From Field to Globe: The Impact of Location-Centric Big Data Across the Value Chain

Quantitative Metrics for Better Business (& food security)

John Corbett Ph.D.
The Problem

The Earth’s Atmosphere is a Heat Engine... In transition

5.5 Quadrillion Ton Heat Engine
The Problem

1°C warming of atmosphere...

Triples weather variance

Warm gets warmer. Cold gets colder. Dry gets dryer. Wet gets wetter.

5.5 Quadrillion Ton Heat Engine
The Problem

Wall Street Journal

It’s the subtle changes

- “Warmer Nights”

- Explosion of foliar diseases

- Viral, bacterial, fungal

1° of Warming: Extreme weather isn’t the worst threat!

A Finer Measure of Weather

Climatologists use measurements of temperature and precipitation to document changes in climate, such as increases in the number of unusually warm days. These “moderate extremes” occur more frequently than severe storms and are better for analyzing global trends.

Average number of days per year that the global temperature exceeded the 90th percentile


USGCRP (2009)
By 2050, our population will gain another 2.4 billion people.

Source: United Nations Dept of Economic and Social Affairs

The Problem

World Median Ages

**YOUNGEST:** 1. Niger (15.1)  2. Uganda (15.5)  3. Mali (16)  4. Malawi (16.3)  5. Zambia (16.7)

**OLDEST:** 1. Germany & Japan (46.1)  2. Italy (44.5)  3. Austria (44.3)  4. Virgin Islands (44.2)

Source: CIA Factbook

Simran Khosla/GlobalPost
By 2050, our population will gain another 2.4 billion people.

Source: United Nations Dept of Economic and Social Affairs

That means, **in just 35 growing seasons**, the world’s **580 million farmers** must feed 9.6 billion while facing:

- Increased weather variability that renders traditional practices ineffective
- Lack of adequate and symmetrical data across the value chain
- Lack of field-level, actionable insight to prevent risk and improve production

Granular data needed:
**Location and Time Specific**

...a Big Data opportunity
Agricultural value chain
agriculture VC’s cannot function in isolation

Symmetrical information across the ag value chain ensures optimization

Solution:
Information!
Agricultural value chain
agriculture VC’s cannot function in isolation

Target & Predict

Symmetrical information across the ag value chain ensures optimization

Solution: Information!
Solution: Localized Information!

Weather
Planning and pre-season - risk!
Monitor in-season

Satellite
Monitor and track

IoT - Internet of Things – sensors to monitor
Precision Ag

Models
When and Where to “do” X

Target & Predict

Cloud or ‘on-line’
24/7 access to info
Local Weather

Current Correct Consistent Complete – 4C’s
…and 100% of the time available on demand!

Weather Station Observations

Satellite Observations

Ground Radar

User Feedback

Spatial Interpolation Models

Global Forecast Models

Download to Excel or Connect by API

- Calculated weather risk,
- Model expected yield (crop/forage)
- Examine various weather stresses
- Simulate effective/adaptive management…
Spatially-coherent weather, particularly rainfall, provides tremendous insight.

Database includes:

- Intermediate Forecast (hourly and daily to 8-days, conditions)
- Daily Observed (Precipitation, temperature, humidity, windspeed, solar radiation)
- Daily Historical (Observed daily data for at least 10 years)
- Agronomic Models (Pest and Disease, Growing Degree Days)
Local Weather

Like having a complete meteorological station every 9 km

Minimum Temperature • Maximum Temperature • Precipitation • Minimum Relative Humidity

Maximum Relative Humidity • Solar Radiation • Wind Speed • Wind Direction • PET • GDD
Ag Weather

vs “Most Weather”

Most weather sources are ‘for anywhere’ & not Agriculturally focused

Ag Weather: Optimized for ag-geographies during growing seasons

- Improved accuracy and more relevant
- Statistics not “watered down” by non-relevant areas
- Utilize sensor technologies = commodity weather stations, IoT
- API’s for agronomic attributes for utilization across the ag value chain
Augment existing knowledge with real-time, current monitoring
Applications – direct calls (API) or via Excel optimized for your business

Field by field
Day by day
Week by week
Over seasons &
Over Years

Risk
Opportunity

Bond to your grower customers
Support your Agents
Give ‘Extension’ real authority!

Songea Ruvuma, Tanzania
HydroBio

Advanced Remote Sensing

Decision driving applications

On-Line (Cloud) tools: Localized and actionable…

Satellite (NDVI) soils, weather
NWave IoT LPWANs – Smart Agriculture

...sensors to observe

Smart Farming

Using NWave IoT LPWANs enable cost effective deployment of multitude of IoT sensors that measure information from any place or of anything. In order to increase the efficiency of farming.
Multi-directional data

Tailored by the grower (crop, variety, date planted…) - real-time hyper local weather and agronomic data delivered to grower, input providers, research organizations, government, buyers – through API, widgets, and applications.
Data Access

- Plant and Harvest Models
- Yield Estimates
- Weather
- Pest, Disease Models

API

Partner Apps
- Farmer SMS Service
- CRC Website
- Farmer Website
- Radio Station Website
- iPad Application

USG

aWhere

partner

???

Target & Predict
Value across agricultural value chain

...since all of this can be done for the farm & field then:

...for a more wildly changing environment

Research priorities can be better articulated
Input providers (i.e., crop protection and fertilizer) informed
Markets optimized
Spatial Characterization

The Problem

- How to dynamically query and map areas of similar weather and pest/disease characteristics globally or regionally.
- Seamlessly develop, train and translate agronomic scientific knowledge into operational systems.

The Action

- Use big data technologies to dynamically mine and query Local Weather database identify areas of similarity.
- Run R in the Hadoop environment allowing iterative development of models on large datasets, deployment across broader geographies, operational runs of models.

The Applications

- Dynamic agro-ecological zones
- Commodity analysis
- Suitability zone mapping
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### Crop Info

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### Map

- **Road**
- **Satellite**
- **Precip**
- **Temp**
- **Soy Rust**

Map shows precipitation and temperature data for different regions in California and Nevada.
Prediction: veg crop, by variety, by plant date and location

Number of acres to harvest: Plan vs. Actual

Commercial Vegetable Growers – and weather variability
For example: Central IL (Peoria!)
Number farms by county
Number acres under which crop
...input volume (crop protection, fertilizer)
...how much produced?? (tons)
with localized weather, satellite
FROM-GC: 30 m global cropland extent derived through multisource data integration
Le Yu\textsuperscript{a}, Jie Wang\textsuperscript{b}, Nicholas Clinton\textsuperscript{a}, Qinchuan Xin\textsuperscript{a}, Liheng Zhong\textsuperscript{c}, Yanlei Chen\textsuperscript{c} and Peng Gong\textsuperscript{a,b,c,*}
Global Cropland Area Database @ 30m (GCAD30)

Global: 1.53 billion Hectares of total croplands at the end of the last millennium (Thenkabail et al., 2011, 2009a, b)

Note: areas in black and white are non-croplands
Global Food Supply & Price Risk Management
What to expect in 2015?

Source: fao.org
For Spot Corn contract (above):

- (A): Carry-over stocks from 2013 into 2014 supported a constructive market.
- (B): Cold winter (remember the misused polar vortex term) contributed to market fears of a late start.
- (C) Cold spring delayed planting; resulted in continued price support.
- (D/E): THEN: US weather turned favorable & market price reaction followed. Once US crop was near harvest completion, record yields softened prices to low $3 range.
- (F) **What to expect in 2015??**
ENSO Relationships

Food Production

Extreme Events (Pakistan Floods)

Monsoon Activity
The North China Plain region had another dry month in December; the first map from MERRA below highlights the surface pressure for December—note the higher heights from Shandong through Liaoning, where growers are in need of a more active moisture pattern this year. The specific humidity map at the 850 mb level, a good proxy for surface precipitation, notes that the north/northeastern provinces are still dry, confirmed by the February 2012 Global Drought Monitor published by University College, London.

Target & Predict

Big Data + Models & Analytics

...new insight for a globally connected world

More real time
More granular
(location)
Now granular (location) and in real time…
And we know what crop, where.

Big data: the questions we can address…
Weather & Satellites

...Big data is part of the solution

Harnessing the Power of Data for Evidence-based Decisions
Location Intelligence for Agriculture

- Markets, Prices
- Research
- Environment
  - Soils, slope, etc.
- Infrastructure
- Socio-Economics
- Disease, Nutrition
- Demography
- Education
- Weather, Climate
- Surveys, Operations
1,000s of fields?  1,000s of farmers??

<table>
<thead>
<tr>
<th>Geography (Point)</th>
<th>Time (Year)</th>
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<th>Local Price (TZS/kilo)</th>
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Legend:
- **Farm 006**: Distance to Maize: 22.85 km, Local Price: 8,177.08 TZS/kilo, Short Season: None
- **Farm 007**: Distance to Maize: 3.00 km, Local Price: 2,500.00 TZS/kilo, Short Season: 4-Far too mud
- **Farm 010**: Distance to Maize: 5.00 km, Local Price: 4-Far too mud
- **Farm 011**: Distance to Maize: 4.00 km, Local Price: 4-Far too mud
- **Farm 012**: Local Price: 6,000.00 TZS/kilo, Short Season: 4-Far too mud
- **Farm 027**: Distance to Maize: 60.00 km, Local Price: 3,000.00 TZS/kilo, Short Season: 5-Far too muc
- **Farm 028**: Distance to Maize: 80.00 km, Local Price: 3,000.00 TZS/kilo, Short Season: 5-Far too muc
- **Farm 030**: Distance to Maize: 80.00 km, Local Price: 3,000.00 TZS/kilo, Short Season: 5-Far too muc
- **Farm 033**: Distance to Maize: 35.00 km, Local Price: 2-Too little
- **Farm 039**: Distance to Maize: 18.00 km, Local Price: 3-Too little
- **Farm 042**: Distance to Maize: 64.00 km, Local Price: 3-About right
- **Farm 045**: Distance to Maize: 60.00 km, Local Price: 2,000.00 TZS/kilo
- **Farm 048**: Distance to Maize: 3.00 km, Local Price: 6-No too little
- **Farm 051**: Distance to Maize: 10.00 km, Local Price: 2,000.00 TZS/kilo
- **Farm 057**: Distance to Maize: 0.00 km, Local Price: 3,000.00 TZS/kilo
- **Farm 062**: Distance to Maize: 10.00 km, Local Price: 2,000.00 TZS/kilo
- **Farm 066**: Distance to Maize: 29.00 km, Local Price: 2-Too little
- **Farm 067**: Distance to Maize: 3.00 km, Local Price: 4-Too little
- **Farm 068**: Distance to Maize: 4.00 km, Local Price: 4-Too little
- **Farm 071**: Distance to Maize: 10.00 km, Local Price: 2,500.00 TZS/kilo
- **Farm 074**: Distance to Maize: 0.00 km, Local Price: 1,500.00 TZS/kilo
- **Farm 076**: Distance to Maize: 29.00 km, Local Price: 3-About right
- **Farm 080**: Distance to Maize: 80.00 km, Local Price: 3-About right
- **Farm 090**: Distance to Maize: 7.00 km, Local Price: 3-Too little
Dynamic aggregation... Decision driving
Location Intelligent Platform

High-resolution Weather Data
Crop Specific Satellite Data
Census, survey, public/private

Data Collection

Dashboards

Data Library

Data Manager

Analysis

Weather

Smart Content Recommendations & Alerts

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Big Data - Business Model

Technology & Data Platform

- SaaS-based Location Intelligence – **BI for Agriculture**
- Real-time, hyper-local agro-meteorological modeling – generate agile content
- Bi-directional content flow – Last Mile Integration

EVERY **farmer** reachable direct or channels – **partners**!

- Big data – terabytes of high resolution weather and other key data – growing everyday

Domain Knowledge

- Agriculture
- Agri-business
- Food security / commodities

**Symmetrical Information across the Ag Value Chain**
Weather & Satellite data are big data: Farm and model data too…

Billions of new data points every day
for real-time, hyper-local information

Information for
Weather agile agriculture™
...wherever ag-information is needed
Help Farmers Feed the World

Current Correct Consistent Complete – 4C’s
…and 100% of the time available on demand!
Current, Correct, Consistent, Complete

Each of 8 agro-met variables, EVERY day
…a virtual weather station every ~9x9km – GLOBALLY

Access via API, ftp push, or various aps

We have your agriculture area covered!
…in real time: observed and 8 days of forecast

Contact: weather@awhere.com
aWhere tailors our weather accuracy assessments by agro-eco types (spatial) – and season (temporal).

Unabashedly agricultural – and growing season - focused
Agricultural Service: utilization of weather data

**Questions:**

- Understand the influence of weather:
  - Simulation: How does weather influence weed/crop competition?
  - Statistical analysis: What is the ROI for each kg of N applied?
- Where to invest (and invest in what?):
  - Yield maps / Yield gap
- Predict the impact of changing weather patterns on distribution of crop pests

**Decision models – farmers and advisors:**

- Recent weather:
  - Which field is most at risk for pest impact?
- Historical weather:
  - What crops to grow given the uncertainty of precipitation?
- Short-term forecast:
  - Should I apply insecticide? N? When is optimal harvest?
  - Will it rain tomorrow afternoon? Morning after tomorrow?
Agricultural Service: utilization of weather data

Maize

When to plant?
Add N? How much?
Field work – rains in forecast?
Growth stage and ROI (pests)

Connect with your growers
Inform your R&D
Expand your extension…
Our Background

- Agricultural intelligence business since 1999
- Cloud-based big data and analytics for agriculture
  - Analytics platform for global development
  - Big Data for agriculture - large farmers & small holder farmers
- Long-term customers and growing

Offices in: USA, Kenya, Malaysia
Our Expertise

- John Corbett, Ph.D
  - CEO, Agricultural Climatologist, U of MN

- Michael Ferrari, Ph.D
  - Sr. Climate Scientist, Rutgers U

- Lori Wiles, Ph.D
  - Crop Science, North Carolina State U

- Stewart Collis
  - CTO, Modeling, U of New South Wales

- Jim Pollock
  - VP, Product Strategy, MIT

- Dave Lundberg
  - EVP, Agricultural Business, Iowa State U

- John L’Heureux
  - Meteorologist, North Carolina State U

- Michael Cullen, Ph.D
  - Agricultural Economics, Oxford U

- Plus more than 30 other professionals and growing…
Product Lines

**Dev aWhere**
- SaaS Data Mgmt
- Large Scale Ag Projects
- Surveys, Science, Adoption

**Weather aWhere**
- **WeatherTerrain™**
  - Forecast, Observed, Historical
- **WeatherAgronomics™**
  - Derived Models, Crop/Pest/Disease
- **WeatherKit™**
  - API’s, Widgets for App Development

**Grow aWhere**
- Multi-field Monitoring
- Yield Curve Management
- Harvest Date

**Intel aWhere**
- Food Security
  - Regional / National
- Commodity Tracking
  - By Crop
  - By Geography