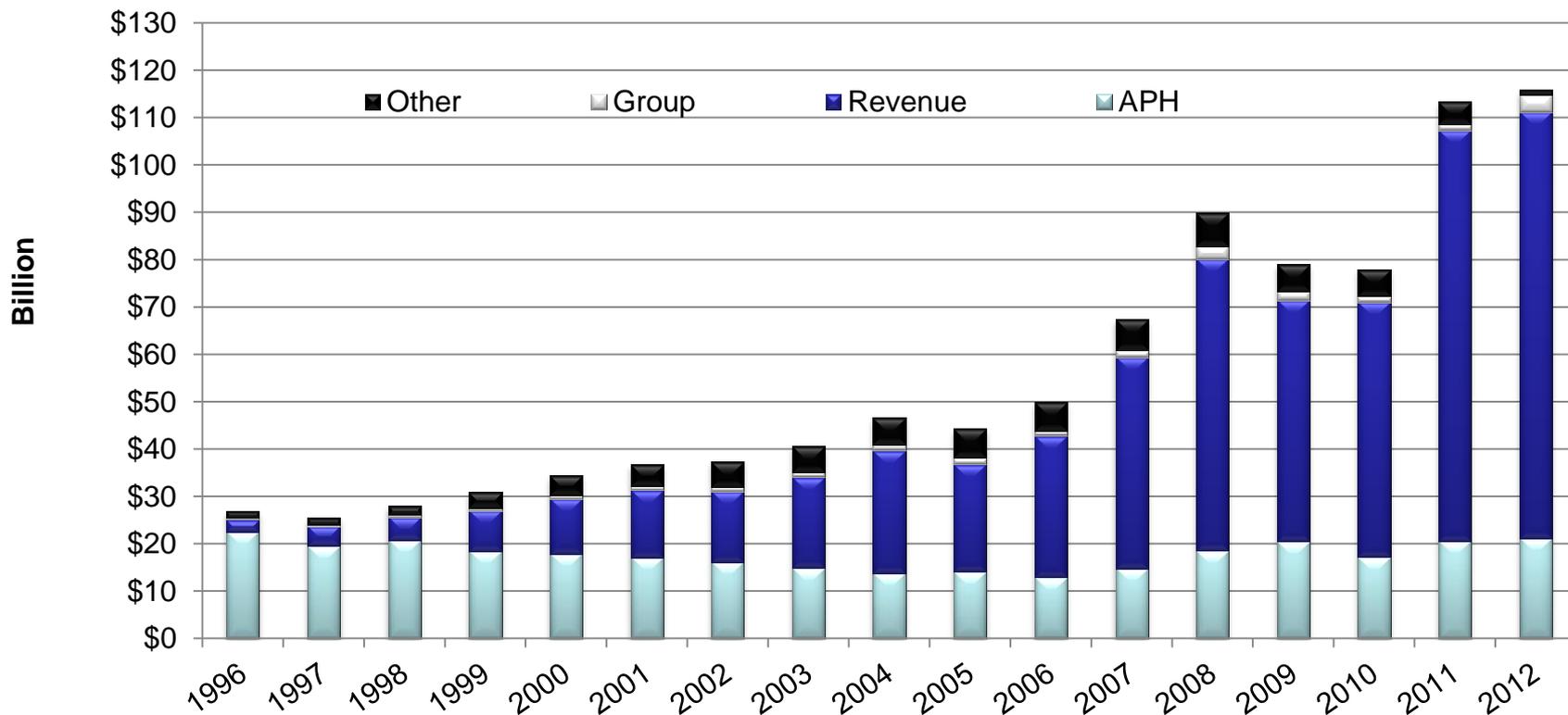
National Crop Ranking



2011 Crop Ranking by Value

Crop	Crop Liability	Percent of Total
Corn	\$54.2 Billion	47%
Soybeans	\$25.5 Billion	22%
Wheat	\$10.5 Billion	9%
Cotton	\$5 Billion	4%
Citrus	\$2.4 Billion	2%
Nursery (FG&C)	\$2 Billion	1.7%
Almonds	\$1.2 Billion	1%
Rice	\$1.1 Billion	0.95%
All Others	\$14.1 Billion	12%
Total	\$116 Billion	100.0%

Total Crop Insurance Liability

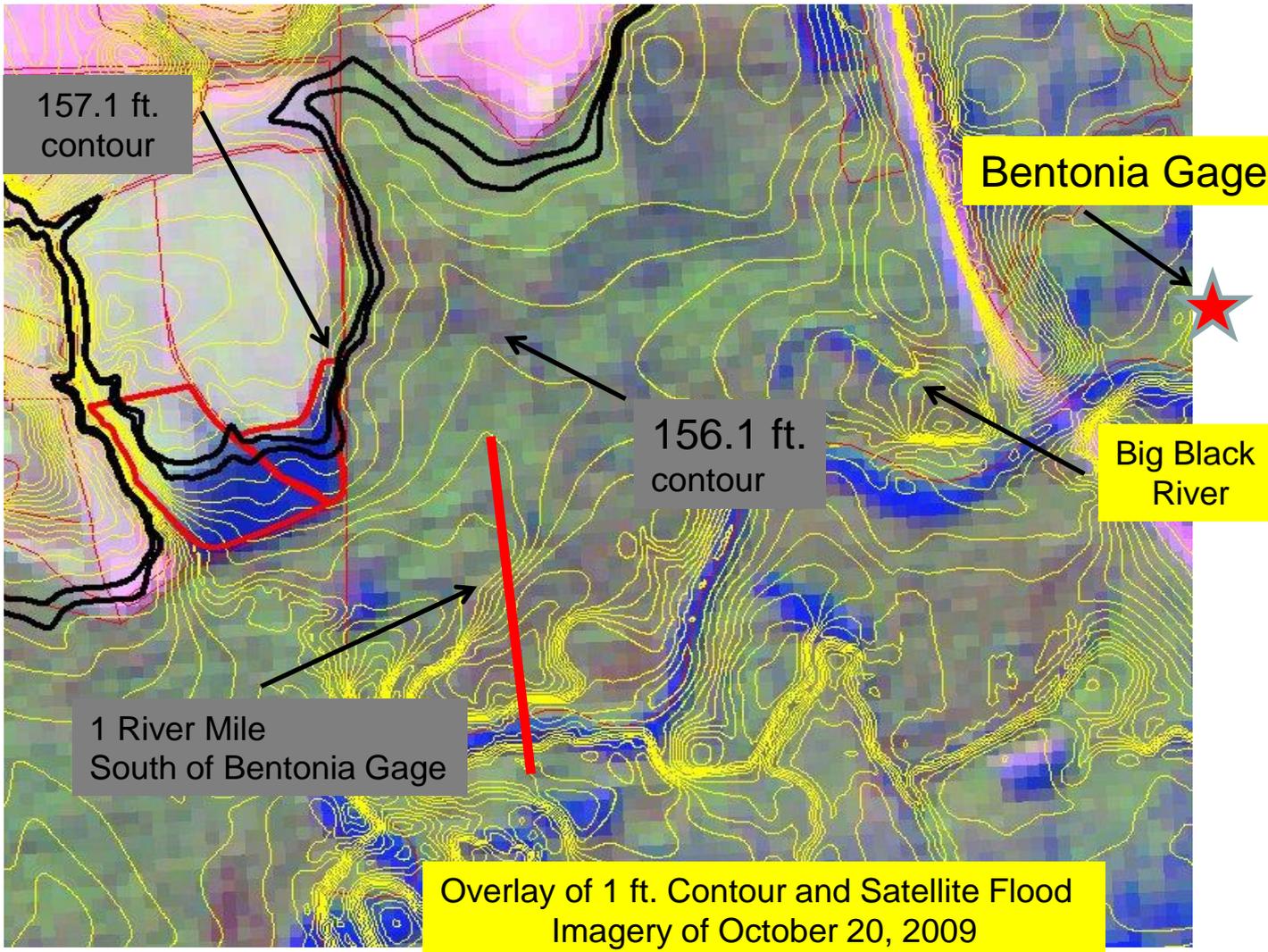


Data current as of September 25, 2012



General uses of RS Data in RMA

Improving Rating Areas

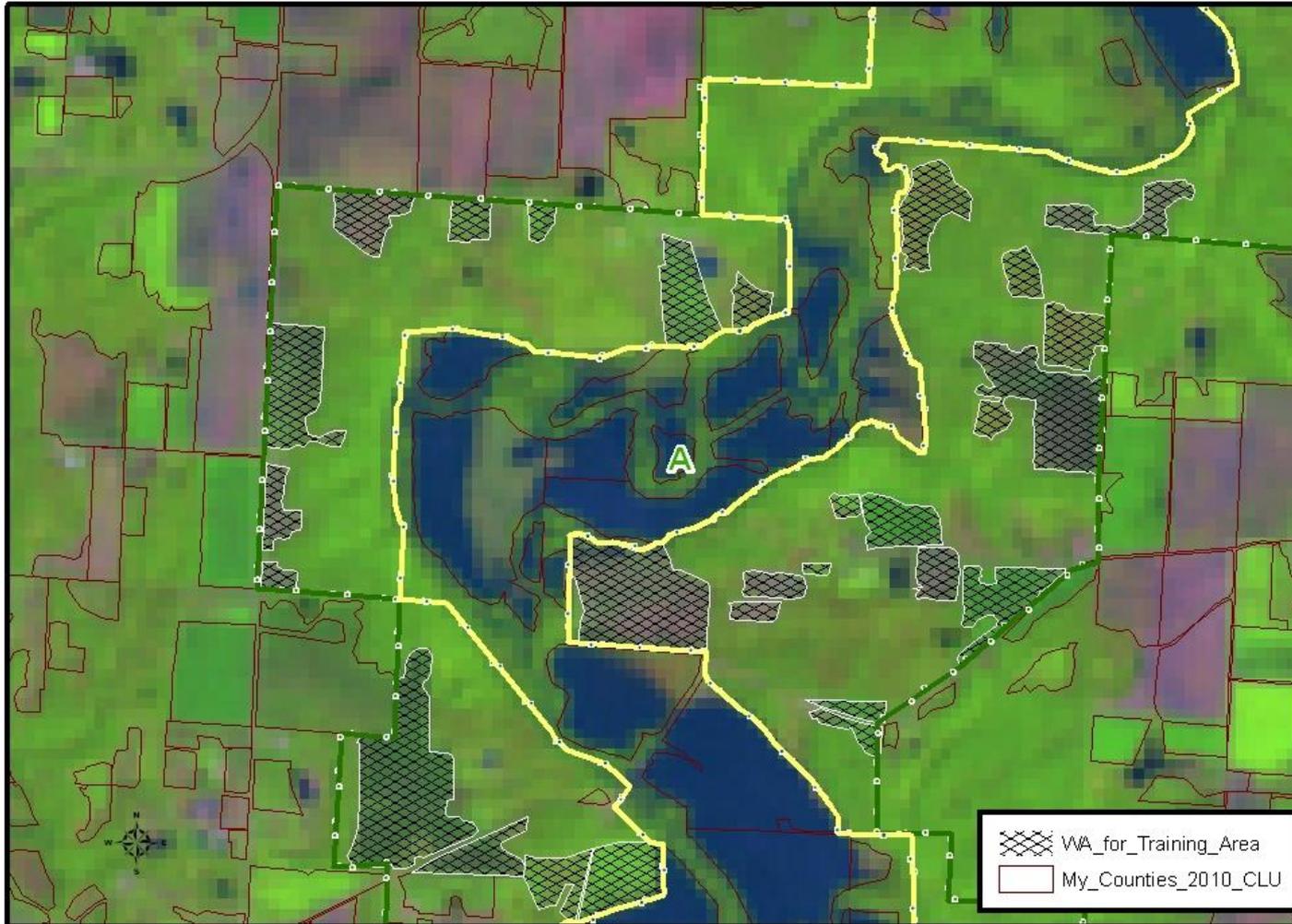


Jackson RO uses satellite imagery to identify historic flooding linking it to high resolution contours to better map risk areas.

Improving Rating Areas



This map shows how written agreements in this area will be affected.



Springfield RO uses satellite imagery to identify historic flooding extent.

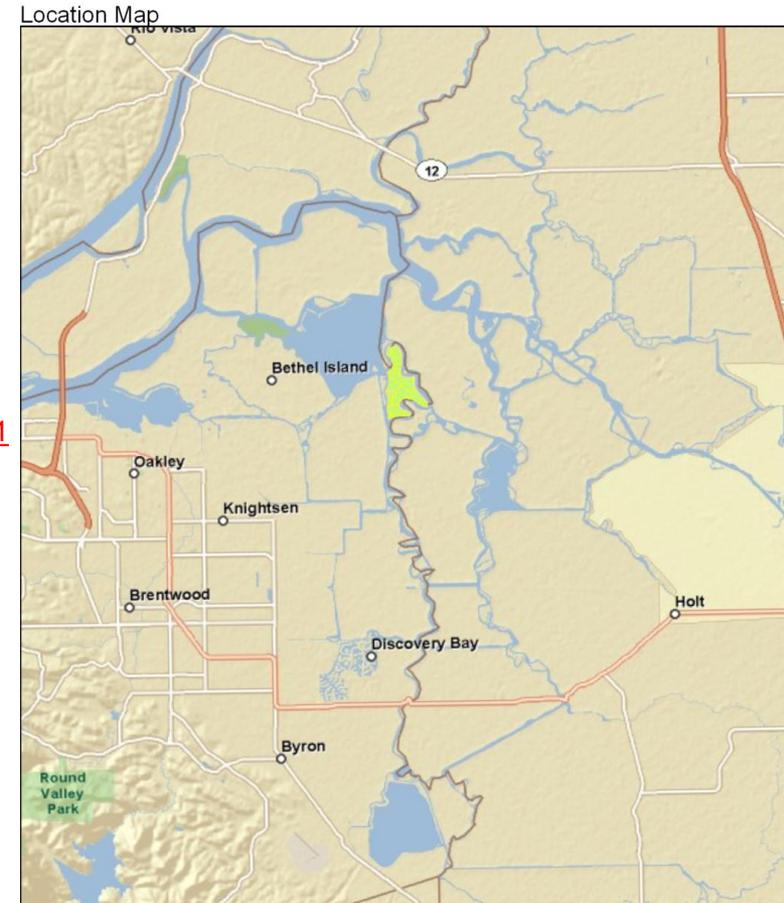
Result: less land in AAA and reducing the number of written agreements.

Compliance Investigation Example



Crop Timeline Summary (as reported to Insurance Company)

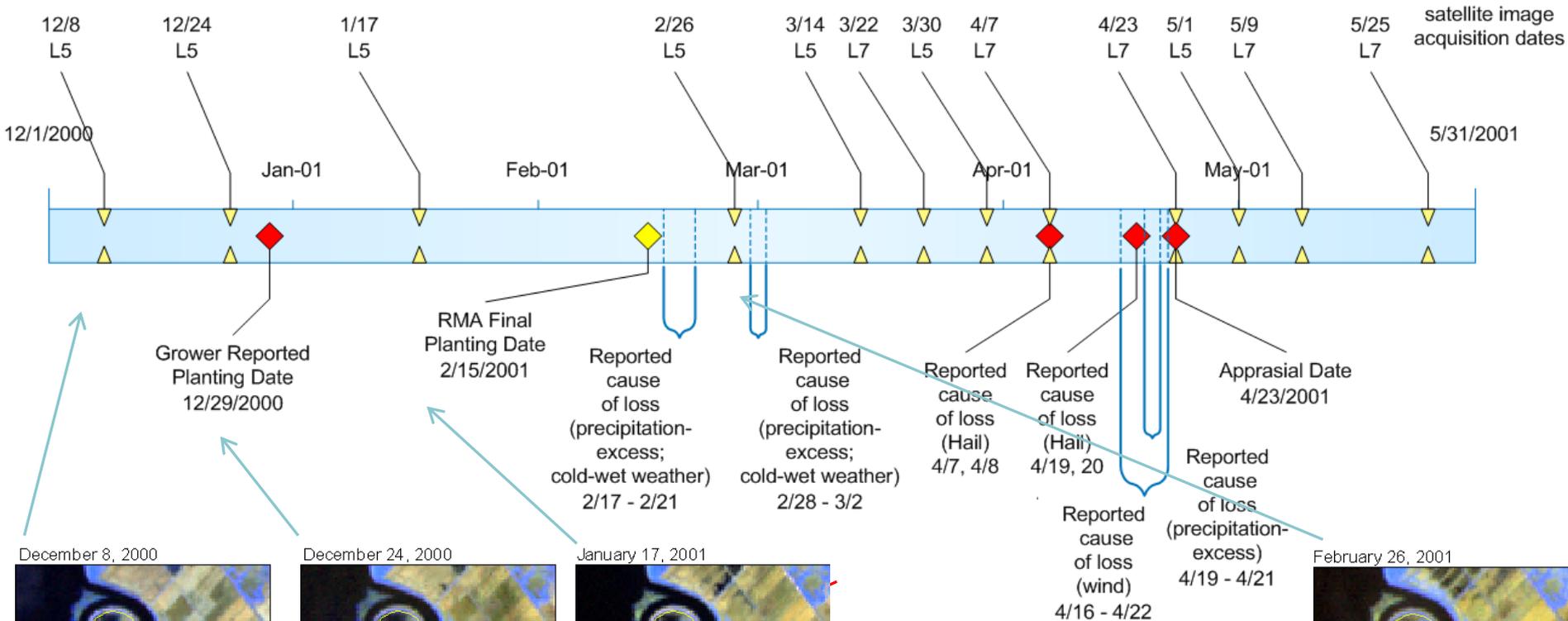
- Grower Reported Planting Date: December 29, 2000
- Grower Reported Acreage: 647.9 acres
- RMA Final Planting Date: February 15, 2001
- Grower Reported Cause of Loss Date: February 17 – 21, 2001
Cause of Loss: precipitation (excess), cold-wet weather
- February 28 – March 2, 2001
Cause of Loss: precipitation (excess), cold-wet weather
- April 7, 8, 19, 20, 2001
Cause of Loss: hail
- April 16-22, 2001
Cause of Loss: wind
- April 19-21, 2001
Cause of Loss: precipitation (excess)
- Loss Adjustment Appraisal Date: April 23, 2001



Crop & Satellite Image Timeline

EXAMPLE

Crop Year 2001 Timeline: WHEAT



Standing water and water saturated soil is evident on numerous fields December 8, 2000 through January 17, 2001.

The area under standing water and water saturated soil increases through January 17, 2001.

Most of the standing water or water saturated soil is gone by February 26, 2001.



Data Mining & Data Warehousing Data in RMA

Mission & Primary Goals



Use Data Mining And Data Warehousing Technology To Prevent Fraud, Waste And Abuse In The US Crop Insurance Program



1. Develop & assist in implementing key strategies in prevention of fraud, waste and abuse in the US Crop Insurance Program
2. Determine impact & influence of factors external to the crop insurance program (weather, crop quality, markets, public policy)
3. To create a single warehouse of crop insurance data
4. To use this data and relevant data mining & statistical tools to decrease program vulnerability

Ultimate goal:

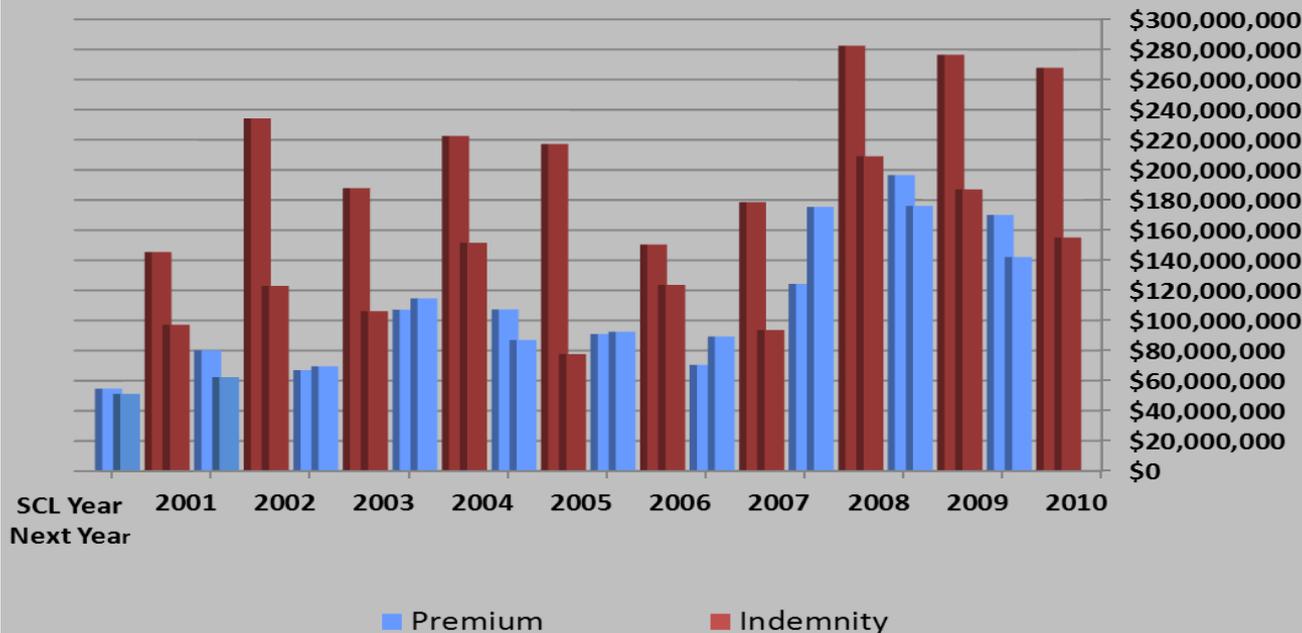
- Enhance integrity of FCIC in compliance with 7 USC 1514 section 515(j)(2) of the Federal Crop Insurance Act

ARPA 2000 SECTION 515(J)

SDAA Spot Check List Cost Avoidance

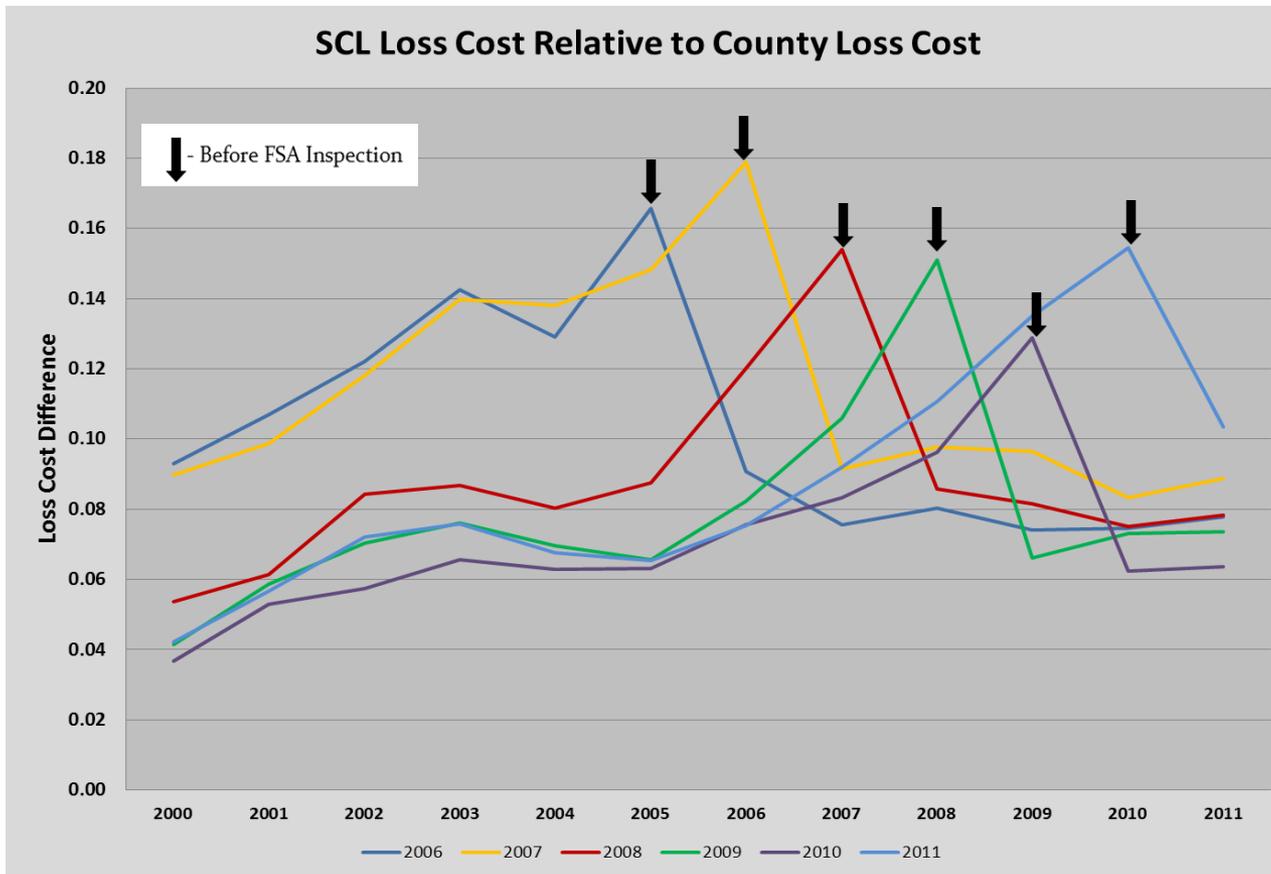


2001-2010 Spotcheck Lists
Premium & Indemnity



SCL Year	Cost Avoidance in Millions
2001	\$48
2002	\$112
2003	\$81
2004	\$71
2005	\$140
2006	\$27
2007	\$85
2008	\$73
2009	\$89
2010	\$112
2011	\$46
Total	\$884

SDAA Spot Check List Cost Avoidance



Possible SCL Scenarios

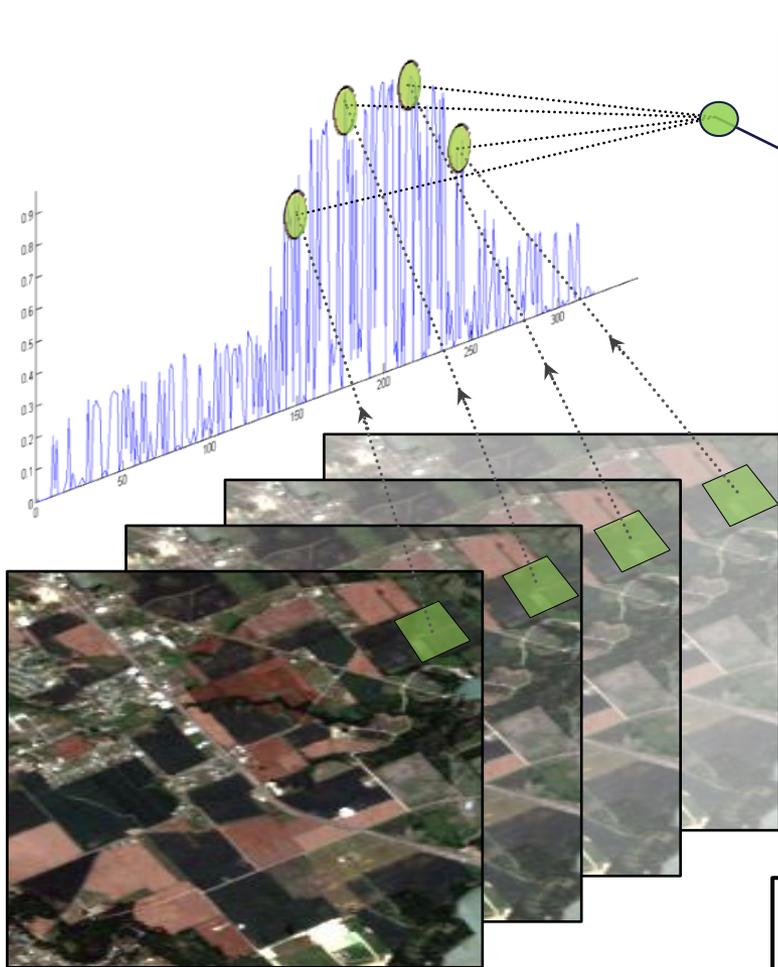
- Producers Adding and Dropping Yields
- Entity Switching
- Excessive Yields
- New Excessive Yields
- FSA Inspection
- Loss Units Changed Yields
- Over Reported Harvested Production
- Persistent Losses
- Producers, Lost Then Found
- Isolated Disasters
- Severe Losses
- New Tax ID's
- Scoring
- Special Investigation Branch
- Yield Switching
- Copied Yields
- Only Loss



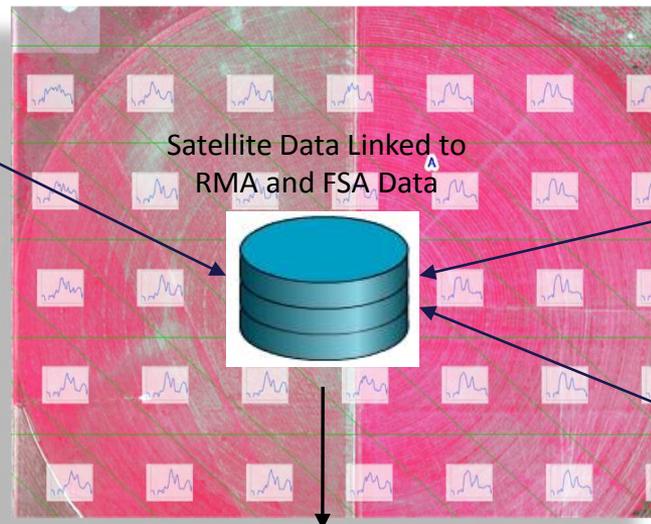
GeoSpatial Integration into Data Mining & Data Warehousing (examples of where we are at)

Spot Check Claims Validation

PP Claims - Growth Curves



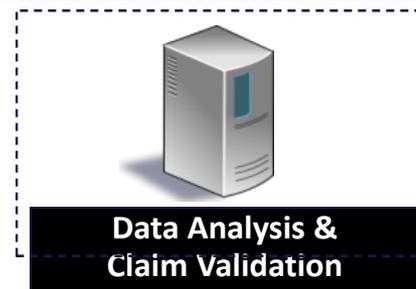
Daily MODIS Data Derives Growth Curves



RMA Data



FSA Data

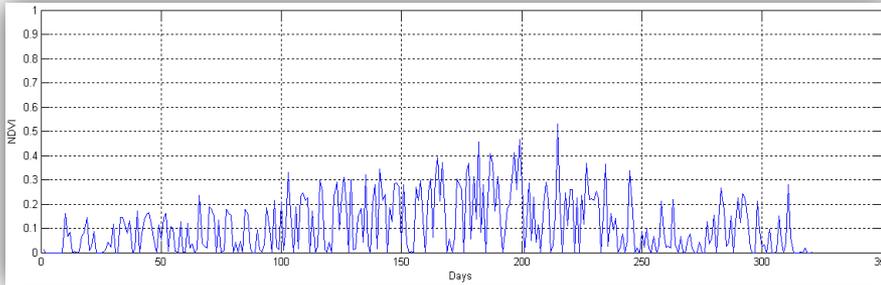


Growth Curves Linked to RMA and FSA Data are Used to Validate Producer Claim Reporting

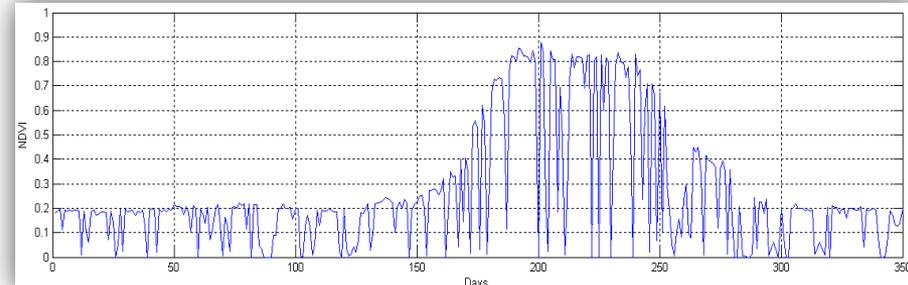
Develop Crop Profiles at Pixel Level



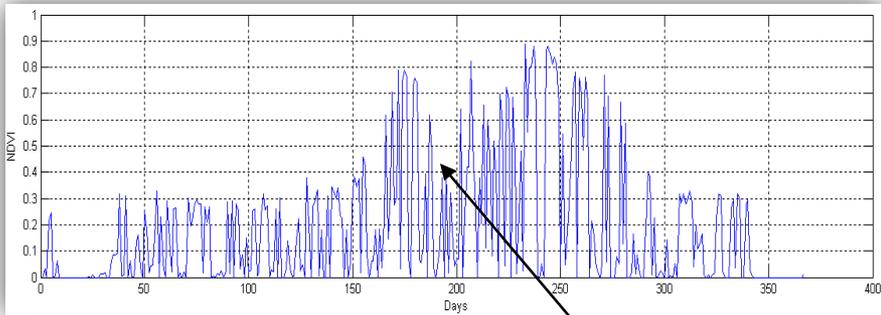
Crop Field Growth Curve Pattern



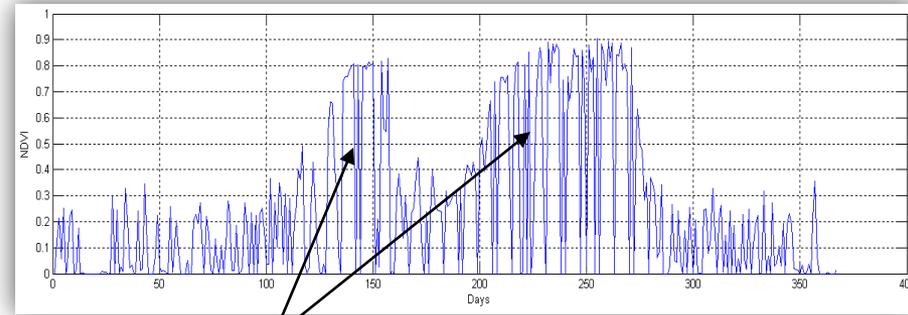
1. No Crop Growth Activity



2. Crop Growth



3. Insurance Claim (Event Indicated by Dip)



4. Consecutive Crops

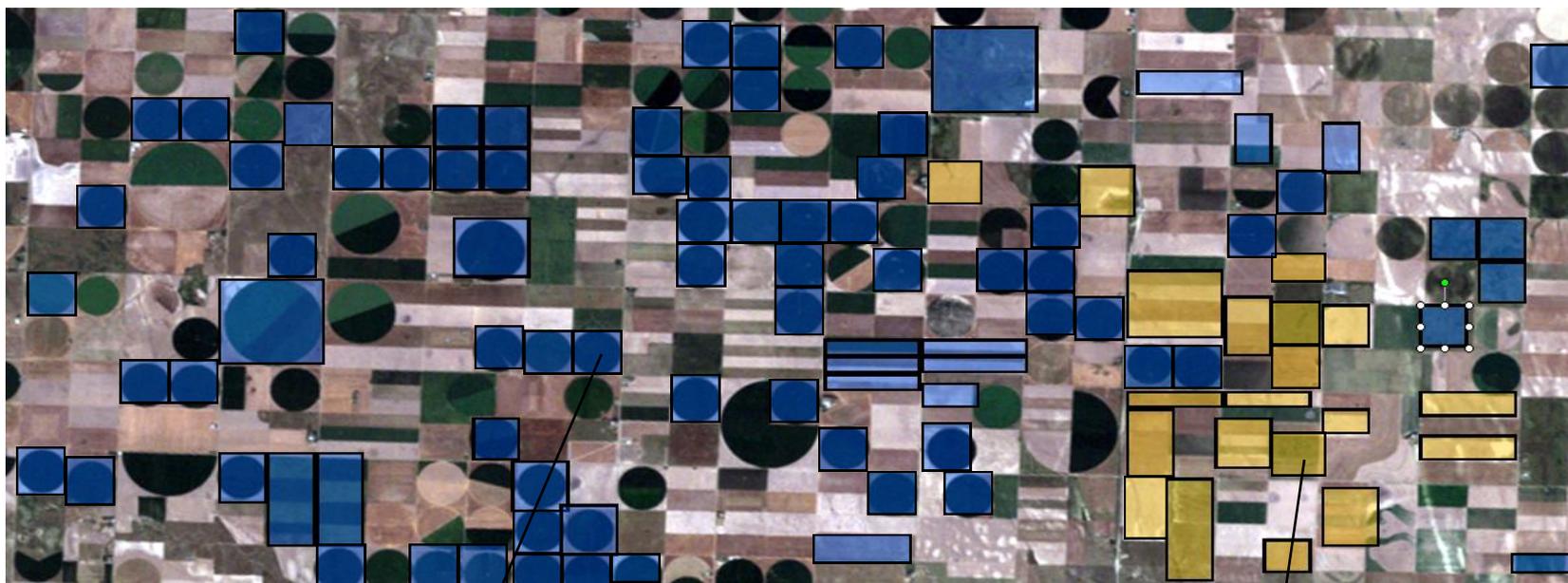
SPOT CHECK CLAIMS VALIDATION

PP CLAIMS - GROWTH CURVES

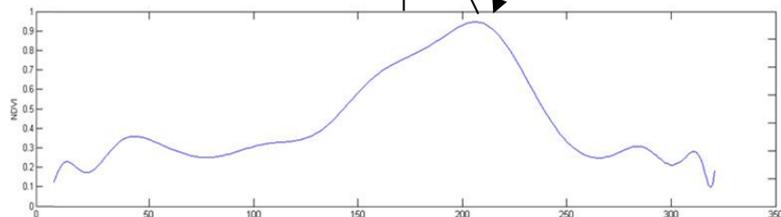


 Crop Growth Detected

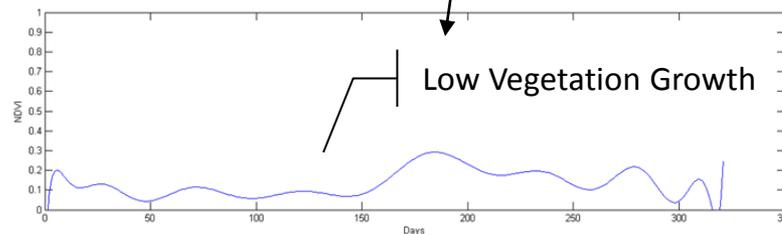
 No Crop Growth Detected



High Vegetation Growth



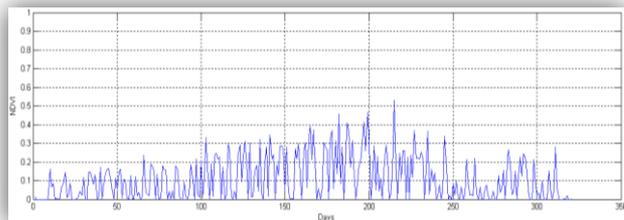
Low Vegetation Growth



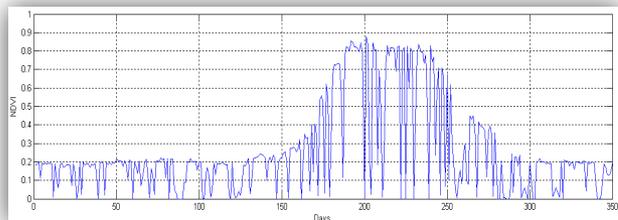
Automated Claims Analysis



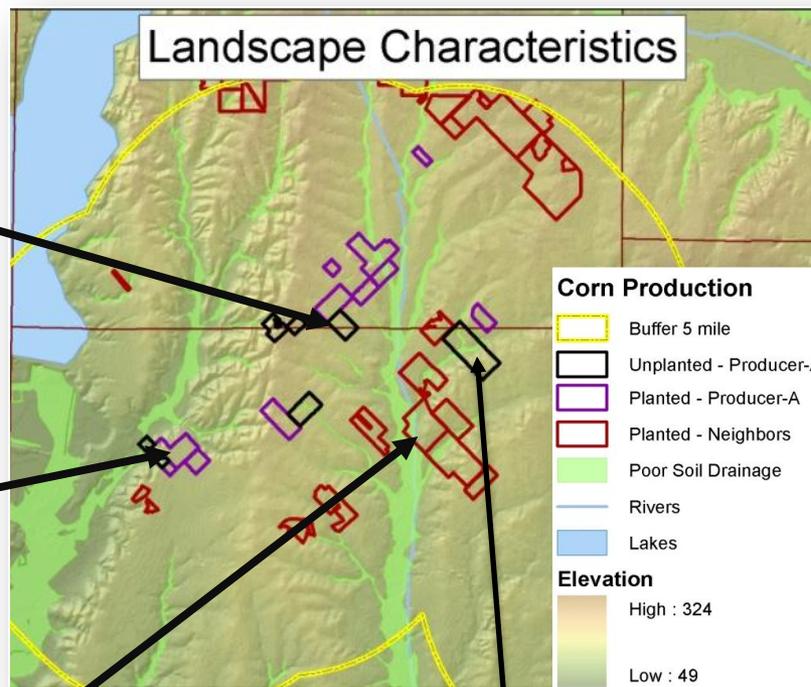
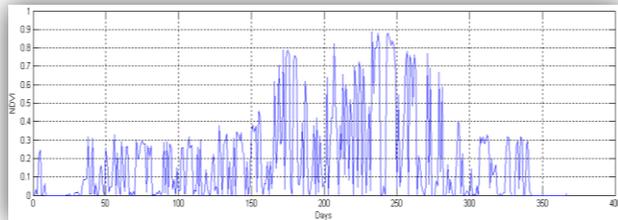
No Crop Growth



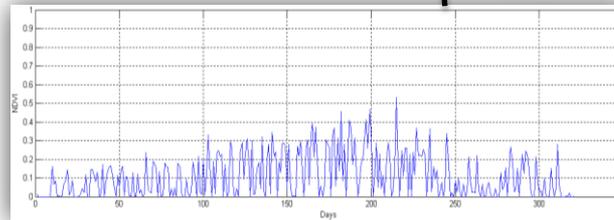
Crop Growth



Crop Growth



No Crop Growth



Spot Check Claims Validation

Hail Claims



- Hail Claims Validation Using NCDC Products
 - NEXRAD Radar Reflectivity Data
 - High Reflectivity Values Associated with Hail/Tornado or Hail Cores
 - Hail Core Data – Derived From Radar
 - Severe Hail Probability, Size, Location, Date and Time
- Hail Claims Validation Methods
 - Prevented Planting Hail Claims are Automatically Identified as Anomalous
 - Identify Distance Between High Radar Values/Hail Cores and Fields with Claims
 - Reasonable Damage Dates were Validated Over Twenty Day Windows
 - Incorrect Damage Dates were Validated for the Entire Growing Season
 - Dates Accidentally Reported Outside of Growing Season
 - Missing Measurements and Unobservable Locations are Identified and Not Used in the Validation

Spot Check Claims Validation

Hail Claims

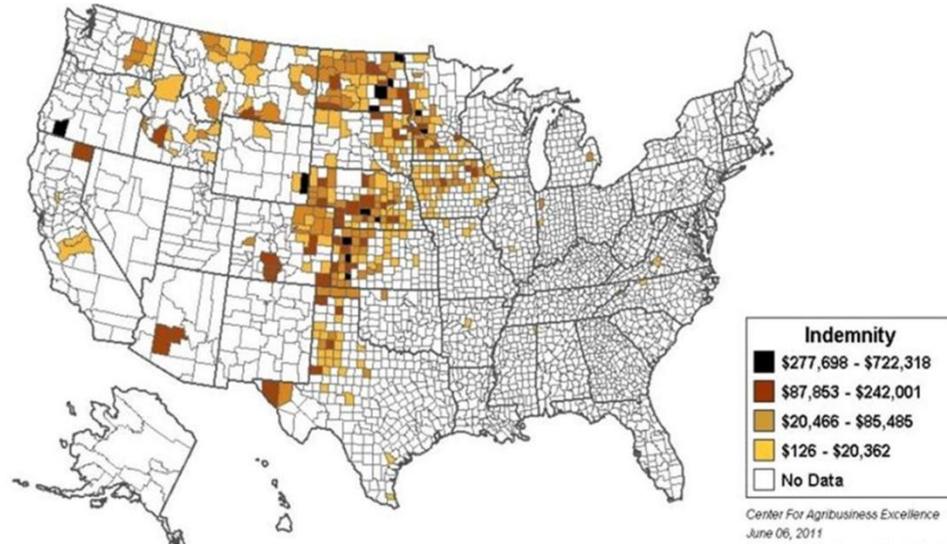
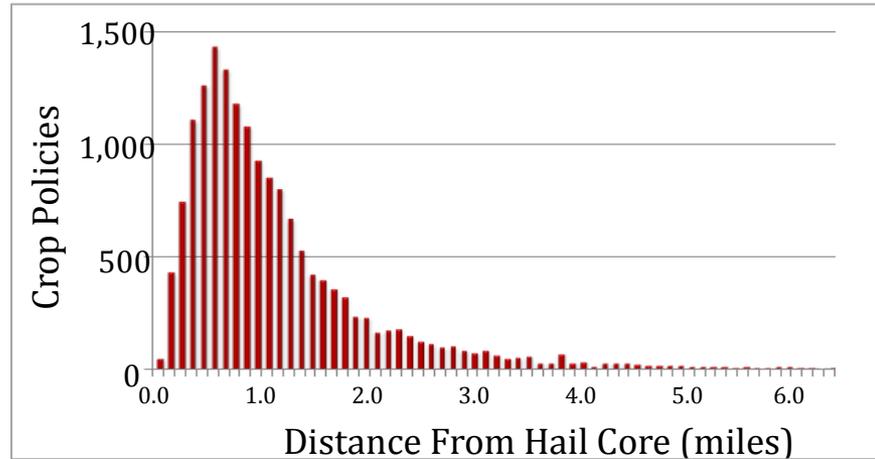


Average Hail Claims

- 0.13 Miles From a High Reflectivity Radar Value
- 1.32 Miles From the Center of the Hail Core

Anomalous Hail Claims

- 3.3 Miles or Greater From a Reflectivity Value Over 54
- 5.0 Miles or Greater From the Center of the Hail Core



Cause of Loss Validation: Hail



Results



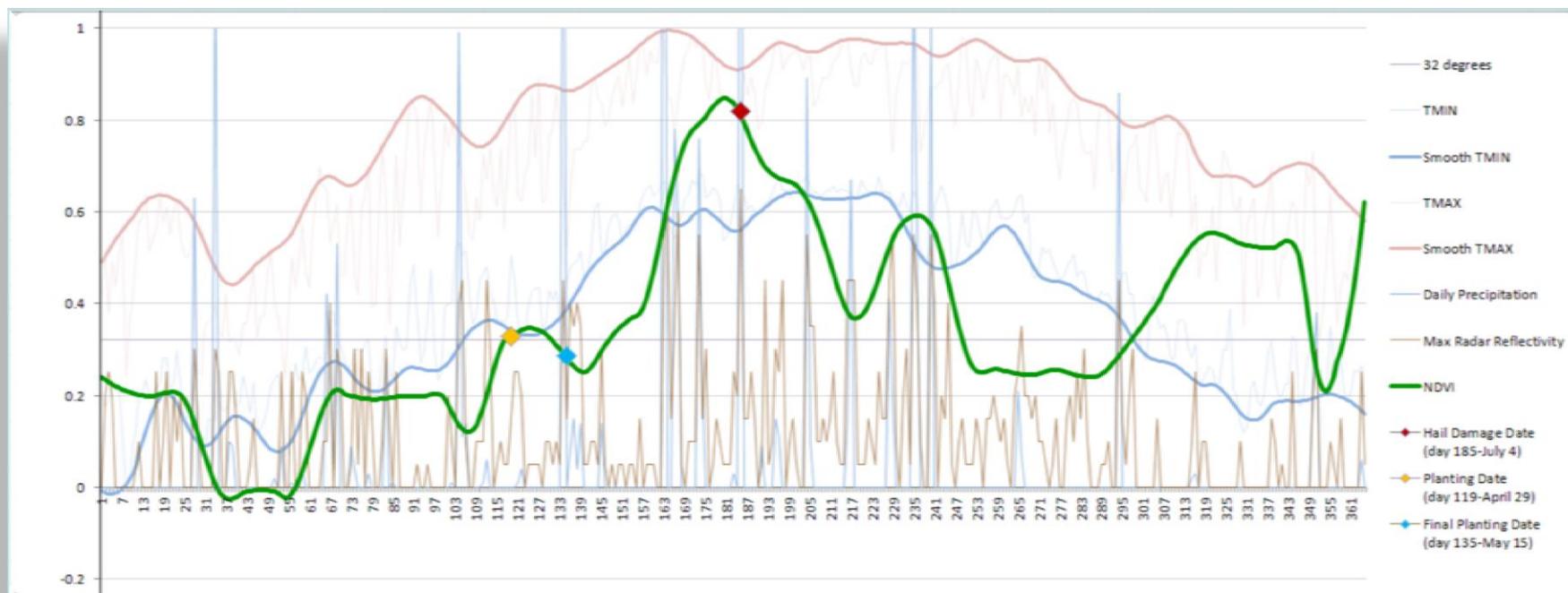
- Hail Indemnity of \$1.7 Billion was Validated in RY 2007 to 2010
- Only 0.53% of All Hail Claims Could Not be Checked (Policy Claims – 0.05% of Fields)
- 1,045 Crop Policies From 24,990 Fields Were Identified as Anomalous in RY 2007 to 2010 with a Total Anomalous Hail Indemnity of \$19,124,052

Hail Radar Status	Fields Checked For Hail RY 2007-2010	Percent of Checked Fields
Radar Validated	1,339,066	97.65%
Anomalous	24,990	1.82%
No Radar Coverage	5,656	0.41%
Radar Data Missing	909	0.07%
Bad Claim Data	721	0.05%

MODIS Growth Curve & Weather Data



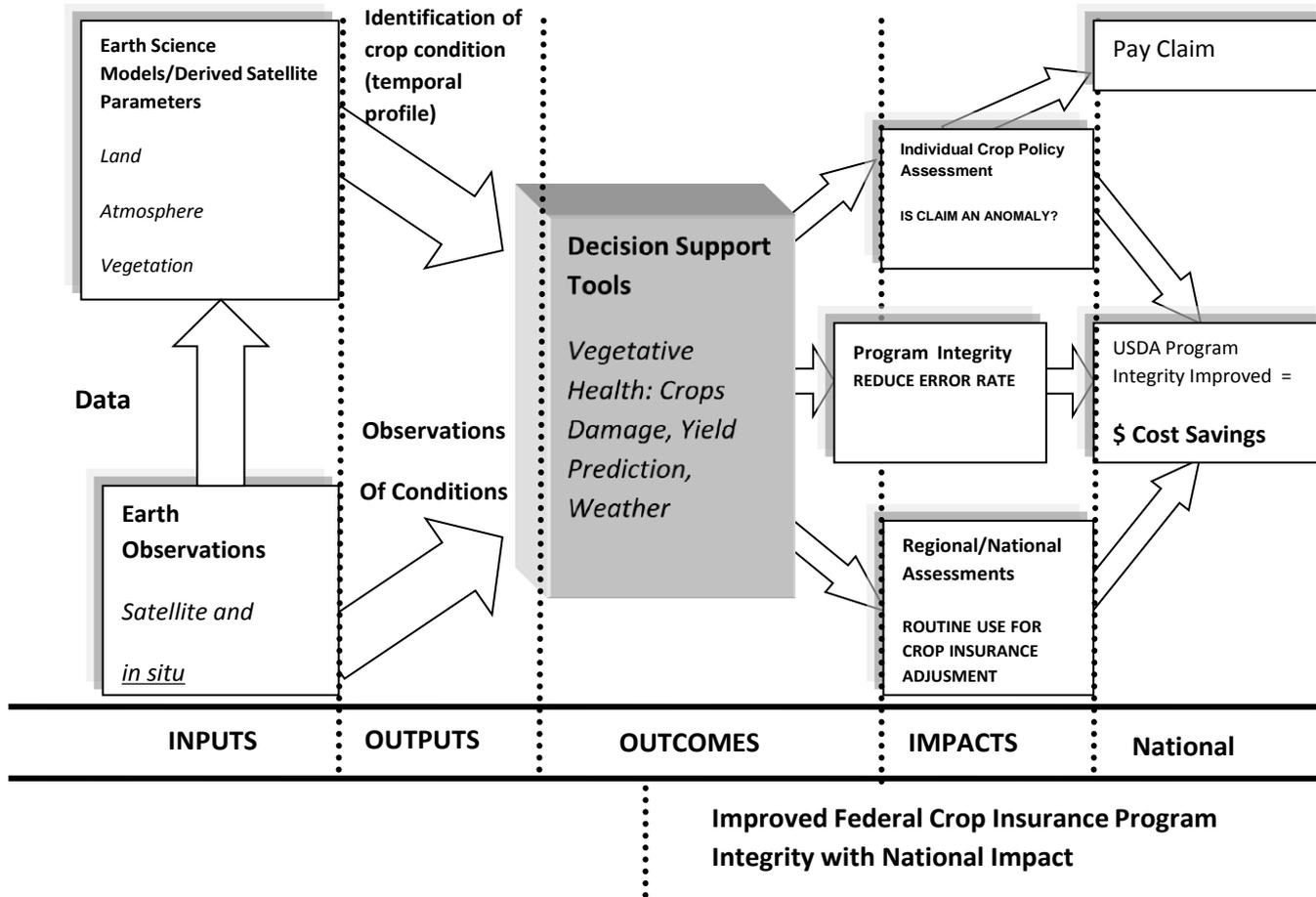
- Pixel Level Annual Growth Curve and Weather Data Graph
- Only Available for Large Fields with Multiple MODIS Grid Cells
- Weather Data and Growth Curve Aggregated to Field Level
 - NDVI, TMAX, TMIN, Daily Precipitation, Max Radar Reflectivity, and RMA Dates





Landsat Science Team Proposal Augmentation

Applications Approach to Integrated Systems Solutions Architecture





Landsat 8 Integration



- incorporate Landsat Science Products – surface reflectance, derived biophysical metrics
- build temporal profile of key satellite derived parameters at the individual field level (mean, median, variability) for each image/date



Landsat 8 Integration



- *Bioophysical Parameters.*



- crop canopy variables like leaf area index (LAI)
- chlorophyll concentration and biomass estimates
- water balance variables such as soil moisture and precipitation (non Landsat derived)
- crop canopy variables estimated through proxies (vegetation indices) and, in turn, used to estimate crop health or yield potential
- soil moisture (or at least excessive moisture in the form of saturated soil and standing water) derived from Landsat data

Landsat 8 Integration



- Issues
 - Preprocessing: Surface reflectance (LEDAPS) for L5, L7 & L8 (other sensors (SPOT 4/5, DMC?))
 - on demand, or in-house
 - Best way of handling processed data – Teradata/Oracle Spatial
 - Currently processing MODIS pixel level as vectors
 - Data volume

L5 & L7 (Measured in TB)	1 SC	1 YR	10 YRS	15 YRS	20 YRS	25 YRS
Compressed Raw Data (geotiff)	0.25 GB	4.9	49	73.5	76	100.5
Compressed SR & TOA (hdf files)	0.5 GB	9.8	98	147	152	201
Compressed SR & NDVI (text files)	1 GB	19.6	196	294	304	402
Uncompressed SR: (7 yr max. for visualization)	1 GB	19.6	137	137	137	137
Processing Space (500 jobs at once)	10 GB	5	5	5	5	5
Uncompress & Pivot NDVI (6 mon) (Final Processing for Teradata Load)	2 GB	19.6	19.6	19.6	19.6	19.6
TOTALS	15 GB	122.6	504.6	676.1	693.6	865.1

Questions?



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