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# Forestation: A Greenhouse Opportunity?

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# Outline

1. Forestation Need
2. Seedling Sector Profile
3. Value Chain
4. CEA Seedling Rearing
5. Carbon Markets
   - Projected growth
   - Pricing
   - Forestry project overview
   - Forest carbon project developers
6. Key Conclusions
7. Appendix: Carbon Market Definitions



# Forestation Need

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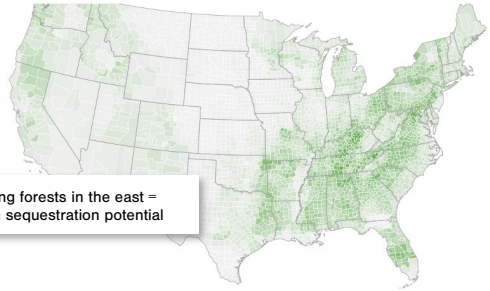
- **A 146-million-acre opportunity exists in the US to restore forest cover for climate mitigation; however, practical, financial, and legal constraints significantly limit feasibility**
- Foresting this entire area with 75 billion trees could capture 372 million metric tonnes (MT) of $CO_2$ per year, equivalent to removing 80 million cars from the road
- Other benefits to forestation include biodiversity, erosion control, air filtering, freshwater supply, habitat linking, ai

- Tree nurseries currently produce 1.3 billion seedlings per year, seemingly indicating enormous potential to increase production*
- In the west, addressing wildfire-generated needs is complicated by:
    - Topography and accessibility; only 10 to 20 percent of burned areas can be replanted
    - Difficulty aligning demand to a supply of seedlings that require two years of rearing
    - High costs and value chain bottlenecks, e.g., seed and labor availability; *"The biggest challenge is getting trees in the ground" – Ben Parkhurst, Anew*
    - Government mandates and the likelihood of post-fire regeneration that limits the additional value associated with, and credited to, reforestation efforts

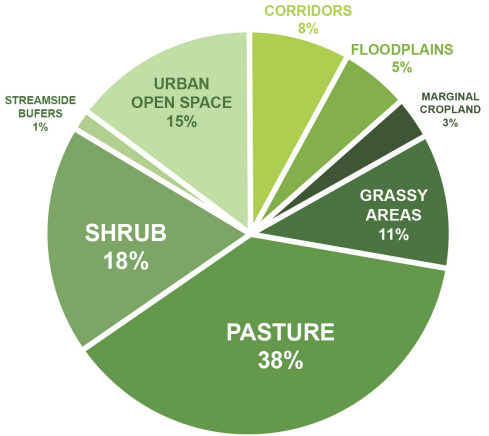
- The east does not have as obvious a gap in seedling capacity and mixed perceptions of forestation in this g resulted from planting-driven oversupply in the timber markets



REFORESTATION OPPORTUNITY



Faster-growing forests in the east = more carbon sequestration potential




*For reforestation and conservation projects only; does not include production for the forestry sector (2019)*

Source: Reforestation Hub; "Developing and Supporting Quality Nursery Facilities"; Forest Nursery Seedling Production in the US"; American Forests; EQ industry interviews

# Seedling Sector Profile



- A lack of seeds, particularly climate-adapted ones, is a significant pain point in the west and within the underfunded public sector
- Forest Service nurseries play an important role in supporting the seed supply, R&D, and non-monetizable forestation benefits; however, their numbers have declined from 15 to five since 2005 4
- Most large forestry companies and private nurseries have their own seed orchards, which are often considered their most valuable assets
- North America's largest private nursery players include PRT Growing Services (acquired in 2021 by InstarAGF), IFCO Seedlings, ArborGen, and Weyerhaeuser; the bulk of seedlings go to large-scale forestation of timberlands following harvests by private landowners
    - *"Nurseries that produce seedlings for profitable commodities... often have more investment into infrastructure, supplies, and training... than do nurseries that produce plants for restoration purposes" – Diane Haase, US Forest Service*
- The commercial timber industry is well-supplied though customers are increasingly willing to pay more for genetically-improved seeds and seedlings, i.e., those engineered for growth, insect/disease resistance, stem form, and biomass

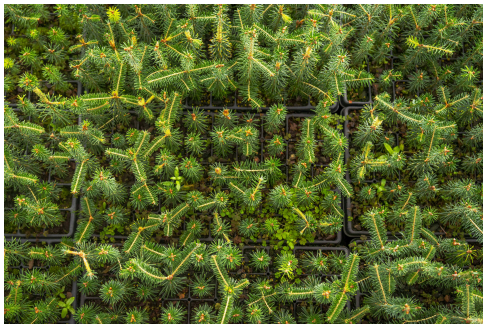


PHOTO CREDIT: LUCIANE COLETTI/AMERICAN FORESTS

**Seeding production is less of a constraint and cost than seeds, labor, and outplanting**

Source: EQ industry interviews

# Seedling Sector Profile (cont'd)

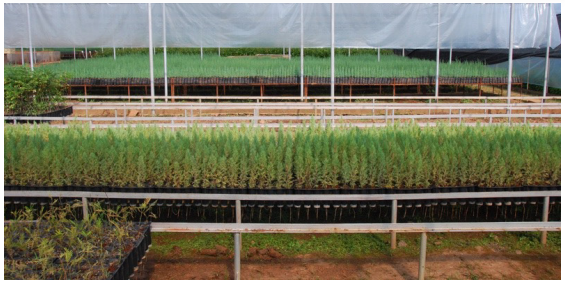


- ArborGen's business model is predicated on a differentiated product, i.e., genetically improved seedlings, whereas PRT relies on a commodity manufacturing one is better suited to the west, where slow-growing trees make it difficult to get a return on research investments 5

- It is important to note that seedling production constitutes less than one-fifth of forestation costs, with the bulk is associated with outplanting
- Labor represents a major bottleneck and automated planting technology does not yet exist
    - Early-stage aerial seeding efforts, while promising, result in relatively low establishment rates. Practitioners report that many projects can still achieve more cost-effective results with hand planting, particularly in seed-constrained areas
- Despite the obvious forestation need, few profitable entry points for new players exist in the traditional seedling market
- The emergence of carbon markets is generating interest in the possibility of credit-driven returns; the next section explores carbon pricing and the likelihood of additional revenue streams attracting private capital to forestation projects

**Seedling Nursery Players**

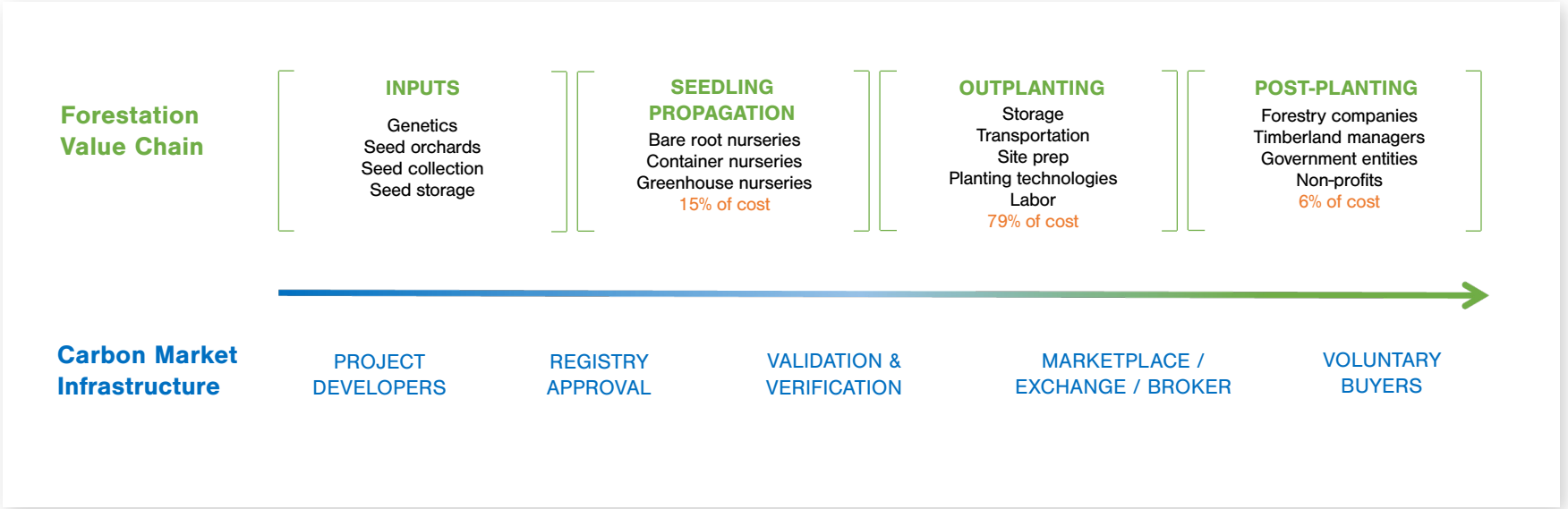
- US Forest Service
- Forestry Companies
- Private Nursery Companies



Source: EQ industry interviews

# Forestation Value Chain and Carbon Markets






Source: EQ industry interviews

# CEA Seedling Rearing

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- Greenhouse nurseries (also referred to as container nurseries) are a long-standing method of production within the forestry industry
- For climate and species reasons, greenhouse nurseries dominate in Canada; in the US, only 30 percent of seedling production takes place within a controlled environment and in the southeast, this figure drops to approximately 15 percent
- High tech glasshouses are not common, but most facilities do have some form of climate control; Cravo retractable roof greenhouses are often used though in some cases, structures are simple plastic hoop houses
- Seedlings are typically sown in March and grown until October, when they're lifted, packaged, and frozen until the next spring planting; most greenhouses are vacant during the winter
- In the US, foreign (H-2A) workers comprise virtually all seasonal greenhouse labor; in Canada, these jobs are typical[illegible] planting ones

- Advantages to CEA production of seedlings do not entirely parallel those seen in food production, e.g., they must be hardened in a manner akin to the outside environment, but do include:
  - Higher seedling-to-seed ratios as a result of improved germination and lower seed predation
  - A "plug" that protects the roots, making greenhouse-grown seedlings more easily plant-able vs. bareroot ones
  - A more consistent product
  - Faster germination rates
- Whether CEA can also serve to mitigate climate change risk, notably in the hurricane-prone southeast, is questionable as sources report sufficient water and only minimal production losses
- Given production costs and the risk profile in southeastern nurseries, greenhouse-grown seedlings are unlikely to be competitive in this geography

Photo credit: Canfor

- CEA need is greatest in the northwest
- CEA advantages outweighed by cost in the south



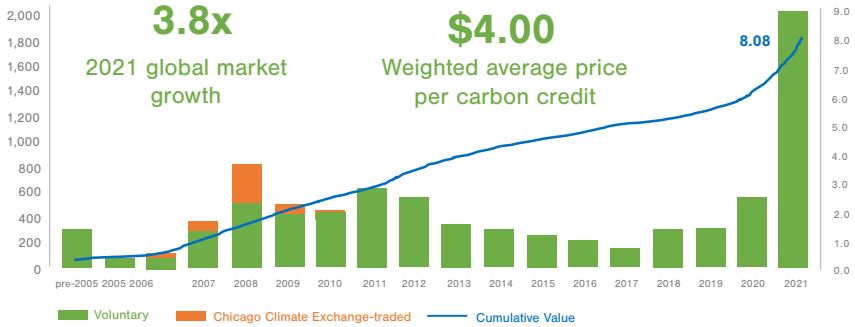
Source: EQ industry interviews; Vertical Farm Daily "Growing tall: trees being grown six times faster in vertical farm saving time and money"

# Carbon Market Growth



## CURRENT STATE

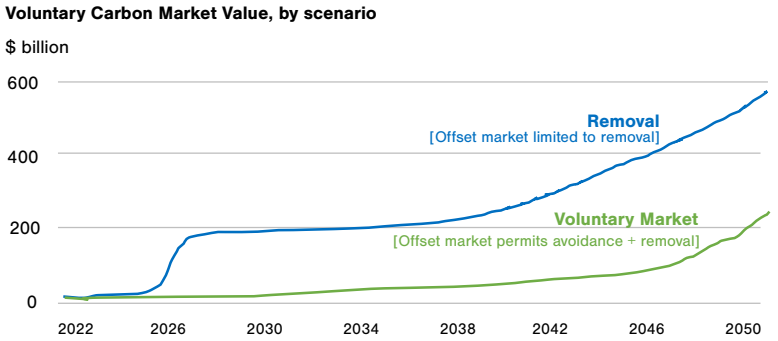
- Carbon markets are expanding; based on value of traded credits, the global market nearly quadrupled in 2021, from $520 million to $1,985 million
- Prices reached an annual global weighted average price of $4.00 per metric tonne (MT) for all transactions in 2021, compared with $2.52 in 2020
- Forestry and land use projects represented 46 percent of volume and 67 percent of value, i.e., the majority of the 2021 voluntary market
- The **average price for a forestry and land use carbon credit was also one of the highest compared to other categories, at $5.80 per MT**




Source: Reforestation Hub; Credit Suisse, "The ROE of a Tree"; Ecosystem Marketplace, "State of the Voluntary Carbon Markets 2022 Q3"; McKinsey, "Blueprint for Scaling Voluntary Carbon Markets."; BloombergNEF

## PROJECTIONS

- Per McKinsey, carbon markets are forecast to grow 5-10x over the next 10 years
- Over the same period, pricing is expected to increase from $3-$5 per MT to $20-$50 per MT for a market value of $10-50 billion by 2030
- Bloomberg's status quo forecast for the voluntary market has pricing at $10-$15 per MT in 2030; however, an aggressive scenario in which supply is limited to removal offsets results in a spike to $200+ per MT
- Such a dramatic increase may not be likely; however, removal credits are expected to sell at a premium to avoidance credits

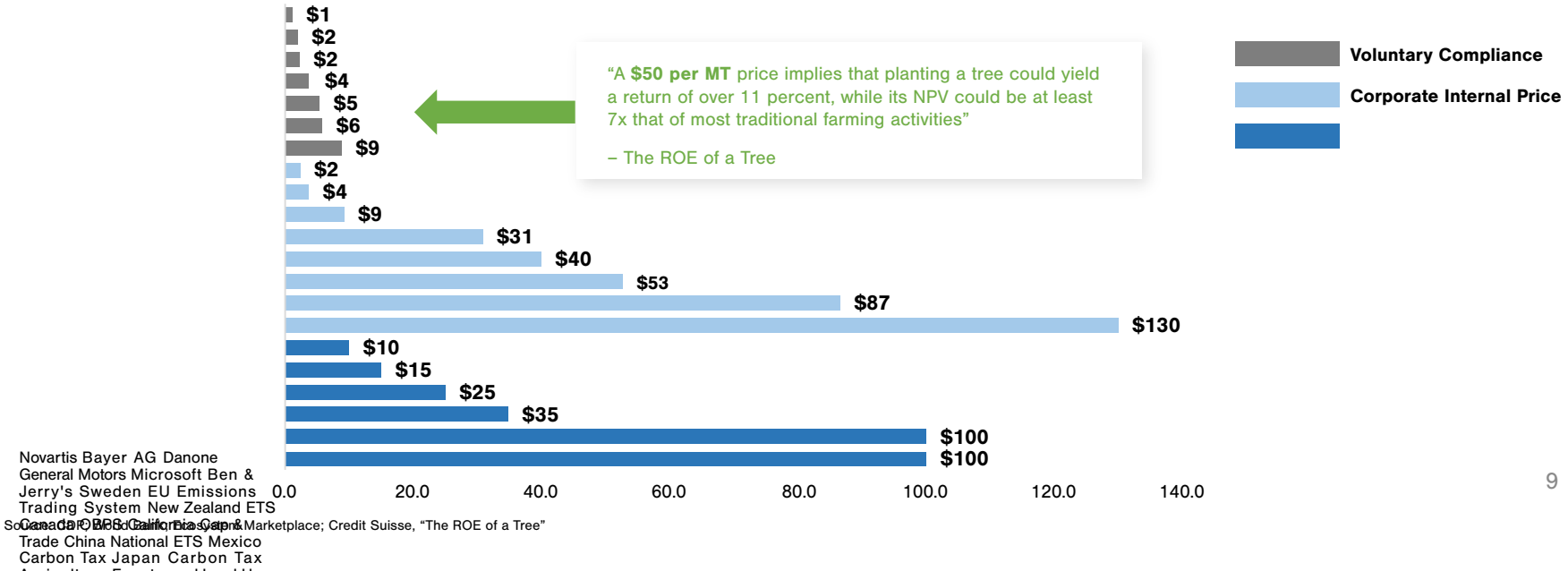



Source: BNEF projections for value of voluntary carbon markets over time. Scenarios are Based on intersection of price, supply and demand, and are not necessarily representative of how the market will evolve.

# Carbon Market Pricing



- Unlike regulated carbon credits, the pricing of voluntary credits is highly fragmented, varied, and opaque; these are not standardized commodities
- Credit pricing varies based on project quality (e.g., additionality and permanence), co-benefits, and market mechanisms, most notably willing buyers
- **Unpredictable pricing and complex, little-understood protocols, coupled with recent bad press pose challenges to institutional-grade investors**
- A near-term competitive advantage exists for credible brokers with institutional relationships




Sources: CBP, Model Ecosystems Marketplace; Credit Suisse, "The ROE of a Tree"

# Forestry Carbon Project Overview



- Forestry carbon projects typically focus on Avoided Conversion (AC) and Improved Forest Management (IFM); Forestation (both reforestation and afforestation) remain less common
  - Forestation involves high upfront costs and a long timeframe for actual sequestration to occur
  - The hard work is physically getting trees in the ground whereas with AC and IFM, the complexity lies in the modelling and verification work
- Forestation poses less of a permanence challenge than soil carbon; the most significant hurdle is proving additionality
  - Credits cannot be generated where forestation is mandated or a business-as-usual scenario, as is always the case following timber harvests and often after wildfires
  - Proof that forestation went beyond a baseline case would be required; however, it can be hard to find legally suitable acres where planting is feasible
  - The conversion of marginal farmland and pastureland may offer potential, particularly in the southeast
- Most sources believe it is impossible to generate carbon credits on public lands and efforts to find a path to do so are unlikely to result in a tradable solution; even if credits were obtainable, a conservation easement is needed for financial viability
- While forest carbon credit pricing averages $6 to $8 per MT, good projects can generate 3-4x that value, i.e., credits are not yet commodified and projects in the $20 to $30 per MT range are economically viable

- To address the fact that tree growth and sequestration timelines mean it could be 30+ years before projects pencil, registries such as Verra and Climate Forward are conducting pilot projects with protocols that shift project economics forward
  - Forecasted Mitigation Units (FMUs) are conservatively forecasted emission reductions that can be generated at the outset of a project
  - FMUs are not offsets and cannot be used to meet Net Zero Commitments; however, they can be used in California for CEQA (the California Environmental Quality Act) compliance, which may make them attractive to large real estate developers
- Recent, high-profile criticisms of flaws in the US forest carbon market suggesting that offset deals provide little, if any, true additionality has created a degree of noise and mistrust, but evidence remains that considerable capital is waiting on the sidelines for quality projects

**Forestation carbon projects hurdles:**

- Additionality
- Suitable land
- Pricing variability
- Sequestration timelines



Source: EQ industry interviews; Ecosystem Marketplace, “The Art of Integrity, State of the Voluntary Carbon Markets 2022 Q3”

# Forest Carbon Project Developers



## STRENGTHS

- **Identifying and procuring land**
  - Diligence on the ability of sites to support forests, legal negotiation, and ensuring permanence [1]
- **Protocol alignment**
  - Knowledge and strict adherence to protocol
- **Carbon strategy and measurement**
  - Optimization of carbon capture at the lowest possible cost
  - Modelling and measuring material project metrics
- **Marketing and sale**
  - Marketing to end buyers (e.g., Fortune 500 companies)
  - Communication around quality of reduction, baseline diligence, additionality, and permanence

## CHALLENGES

- **Procurement**
  - Limited vertical integration or partnerships with nurseries
  - Alignment of demand and seedling supply
  - Distance to projects means high transport costs and risks
- **Working capital**
  - Cash flow may not cover upfront land, seedling, and labor costs
  - Offsets are only generated after trees are grown and sequestering carbon
  - FMUs will not serve buyers' offset requirements
- **Labor**
  - Costly to aggregate small landowners
  - Varying physical environments and regulatory contexts, and species requirements across geographies
- **Scalability and Replicability**
  - Costly to aggregate small landowners
  - Varying physical environments and regulatory contexts, and species requirements across geographies

**Forest carbon project development requires ground-up forestry expertise**

Source: Reforestation Hub; EQ industry interviews

# Key Conclusions



- The traditional private sector reforestation value chain reflects a mature industry populated by large forestry companies, TIMOs, and established suppliers, which operate under varying degrees of government regulation
- Many seed orchards and seedling nurseries are vertically integrated within large forestry companies or run by government entities; privately-owned nurseries also serve a mix of customers
- The supply of seeds and seedlings falls short of reforestation needs in the western US, particularly in the context of increasingly frequent wildfires, however, bottlenecks in the value chain, high costs, unpredictable needs, and varied governance structures make it difficult to capitalize on this supply-demand gap



- Controlled environment production is common in the west (and in Canada); greenhouses are typically lower tech
- The southeastern US offers better reforestation potential in terms of faster growth, seed availability, and access to suitable land; there appears to be an adequate supply of bareroot seedlings to meet existing demand
- Climate, species requirements and production economics do not lend themselves to widespread greenhouse use in the southeast
- Faster-growing species do lend themselves to genetic improvements and premium pricing vs. the west's production-driven commodity model
- **EQ believes the opportunity to invest in greenhouse nurseries to serve the traditional reforestation seedling market is limited**

- The emergence of carbon markets could boost the economic viability of reforestation projects and create another demand source for greenhouse-grown seedlings
- The sequestration potential of trees is greater than of soil; however, significant amounts of carbon are not absorbed until they are fully grown
- The current reforestation carbon credit system is complex and not yet conducive to institutional investment
  - Finding suitable land and proving additionality can be difficult; in the west, public lands are generally not viable options while in the east, it can be costly to consolidate fragmented private ownership
  - Pricing is not standardized in the voluntary carbon markets
  - Reforestation requires a forward crediting system; offsets cannot be generated until sequestration occurs
  - Forecast Mitigation Units (FMUs) cannot be used by the voluntary markets as offsets, but they do qualify for CEQA compliance in California
- **EQ does not believe the reforestation carbon markets offers scalable demand for profitable seedling greenhouses**

**EQ will:**

- Watch for increased CEA nursery use as yield, growth cycle, and climate risk mitigation advantages are proven
- Watch for standardized carbon forestry pricing in the $20+ per MT range

# Appendix

# Carbon Market Definitions



| Principle | Explanation | Example |
|---|---|---|
| **Additionality** | Carbon credits must result in a direct reduction of CO2 that would not have occurred had the credits not been issued | Farmland is managed without sustainable practices. Then, farmer implements no-till and cover cropping practices |
| **Permanence** | Carbon must be stored in perpetuity | If a forest is planted and sequesters carbon, the carbon credits are null if the land is developed into residences |
| **No Double-Counting** | A carbon credit can be issued only once for the ton of carbon it sequesters. It must be listed on a registry | If Microsoft purchases and retires a credit from a farmer, that credit cannot be purchased by another company |
| **Measuring, Reporting and Verification ("MRV")** | Quality standards and protocols need to be met. Protocols include measuring the baseline of carbon associated with the land and monitoring the build-up of the carbon asset over the life of the credit; following accounting guidelines and emissions established by the GHG Protocols; and using third party certifiers to audit the management and reporting of carbon assets | |

Source: "Financialization of Carbon Assets in Food & Agriculture," HighQuest Consulting.