Andes Bio

Carbon Removal Purchase Application

General Application

(The General Application applies to everyone, all applicants should complete this)

Company or organization name

Andes Ag, Inc.

Company or organization location (we welcome applicants from anywhere in the world)

Alameda, CA

Name of person filling out this application

Gonzalo Fuenzalida, Tania Timmermann, Bjorn Traag, Lena Burova, Yun-Ya Yang

Email address of person filling out this application

[redacted]

Brief company or organization description

Andes empowers biology to enable positive action against climate change.

1. Overall CDR solution (All criteria)

a. Provide a technical explanation of the proposed project, including as much specificity regarding location(s), scale, timeline, and participants as possible. Feel free to include figures and system schematics.

Andes has developed a carbon dioxide removal solution called Microprime™ carbon dioxide removal (CDR) which is based on the action of microorganisms interacting with plant roots. Andes' microorganisms accelerate the formation of bicarbonate and carbonate minerals (bio-mineralization) in the soil, Earth's largest carbon reservoir. Contrary to other approaches for carbon capture in soil which focus on Soil Organic Carbon (SOC) buildup, Andes Microprime™ CDR technology is focused on Soil Inorganic Carbon (SIC) formation in agricultural lands.

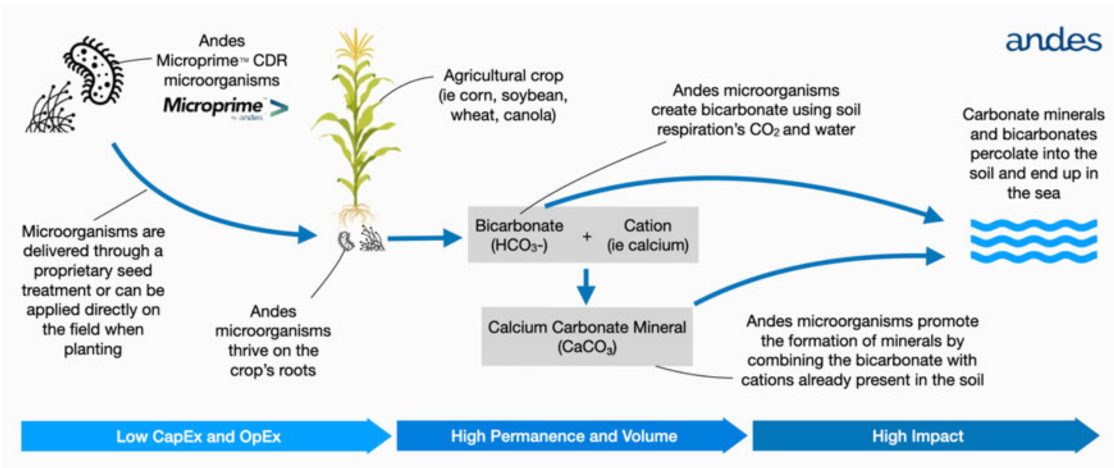


Figure 1. Andes Microprime™ CDR technology.

Soil inorganic carbon (SIC) is mainly dominated by calcium carbonate ($CaCO_3$), and it makes up dominant carbon stocks in 54% of soils globally, or ~750 Gt carbon in the top 1-meter depth (Zamanian et al., 2018). Typically, carbon dioxide (CO_2) can naturally be converted into solids, including carbonate minerals such as $CaCO_3$ and magnesium carbonate ($MgCO_3$); however, the process of abiotic hydration of CO_2 which generates bicarbonate (HCO_3^-) is slow (~1.3×10^{-1} s^{-1}, or 1.3 reactions per second). Certain microbes in the presence of CO_2 can trigger a bio-mineralization process that is significatively faster (e.g., 10 to 10^6 s^{-1}, or up to 1 million reactions per second) than the abiotic mineralization process. In the natural environment, Andes Microprime™ CDR microbes can produce visible precipitation of carbonate ions (CO_3^{2-}) when cations such as Ca^{2+} are available in the soil solution.

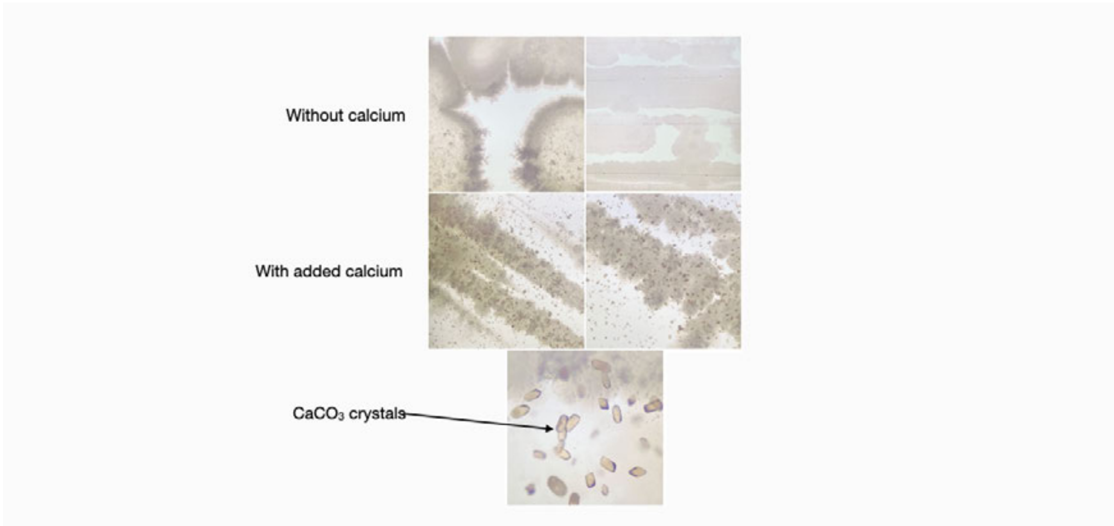


Figure 2. Andes Microprime CDR technology is able to generate $CaCO_3$ crystals in the presence of calcium.

It has been noticed that a high microbial content (~10 billion microbial cells per gram of soil) is found in the plant rhizosphere (Torsvik and Øvreås, 2002). Andes Microprime™ CDR technology uses proprietary microbial strains and seed treatments to accelerate the bicarbonate (HCO_3^-) and carbonate mineral generation process at commercial scale. Andes Microprime™ CDR technology allows highly stable colonization of these microbes in the plant roots and rhizospheric soil, where an elevated concentration of CO_2 is present due to plant (autotrophic) and microbial (heterotrophic) respiration (i.e. a corn plantation releases over 7 tons of CO_2 per acre per season, Rochette & Flanagan, 1997). Consequently, with Andes Microprime™ CDR technology placed in the soil, a significant amount of CO_2 is removed from the atmosphere (e.g., 3 tons of CO_2 per acre per season).

Under the right conditions, SIC compounds such as bicarbonate (HCO_3^-) and calcium carbonate ($CaCO_3$) have the ability to store carbon in the soil for thousands of years (Zamanian et al., 2018).

Andes aims to generate carbon credits by removing CO_2 and capturing it as SIC (i.e. HCO_3^- and $CaCO_3$).

The suitable agricultural land for Andes first generation Microprime™ CDR technology is roughly 200 million acres in the US, 43 million acres in Canada and more than 150 million acres in South America.

The company's current primary crop focus is on corn, soybean, wheat, and canola. The selection of these first crops is to be able to reach a high acreage and thus rapid deployment of Microprime™ CDR technology and positive environmental impact.

Andes is starting in 2022 its first commercial season in the US, partnering with farmers who will be implementing the Microprime™ CDR technology on more than 25,000 acres. The company has a plan of reaching over 65 million acres within 10 years, generating a yearly carbon dioxide removal rate of over 195 million tons CO_2.

Most soil carbon capture initiatives (mainly focused on organic matter buildup) require farmers to make large investments associated with the change of practices, leaving many farmers averse to pursuing such projects due to the high cost associated and a long-term payment from the programs. Andes Microprime™ CDR technology requires no investment from farmers nor change of practices, hence exponentially increasing adoption by lowering the cost of participation in carbon markets. Andes Microprime™ CDR technology creates a win-win solution by lowering the barrier of entry for farmers to contribute to sustainably reduce CO_2 from the atmosphere while creating a new income stream.

Detailed Description of Andes Microprime™ CDR technology:

Because of the respiration of plant roots, soil fauna, and microbial activity, soil can contain greatly elevated levels of CO_2 compared to the atmosphere. Both CO_2 and HCO_3^- spontaneously equilibrate in solution, and the low concentration of CO_2 in air and its rapid diffusion from the cell mean that insufficient HCO_3^- is spontaneously made to meet cellular needs.

The acceleration of carbonate formation and silicate weathering by microorganisms has been studied in the literature (Xiao et al., 2015). The potential for microbially-induced bio-mineralization and applications such as bioconcrete production are also well studied (Castro-Alonso et al., 2019). It has also been recognized that some microorganisms can actively capture CO_2 and convert it into solid carbonates (Kim et al. 2012; Favre et al. 2009; Ramanan et al. 2009). Andes Microprime™ CDR microorganisms produce HCO_3^- through enzyme-mediated hydration of CO_2 and releases HCO_3^- into the soil. During the processes of mineralization, we expect the generation of carbonate ions (CO_3^{2-}) from HCO_3^- via hydrolysis to increase the pH of soils (*Eq. 1*) and further promote the precipitation of carbonate and bicarbonate ions by cations such as calcium (*Eq. 2*).

$HCO_3^- + OH^- \rightarrow CO_3^{2-} + H_2O$ (*Eq. 1*)
$Ca^{2+} + CO_3^{2-} \rightarrow CaCO_3$ (*Eq. 2*)

Efficient colonization of plant roots by Microprime™ CDR microorganisms, aided by Andes proprietary seed treatment, ensures that Microprime™ CDR microorganisms are able to take advantage of the elevated levels of CO_2 in the soil and effectively promote the precipitation of $CaCO_3$ minerals through a combination of enzymatic and cellular properties.

References:

Castro-Alonso, M. J., Montañez-Hernandez, L. E., Sanchez-Muñoz, M. A., Macias Franco, M. R., Narayanasamy, R., and Balagurusamy, N. Microbially induced calcium carbonate precipitation (MICP) and its potential in bioconcrete: microbiological and molecular concepts. *Frontiers in Materials.* 2019, 6:126.

Favre N., Christ, M., Pierre, A. Biocatalytic capture of CO_2 with carbonic anhydrase and its transformation to solid carbonate. *Journal of Molecular Catalysis B: Enzymatic* 2009, 60(3-4): 163-170.

Ferrer, F.M., Hobart, K., Bailey, J.V. Field detection of urease and carbonic anhydrase activity using rapid economical tests to assess microbially induced carbonate precipitation. *Microbial Biotechnology.* 2020, Nov, 13(6): 1877-1888.

Karberg, N.J., Pregitzer, K.S., King, J.S., Friend, A.L., Wood, J.R. Soil carbon dioxide partial pressure and dissolved inorganic carbonate chemistry under elevated carbon dioxide and ozone. *Oecologia.* 2005, 142, 296-306.

Kim, I.G., Jo, B.H., Hang, D.G., Kim, C.S., Choi, Y.S. Cha, H.J. Biomineralization-based conversion of carbon dioxide to calcium carbonate using recombinant carbonic anhydrase. *Chemosphere* 2012, 87(10): 1091-1096.

Ramana, R., Kannan, K., Sivanesan, S.D., Mudliar, S., Kaur, S., Tripathi, A.K., Chakrabarti, T. Bio-sequestration of carbon dioxide using carbonic anhydrase enzyme purified from Citrobacter freundii. *World Journal of Microbiology and Biotechnology.* 2009, 25: 981-987.

Rochette, P., & Flanagan, L. B. (1997). Quantifying rhizosphere respiration in a corn crop under field conditions. *Soil Science Society of America Journal.* 61(2), 466-474.

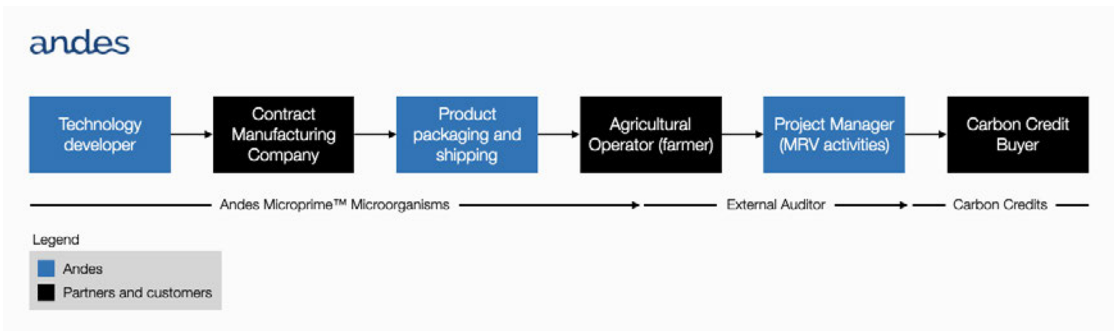
Torsvik V., Øvreås L. Microbial diversity and function in soil: from genes to ecosystems. *Current Opinion in Microbiology.* 2002, 5(3): 240-245.

Xiao, L., Lian, B., Hao, J., Liu, C., Wang, S. Effect of carbonic anhydrase on silicate weathering and carbonate formation at present day CO_2 concentrations compared to primordial values. *Scientific Reports.* 2015, 5(1): 1-10.

Zamanian, K., Zarebanadkouki, M., Kuzyakov, Y. Nitrogen fertilization raises CO_2 efflux from inorganic carbon: A global assessment. *Global Change Biology.* 2018, 24(7), 2810-2817.

Zamanian, K., Pustovoytov, K., & Kuzyakov, Y. Pedogenic carbonates: Forms and formation processes. *Earth-Science Reviews.* 2016, 157, 1-17.

b. What is your role in this project, and who are the other actors that make this a full carbon removal solution? *(E.g. I am a broker. I sell carbon removal that is generated from a partnership between DAC Company and Injection Company. DAC Company owns the plant and produces compressed CO_2. DAC Company pays Injection Company for storage and long-term monitoring.)*



Andes is the technology developer, product packager and shipper, and project manager. As a company, we plan to be vertically integrated, covering from the development of the core biotechnology for carbon dioxide removal to the selling of the associated carbon credits.

Andes will partner with farmers to deploy its Microprime™ CDR technology on their fields, and will provide them with compensation.

c. What are the three most important risks your project faces?

1) Adequate development of the voluntary credits market: demand at scale for carbon credits coming from CO_2 removal technologies.

2) Price of voluntary carbon credits: although we are projecting a long-term price of $25 per carbon credit sold, future technologies that could provide high-quality carbon credits at a lower cost would threaten our business model.

3) Abrupt changes in soil pH and acidic rainfall can lead to leaching of soil basic ions such as calcium (Ca^{2+}), that play an essential role in soil carbon sequestration in mineral forms.

d. If any, please link to your patents, pending or granted, that are available publicly.

- Novel seed treatment methods and compositions for improving plant traits and yield:

patent application covering the development of stable biosystems of bacteria and seeds for the deployment at scale of our Microprime™ CDR biotechnology.
Andes patent - novel seed treatment methods

- Compositions and methods for producing bicarbonate and minerals to microbially sequester CO_2: patent application to become publicly available during May 2022.

e. Who's the team working on this? What's your team's unfair advantage in building this solution? What skills do you not yet have on the team today that you are most urgently looking to recruit?

Andes' team consists of 30 multidisciplinary professionals, 17 of which have Ph.D. in biological sciences and extensive experience in microbiology, enzyme biochemistry, synthetic biology, soil science and agriculture. The team has performed extensive R&D studies during the past five years on seed treatments, environmental microbiology and synthetic biology. Currently Andes is growing its team looking to fulfill several positions on the commercial and operations teams to scale up the deployment of its Microprime™ CDR technology.

The company has been backed-up by leading incumbents in the agricultural industry including Bayer, a world leader on row crop seed genetics and traits, and Wilbur-Ellis, a U.S. leader in the supply and distribution of agricultural inputs.

2. Timeline and Durability (Criteria #4 and Criteria #5)

a. Please fill out the table below.

	Timeline for Offer to Stripe
Project duration	May 2022 - Nov. 2022
When does carbon removal occur?	The carbon removal will occur during the project duration.
Distribution of that carbon removal over time	The carbon removal will be evenly distributed over the whole time frame.
Durability	Over 1,000 years.

b. What are the upper and lower bounds on your durability claimed above in table 2(a)?

1,000 to 1,000,000 years.

c. Have you measured this durability directly, if so, how? Otherwise, if you're relying on the literature, please cite data that justifies your claim. *(E.g. We rely on findings from Paper_1 and Paper_2 to estimate permanence of mineralization, and here are the reasons why these findings apply to our system. OR We have evidence from this pilot project we ran that biomass sinks to D ocean depth. If biomass reaches these depths, here's what we assume happens based on Paper_1 and Paper_2.)*

Literature has shown under natural conditions and over millions of years, soil carbonate minerals have buffered the negative consequences of acid rain and CO_2 from root and microbial respiration (Zamanian et al. 2021, 2016; Turner and Laliberte, 2015; Cailleau et al., 2004; Monger and Gallegos, 2000; Retallack, 1990; Schlesinger, 1982) and thus can stay for long residence times (1,000 to 1,000,000 years).

Literature supporting durability expectation:

Cailleau, G., Braissant, O., Verrecchia, E.P. Biomineralization in plants as a long-term carbon sink. *Naturwissenschaften.* 2004, 91, 191-194.

Monger, H.C., Gallegos, R.A. Biotic and abiotic processes and rates of pedogenic carbonate accumulation in the southwestern United States - relationship to atmospheric CO_2 sequestration. In: Lal R., Kimble, J.M., Eswaran, H., Stewart, B.A. (eds) Global climate change and pedogenic carbonate. Lewis Publishers, Roca Raton, 2000, pp 273-290.

Retallak, G.J. Soils of the past: an introduction to paleopedology. 1990. Unwin-Hyman, London.

Schlesinger, W.H. Carbon storage in the caliche of arid soils: a case study from Arizona. *Soil Science* 1982, 133(4), 247-255.

Turner, B.L., and Laliberte, E. Soil development and nutrient availability along a 2 million-year coastal dune chronosequence under species-rich mediterranean shrubland in Southwestern Australia. *Ecosystems.* 2015, 18(2), 287-309.

Zamanian, K., Zhou, J., Kuzyakov, Y. Soil carbonates: The unaccounted, irrecoverable carbon source. *Geoderma.* 2021, 384, 114817.

Zamanian, K., Pustovoytov, K., Kuzyakov, Y. Pedogenic carbonate: forms and formation processes. *Earth Science Reviews.* 2016, 157, 1-17.

d. What durability risks does your project face? Are there physical risks (e.g. leakage, decomposition and decay, damage, etc.)? Are there socioeconomic risks (e.g. mismanagement of storage, decision to consume or combust derived products, etc.)? What fundamental uncertainties exist about the underlying technological or biological process?

One potential risk of the durability is abrupt changes in soil pH to become acidic. This could be caused by a natural catastrophe (e.g., intense and continued acid rain) or by human intervention (e.g., applying acidic substances to the soil). Heavy rainfall can lead to the leaching away of soil basic ions such as calcium (Ca^{2+}), which play an important role in soil carbon dioxide sequestration mediated by mineralization.

Further, soil pH is closely linked with biogeochemical cycles, including the carbon cycle, and can be affected by the inefficient use of ammonium-based fertilizers. Acidification could not only release back carbon captured by the Andes Microprime™ CDR technology but also release carbon naturally stored as minerals by natural processes (i.e. SIC pool).

Wet climates generally have a greater potential for acidic soil. The historical average annual precipitation in our project area ranges from 18 to 33 inches based on data from NOAA (source). Thus, the risks of heavy rainfall and the use of acidic substances in the soil are considered low for the geographic areas covered in the Andes project.

e. How will you quantify the actual permanence/durability of the carbon sequestered by your project? If direct measurement is difficult or impossible, how will you rely on models or assumptions, and how will you validate those assumptions? *(E.g. monitoring of injection sites, tracking biomass state and location, estimating decay rates, etc.)*

Andes team will be collecting extensive soil samples and data from farms for direct measurement as part of its program offering to farmers implementing Andes Microprime™ CDR technology on their fields. This data collected will enable us to develop internal models to more precisely understand the temporal and spatial dynamic of $CaCO_3$ formation under different types of soil and water regimes.

As part of the precipitation process, carbonate minerals such as $CaCO_3$ begin to leach out from the top layer of soil and move deeper as rainfall, irrigation, and snowmelt move down through the soil profile (Monger, C.H. 2014; Sanderman, J. 2012). Under relatively basic pH (e.g. pH 7.0 - 8.5), there is a high likelihood for carbonate minerals to stay in their mineral form after they percolate through soil profile into groundwater and eventually reach water systems (e.g., streams, rivers and ocean) (Sanderman, J. 2012).

References:

Monger, C.H. Soils as generators and sinks of inorganic carbon in geologic time. In Soil Carbon, Progress in Soil Science; Hartemink, A., McSweeney, K., Eds.; Springer: Cham, Switzerland, 2014; pp. 27–36.

Sanderman, J. Can management induced changes in the carbonate system drive soil carbon sequestration? A review with particular focus on Australia. *Agriculture, Ecosystems and Environment.* 2012, 155, 70-77.

3. Gross Capacity (Criteria #2)

a. Please fill out the table below. **All tonnage should be described in metric tonnes here and throughout the application.**

	Offer to Stripe (metric tonnes CO_2) over the timeline detailed in the table in 2(a)
Gross carbon removal	75,000 tCO_2
If applicable, additional avoided emissions	N/A

b. Show your work for 3(a). How did you calculate these numbers? If you have significant uncertainties in your capacity, what drives those? *(E.g. This specific species sequesters X tCO_2/t biomass. Each deployment of our solution grows on average Y t biomass. We assume Z% of the biomass is sequestered permanently. We are offering two deployments to Stripe. X*Y*Z*2 = 350 tCO_2 = Gross removal. OR Each tower of our mineralization reactor captures between X and Y tons CO_2/yr, all of which we have the capacity to inject. However, the range between X and Y is large, because we have significant uncertainty in how our reactors will perform under various environmental conditions)*

Based on 2020 and 2021 field trials, we expect the Andes Microprime™ CDR technology to remove at least 3 tons of CO_2/acre/season during the upcoming 2022 farming season.

We obtained data of $CaCO_3$(%) in soil, soil bulk density, and volume of soil from our 2020 and 2021 field trials, and calculated 3 tons of CO_2/acre/season using the following formulas that were modified from Wang et al. (2022):

$$CaCO_3\left(\frac{kg}{ha}\right) = \frac{CaCO_3(\%)\times\left(soil\ bulk\ density\ \left(\frac{kg}{m^3}\right)\times volume\ of\ soil\ (m^3)\right)}{100}$$

where 100 is the unit conversion factor. As 1 kg = 0.001 tons, and 1 ha = 2.471 acres

$$CaCO_3\left(\frac{tons}{acre}\right) = \frac{\left(CaCO_3\left(\frac{kg}{ha}\right)\times 0.01\right)}{2.471}$$

The conversion of $CaCO_3$ to CO_2 is explained by the chemical equations and the molecular weights of both molecules:

(1) $\mathbf{CO_2} + H_2O \leftrightarrow HCO_3^- + H^+$ (Eq. 1)
(2) $HCO_3^- + OH^- \leftrightarrow CO_3^{2-} + H_2O$ (Eq. 2)
(3) $Ca^{2+} + CO_3^{2-} \rightarrow \mathbf{CaCO_3}$ (Eq. 3)

To form one molecule of $CaCO_3$, one molecule of CO_2 is needed. CO_2 has a molecular weight of 44.01 g/mol and $CaCO_3$ has a molecular weight of 100.09 g/mol, thus the factor 0.44 is used for conversion of the mole equivalent of CO_2 from $CaCO_3$.

We will start with an extension of 25,000 acres in 2022. Thus, the gross carbon removal will be 3 tCO_2/ acre x 25,000 acres = 75,000 tCO_2.

References:

Wang, S., Lu, W., Zhang, F. Vertical distribution and controlling factors of soil inorganic carbon in poplar plantations of coastal eastern China. *Forests* 2022, 13, 83.

c. What is your total overall capacity to sequester carbon at this time, e.g. gross tonnes / year / (deployment / plant / acre / etc.)? Here we are talking about your project / technology as a whole, so this number may be larger than the specific capacity offered to Stripe and described above in 3(b). We ask this to understand where your technology currently stands, and to give context for the values you provided in 3(b).

Based on our last two year field trial results covering more than 1,500 acres, we estimated that with our first generation Microprime™ CDR technology has a capacity to sequester carbon in agricultural soil at a rate of **3 tons of CO_2/acre/year**.

During 2022, we will implement Andes Microprime™ CDR technology on an extension of 25,000 acres, which will lead to the creation of 75,000 carbon credits (3 tCO_2/acre x 25,000 acres).

For the first generation Microprime™ CDR technology, there are approximately 200 million acres compatible in the U.S., 43 million acres in Canada and more than 150 million acres in South America. We are planning on abruptly scaling the acreage with Microprime™ CDR technology reaching multiple million acres within the upcoming years.

We are further engineering our microorganisms to improve their CDR capabilities. We expect that future generations of Andes Microprime™ CDR technology will reach a CDR potential of over 9 tons of CO_2/acre/year.

d. We are curious about the foundational assumptions or models you use to make projections about your solution's capacity. Please explain how you make these estimates, and whether you have ground-truthed your methods with direct measurement of a real system (e.g. a proof of concept experiment, pilot project, prior deployment, etc.). We welcome citations, numbers, and links to real data! *(E.g. We assume our sorbent has X absorption rate and Y desorption rate. This aligns with [Sorbent_Paper_Citation]. Our pilot plant performance over [Time_Range] confirmed this assumption achieving Z tCO_2 capture with T tons of sorbent.)*

We have conducted field trials on corn and soybean during the 2020 and 2021 U.S. agricultural seasons in the Midwest. These trials included the States of ND, MN, WI, IL, IN, MI and OH, using different seed genetics and traits (from Bayer and Corteva) and different relative maturities.

To further understand the performance potential of Andes Microprime™ CDR technology, we increased the extension of the field trials in 2021 to roughly 1,400 acres. The 2021 field trials included both corn and soybean treated with Andes proprietary seed treatment across different fields with varying levels of initial soil pH and cation-exchange capacity (CEC). The focus of true data from 2020 and 2021 field trials has been on soil samples and final crop yield. Soil samples have been taken at different stages of the plant development (e.g. pre-planting, V4 and V11 plant development stages, and post-harvest) during the season and from three different soil depths (1, 2, and 3 feet).

The vast majority of the soil samples have been analyzed by an independent laboratory (UC Davis). We have systematically observed newly created $CaCO_3$ minerals on soils where Andes Microprime™ CDR technology was implemented on both 2020 and 2021 seasons. In addition, we have also systematically observed an increase in concentration of bicarbonate (HCO_3), the resulting product of the CO_2 hydration, catalyzed by action of Microprime™ CDR microorganisms.

Based on our 2020 and 2021 field trial data obtained from our soil samples, we feel confident that Andes Microprime™ CDR technology will sequester significant amounts of CO_2 by creating HCO_3 and ultimately $CaCO_3$ on agricultural soils.

e. Documentation: If you have them, please provide links to any other information that may help us understand your project in detail. This could include a project website, third-party documentation, project specific research, data sets, etc.

- Technical and commercial FAQ for Andes Microprime CDR technology
- https://www.andes.bio
- Andes patent - novel seed treatment methods

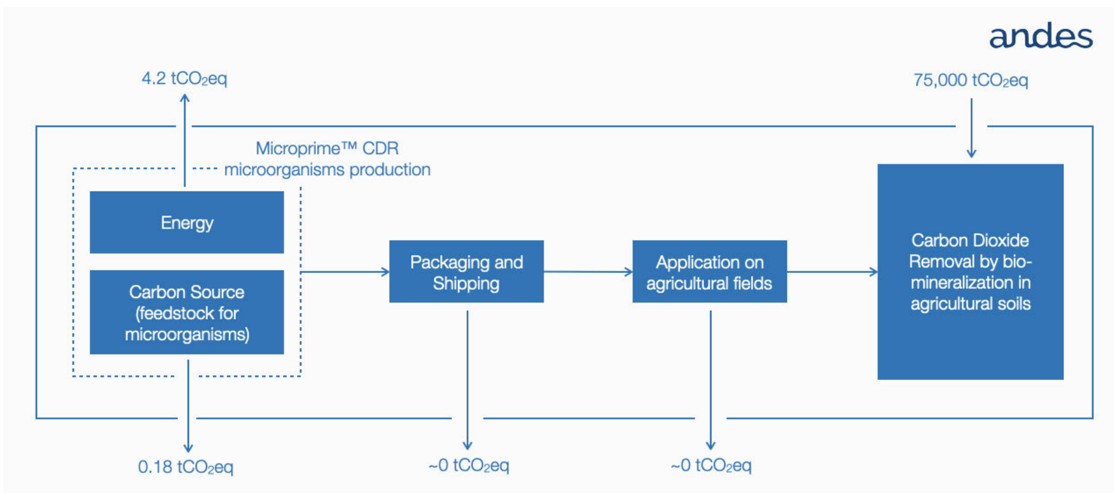
4. Net Capacity / Life Cycle Analysis (Criteria #6 and Criteria #8)

a. Please fill out the table below to help us understand your system's efficiency, and how much your lifecycle deducts from your gross carbon removal capacity.

	Offer to Stripe (metric tonnes CO_2)
Gross carbon removal	75,000 tCO_2
Gross project emissions	4.38 tCO_2

Emissions / removal ratio	0.0000584
Net carbon removal	74,995.62 tCO_2

b. Provide a carbon balance or "process flow" diagram for your carbon removal solution, visualizing the numbers above in table 4(a). Please include all carbon flows and sources of energy, feedstocks, and emissions, with numbers wherever possible *(E.g. see the generic diagram below from the CDR Primer, Charm's application from 2020 for a simple example, or CarbonCure's for a more complex example).* If you've had a third-party LCA performed, please link to it.



c. Please articulate and justify the boundary conditions you assumed above: why do your calculations and diagram include or exclude different components of your system?

Our lifecycle analysis starts with the production of Andes Microprime™ CDR microorganisms, which consists of a fermentation process performed on a bioreactor by a contract manufacturing company. During the fermentation process, energy and a carbon source (which is the feedstock for the microorganisms) are used. The product of the fermentation and downstream process is packaged and shipped to the agricultural operator (farmer) who applies Andes Microprime™ CDR microorganisms on the field.

According to our contract manufacturing company, a 5,000 liter bioreactor production run will require 9,600 kWh of electrical energy and 400 lbs of carbon feedstock for the microorganisms. The amount of Andes microorganisms obtained from a 5,000 liter bioreactor production run is typically around 1.54E+16 CFU. This amount of Andes Microprime™ CDR microorganisms is enough to cover an extension of 165,257 acres of corn, soybean or wheat fields.

9,600 kWh of electrical energy is equivalent to emissions of 4.2 metric tons of CO_2 (according to EPA's Greenhouse Gas Equivalencies Calculator). 400 lbs of carbon feedstock is roughly 0.18 metric tons of CO_2 equivalent emissions. Thus, the total emissions of CO_2 equivalent from a 5,000 liter bioreactor production run is 4.38 tons.

We are excluding or considering close to zero tCO_2e emissions in the following parts of the process flow:

1) Transport and packaging of the Andes Microprime™ CDR microorganisms, either as seed treatment or as a stand-alone product to be applied on the field. The amount of Andes Microprime™ CDR microorganisms necessary to cover the 25,000 acres is only a few pounds, making the footprint of the transportation and packaging minimal;

2) The direct application of the Andes Microprime™ CDR microorganisms on the field doesn't require a special process as the material is mixed with fertilizer applications that are typically performed by farmers. Additionally, the application of the Andes Microprime™ CDR microorganisms as a seed treatment is integrated into the traditional seed treatment processes currently performed in the industry.

d. Please justify all numbers used in your diagram above. Are they solely modeled or have you measured them directly? Have they been independently measured? Your answers can include references to peer-reviewed publications, e.g. Climeworks LCA paper.

We have measured the amount of carbon captured by our technology during the 2020 and 2021 field trials by taking soil samples following strict protocols and processing them by a third party laboratory (UC Davis) obtaining an average of 3 tons CO_2/acre/season. We have further confirmed internally these measurements performed by the external laboratory.

The emissions coming from the production of Andes Microprime™ CDR microorganisms were estimated by the contract manufacturing company.

e. If you can't provide sufficient detail above in 4(d), please point us to a third-party independent verification, or tell us what an independent verifier would measure about your process to validate the numbers you've provided.

N/A

5. Learning Curve and Costs (Backward-looking) (Criteria #2 and #3)

We are interested in understanding the learning curve of different carbon removal technologies (i.e. the relationship between accumulated experience producing or deploying a technology, and technology costs). To this end, we are curious to know how much additional deployment Stripe's procurement of your solution would result in. (There are no right or wrong answers here. If your project is selected we may ask for more information related to this topic so we can better evaluate progress.)

a. Please define and explain your unit of deployment. (*E.g.* # of plants, # of modules)

> We define one unit as one acre of agricultural land treated with Andes Microprime™ CDR microorganisms.

b. How many units have you deployed from the origin of your project up until today? Please fill out the table below, adding rows as needed. Ranges are acceptable.

Year	Units deployed (#)	Unit cost ($/unit)	Unit gross capacity (tCO_2/unit)	Notes
2022 est.	25,000	75	3 tCO_2/unit	First commercial pilot
2021	1,400	75	3 tCO_2/unit	2021 US Field trials
2020	3	75	3 tCO_2/unit	2020 US Field trials

c. Qualitatively, how and why have your deployment costs changed thus far? (*E.g. Our costs have been stable because we're still in the first cycle of deployment, our costs have increased due to an unexpected engineering challenge, our costs are falling because we're innovating next stage designs, or our costs are falling because with larger scale deployment the procurement cost of third party equipment is declining.*)

> Our costs have been maintained constant as the increase of units doesn't have yet an effect on the marginal cost.

d. How many additional units would be deployed if Stripe bought your offer? The two numbers below should multiply to equal the first row in table 3(a).

# of units	Unit gross capacity (tCO_2/unit)

25,000	3 tCO_2/unit

6. Cost and Milestones (Forward-looking) (Criteria #2 and #3)

We are open to purchasing high cost carbon removal today with the expectation the cost per ton will rapidly decline over time. We ask these questions to get a better understanding of your potential growth and the inflection points that shape your cost trajectory. There are no right or wrong answers, but we would prefer high and conservative estimates to low and optimistic. If we select you for purchase, we'll expect to work with you to understand your milestones and their verification in more depth. If you have any reservations sharing the information below in the public application format, please contact the Stripe team.

a. What is your cost per ton of CO_2 today?

\$25/tCO_2

b. Help us understand, in broad strokes, what's included vs excluded in the cost in 6(a) above. We don't need a breakdown of each, but rather an understanding of what's "in" versus "out." Consider describing your CAPEX/OPEX blend, non-levelized CAPEX costs, assumptions around energy costs, etc.

Cost includes the production of Andes Microprime™ CDR microorganisms, treatment of the seed (when not applying the technology directly on fields), shipping and packaging, payment to Andes partners (farmers), payment to distributors, and MVR activities.

c. How do you expect your costs to decline over time? Specifically, what do you estimate your cost range will be as you reach megaton and then gigaton scale? We recognize that at this point, these are speculative and directional estimates, but we would like to understand the shape of your costs over time.

We expect to sustain the same price of **\$25 per ton CO_2** during the near future. We do not expect the cost to decline drastically since one of the biggest components is the payment to farmers.

d. Where are the primary areas you expect to be able to achieve cost declines? E.g., what are the primary assumptions and sensitivities driving your cost projection? What would need to be true for a long-term cost of <\$100/ton to be achievable with your technology? (i.e., you are able to negotiate an x% reduction in CAPEX at scale and purchase renewable electricity at \$y/kWh)

Although we are developing technology to improve the efficiency of MRV activities to make them compatible with multi-million acreage deployment of Andes Microprime™ CDR technology, we don't expect a reduction of the cost of ton CO_2 to below $25.

e. In a worst case scenario, what would your range of cost per ton be? We've been doing a lot of purchasing over the past few years and have started to see a few pieces that have tripped people up in achieving their projected cost reductions: owned vs leased land, renewable electricity cost, higher vendor equipment costs, deployment site adjustments, technical performance optimization, supporting plant infrastructure, construction overruns, etc. As a result, we'll likely push on the achievability of the cost declines you've identified to understand your assumptions and how you've considered ancillary costs. We would love to see your team kick the tires here, too.

In a worst case scenario where we could only scale deployment of Andes Microprime™ CDR technology having to pay higher compensation to stakeholders or experiencing higher MRV costs, we estimate the cost could go as high as $35 per ton of CO_2.

f. List and describe **up to three** key upcoming milestones, with the latest no further than Q2 2023, that you'll need to achieve in order to scale up the capacity of your approach.

Milestone #	Milestone description	Why is this milestone important to your ability to scale? (200 words)	Target for achievement (eg Q4 2021)	How could we verify that you've achieved this milestone?
1	Commercial pilot proof of concept	Our ability to generate and sell carbon credits generated from 2022 field activities will prove the thesis on which we can scale further.	Q4 2022	Andes will be collecting extensive soil samples and true data from farms through the course of the farming season. By the end of the season we will have a database to verify 3 tons CO_2/acre data. We can provide direct access to Stripe's team to the data and samples and also provide

				verification by an independent third party.
2	Building proprietary MRV process and tools	Building our own MRV process and tools is required to match the speed and volume of carbon credits we project to generate.	Q1 2023	We can showcase the software and tools we will develop to Stripe's team or to third party experts appointed by Stripe.
3	Funding round	Additional capital will allow us to scale significantly to deploy Andes Microprime™ CDR technology on millions of acres.	Q2 2023	We can introduce Stripe's team to our investors and our corporate counsel (WSGR).

i. How do these milestones impact the total gross capacity of your system, if at all?

Milestone #	Anticipated total gross capacity prior to achieving milestone (ranges are acceptable)	Anticipated total gross capacity after achieving milestone (ranges are acceptable)	If those numbers are different, why? (100 words)
1	3 tCO_2/acre trialed on approximately 1,400 acres	75,000 tCO_2 per year (3 tCO_2/acre x 25,000 acres)	During the current season (2022), we are scaling from medium size trials (1,400 acres) to a pilot commercial scale (25,000 acres). The ability to demonstrate traction (i.e. enrolling farmers on the Andes Microprime™ CDR program and partnering with buyers of our carbon credits) will enable the expansion of our total gross capacity.

2	75,000 tCO_2 per year (3 tCO_2/acre x 25,000 acres)	1,500,000 tCO_2 per year (3 tCO_2/acre x 500,000 acres)	With improved MRV processes and tools, we will be able to scale up the deployment of Andes Microprime™ CRD technology from 25,000 acres to 500,000 acres.
3	75,000 tCO_2 per year (3 tCO_2/acre x 25,000 acres)	1,500,000 tCO_2 per year (3 tCO_2/acre x 500,000 acres)	With additional funding, we will be able to scale up the deployment of Andes Microprime™ CRD technology from 25,000 acres to 500,000 acres.

g. How do these milestones impact your costs, if at all?

Milestone #	Anticipated cost/ton prior to achieving milestone (ranges are acceptable)	Anticipated cost/ton after achieving milestone (ranges are acceptable)	If those numbers are different, why? (100 words)
1	$25/$tCO_2$	$25/$tCO_2$	-
2	$25/$tCO_2$	$25/$tCO_2$	While we expect better efficiency by achieving this milestone, we don't expect a total decrease of the cost/ton, but gaining the capacity to increase the acreage for deployment for Andes Microprime™ CDR technology.
3	$25/$tCO_2$	$25/$tCO_2$	-

h. If you could ask one person in the world to do one thing to most enable your project to achieve its ultimate potential, who would you ask and what would you ask them to do?

President Joe Biden and would ask him to push for strict regulation on the quality (permanence, co-benefits, additionality and CDR-origin) of carbon credits that can be valid for being transacted both on regulated and voluntary markets in the U.S.

i. Other than purchasing, what could Stripe do to help your project?

Create exposure to key stakeholders and decision makers about Andes Microprime™ CDR technology.

7. Public Engagement (Criteria #7)

In alignment with Criteria 7, Stripe requires projects to consider and address potential social, political, and ecosystem risks associated with their deployments. Projects with effective public engagement tend to do the following:

- Identify key stakeholders in the area they'll be deploying
- Have mechanisms to engage and gather opinions from those stakeholders and take those opinions seriously, iterating the project as necessary.

The following questions are for us to help us gain an understanding of your public engagement strategy and how your project is working to follow the White House Council on Environmental Quality's draft guidance on responsible CCU/S development. We recognize that, for early projects, this work may be quite nascent, but we are looking to understand your early approach.

a. Who have you identified as your external stakeholders, where are they located, and what process did you use to identify them? Please include discussion of the communities potentially engaging in or impacted by your project's deployment.

For the current year (2022), our stakeholders include farmers across the U.S. (where the initial deployment of Andes Microprime™ CDR technology will take place), distributors, registries (i.e. Verra), validation and verification body, and companies that buy carbon credits. In the upcoming year, stakeholders will also include farmers and their communities in other countries including Canada, Argentina, and Brazil.

b. If applicable, how have you engaged with these stakeholders and communities? Has this work been performed in-house, with external consultants, or with independent advisors? If you do have any reports on public engagement that your team has prepared, please provide. *See Project Vesta's community engagement and governance approach as an example.*

We have met with farmers participating in our Microprime™ CDR program face-to-face and have discussed the details of the offering. We also have engaged with a validation and verification body that will be responsible for assessing our claims of CDR.

c. If applicable, what have you learned from these engagements? What modifications have you already made to your project based on this feedback, if any?

All the farmers who participated in our field trials of 2020 and 2021 are very keen in partnering with Andes not only because of the monetary incentives, but also because they saw a positive effect of Andes Microprime™ CDR technology on crop health and yields.

d. Going forward, do you have changes planned that you have not yet implemented? How do you anticipate that your processes for (a) and (b) will change as you execute on the work described in this application?

We are at an early stage of the Andes Microprime™ CDR program development. As the program progresses and we scale up, we anticipate having a deeper level of engagement with our stakeholders that are listed above.

8. Environmental Justice (Criteria #7)

a. What are the potential environmental justice considerations, if any, that you have identified associated with your project? Who are the key stakeholders?

There are no potential environmental justice considerations that we have identified by deploying Andes Microprime™ CDR technology while partnering with U.S. farmers.

b. How do you intend to address any identified environmental justice concerns?

There are no identified environmental justice concerns at the moment. However, we will continue to engage with stakeholders to monitor and identify any environmental justice concerns that might arise in the future.

9. Legal and Regulatory Compliance (Criteria #7)

a. What legal opinions, if any, have you received regarding deployment of your solution?

We have engaged with counsel and experts to receive opinion on the deployment of Andes Microprime™ CDR technology, receiving positive feedback. We are complying with State laws associated with the use of microorganisms in agriculture intended for use as soil amendments.

We are currently understanding regulations in other countries where we will be expanding Andes Microprime™ CDR technology deployment.

b. What domestic permits or other forms of formal permission do you require, if any, to engage in the research or deployment of your project? Please clearly differentiate between what you have already obtained, what you are currently in the process of obtaining, and what you know you'll need to obtain in the future but have not yet begun the process to do so.

This farming season, 2022, Andes will have implemented its technology on the fields of several States. For all the States, we will be deploying Andes Microprime™ CDR technology by complying with all local laws.

c. Is your solution potentially subject to regulation under any international legal regimes? If yes, please specify. Have you engaged with these regimes to date?

No.

d. In what areas are you uncertain about the legal or regulatory frameworks you'll need to comply with? This could include anything from local governance to international treaties. For some types of projects, we recognize that clear regulatory guidance may not yet exist.

No, we have done an extensive assessment of any potential regulations we need to comply with, in particular as it pertains to the application of our microbial treatment in agriculture which falls under Federal (USDA and EPA) and State regulations.

e. Has your CDR project received tax credits from any government compliance programs to-date? Do you intend to receive any tax credits during the proposed delivery window for Stripe's purchase? If so, which one(s)? (50 words)

No.

10. Offer to Stripe

This table constitutes your offer to Stripe, and will form the basis of our expectations for contract discussions if you are selected for purchase.

	Offer to Stripe
Net carbon removal	74,995.62 metric tonnes CO_2
Delivery window	Q3 - Q4 2022

Price ($/metric tonne CO_2)	$25/metric tonne CO_2

Application Supplement: Surface Mineralization

(Only fill out this supplement if it applies to you)

Source Material and Physical Footprint (Criteria #1 and #8)

1. What source material are you using, and how do you procure it?

Calcium carbonate ($CaCO_3$), is formed from bicarbonate (HCO_3^-) produced by Andes Microprime™ CDR microorganisms and cations (e.g., calcium, magnesium) already present in the soil. No additional cations need to be sourced externally or applied.

2. Describe the ecological impacts of obtaining your source material. Is there an existing industry that co-produces the minerals required?

Calcium carbonate ($CaCO_3$), is formed from bicarbonate (HCO_3^-) produced by Andes Microprime™ CDR microorganisms and soil parent materials that provides cations (e.g., calcium, magnesium) already present in the soil. Other potential sources of cations include rainfall and irrigation water. Rainfall containing cations such as calcium and magnesium has been found in different climate regions (Cerón et al. 2013; Keresztesi et al., 2020a and 2020b; Keresztesi et al. 2019). No additional cations need to be sourced or applied, hence there is no impact from obtaining the cations.

Bicarbonate produced by the Microprime™ CDR technology, does not have negative ecological impacts. On the contrary, if the bicarbonate molecules finally reach the ocean, its presence will increase the water pH and benefit the marine ecosystem.

References:

Cerón, R.M., Cerón, J.G., Carballo, C.G., Aguilar, C.A., Montalvo, C., Benítez, J.A., Villareal, Y.J., Gómez, M.M. Chemical composition, fluxes and seasonal variation of acid deposition in Carmen Island, Campeche, Mexico. *Journal of Environmental Protection.* 2013, 4, 50-56.

Keresztesi, Á., Nita, I., Birsan, M., Bodor, Z., Pernyeszi, T., Micheu, ., Szép, R. Assessing the variations in the chemical composition of rainwater and air masses using the zonal and meridional index. *Atmospheric Research.* 2020a, 237, 104846.

Keresztesi, Á., Nita, I., Boga, R., Birsan, M., Bodor, Z., Szép, R. Spatial and long-term analysis of rainwater chemistry over the conterminous United States. *Environmental Research.* 2020b, 188, 109872.

Keresztesi, Á., Birsan, M., Nita, I., Bodor, Z., Szép, R. Assessing the neutralisation, wet deposition and source contributions of the precipitation chemistry over Europe during 2000-2017. *Environmental Sciences Europe.* 2019, 31, 50.

3. Do you process that source mineral in any way (e.g grinding to increase surface area)? What inputs does this processing require (e.g. water, energy)? You should have already included their associated carbon intensities in your LCA in Section 6.)

This question doesn't apply to our CDR technology.

4. Please fill out the table below regarding your project's physical footprint. If you don't know (e.g. you procure your source material from a mining company who doesn't communicate their physical footprint), indicate that in the square.

	Land area (km^2) in 2021	Competing/existing project area use (if applicable)
Source material mining	N/A	N/A
Source material processing	N/A	N/A
Deployment	101 km^2	Agricultural lands

1. Imagine, hypothetically, that you've scaled up and are sequestering 100Mt of CO_2/yr. Please project your footprint at that scale (we recognize this has significant uncertainty, feel free to provide ranges and a brief description).

	Projected # of km^2 enabling 100Mt/yr	Projected competing project area use (if applicable)
Source material mining	N/A	N/A
Source material processing	N/A	N/A
Deployment	100Mt/y at 7.5t/ha = 134,953 km^2 (13.5M ha or 33.3M acres).	Agricultural lands, including corn, soybean, wheat and other row crops.

5. If you weren't proceeding with this project, what's the alternative use(s) of your source material? What factors would determine this outcome? *(E.g. Alternative uses for olivine include X & Y. It's not clear how X & Y would compete for the olivine we use. OR Olivine would not have been mined but for our project.)*

This question doesn't apply to our CDR technology.

Measurement and Verification (Criteria #4 and #5)

6. We are aware that the current state of the field may include unknowns about the kinetics of your material. Describe how these unknowns create uncertainties regarding your carbon removal and material, and what you wish you knew.

The major factors influencing precipitation of $CaCO_3$ are soil pH and heavy rainfall. Heavy rainfall can lead to the leaching away of soil cations such as Ca^{2+} that are needed for the formation of $CaCO_3$ minerals in soil. In addition, Ca^{2+} is most available in the pH range 6.5 to 8.5. Use of ammonium-based fertilizers can potentially lead to soil acidification.

Considering this, Andes Microprime™ CDR technology will be deployed on fields that have soil with a pH above 6.5 to increase $CaCO_3$ generation and sequester significant amounts of CO_2.

7. If your materials are deployed extensively, what measurement approaches will be used to monitor weathering rates across different environments? What modeling approaches will be used, and what data do these models require?

Our project does not rely on weathering, since the Andes Microprime™ CDR proprietary technology only speeds up the naturally occurring process of bio-mineralization.

We plan to measure bio-mineralization by conducting several soil sampling events (e.g., pre-planting, during the growing season, and post-harvest) during the course of upcoming seasons for various soil analyses. We will monitor the $CaCO_3$ in soil in our laboratory using a modified pressure-calcimeter method (Sherrod et al. 2002; Fonnesbeck et al. 2012) and hyperspectral soil analysis. Further, Andes will be collecting extensive soil data from farms with different soil types that will enable us to develop internal models to better estimate $CaCO_3$ and HCO_3^- generation and accumulation in the soil.

References:

Fonnesbeck, B.B., Boettinger, J.L., Lawley, J.R. Improving a simple pressure-calcimeter method for inorganic carbon analysis. *Soil Science Society of America Journal.* 2012, 77, 1553-1562.

Sherrod, L.A., Dunn, G., Peterson, G.A., Kolberg, R.L. Inorganic carbon analysis by modified pressure-calcimeter method. *Soil Science Society of America Journal.* 2002, 66, 299-305.

Human and Ecosystem Impacts, Toxicity Risk (Criteria #7)

8. What are the estimated environmental release rates of heavy metals (e.g. Cr, Ni, Pb, Hg)? Dust aerosol hazards? P loading to streams? How will this be monitored?

Andes Microprime™ CDR technology does not involve the release of any kind of heavy metals, neither aerosol's dust nor phosphorus, into water streams.

9. If minerals are deployed in farmland, what are the estimated effects on crop yields, what's this estimation based on, and how will actual effects be monitored?

We do not deploy minerals, but we deploy microorganisms that accelerate the naturally occurring bio-mineralization process.

Our data from 2020 and 2021 trials shows higher levels of exchangeable soil cations (e.g., Ca^{2+}) in Andes Microprime™ CDR treated soils compared against untreated soil.

We expect soil flocculation to happen when the soil Ca^{2+} are tightly adsorbed with the soil colloids. As soil flocculation can lead to well-structured soils to hold more water and improve infiltration, we also expect plant roots may penetrate deeper potentially leading to a higher yield of crops.

Our data from 2020 and 2021 field trials showed substantial improvement in plant health and yields (both on corn and soybeans). To further understand whether there are other factors playing a role in Andes Microprime ™ CDR technology, we will need to collect and analyze more data.

10. How will you monitor potential impacts on organisms in your deployment environment? (E.g. Health of humans working in agricultural contexts, health of intertidal species, etc. depending on the context of deployment)

Our first generation Microprime™ CDR technology is integrated by natural, non-engineered microorganisms. The microorganisms we are using have a history of safe use in food and agriculture, and are considered not to possess traits that cause disease.

We have further evaluated the safety of Microprime™ CDR microorganisms with an external contract research organization, performing acute toxicity studies and found no detrimental effects on mice.

11. If you detect negative impacts, at what point would you choose to abort the project and how?

We have conducted field trials during several years to assess the effect of Andes Microprime™ CDR technology on agricultural fields without observing negative impacts. So far we have performed field trials on over 1,500 acres of agricultural land growing corn and soybean.

As we scale-up the deployment of the Microprime™ CDR technology across 25,000 acres, we will monitor the effect on crops and fields to detect any negative impacts and environmental issues.