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THE FUTURE OF COMMODITIES™

Carbon Farm Economics

Course Outcomes

In this course, you will learn more about:

1. Carbon program and market basics
2. Economic feasibility of soil carbon sequestration
3. How soil and practices impacts sequestration rates
4. Industrial hemp's effect on carbon sequestration and program feasibility

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What are Carbon Credits?

- Statement certifying that 1 metric ton of CO_2 or equivalent has been offset from the atmosphere.
  - Offsets = “removals”, “reductions” or “replacements”

- How can agriculture **remove** atmospheric carbon?
  - Soil Organic Carbon, Carbon within plant matter

- How can agriculture **reduce** carbon emissions?
  - Combustion Improvement, Nutrient management

- How can agriculture **replace** carbon emissions?
  - Substitutes for fossil fuel derived materials

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Defining a Carbon Credit

- Carbon credits are measured in terms of CO_2 , **not** elemental carbon.

- Plants photosynthesize CO_2 and H_2O into organic matter (leaves, stems, roots), which manifests as soil organic carbon through natural processes.

- The change of soil organic carbon (in terms of MT CO2) during the program life determine earned credits.

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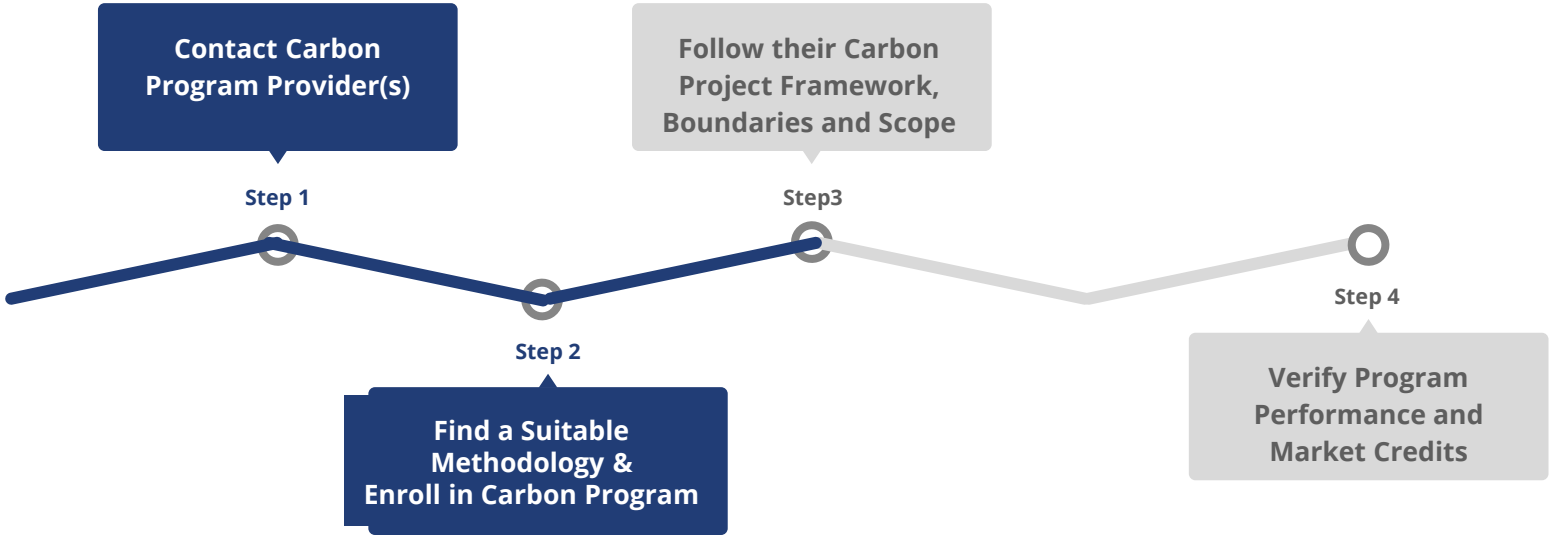
Carbon Project Roadmap



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The Carbon Project Framework

Project Design Document	Validate Project	Start Your Project	Verify Your Project	Register & Sell
Prepare a document that describes:	**Approved validator checks project eligibility.**	**Implement your project and begin monitoring.**	**Approved auditor verifies data to promote integrity.**	
Project Design/Scope	Program Rules	Start Any Time	Check / Sample Inputs	
Methodology Used	Add to Database	Risk of Rejection		
Economic Feasibility	No “Double Counting”	Pre-Issue Credits (Optional)		
Stakeholder Relations				

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Methodology: Carbon Project Rules

1. DEFINE YOUR BASELINE
2. "ADDITIONALITY" - MEANINGFUL CHANGE FROM THE BASELINE
3. PERMANENCE / NO "REVERSALS"
4. CONSERVATIVENESS
5. NO DOUBLE COUNTING

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Analysis: Economic feasibility

- Goal: *Generate a farm-level cost/benefit analysis that allows producers to determine their own feasibility.*

- Key Monetary Components
  - Program setup and maintenance
  - Short-term production impacts
  - Crop and CO2 revenue impacts
- Major Assumptions
  - Price $/MTCO2: $40/MTCO2 Year 1 and increasing by $5/MTCO2 through year 5
  - Maximum costs for program setup and maintenance
  - 12.5% of the total estimated credits are issued annually years 1-4.
  - Remaining ~50% of credits are issued after verification in year 5.
  - Breakeven hemp crop revenue

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Case Study - Average Farm

- State (MT) average sequestration performance
- Average yield performance and practice impacts
- 2021 EOY crop prices
- Crop Rotations (1200 acres):
  - 100% small grains (wheat, barley, oats, millet)
  - 80% small grains & 20% Hemp

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Carbon Credit Case Study- Practices

Practice	Description	Min (MTCo2/acre)*	Max (MTCo2/acre)*	Notes
No-Till	Converting to no-till from intensive or reduced tillage	0.12	0.77	Intensive till to no-till captures the most carbon. No-till best suited for semi-arid climates and soils with lower compaction concerns. Legumes and oilseeds observe negligible yield impact on average. Corn and other cereals observe biggest yield impact in humid climates.
Cover Crops	Establishing cover crops on otherwise fallow land	0.02	0.47	Legumes tend to sequester more Co2 on average.
Conservation Crop Rotation	Crop rotation to enhance conservation. Reducing fallow and repeat rotation occurrence.	0.22	0.26	Reduction of fallow land is imperative. Introducing biomass crops into rotations is not within this calculation and could greatly increase performance.
Nutrient Management	Reducing inorganic fertilizer inputs or replacing with organic forms (manure/compost)	-0.02	0.50	Replacing with manure/compost is most effective for carbon. Well drained loess soils appears well suited for use. Crop performance may be affected depending on implementation/environment.
Mulching	Incorporating a form of mulch into soil	0.32	0.32	Result range for mulching does not include biochar.

**Min & Max Co2/Acre was sourced from USDA/COMET*

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Cost/Benefit of PanXchange Carbon Program Implementation: Traditional Farm

Performance	Variable	Year 1	year2	year 3	year 4	year 5
Minimum	Total Revenue Impact at End of Year(Not Till)	$ (63,598.00)	$ (76,729.00)	$ (92,600.00)	$ (108,471.00)	$ (120,321.00)
	Total Revenue Impact at End of Year(NT+CR)	$ (55,248.00)	$ (60,028.00)	$ (67,549.00)	$ (75,070.00)	$ (53,519.00)
	Total Revenue Impact at End of Year(NT+CR+NM)	$ (57,099.00)	$ (63,731.00)	$ (73,103.00)	$ (82,476.00)	$ (68,330.00)
	Total Revenue Impact at End of Year(NT+CR+NM+M)	$ (49,386.88)	$ (48,305.75)	$ (49,965.67)	$ (51,625.59)	$ (6,630.06)
Average	Total Revenue Impact at End of Year(Not Till)	$ (57,789)	$ (65,110)	$ (75,172)	$ (85,235)	$ (73,848)
	Total Revenue Impact at End of Year(NT+CR)	$ (48,139)	$ (45,810)	$ (46,223)	$ (46,635)	**$ 3,351**
	Total Revenue Impact at End of Year(NT+CR+NM)	$ (45,106)	$ (39,745)	$ (37,124)	$ (34,504)	**$ 27,614**
	Total Revenue Impact at End of Year(NT+CR+NM+M)	$ (36,686)	$ (22,904)	$ (11,864)	$ (823)	**$ 94,975**
Maximum	Total Revenue Impact at End of Year(Not Till)	$ (39,385.00)	$ (28,302.00)	$ (19,961.00)	$ (11,619.00)	**$ 73,384.00**
	Total Revenue Impact at End of Year(NT+CR)	$ (29,486.00)	**$ (8,505.00)**	**$ 9,736.00**	**$ 27,976.00**	**$ 152,574.00**
	Total Revenue Impact at End of Year(NT+CR+NM)	$ (10,815.00)	**$ 28,839.00**	**$ 65,751.00**	**$ 102,663.00**	**$ 301,947.00**
	Total Revenue Impact at End of Year(NT+CR+NM+M)	**$ 1,300.70**	**$ 53,069.39**	**$ 102,097.05**	**$ 151,124.70**	**$ 398,870.52**

Cost/Benefit of PanXchange Carbon Program Implementation: Hemp Comparison

Performance	Variable	Year 1	year2	year 3	year 4	year 5
Average	Total Revenue Impact at End of Year(Not Till)	$ (57,789.00)	$ (65,110.00)	$ (75,172.00)	$ (85,235.00)	$ (73,848.00)
	Total Revenue Impact at End of Year(NT+CR)	$ (48,139.00)	$ (45,810.00)	$ (46,223.00)	$ (46,635.00)	$ 3,351.00
	Total Revenue Impact at End of Year(NT+CR+NM)	$ (45,106.00)	$ (39,745.00)	$ (37,124.00)	$ (34,504.00)	$ 27,614.00
	Total Revenue Impact at End of Year(NT+CR+NM+M)	$ (36,686.23)	$ (22,904.46)	$ (11,863.74)	$ (823.01)	$ 94,975.10
Average + Hemp_Soil	Total Revenue Impact at End of Year(Not Till)	$ (18,278)	**$ 13,912**	**$ 46,102**	**$ 78,292**	**$ 176,456**
	Total Revenue Impact at End of Year(NT+CR)	$ (9,875)	**$ 30,719**	**$ 71,312**	**$ 111,906**	**$ 243,683**
	Total Revenue Impact at End of Year(NT+CR+NM)	$ (2,048)	**$ 46,372**	**$ 94,792**	**$ 143,212**	**$ 306,295**
	Total Revenue Impact at End of Year(NT+CR+NM+M)	**$ 9,112**	**$ 68,693**	**$ 128,273**	**$ 187,854**	**$ 395,580**
Average + Hemp_ALL	Total Revenue Impact at End of Year(Not Till)	$ (1,642.00)	**$ 47,183.00**	**$ 96,009.00**	**$ 144,834.00**	**$ 309,540.00**
	Total Revenue Impact at End of Year(NT+CR)	**$ 6,761.00**	**$ 63,990.00**	**$ 121,219.00**	**$ 178,448.00**	**$ 376,767.00**
	Total Revenue Impact at End of Year(NT+CR+NM)	**$ 14,587.00**	**$ 79,643.00**	**$ 144,698.00**	**$ 209,754.00**	**$ 439,379.00**
	Total Revenue Impact at End of Year(NT+CR+NM+M)	**$ 25,748.00**	**$ 101,964.00**	**$ 178,180.00**	**$ 254,396.00**	**$ 528,664.00**

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Case Study - Conclusions

- Carbon credits are profitable for many operations, and can successfully subsidize the transition to regenerative practices in most operations.
- Education and execution is imperative for a successful project.
- Understand your soil and its potential to sequester carbon.
- At scale, carbon credits act as a subsidy for all many aspects of sustainable agriculture.
- Rotating hemp fiber and other sustainable crop varieties are effective for carbon and agronomic management.
- Carbon from applications of plant material increases earned credits, and are dependant on points of sale and yield.

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Contact Information

For additional business inquiries and/or to request consulting services, please contact:

carbon@panxchange.com

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Arva Intelligence

Bridging Agronomics with Carbon through AI

Problems

Supply

Agriculture offers the largest and most cost effective source of nature based carbon offsets but is limited by the industry's disconnected digital infrastructure

Demand

Corporate net zero pledges require a cost effective path to achieve aggressive carbon reduction targets

Solution

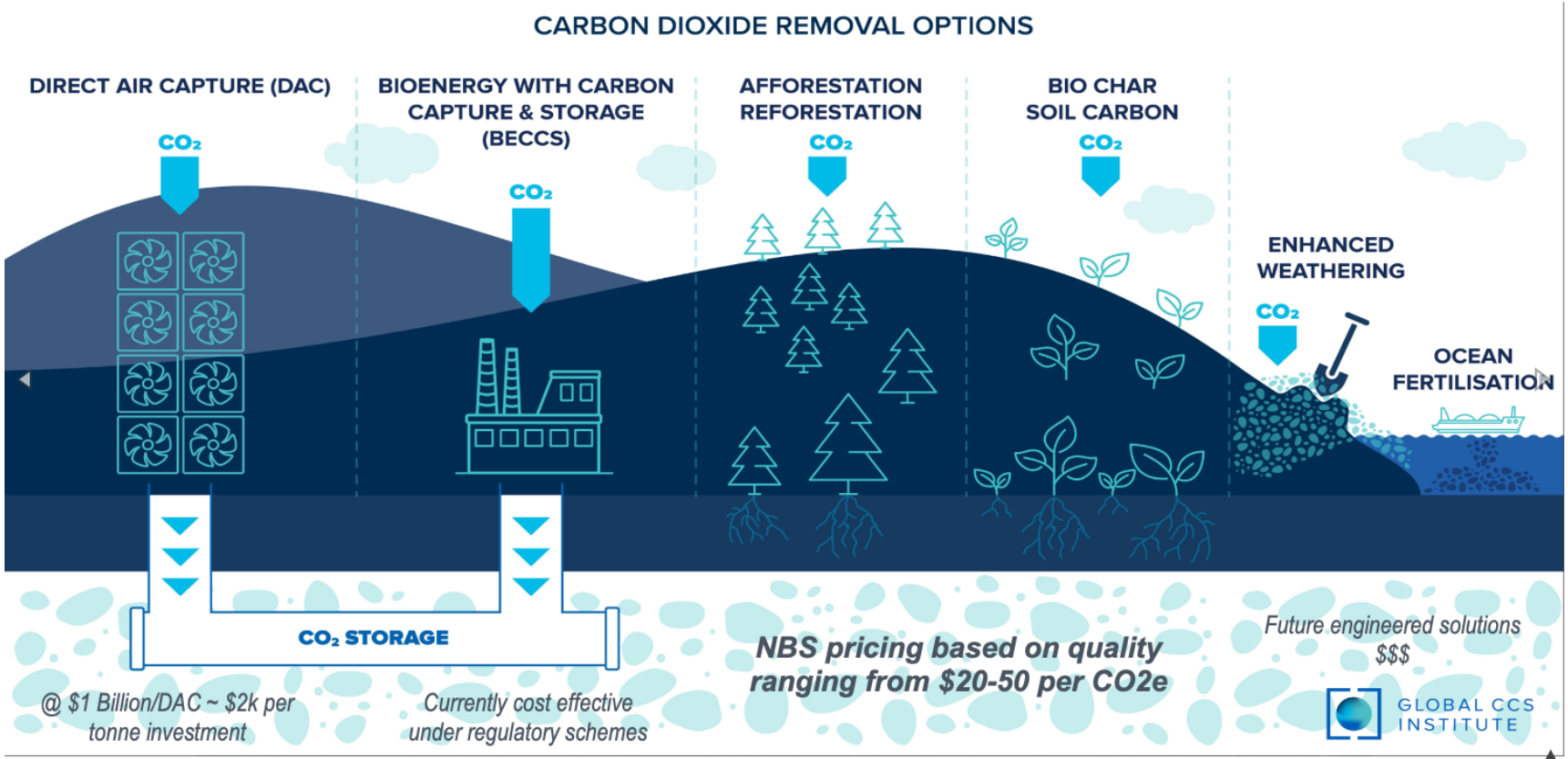
Arva seamlessly connects agriculture to carbon and environmental offset buyers by harnessing big data and AI to meet sustainability pledges, enhance agronomic decisions and improve grower profits.

Ag Producers

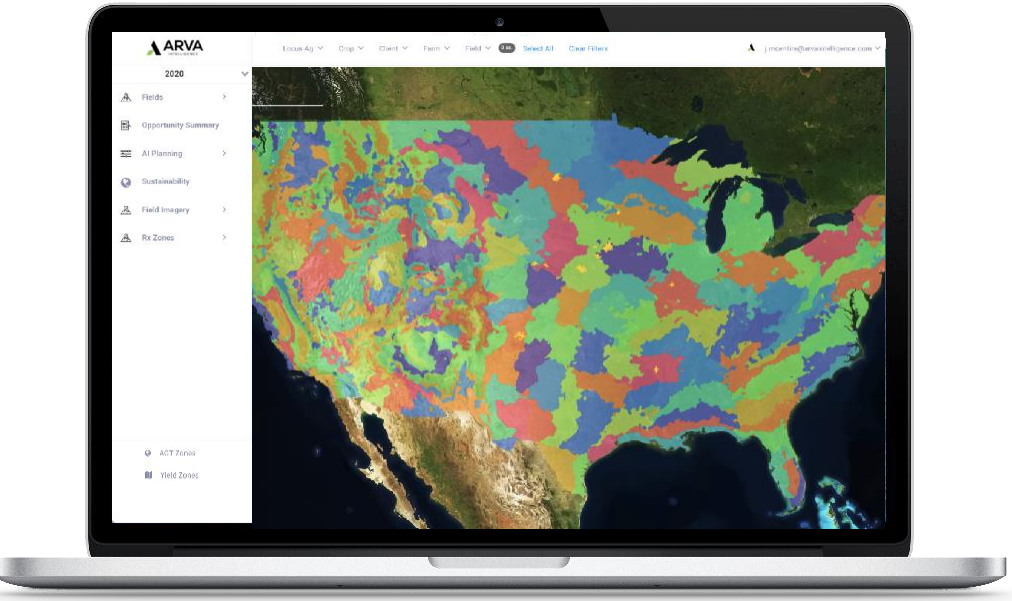
Bridging carbon supply with demand

Corporate Offset Buyers

Cost of Net-Zero



Agronomic focused



The 1st earth modeled, data driven nature based carbon offset program leveraging agronomics to optimize the carbon intensity of yield producing high quality environmental offset credits.

Predictive analytics

Agronomic life cycle and carbon accounting to optimize ROI

CropForce™

The Most Comprehensive Geospatial Dataset & AI Platform

Seed Selector

Match hybrids to environment reducing risk and improving performance

Fertilizer Optimization

Optimize fertility by crop by environment - Arva Ground Types

Harvest Analytics

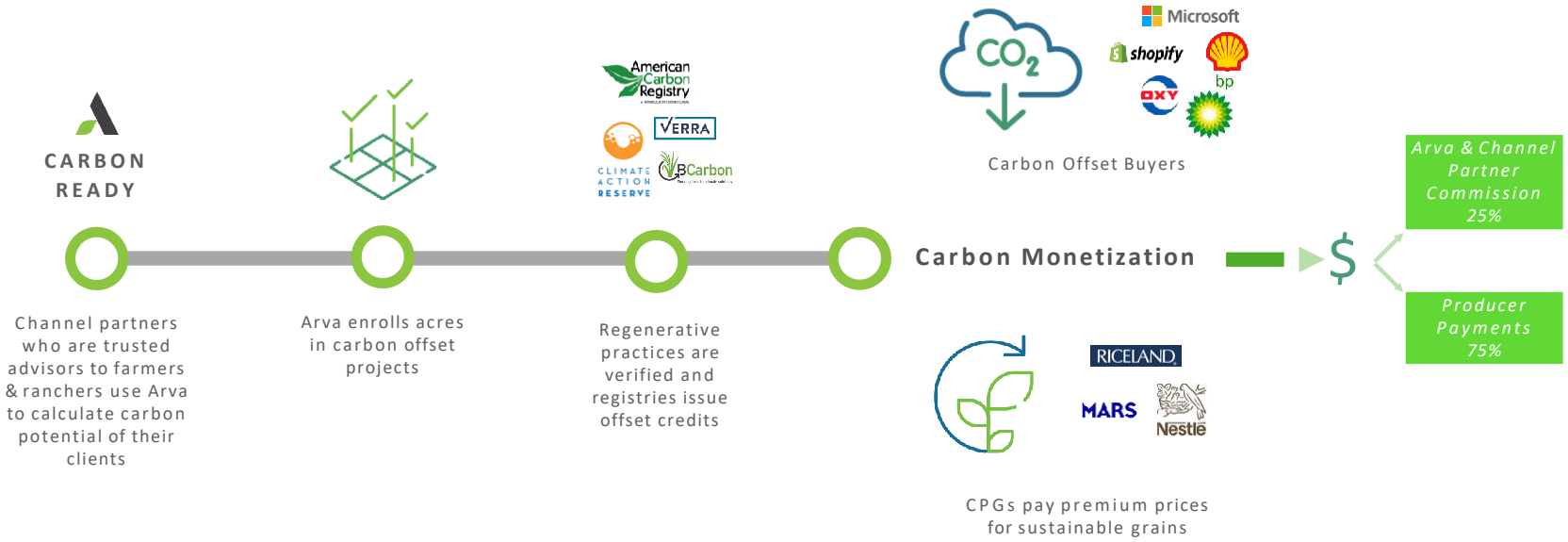
Automated field and farm-level performance analytics

Carbon Accounting

Measurement, reporting & verification (“**MRV**”) for carbon markets and CPGs

The journey to carbon monetization

Working with channel partners accelerates pathway to carbon



Arva is the only truly integrated carbon & agronomic solution

Competitive landscape

Company	Independent & Unbiased	Channel Partnerships	Platform for Carbon	Platform for Agronomy	Climate Science Driven		Carbon Registries
ARVA	✗	✗	✗	✗	✓	3	
Indigo	✗	✗	−	✗	✗	2	
ESMC	✗	✗	−	✗	✗	1	
Farmers Edge	✗	−	−	✓	−	1	✗
Rabobank	✗	−	−	✗	✗	1	✗

*Source Congressional Research Agency "Agriculture and Forestry Offsets in Carbon Markets: Background and Selected Issues November 3, 2021 https://crsreports.congress.gov

R&D to future proof our environmental assets

- Contractor to DOE Advanced Research Project Agency-Energy
- Collaborating with 3 US National Labs
- Partnering with international geoscience company to explore subsurface influence in soil carbon stores
- Global soil stratification and uncertainty quantification for targeted soil sampling
- Patents Filed in scalable predictive analytics

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CHANGING WHAT'S POSSIBLE

Highly qualified leadership team

Cross functional team with track record of success.

Commercial

Jay McEntire
CEO & CoFounder
Former Fintech software CEO, bank CFO, & energy exec. Manager of Glennoe Farmland Partners. Successful Exits.

Matt Rohlik
Head of Sales
15 years of Precision Ag Management Experience, Nat'l Sales Director of 2 Ag Tech Start Ups, Farmer and Rancher.

Bret Kadison
CFO / COO
Former tech & finance CFO / COO and served as Financial Market Development Lead at DOE and Policy Advisor Export-Import Bank.

Audrey Barrett Bixler
Director of Carbon Markets
Former Energy Security & Sustainability Analyst for DoD. Speech writer for the Army Secretariat. MS & MPH from UC Berkeley.

Technology & Science

Ben Brown, PhD
Chief ML Architect & CoFounder
Machine Learning Lead & Head of Molecular Ecosystems at Lawrence Berkley National Lab.

Tom Dye
Chief Technology Officer
CEO / CTO / Co Founder of multiple tech firms with IPOs & acquisitive exits. Inventor of 55 patents for system architecture.

Chris Fedor
Product Lead, Geospatial Engineering
Interdisciplinary environmental science and engineering. B.S./M.S. Stanford. Employee #1 Mavrx (acquired by Taranis) and Frontier Farmland (acquired by FBN).

Lacey Pyle, PhD
Director of Soil Science
Soil scientist / data scientist with PhD from Rice University; previously worked with Shell Technology Center.

Key Advisors

Mark Isbell
Board Member & CoFounder
4th Generation Rice Farmer. First carbon trade in Ag with Microsoft. Board Member Field to Market & USE Rice.

Charles Tate
Chairman of the Board
Former Partner at Hicks, Muse, Tate & Furst and ex-Investment Banker; Energy & financial sector leader

Michael Schuppenhauer, PHD
Carbon & GHG Research Research Scientist with Lawrence Berkley Lab. Former McKinsey Consultant

Daniel Jacobson, PhD
Biological & Environmental Systems Science Directorate
Expert in systems biology at Oak Ridge National Lab. Gordan Bell Prize winner, 2018.

Join Us!

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