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Economic Assessment for Ecosystem Service Market Credits from Agricultural Working Lands

Prepared for:

Ecosystem Services Market Consortium LLC

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Disclaimer

This report was produced for the Noble Research Institute (NRI). Noble Research Institute, LLC initiated, financially supported and led almost two years of activities to develop and launch the Ecosystem Services Market Consortium (ESMC). Noble continues to contribute to the ESMC through its research as well as its land stewardship and producer education programs. In February 2019, Noble initiated the transfer of its work and management of the project to the Consortium (housed under the Soil Health Institute) to advance this program. The purpose of the study is to provide an economic assessment for ecosystem service market credits in terms of potential supply from privately owned working lands and in terms of potential demand for ecosystem service credits driven by corporate commitments related to carbon and water.

Informa Agribusiness Consulting ("Informa") has used the best and most accurate information available to complete this study. Informa is not in the business of soliciting or recommending specific investments. The reader of this report should consider the market risks inherent in any financial investment opportunity. Furthermore, while Informa has extended its best professional efforts in completing this analysis, the liability of Informa to the extent permitted by law, is limited to the professional fees received in connection with this project.

Important Note: Following the acquisition of Agribusiness Intelligence by IHS Markit (from Informa plc) on July 1, 2019, we are pleased to say that we bring the combined resources of Agribusiness Intelligence, a global leader in agriculture and the bio-energy space) and IHS Markit (a global leader in the energy space who also has significant experience in bioenergy).

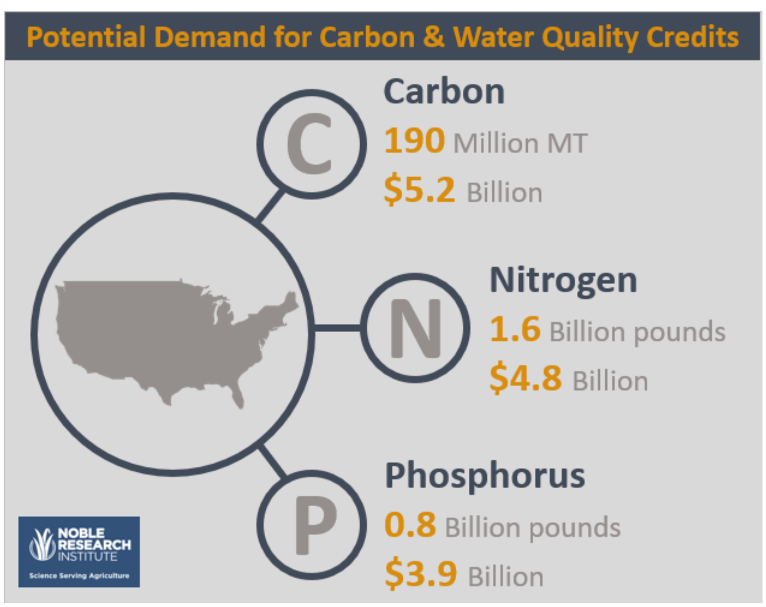
I. EXECUTIVE SUMMARY

The Noble Research Institute (NRI) embarked in 2018 on an effort to advance ecosystem service markets (ESM) that incentivize farmers and ranchers to improve soil health systems benefiting society. The intent is to enable and encourage farmers and ranchers to adopt and sustain conservation management practices to improve soil health, reduce greenhouse gas (GHG) emissions and improve related water quality and reduce water use. Healthy soils also improve crop yield and resilience while decreasing farmers' and ranchers' need for agricultural inputs.

In support of the NRI efforts, Informa conducted an economic assessment to inform the total potential value of ecosystem services, in terms of national and regional supply and demand, that can be provided from privately owned, working agricultural lands.

- The focus on the supply side is on monetizing soil health to reward farmers and ranchers who actively adopt and improve management practices that protect the environment.
  - GHG mitigation potential is associated with changes in farm management practices for field crops, pasture/grazing land and specialty crops.
  - Supply estimates to improve water quality were based on estimated agriculture nutrient runoff focusing on nitrogen and phosphorous.
- The focus on the demand side is on potential buyers of ecosystem credits such as corporations, industrial or municipal operations that are interested in meeting publicly stated goals on environmental impacts, shareholder and stakeholder expectations or regulatory obligations to improve the environment.

This study estimates potential demand for ecosystem market credits at $13.9 billion.



A. Carbon Credit Potential

This study estimates the potential volume of carbon credits at 190 million tonnes[1] CO2e and the potential value at $5.2 billion. The demand focus is on companies seeking to reduce their environmental and GHG footprint due to either shareholder pressure, corporate social responsibility, license to operate, or real or perceived consumer demand, many of whom have established public commitments to reduce their direct (in-house) and indirect (i.e., supply chain) footprints, and who may thus have a need or a desire to purchase either compliance or voluntary offsets or achieve "in-setting" (supply chain) targets associated with global sustainability goals.

1. Supply Potential

The potential supply of carbon credits is estimated at 326 million tonnes CO2e and sharply exceeds demand. Field crops have the most potential for ecosystem credits accounting for 60 percent of the total potential credit supply. The Corn Belt, Northern Plains and Lake States account for two-thirds of the field crop credit supply. Rangeland and pasture rank second with 35 percent of the total potential carbon credit supply. The Mountain States, Southern Plains and Northern Plains, account for 75 percent of the potential grazing land carbon credit supply.

2. Buyer Potential

Informa evaluated potential demand for more than 100 companies across several sectors including: food and beverage; energy; industrial; chemical, fertilizer and other materials; information and telecommunications; utilities; financial; and consumer discretionary. This study recommends NRI focus on the food and beverage sector because it accounts for 57 percent of total potential demand from all sectors examined. The food and beverage sector is the sector where companies are specifically focusing Scope 3 goals and that is because they are heavily involved in their value chains. Many food and beverage companies are already committed to working with their suppliers in their value chain, NGOs and their communities to reduce their carbon footprints. Although the share of total potential demand in other sectors is less than for the food and beverage sector, there are other factors that need to be considered in setting up an ESM. For example, many banks in the financial sector have a strong interest in the environment and could help in establishing an ESM.

[1] Total potential supply of carbon credits is estimated at 324 million tonnes CO2e compared with potential demand of 190 million tonnes.

3. Carbon Credit Value

This study estimates the potential carbon market at $5.2 billion based on an evaluation of carbon credit market prices and internal company prices. Carbon prices currently range from $3.30 to $150 per tonne CO2e depending on region and whether markets are voluntary or compliance. Internal company prices currently range from $5 to $60 per tonne CO2e. Carbon pricing has emerged as an important mechanism to help companies manage risks and capitalize on emerging opportunities in the transition to a low carbon economy. Some companies are putting a price on carbon emissions because they understand that carbon risk management is a business imperative.

B. Water Quality Credit Potential

Nitrogen and phosphorous are essential in the production of crops. Although most nutrients are absorbed by crops, when applied in excess they can be lost through volatilization into the air, leaching into groundwater, emission from soil to air, and runoff into surface water. These losses can be reduced by adopting best management practices. This study assesses the amount of nutrient runoff that can be reduced by farmers for water quality credits. To succeed, a trading program must be in the watershed where the runoff occurs. The combined value of nitrogen and phosphorous water quality credits is estimated at $8.7 billion.

1. Supply Potential

Informa estimates the potential supply of ESM water quality credits for nitrogen at 3.76 billion pounds compared with potential demand of 2.16 billion pounds in all waterways. Potential supply exceeds demand in the Corn Belt, Appalachia, Delta States, Lake States, Mountain States, Northern Plains and Southeast and accounts for half the U.S. potential demand for nitrogen credits. The situation is the opposite for phosphorous. Informa estimates the potential supply of ESM water quality credits for phosphorous at 1.33 billion pounds compared with potential demand of 3.15 billion pounds in all waterways. Potential demand exceeds supply in the Corn Belt, Mountain States, Northeast and Pacific States.

Matching supply with demand for all waterways[2] indicates that 1.58 billion pounds of nitrogen and about 800 million pounds of phosphorous credits could potentially be bought through ESM.

[2] Within the same watershed.

2. Buyer Potential

Informa focused on the compliance market for entities that could potentially buy water quality credits. Publicly owned treatment works (POTW) had the greatest discharges of nutrients, accounting for approximately 63 percent of nitrogen discharges and 94 percent of phosphorous discharges into all waterways. POTW's are ideal candidates for a credit marketplace, as many have dated infrastructure and their cost of compliance to remove the next pound of phosphorous can be very high, as the facility is maxed out and the regulatory obligation may go beyond what this facility can do today.

3. Water Quality Credit Value

This study estimates the potential water quality credit market at $4.8 billion for nitrogen and $3.9 billion for phosphorous. It is difficult to come up with an average national price for nitrogen and phosphorous credits to calculate the potential value of nutrient credits based on nutrient runoff. Availability of water quality credit prices is limited because trading has yet to take off on a widespread scale and information on prices market participants are willing to pay can vary widely by region. As a price indicator, Informa used average water quality trading prices from the Chesapeake Bay Watershed since that watershed appears to have had more trading volume than other watersheds.

C. Water Quantity Markets

The ESM is proposing to generate water quantity credits in three different areas:

- Water Efficiency (Using Less)
- Water Conservation (Preserving the Downstream Market)
- Flood Reduction (Increasing the Upstream Water Holding Capacity/Floodplain Strengthening)

The Water Efficiency and Water Conservation market segments suffer from the related issues that water quantity reduction in many cases requires fields to be left fallow and/or crops to be switched, reducing farm productivity and leading to farmer concerns. There are also numerous legal hurdles related to water rights in the 17 Western states where water rights are administered by state governments. These considerations coupled with difficulties in quantifying reduction goals led Informa to exclude these segments from the Noble Addressable Market at present. The Flood Reduction market segment is expected to have little commercial demand at present due to a lack of commercial economic incentives, non-transferability of downstream community benefits, and complex localized analysis requirements, though there may be future opportunities in this area depending on policy developments.

D. Recommendations to Establish ESM

- Carbon Credit Focus:
  - Voluntary sector;
  - Food and beverage companies in terms of demand; and
  - Field crops in terms of supply.
- Water Quality Credit Focus:
  - Compliance and
  - Mainly POTWs.
- Encourage potential ESM credit buyers to work directly with NRI within their own supply chain.
  - Many interviewees, primarily food and beverage companies, want to be directly involved with their supply chain and have their own imprint included in improving the environment, especially for water quality.
- Work with other NGOs and other groups jointly to make the ESM work.
  - Groups such as the Environmental Defense Fund, The Nature Conservancy, World Wildlife Fund, Field-to-Market and Ducks Unlimited as well as individual companies such as food and beverage companies and fertilizer companies to improve soil health including improving water quality and reducing GHG emissions. Some are using protocols such as the Environmental Defense Fund.
- NRI's vision of a national system and their ability to leverage their regional network is what will differentiate the NRI ESM program from others.
- Create Protocols for carbon sequestration (GHG emission reductions) and water quality trading that can accurately measure reductions in GHG emissions and improvements in water quality from agriculture production.
  - The priority concern by potential ecosystem credit buyers is for ESM to have accurate protocols.

- Protocols and protocol development for emissions and air quality trading are a significant part of the process of developing a trading-based credit system.
- Protocols are considered a game changer for trading credits.

Determining potential area that best management practices can be applied for ecosystem markets is vital in evaluating the potential supply of ecosystem credits. Although USDA does provide data estimates on acres currently using best management practices, some private sources argue this data is underestimated. This study recommends USDA focus efforts on providing more reliable acreage data on acres currently using best management practices to better determine acreage potential for best management practices to be applied on new acres.

The Ecosystem Services Market program started by NRI became the Ecosystem Market Consortium (ESMC) in February of this year. ESMC is comprised of ADM, Bunge, Cargill, General Mills, Indigo Agriculture, McDonald's USA, Noble Research Institute, LLC, Soil health Institute and the Nature Conservancy. Mars Incorporated joined at the Legacy Partner level. The ESMC goal is to continue to build developing resources and information to establish a successful ecosystems market.

This report confirms that there is demand for ecosystem credits that is tangible and credible and not just theoretical and conceptual. The next step regarding the economic assessment is to conduct another study to evaluate the share of the potential market ESMC can capture.

II. ESM CARBON CREDIT SUPPLY POTENTIAL

A. Background

This section analyzes greenhouse gas (GHG) mitigation potential associated with changes in U.S. agricultural management practices for field crops, specialty crops (fruit, vegetables and tree nuts) and grazing lands (pasture and rangeland). The potential GHG reductions are calculated based on planted area for each land use minus the area in which management practices are currently being used by farmers[3] times mitigation factors for each best management practice examined. The mitigation potential is expressed in tonnes of carbon dioxide equivalents (CO2e).

The farm management practices used in the study were based on extensive desk research including:

- COMET-Planner Carbon and greenhouse gas evaluation for NRCS conservation practice planning, NRCS/USDA and Colorado State University.
- *Managing Agricultural Land for Greenhouse Gas Mitigation Within the United States*, ICF International.
- Economics of Sequestering Carbon in the U.S. Agricultural Sector, ERS/USDA.
- *Soil Health and Carbon Sequestration in US Croplands: A Policy Analysis*, Goldman School of Public Policy, University of California Berkley.
- *rethink Soil: A Roadmap for Collective Action to Secure the Conservation and Economic Benefits of Healthy Soils*, The Nature Conservancy.
- *Alternative Management Practices Improve Soil Health Indices in Intensive Vegetable Cropping Systems: A Review*, Department of Plant Sciences, University of Saskatchewan, Canada.
- *Cover Crops in Vegetable Production Systems*, Iowa State University.
- Other reports.

Informa also conducted interviews at the Environmental Protection Agency, Economic Research Service, Agricultural Research Service, Natural Resources Conservation Service, Office of the Chief Economist at the USDA, National Agricultural Statistics Service, Risk Management Agency,

[3] Depending on data availability.

Farm Service Agency and others to further evaluate the best management practices to use for the study.

This study applied the following best management practices to evaluate potential GHG reductions:

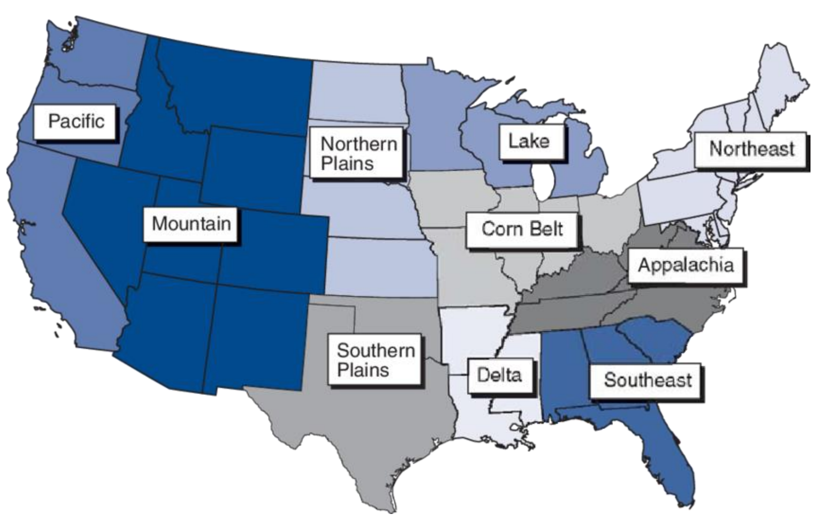
- For field crops:
  - Converting from conventional (full-width) tillage to reduced till (excluding no-till).
    - This practice applies to all cropland and is commonly referred to conservation tillage where the entire soil surface is disturbed by tillage operations.
  - Converting from conventional (full-width) tillage to no-till.
    - This practice applies to all cropland and only involves an in-row soil tillage operation during planting and a seed row/furrow closing device.
  - Seasonal cover crops.
    - Applies to all lands requiring seasonal vegetative cover for natural resource protection or improvement.
    - Help preserve environmental sustainability of field crops and specialty crops such as vegetable cropping systems and render benefits to the soil.
  - Conservation crop rotation.
    - This practice applies to all cropland where at least one annually planted crop is included in the crop rotation.
- For Fruit, vegetable and tree nut crops.
  - Nutrient Management involving replacing synthetic nitrogen fertilizer with soil amendments.
    - This practice applies to lands (primarily specialty crops such as vegetables) where plant nutrients and soil amendments are applied
    - Improves soil chemical and nutrient indices of health—soil carbon levels and nitrogen reserves.
  - Cover Crops.
- Pasture and Rangeland
  - Prescribed grazing.
    - Applies to all lands where grazing and/or browsing animals are managed.

    - Assumed to improve grassland condition and productivity, which is expected to increase soil carbon stocks.
- Legume interseeding.

Informa also differentiated benefits from improved management practices by region and climate zone. This study uses USDA's farm production regions including:

- **Northeast**: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island and Vermont.
- **Lake States**: Michigan, Minnesota and Wisconsin.
- **Corn Belt**: Illinois, Indiana, Iowa, Missouri and Ohio.
- **Northern Plains**: Kansas, Nebraska, North Dakota and South Dakota.
- **Appalachia**: Kentucky, North Carolina, Tennessee, Virginia and West Virginia.
- **Southeast**: Alabama, Florida, Georgia and South Carolina.
- **Delta**: Arkansas, Louisiana and Mississippi.
- **Southern Plains**: Oklahoma and Texas.
- **Mountain**: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming.
- **Pacific**: California, Oregon and Washington.

Exhibit 1. USDA Farm Production Regions



Informa used the COMET-Planner to attribute climate zones by region.

Exhibit 2. Region by Climate Zone

Region	Climate Zone
Northeast	moist/humid
Lake States	moist/humid
Corn Belt	moist/humid
Northern Plains	moist/dry
Appalachia	moist/humid
Southeast	moist/humid
Delta	moist/humid
Southern Plains	moist/dry
Mountain	dry/semiarid
Pacific	dry/semiarid & moist humid

Sources: COMET-Planner, NRCS/USDA and Colorado State University and Informa Agribusiness Consulting

Informa used the Comet-Planner average GHG reduction coefficients to take into account different climate zones (Exhibit 3). Since the range in coefficients for each mitigation practice is quite wide, Informa used the average coefficient range to calculate potential reductions in GHG emissions.

Exhibit 3. Best Management Practices , Climate Zone & GHG Reduction Coefficients

		Coefficients		
Best management Practices	**Climate Zone**	**Min**	**Max**	**Avg**
convert to no-till	dry/semiarid	0.02	0.54	0.22
convert to no-till	moist/humid	0.13	0.77	0.42
convert to no-till	moist/dry			0.32
convert to reduced till	dry/semiarid	0.04	0.19	0.1
convert to reduced till	moist/humid	0.02	0.22	0.13
convert to reduced till	moist/dry			0.115
Change from reduced till to no-till	dry/semiarid			0.12
Change from reduced till to no-till	moist/humid			0.29
Change from reduced till to no-till	moist/dry			0.205
conservation crop rotation	dry/semiarid	-0.18	0.71	0.26
conservation crop rotation	moist/humid	0	0.49	0.21
conservation crop rotation	moist/dry			0.235
cover crops	dry/semiarid	0.08	0.45	0.21
cover crops	moist/humid	0.16	0.46	0.32
cover crops	moist/dry			0.265
prescribed grazing	dry/semiarid	0.08	0.38	0.18
prescribed grazing	moist/humid	0.16	0.41	0.26
prescribed grazing	moist/dry			0.22
nutrient Management - soil amendments	dry/semiarid	0.4	2.17	1
nutrient management - soil amendments	moist/humid	0.85	2.51	1.75
nutrient management - soil amendments	moist/dry			1.375

Source: COMET-Planner, NRCS/USDA and Colorado State University

B. Carbon Sequestration/GHG Reduction Potential

1. Total Potential Mitigation Volume Across All Land Uses

Informa estimates total potential GHG reductions from farmers adopting best management practices on all land uses evaluated at 326 million tonnes CO2e.

- Field crops represent the greatest potential reduction in GHG emissions through improved management practices, estimated at 196 million tonnes CO2e (Exhibit 4).
  - The regions with the most potential are the Corn Belt (29 percent of the potential reduction) followed by the Northern Plains (24 percent), Lake States (13 percent) and Southern Plains (9 percent).
- Rangelands rank second in potential GHG reductions estimated at more than 84 million tonnes of CO2e.
  - The Mountain, Southern Plains and Northern Plains combined account for 90 percent of this potential.
- Pasture potential is estimated at 32 million tonnes of CO2e.
  - The Southern Plains, Appalachia and Corn Belt account for more than half this potential.
- Specialty crop potential is estimated at only 13 million tonnes of CO2e mainly because they represent a much smaller area than other land uses.
  - The Pacific region accounts for nearly half of this potential.

Exhibit 4. Potential Carbon Sequestration/GHG Reduction By Land Use & Region

In 1,000 Tonnes CO2e

Region	Field Crops	Fruit, Vegetable & Tree Nuts	Pasture	Rangeland	Total
Northeast	5,581	1,204	1,743	0	8,528
Lake States	25,374	1,495	2,652	0	29,520
Corn Belt	56,446	344	5,799	13	62,602
Northern Plains	46,730	174	2,151	16,414	65,469
Appalachia	9,977	427	4,671	0	15,075
Southeast	5,501	2,050	2,809	686	11,046
Delta	10,561	129	2,852	60	13,603
Southern Plains	18,475	497	6,660	24,551	50,183
Mountain	11,798	754	1,982	35,474	50,008
Pacific	5,488	6,180	1,018	7,279	19,965
United States	**195,931**	**13,255**	**32,337**	**84,477**	**326,000**

Source: Informa Agribusiness Consulting

2. Potential Mitigation Value

For the potential value of mitigation prices, Informa reviewed:

- EQIP program payments for soil health related practices including cover-cropping, no till, reduced tillage, conservation crop rotations, and nutrient management.
- Breakeven prices for mitigation practices calculated in other studies.

Breakeven prices for applying mitigation practices can vary sharply based on region and crop. For example, breakeven prices for converting conventional till to no till can range from an average of $21 per tonne of CO2e in the Northern Plains to as high as $104 per tonne in the Corn Belt (Exhibit 5). This suggests that a dollar spent in the Northern Plains for converting conventional tillage to no-till will yield the highest benefit in terms of CO2e captured. It also suggests that a dollar spent on using this practice on corn yields the highest benefit in capturing CO2e compared with cotton land yields showing the least benefit in terms of CO2e captured.

Exhibit 5. Potential Breakeven Prices for Converting from Conventional Till to No-Till by Region and Select Crop

In $/tCO2e

Crop	Northern Plains	Mountain	Southern Plains	Delta	Lake	Pacific	Corn Belt	Appalachia	Northeast
Soybeans	<$0		$3	$23	$17		$32	$114	$104
Corn	$18	$1	$14	$16	$22	$20	$34	$42	$44
Sorghum	$26	$18	$27	$27			$74		
Wheat	$39	$16	$44	$17	$47	$106	$57	$57	$58
Cotton		$136	$93	$141			$324		
Average	**$21**	**$43**	**$36**	**$45**	**$29**	**$63**	**$104**	**$71**	**$69**

Sources: *Greenhouse Gas Mitigation Options and Costs for Agricultural Land and Animal Production within the United States*, ICF International, NRCS/USDA and Informa Agribusiness Consulting.

Breakeven prices for converting reduced till to no till can range from an average of $23 per tonne of CO2e in the Northern Plains to as high as $207 per tonne in the Pacific region (Exhibit 6).

Another way to view costs and prices for capturing CO2e is in examining NRCS payments through the EQIP program for farmers to use soil health practices. For example, to capture one ton of carbon through soil health practices costs NRCS/USDA $33 per ton of CO2e for no-till, $32 per tonne for crop rotation, and $184 per tonne for cover crops[4]. The availability and amount of financial assistance through EQIP also varies between states.

Exhibit 6. Potential Breakeven Prices for Converting from Reduced Till to No-Till by Region and Select Crop

Crop	Northern Plains	Mountain	Southern Plains	Delta	Lake	Pacific	Corn Belt	Appalachia	Northeast	Southeast
Soybeans	$34		$78	$36	$62		$77	$72	$72	
Corn	$14	$13		$11	$20	$16	$30	$25	$30	
Sorghum	$18	$56	$11	$13			$51			
Wheat	$27	$64	$17	$8	$38	$63	$37	$24	$24	
Cotton		$466	$126	$67		$542	$230			<$0
Average	**$23**	**$150**	**$58**	**$27**	**$40**	**$207**	**$85**	**$40**	**$40**	

Sources: *Greenhouse Gas Mitigation Options and Costs for Agricultural Land and Animal Production within the United States*, ICF International, NRCS/USDA and Informa Agribusiness Consulting.

The ICF report, *Managing Agricultural Land for Greenhouse Gas Mitigation within the United States*, evaluated marginal abatement cost curve for crop production systems (major field crops) for the adoption of GHG mitigating nitrogen and tillage management practices for breakeven prices between $1 and $100 per tonne of CO2e. That report found that half of their mitigation supplied by U.S. farms at $100 per tonne of CO2e can be achieved at $30 per tonne. Above $40 per tonne the marginal cost of achieving additional mitigation through changes in nitrogen and tillage management practices increases rapidly.

The above examples demonstrate that, although the potential area that can be converted to mitigation practices is large, prices will need to be at least equivalent to breakeven prices and more likely higher to encourage farmers to use soil health mitigation practices. It is important to note that the major interest of farmers is to achieve increased revenue from improved yields and/or reduced input costs. Farmers have the option to use different inputs such as fertilizer, irrigation water and pesticides to substitute for soil health and some farmers may decide that increasing the use of inputs is a better option than making a long-term investment (sometimes up to 20 years) in soil health. An issue for some farmers to implement soil health practices is the time lag required to achieve improvements in soil health. Costs are usually higher in the early years while improvements in soil health build slowly over time. Even if benefits outweigh the costs overtime, financial constraints or uncertainty about the long-term benefits can affect farmer decisions.

[4] *Soil Health and Carbon Sequestration in US Croplands: A Policy Analysis*, Goldman School of Public Policy, University of California. Calculated using 2016 NRCS EQIP payment prices and COMET-Planner.

3. Field Crops

Field crops include: corn, sorghum, oats, barley, rye, winter wheat, durum wheat, other spring wheat, rice, soybeans, peanuts, sunflower, cotton, dry edible beans, potatoes, canola, proso millet, and sugar beets. In 2017 planted area for field crops is estimated at 318 million acres (Exhibit 7). The Corn Belt and Northern Plains account for about half that area.

Exhibit 7. US Field Crop Area by Region

In 1,000 Acres

Region	2017
Northeast	9,733
Lake States	33,844
Corn Belt	83,144
Northern Plains	84,778
Appalachia	18,651
Southeast	8,561
Delta	14,563
Southern Plains	31,630
Mountain	23,981
Pacific	8,762
Total	**317,647**

Source: NASS/USDA

Informa used NASS/USDA data in estimating the share of field crop area to estimate area using best management practices.

Improving tillage management in terms of converting land from conventional tillage to longer-term no-till and converting reduce till to no-till is considered one of the more effective farm management practices to improve carbon sequestration. This practice limits soil disturbance to crop and plant residue on the soil surface year-round. The purpose of this practice is to reduce sheet, rill and wind erosion; reduce tillage-induced particulate emissions; maintain or increase soil quality and organic matter content; reduced energy use; and increase plant available moisture.[5]

According to NASS/USDA data, currently about 39 percent of field crop area is estimated to be no-till and is estimated to have reduced GHG emissions of nearly 34 million tonnes of CO_2e (Exhibit 8). These acres are not included in the potential area for no-till because they are already being managed with a tillage option that maximizes soil health.

[5] NRCS COMET Planner.

Informa estimates that field crop area currently under conventional tillage that could be converted to no-till at over 103 million acres. This area could contribute to a 37.5 million tonnes of CO2e reductions (Exhibit 9). Informa also estimates that field crop area currently under reduced tillage of about 75 million acres could be further reduced to no-till. This would contribute an additional 18.5 million tonne reduced in CO2e[6] (Exhibit 10).

Exhibit 8. Field Crop Area Currently Using No-Till & Potential GHG Reduction

Region	2017 *1,000 Acres*	GHG Reduction Coefficient	1,000 tCO2e
Northeast	2,716	0.420	1,141
Lake States	3,989	0.420	1,675
Corn Belt	25,865	0.420	10,863
Northern Plains	35,413	0.320	11,332
Appalachia	7,103	0.420	2,983
Southeast	2,014	0.420	846
Delta	1,878	0.420	789
Southern Plains	4,776	0.320	1,528
Mountain	10,313	0.220	2,269
Pacific	1,512	0.287	433
United States	**95,578**		**33,860**

Sources: Informa Agribusiness Consulting, NASS/USDA and NRCS COMET-Planner.

Exhibit 9. Field Crop Area Converted from Conventional Tillage to Long-Term No-Till and Potential Carbon Sequestration

Region	2017 *1,000 Acres*	GHG Reduction Coefficient	1,000 tCO2e
Northeast	2,120	0.420	891
Lake States	16,140	0.420	6,779
Corn Belt	25,105	0.420	10,544
Northern Plains	22,088	0.320	7,068
Appalachia	2,363	0.420	993
Southeast	2,842	0.420	1,193
Delta	6,714	0.420	2,820
Southern Plains	12,625	0.320	4,040
Mountain	7,622	0.220	1,677
Pacific	5,390	0.287	1,545
United States	**103,008**		**37,549**

Sources: Informa Agribusiness Consulting, NASS/USDA and NRCS COMET-Planner.

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[6] Potential CO2e reductions are calculated by multiplying the average GHG reduction coefficient in Table 3 per best management practice by the acreage estimate for 2017.

Exhibit 10. Field Crop Area Converted from Reduced Till to Long-Term No-Till and Potentail Carbon Sequestration

Region	2017 *1,000 Acres*	GHG Reduction Coefficient	1,000 tCO2e
Northeast	1,491	0.290	432
Lake States	10,138	0.290	2,940
Corn Belt	24,193	0.290	7,016
Northern Plains	20,986	0.205	4,302
Appalachia	1,744	0.290	506
Southeast	1,629	0.290	472
Delta	3,080	0.290	893
Southern Plains	4,700	0.205	963
Mountain	4,831	0.120	580
Pacific	2,499	0.177	442
United States	**75,290**		**18,547**

Sources: Informa Agribusiness Consulting, NASS/USDA and NRCS COMET-Planner.

Cover crops are another way a farmer can improve carbon sequestration. Cover crops include grasses, legumes, and forbs planted for seasonal vegetative cover. The purpose of cover crops is to: reduce erosion from wind and water; maintain or increase soil health and organic matter content; reduce water quality degradation by utilizing excessive soil nutrients; suppress excessive weed pressures and break pest cycles; improve soil moisture use efficiency and minimize soil compaction[7].

Current U.S. field crop area using cover crops (excluding CRP land) is estimated at nearly 10 million acres, representing about 2.9 million tonnes of CO2e emission reductions (Exhibit 11).

The potential to further reduce GHG emissions by using cover crops on all field crops not currently using that practice is estimated at 89 million tonnes of CO2e (Exhibit 12).

[7] NRCS COMET Planner.

Exhibit 11. Field Crop Area Currently Using Cover Crops & Potential GHG Reductions

Region	2017 *1,000 Acres*	GHG Reduction Coefficient	1,000 tCO2e
Northeast	1,152	0.320	369
Lake States	1,358	0.320	435
Corn Belt	2,002	0.320	641
Northern Plains	1,062	0.265	281
Appalachia	1,214	0.320	389
Southeast	733	0.320	235
Delta	233	0.320	75
Southern Plains	1,107	0.265	293
Mountain	514	0.210	108
Pacific	537	0.208	112
United States	**9,913**		**2,936**

Sources: Informa Agribusiness Consulting, NASS/USDA and NRCS COMET-Planner.

Exhibit 12. Potential Field Crop Area to Use Cover Crops & Potential GHG Reductions

Region	2017 *1,000 Acres*	GHG Reduction Coefficient	1,000 tCO2e
Northeast	8,581	0.320	2,746
Lake States	32,486	0.320	10,396
Corn Belt	81,142	0.320	25,965
Northern Plains	83,716	0.265	22,185
Appalachia	17,437	0.320	5,580
Southeast	7,828	0.320	2,505
Delta	14,330	0.320	4,586
Southern Plains	30,523	0.265	8,089
Mountain	23,467	0.210	4,928
Pacific	8,225	0.247	2,029
United States	**307,734**		**89,007**

Sources: Informa Agribusiness Consulting, NASS/USDA and NRCS COMET-Planner.

Conservation crop rotation is another way carbon sequestration can be improved. This is a planned sequence of crops grown on the same ground over a period. Its purpose is to: reduce sheet, rill and wind erosion; maintain or increase soil health and organic matter content; reduce water quality degradation due to excess nutrients; improve soil moisture efficiency; reduce the concentration of salts and other chemicals from saline seeps; and reduce plant pest pressures; provide feed and forage for domestic livestock[8].

[8] NRCS COMET Planner.

Current U.S. field crop area using crop rotation is estimated at 82.6 million acres, representing about 17.9 million tonnes of CO2e emission reductions (Exhibit 13).

Exhibit 13. Field Crop Area Currently in Crop Rotation & Potential GHG Reductions

Region	2017 *1,000 Acres*	GHG Reduction Coefficient	1,000 tCO2e
Northeast	2,531	0.210	531
Lake States	8,799	0.210	1,848
Corn Belt	21,617	0.210	4,540
Northern Plains	22,042	0.210	4,629
Appalachia	4,849	0.210	1,018
Southeast	2,226	0.210	467
Delta	3,786	0.210	795
Southern Plains	8,224	0.230	1,891
Mountain	6,235	0.260	1,621
Pacific	2,278	0.227	517
United States	**82,588**		**17,858**

Sources: Informa Agribusiness Consulting, NASS/USDA, NRCS Comet-Planner and *ReThink Soil: A Roadmap to Soil Health.*

The potential to further reduce GHG emissions by using crop rotation on all field crops not currently using that practice is estimated at more than 50.8 million tonnes of CO2e (Exhibit 14).

Exhibit 14. Field Crop Potential Rotation & GHG Reductions

Region	2017 *1,000 Acres*	GHG Reduction Coefficient	1,000 tCO2e
Northeast	7,202	0.210	1,513
Lake States	25,045	0.210	5,259
Corn Belt	61,527	0.210	12,921
Northern Plains	62,736	0.210	13,175
Appalachia	13,802	0.210	2,898
Southeast	6,335	0.210	1,330
Delta	10,777	0.210	2,263
Southern Plains	23,406	0.230	5,383
Mountain	17,746	0.260	4,614
Pacific	6,484	0.227	1,472
United States	**235,059**		**50,828**

Sources: Informa Agribusiness Consulting, NASS/USDA and NRCS COMET-Planner.

Determining potential area that best management practices can be applied for ecosystem markets is vital in evaluating the potential supply of ecosystem credits. Although data estimates on acres currently using best management practices can be obtained from NASS/USDA data, some private sources argue this data is underestimated. This study recommends USDA focus efforts on providing more reliable acreage data on acres currently using best management practices to better determine acreage potential for best management practices to be applied on new acres.

4. Fruit, Vegetable and Tree Nut Crops (Specialty Crops)

Specialty cropping systems are managed more intensely than field crops. They require large quantities of fertilization, frequent irrigation, and repeated tillage operations. However, mainstream agricultural research has largely ignored soil health in specialty cropping systems, and this represents a conspicuous research gap. Research on soil attributes in various specialty crop systems needs to be synthesized to understand which type of management practices best promote soil health and long-term intensive agricultural sustainability. Based on the limited literature available on specialty crop systems and soil health, soil amendments have been found to generally improve soil chemical and nutrient indices of health—soil carbon levels and nitrogen reserves. Also, incorporation of cover crops to vegetable crop rotations tended to improve nitrogen recycling via reduced nitrate leaching risks, increased soil carbon levels, and weed suppression. Reduced tillage systems are rare and could be a challenge and opportunity to improve soil health dynamics.

For this report Informa focused on calculating potential GHG reductions based on using soil amendments and cover crops. Nutrient management involving replacing synthetic nitrogen fertilizer with soil amendments has the greatest potential to reduce GHG emissions from specialty crops. This practice involves managing the rate, source, placement and timing of plant nutrients and soil amendments. The purpose of the practice is to: supply and conserve nutrients for plant production; minimize agricultural nonpoint source pollution of surface and groundwater resources; properly utilize manure or organic by-products as a plant nutrient source; protect air quality by reducing odors, nitrogen emissions and the formation of atmospheric particulates and improve the physical, chemical and biological condition of the soil.

In 2017 planted area for specialty crops is estimated at 9.5 million acres (Exhibit 15). The Pacific and Southeast regions account for about two-thirds of that area. Informa assumes very little cover cropping is currently used for specialty crops. Although soil amendments could be used more than cover crops, there is no information available on what that area may be. As a result, Informa used the total planted area to specialty crops to calculate the potential for reducing GHG emissions. Informa estimates the potential reduction in GHG emissions for specialty crops at 13.3 million tonnes of CO_2e (Exhibit 15). This quantity is relatively small compared to field crops because of the much smaller planted area.

Exhibit 15. Specialty Crop Crop Cover & Soil Amendment Potential GHG Reductions

In 1,000 Acres

Region	Total Area	Cover Crop Factor	M tCO2e	Soil Amendmen	M tCO2e	Total M tCO2e
Northeast	644	0.118	76	1.750	1,128	1,204
Lake States	835	0.040	34	1.750	1,462	1,495
Corn Belt	194	0.024	5	1.750	340	344
Northern Plains	126	0.013	2	1.375	173	174
Appalachia	236	0.065	15	1.750	412	427
Southeast	1,117	0.086	96	1.750	1,954	2,050
Delta	73	0.016	1	1.750	128	129
Southern Plains	352	0.035	12	1.375	484	497
Mountain	738	0.021	16	1.000	738	754
Pacific	5,210	0.061	319	1.125	5,861	6,180
Total	**9,525**		**575**		**12,679**	**13,255**

Sources: Informa Agribusiness Consulting, NASS/USDA and NRCS COMET-Planner.

5. Grazing Lands (Pasture and Rangeland)

There are about 525 million acres of grazing lands in the U.S. in 2017[9] (Exhibit 16). Pasture accounted for about 120,000 acres and rangeland 405,000 acres.

U.S. grazing lands can be managed to significantly increase the amount of carbon stored in their soils. The practice cited the most that could improve carbon sequestration is prescribed grazing. The purpose of prescribed grazing is: improve or maintain desired species composition and vigor of plant communities; improve or maintain quantity and quality of forage for grazing and browsing animal's health and productivity; improve or maintain surface and/or subsurface water quality and quantity; improve or maintain riparian and watershed function; and reduce accelerated soil erosion and maintain or improve soil condition.

[9] Not including Federal lands.

Exhibit 16. US Grazing Land Area in 2017
In 1,000 Acres

Region	Pasture	Rangeland	Total
Northeast	5,924	0	5,924
Lake States	9,058	0	9,058
Corn Belt	19,661	47	19,708
Northern Plains	8,555	71,892	80,447
Appalachia	15,848	0	15,848
Southeast	10,803	2,640	13,443
Delta	10,970	231	11,201
Southern Plains	26,330	107,436	133,766
Mountain	9,321	188,489	197,810
Pacific	4,209	33,845	38,054
Total	**120,681**	**404,580**	**525,261**

Source: NRCS/USDA

Prescribed grazing has been shown to improve the profitability of cattle operations:

- Beef cattle raised and finished on high quality pasture that is thick and lush has been shown to have a rapid average daily gain of two or more pounds and reach marketable weight within just 20 months at a cost of $27 per hundred-weight of gain, compared with $60 in confinement.
- Dairies in New York and Wisconsin using grazing management found that pastured lactated dairy cows consistently provide a higher net farm income from operations over a 4-year period when compared to cows that are confined, whether measured per cow or per hundred weight of milk.[10]

In addition, startup and maintenance costs are lower for grazing systems than for confinement operations. Prescribed grazing systems also save on energy costs. To raise, harvest, store and feed a ton of grass hay takes about 50 pounds of nitrogen and 1.24 gallons of diesel fuel. Using costs of $0.55 per pound of nitrogen and $2.60 per gallon of fuel there are potentially direct energy savings of $15.59 per month per cow for each month a 1200-pound cow remains on pasture[11].

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[10] USDA Grazing Management, 2017.

[11] Ibid.

At the same time, from an economic perspective, GHG mitigation on rangelands is sometimes a marginal economic use of land. The reason for this is grazing lands, especially rangelands, are often of marginal economic use because of much lower economic returns. This makes it questionable whether farmers will want to incur additional costs to improve management practices. In addition, successful carbon sequestration involves maintaining improved practices for many years, often up to 20 years. Nevertheless because of the vast number of acres used for grazing there is considerable potential to reduce GHG emissions.

The USDA in the Farm Census reports the number of farms practicing management-intensive grazing but does not indicate the number of acres involved. Thus, it is essentially impossible to estimate how many acres of pasture and rangeland currently practice intensive grazing. The report, *Managing Agricultural Land for Greenhouse Gas Mitigation within the United States*, also suggests legume seeding as another option for grazing lands but this involves only a relatively small potential number of acres to reduce GHG emissions.

Informa estimates the potential reduction in GHG emissions for pasture using prescribed grazing and legume seeding at over 32 million tonnes of CO2e (Exhibit 17). The regions with the most potential are Southern Plains, Corn Belt and Appalachia, accounting for more than half of the total potential reductions in GHG emissions.

Exhibit 17. US Pasture Land Potential Carbon Sequestration

	Area	**Prescribed Grazing**		**Legume Interseeding**		
	2017	**GHG Reduction**	**1,000**	**GHG Reduction**	**Applied in**	**1,000**
Region	1,000 Acres	**Coefficient**	**tCO2e**	**Coefficient**	**1,000 Acres**	**tCO2e**
Northeast	5,924	0.260	1,540	0.665	305	203
Lake States	9,058	0.260	2,355	0.665	446	297
Corn Belt	19,661	0.260	5,112	0.665	1,033	687
Northern Plains	8,555	0.220	1,882	0.665	404	269
Appalachia	15,848	0.260	4,120	0.665	828	551
Southeast	10,803	0.260	2,809	0.665		
Delta	10,970	0.260	2,852	0.665		
Southern Plains	26,330	0.220	5,792	0.665	1,305	868
Mountain	9,321	0.180	1,678	0.665	457	304
Pacific	4,209	0.207	871	0.665	221	147
Total	**120,681**		**29,013**		**4,999**	**3,324**

Sources: NASS/USDA; COMET-Planner; ICF International.

Informa estimates the potential reduction in GHG emissions for rangeland using prescribed grazing and legume seeding at nearly 85 million tonnes of CO2e (Exhibit 18). The regions with the most potential are the Mountain states, Southern Plains and Northern Plains, accounting for ninety percent of the total potential reductions in GHG emissions.

Exhibit 18. US RangeLand Potential Carbon Sequestration

	Area	Prescribed Grazing		Legume Interseeding		
	2017	**GHG Reduction**	**1,000**	**GHG Reduction**	**Applied in**	**1,000**
Region	1,000 Acres	**Coefficient**	**tCO2e**	**Coefficient**	**1,000 Acres**	**tCO2e**
Northeast	0	0.260	0	0.665		
Lake States	0	0.260	0	0.665		
Corn Belt	47	0.260	12	0.665	1	1
Northern Plains	71,892	0.220	15,816	0.665	899	598
Appalachia	0	0.260	0	0.665		
Southeast	2,640	0.260	686	0.665		
Delta	231	0.260	60	0.665		
Southern Plains	107,436	0.220	23,636	0.665	1,376	915
Mountain	188,489	0.180	33,928	0.665	2,325	1,546
Pacific	33,845	0.207	7,006	0.665	410	273
Total	**404,580**		**81,145**		**5,011**	**3,332**

Sources: NASS/USDA; COMET-Planner; ICF International.

Based on NRCS EQIP payments to farmers for standard grazing management of $3.84 per acre (traditional and 50 percent of the cost) and using COMET-Planner, total costs for managed grazing would be roughly $30 per tonne CO2e to meet costs. Even with the payments from EQIP that cover 50 percent of costs in 2017 only 2.75 million acres used prescribed grazing compared with 6.6 million acres in 2012 (Exhibit 19). Prescribed grazing under the EQIP program has been declining.

Exhibit 19. Prescribed Grazing Acres Under EQIP Programs for FY 2009 to 2017

FY	Practice Code	Acres
2009	528	4,967,066
2010	528	4,403,352
2011	582	5,247,348
2012	528	6,623,234
2013	528	6,213,806
2014	528	2,924,258
2015	528	2,887,390
2016	528	2,675,876
2017	528	2,760,045

Source: NRCS/USDA

The Jensen study indicated a profile of farmers who are more likely to adopt prescribed grazing include those who are more highly educated, younger, and less risk averse about technology adoption; have more favorable attitudes about government incentives; view themselves as environmental stewards of the land; and have previously used the practice. Education/information variables, such as having a college degree, using the Internet to make farm business decisions, and attending extension workshops, positively influenced willingness to adopt or expand prescribed grazing, suggesting that educational programming may be an effective way to promote prescribed grazing.

III. ESM WATER CREDIT SUPPLY POTENTIAL

A. Water Quality Background

Nitrogen, phosphate, and potash are essential in the production of crops used for food, feed, fiber, and fuel. Applied annually, most of these nutrients are absorbed by the crop, but when applied in excess, they can be lost to the environment through volatilization into the air, leaching into ground water, emission from soil to air, and runoff into surface water. These losses can be reduced by adopting best management practices (BMPs) that increase nutrient accessibility and enhance plants' ability to uptake the nutrients, and more closely match nutrient applications with agronomic needs.

There are many management practices farmers can use to reduce nutrient pollution, including:

- **Nutrient management:** Applying fertilizers in the proper amount, at the right time of year and with the right method can significantly reduce the potential for pollution.
- **Cover crops:** Planting certain grasses, grains or clovers can help keep nutrients out of the water by recycling excess nitrogen and reducing soil erosion.
- **Conservation tillage:** Reducing how often fields are tilled reduces erosion and soil compaction, builds soil organic matter, and reduces runoff.
- **Drainage water management:** Reducing nutrient loadings that drain from agricultural fields helps prevent degradation of the water in local streams and lakes.
- **Irrigation management**: Making irrigation more efficient and only using water needed.
- **Watershed efforts:** The collaboration of a wide range of people and organizations often across an entire watershed is vital to reducing nutrient pollution. State governments, farm organizations, conservation groups, educational institutions, non-profit organizations, and community groups all play a part in successful efforts to improve water quality.
- **Buffers:** Planting trees, shrubs and grass around fields, especially those that border water bodies, can help by absorbing or filtering out nutrients before they reach a water body.
- **Managing livestock waste:** Keeping animals and their waste out of streams, rivers and lakes keeps nitrogen and phosphorus out of the water and restores stream banks.

Informa conducted interviews at the Economic Research Service, Natural Resources Conservation Service, Environmental Protection Agency, Office of the Chief Economist at the USDA, National Agricultural Statistics Service, Risk Management Agency, Farm Service Agency and others to further evaluate ways to evaluate agriculture nutrient runoff.

Informa also conducted extensive desk research including:

- Conservation Effects Assessment Project (CEAP) is a multi-agency effort to quantify the environmental effects of conservation practices and programs and develop the science base for managing the agricultural landscape for environmental quality.
- *Model Simulation of Soil Loss, Nutrient Loss and Soil Organic Carbon Associated with Crop Production*, NRCS - identifies areas of the country that have the highest potential for sediment and nutrient loss from farm fields, wind erosion, and soil quality degradation - areas of the country that would likely benefit the most from conservation practices.
- *Agriculture and Water Quality Trading: Exploring the Possibilities*, ERS.
- ERS Fertilizer and Price data at https://www.ers.usda.gov/data-products/fertilizer-use-and-price.aspx for crop specific fertilizer application estimates.
- *Cost of Reactive Nitrogen Release from Human Activities to the Environment in the United States*, 2015, Daniel J Sobota, Jana E Compton, Michelle L McCrackin and Shweta Singh.
- *A Compilation of Cost Data Associated with the Impacts and Control of Nutrient Pollution*, EPA, 2015.
- *Watershed Abatement Costs for Agricultural Phosphorus*, Dr. Robert Johansson, ERS/USDA, 2003.
- *Building a Water Quality Trading Program: Options and Considerations*, June 2015 Point-NonPoint Trades, 2015.

This section assesses the amount of nutrient runoff from agriculture that could be used for water quality credits. The focus of the nutrient runoff is on nitrogen and phosphorus. There are various ways that nitrogen and phosphorus loss occur as well as how the nutrient finds its way onto the field. For nitrogen, the main input pathways are commercial fertilizer application, manure, atmospheric deposition and bio-fixation. The main input pathways for phosphorus are commercial fertilizer application and manure. After these nutrients find their way into the field, there are several pathways for them to find their way off.

- For nitrogen, the main loss pathways are for the nutrient to be volatized, dissolved in surface water runoff, dissolved in leachate, dissolved in lateral subsurface, lost with waterborne sediments and lost with windborne sediment.
- For phosphorus, the main loss pathways are for the nutrient to be dissolved in water surface runoff, dissolved in leachate, dissolved in lateral subsurface, lost with waterborne sediments and lost with windborne sediment.

For nutrient runoff as it pertains to water quality, the loss focus for nitrogen will be on the nutrient being dissolved in surface water runoff, dissolved in leachate, dissolved in lateral subsurface and lost with waterborne sediments. The loss focus for phosphorus will be on the nutrient being dissolved in surface water runoff, dissolved in leachate and lost with waterborne sediments.

To succeed, a trading program must be in a watershed where Federal regulations have placed caps on the amount of pollution from nutrients that can be legally discharged. For farmers to benefit by participating in a water quality market, there also must be enough demand for agricultural offsets from regulated sources, as well as an adequate supply of low-cost agricultural offsets from farmers.

Methodology

Informa calculated agriculture nutrient runoff by region, using USDA's farm production regions including:

- **Northeast**: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island and Vermont.
- **Lake States**: Michigan, Minnesota and Wisconsin.
- **Corn Belt**: Illinois, Indiana, Iowa, Missouri and Ohio.
- **Northern Plains**: Kansas, Nebraska, North Dakota and South Dakota.
- **Appalachia**: Kentucky, North Carolina, Tennessee, Virginia and West Virginia.
- **Southeast**: Alabama, Florida, Georgia and South Carolina.
- **Delta**: Arkansas, Louisiana and Mississippi.
- **Southern Plains**: Oklahoma and Texas.
- **Mountain**: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming.
- **Pacific**: California, Oregon and Washington.

Informa used 2017 NASS data on crop acreage in each production region. Crops covered include barley, beans, canola, corn, cotton, flaxseed, hay, hops, legumes, lentils, millet, mint, oats, peanuts, peas, rice, rye, safflower, sorghum, soybeans, sugar beets, sugarcane, sunflower, taro, tobacco and wheat.

Data on nitrogen and phosphorus runoff rates by crop and by region in the US were not available for 2017. To calculate levels of runoff, data was pulled from several sources and used to develop approximate runoff levels for 2017. The general formulas used to calculate those levels are below followed by a breakdown of each variable.

Nitrogen

Nitrogen Runoff = 2017 Crop Acreage * % of Acres Receiving N * N Application Rate * % N Runoff

Phosphorus

Phosphorus Runoff = 2017 Crop Acreage * % of Acres Receiving P * P Application Rate * % P Runoff

Percent of Acres Receiving Nitrogen, Percent of Acres Receiving Phosphorus

- Nitrogen Application Rate, Phosphorous Application Rate
  - Along with the data reported on percent of acreage receiving nitrogen and phosphorus explained above, the Economic Research Service (ERS), with assistance from varying state and federal agencies, also tracks and reports the level of nitrogen and phosphorus application per acre at the national and state level. Reporting is not done on a yearly basis and the most recent data from 2015 and 2016 was used as a proxy for 2017. For this report, state data is aggregated into NASS production regions and applied to each crop as reported. The crops reported are corn, cotton, soybeans and wheat. For crops not specifically reported on (i.e. barley, beans, etc.), the average of reported crops in a specific region is used. These numbers are then used as the level of nitrogen and phosphorus application for each crop in each region.
  - Informa understands that using averages of reported crops for non-reported crops will not be exact for levels of nitrogen and phosphorus application. However, reported crops make up 75 percent of acreage and the slight variation from using an average for non-reported crops in place of data specific to non-reported crops will be minimal.

Percent Nitrogen Runoff, Percent Phosphorous Runoff

- To determine the percent of nitrogen and phosphorus runoff, shares were developed from the most recent NRCS data. These shares were developed by taking pounds per acre of N loss and dividing by pounds per acre of N input. This gives an approximate percent loss number that can be applied to current nitrogen and phosphorus application data.

B. Potential Nutrient Credits from Runoff

1. Total Potential Nutrient Runoff Reductions

(a) Nitrogen Runoff

Informa estimates the potential supply of ESM water quality credits for nitrogen at 3.76 billion pounds (Exhibit 20). The Corn Belt accounts for the largest share (35 percent) followed by Northern Plains (14 percent), Lake States (11 percent) and Appalachia (10 percent).

Exhibit 20. Agriculture Nitrogen Runoff by Region, 2017

Region	Nitrogen (mil pounds)	Percent Runoff
Appalachia	384.2	10.2%
Corn Belt	1,303.9	34.6%
Delta	214.4	5.7%
Lake States	409.8	10.9%
Mountain	263.5	7.0%
Northeast	129.7	3.4%
Northern Plains	514.8	13.7%
Pacific	100.7	2.7%
Southeast	267.5	7.1%
Southern Plains	168.9	4.5%
Total	**3,757.5**	**100%**

Sources: NRCS, ERS, NASS and Informa Agribusiness Consulting.

Corn production accounts for 65 percent of the total nitrogen runoff (Exhibit 21) followed by wheat (11 percent), cotton (8 percent), hay (4 percent) and rice (2 percent).

Exhibit 21. Agriculture Nitrogen Runoff by Crop, 2017

Crop	Nitrogen (mil pounds)	Percent Runoff
Corn	2,432.0	64.7
Wheat	426.0	11.3
Cotton	285.9	7.6
Hay	143.9	3.8
Rice	80.3	2.1
Other	389.4	10.4
Total	**3,757.5**	**100.0**

Sources: NRCS, ERS, NASS and Informa Agribusiness Consulting.

Note: Other Category does not include pastureland; data unavailable to estimate runoff for pasture.

Nutrient runoff also has off-farm impacts. Nitrogen runoff from human activities to the environment can cause human health and ecological problems. These harmful effects are not reflected in the costs of food, fuel, and fiber that derive from nitrogen use. Economic losses impact recreation, human health, property values, wildlife, etc. To evaluate these effects Informa applied potential nitrogen damage cost factors from the study, *Cost of reactive nitrogen release from human activities to the environment in the United States* to Informa's calculation of nitrogen runoff (Exhibit 22). The combination of these costs ranges from $4.20 to $14.50 per pound.

Informa estimates potential off-farm damage from nitrogen runoff at $15.8 billion to $54.5 billion in 2017 (Exhibit 23). The region with the highest economic cost of nitrogen runoff is the Corn Belt followed by the Northern Plains.

Exhibit 22. Nitrogen Leaching Cost Factors of Nutrient Runoff, 2017

$/Pound

Nitrogen Damage Type	Range		
	Low	Median	High
Waterfront Property Value ($/Kg)[1]	$ 0.21	$ 0.21	$ 0.21
Recreational Use ($/Kg)[1]	$ 0.17	$ 0.17	$ 0.17
Endangered Species ($/Kg)[1]	$ 0.01	$ 0.01	$ 0.01
Eutrophication ($/Kg)[2]	$ 6.44	$ 16.10	$ 25.75
Odor/taste in drinking water ($/Kg)[3]	$ 0.14	$ 0.14	$ 0.14
Nitrate contamination($/Kg)[2]	$ 0.54	$ 0.54	$ 0.54
Colon cancer risk ($/Kg)[4]	$ 1.76	$ 1.76	$ 5.15
Total ($/Kg)	$ 9.27	$ 18.93	$ 31.97
N Leaching cost estimate ($/lb)	**$ 4.20**	**$ 8.59**	**$ 14.50**

Source: Cost of reactive nitrogen release from human activities to the environment in the United States (2015), Informa Agribusiness Consulting

[1] Dodds et al (2009) - Eutrophication of US freshwaters: analysis of potential economic damages

[2] Compton et al (2011) - Ecosystem services altered by changes in reactive nitrogen: a new perspective for US decision making, van Grinsven et al (2013) - Costs and benefits of nitrogen for Europe and implications for mitigation

[3] Kusiima et al (2010) - Monetary value of the environmental and health externalities associated with production of ethanol from biomass feedstocks

[4] van Grinsven et al (2013) - Costs and benefits of nitrogen for Europe and implications for mitigation

Exhibit 23. Economic Cost of Nitrogen Runoff by Region, 2017

$ Million

Region	Range		
	Low	Medium	High
Appalachia	1,616	3,299	5,572
Corn Belt	5,483	11,196	18,908
Delta	901	1,841	3,109
Lake States	1,723	3,519	5,943
Mountain	1,108	2,263	3,822
Northeast	545	1,114	1,881
Northern Plains	2,165	4,420	7,465
Pacific	424	865	1,461
Southeast	1,125	2,297	3,879
Southern Plains	710	1,450	2,450
Total	**15,799**	**32,264**	**54,488**

Source: Informa Agribusiness Consulting, NASS, ERS, NRCS and sources from Exhibit 22

Informa's also estimates potential off-farm damage from nitrogen runoff by crop (Exhibit 24). The crop with the highest economic cost of nitrogen runoff is corn followed by wheat and cotton.

Exhibit 24. Economic Cost of Nitrogen Runoff by Crop, 2017

$ Million

Region	Range		
	Low	Medium	High
Corn	10,226	20,882	35,267
Wheat	1,791	3,658	6,178
Cotton	1,202	2,455	4,145
Hay	604	1,234	2,084
Rice	338	689	1,164
Peanuts	313	640	1,080
Other	1,325	2,705	4,569
Total	**15,799**	**32,264**	**54,488**

Source: Informa Agribusiness Consulting, NASS, ERS, NRCS and sources from Exhibit 22

(b) Phosphorous Runoff

Informa estimates 2017 phosphorus runoff at 1.33 billion pounds (Exhibit 25). The Corn Belt accounts for the largest share (42 percent) followed by Northern Plains (22 percent), Lake States (12 percent) and Delta (9 percent).

Corn accounts for 42 percent of the total phosphorus runoff (Exhibit 26) followed by soybeans (36 percent), wheat (6 percent), hay (6 percent) and cotton (4 percent).

Exhibit 25. Agriculture Phosphorus Runoff by Region, 2017

Region	Phosphorus (mil pounds)	Percent
Appalachia	62.7	4.7%
Corn Belt	565.6	42.4%
Delta	125.0	9.4%
Lake States	157.0	11.8%
Mountain	24.7	1.9%
Northeast	36.9	2.8%
Northern Plains	288.5	21.6%
Pacific	4.2	0.3%
Southeast	33.5	2.5%
Southern Plains	30.9	2.3%
Total	**1,329.1**	**100%**

Sources: NRCS, ERS, NASS and Informa Agribusiness Consulting

Exhibit 26. Agriculture Phosphorus Runoff by Crop, 2017

Crop	Phosphorus (mil pounds)	Percent Runoff
Corn	561.4	42.2
Soybeans	476.1	35.8
Wheat	80.4	6.1
Hay	72.6	5.5
Cotton	51.6	3.9
Other	86.9	6.5
Total	**1,329.1**	**100.0**

Sources: NRCS, ERS, NASS and Informa Agribusiness Consulting.

Excess discharge of phosphorus from agricultural production is a national and state concern. This is reflected in current and proposed water quality regulations such as the proposed Total Maximum Daily Load (TMDL) standards and watershed rules. The study, *Watershed abatement costs for agricultural phosphorus*, used a hypothetical budget to illustrate the benefits of including both economic and biophysical information when targeting government conservation payments (such as CRP and/or EQIP) for a national phosphorus mitigation policy. The study linked phosphorus loading potentials to heterogeneous agricultural productivity, targeting phosphorus abatement at an average cost of $20.63 per kilogram ($9.36 per pound). This cost was attributed to a specific targeted phosphorous abatement and although the study was done in 2003, the abatement cost in this study would represent the low end of the economic cost of phosphorous abatement, but it at least gives some perspective on the cost. Applying this cost to Informa's phosphorous runoff would put the total economic cost of phosphorous runoff at $12.4 billion.

C. Water Quality Markets

Water quality trading, also known as nutrient trading, holds the promise of saving billions of dollars for waste-water treatment plants and industrial polluters in the United States. But despite its enticing promise, water quality trading has yet to take-off on a widespread scale. For example, two separate entities within a watershed, such as a Waste Water Treatment Plant (WWWTP) and a farmer, each have a water discharge that has a pollutant of interest in it. In a trading scenario between the two dischargers, point and nonpoint source, the WWTP, who has a higher cost for removing one unit of phosphorus, would pay the farmer to remove an extra unit of phosphorus at the lower cost. The payment that the WWTP makes to the farmer is negotiated between them.

These prices can vary by location (Exhibit 27) so it is very difficult to come up with an average national price for nitrogen and phosphorous to calculate the value of credits based on Informa's estimate of runoff. Availability of water quality credit prices is limited because trading has yet to take off on a widespread scale and information on prices market participants are willing to pay can vary widely by region. Informa could have used abatement cost curves to determine ecosystem market prices but supply demand curves are used mainly for developed markets and these are fully developed. As a price indicator, Informa used average water quality trading prices from the Chesapeake Bay Watershed since that watershed appears to have had more trading volume than other watersheds. Using the average prices for the Chesapeake Bay Watershed in Exhibit 27 for nitrogen and phosphorous and Informa runoff estimates for those nutrients are:

- Nitrogen runoff credits could be $11.5 billion and
- Phosphorous runoff credits could be $6.55 billion.

Exhibit 27. Major US Water Quality Trading and Offsets Programs by Value, Volume, Credit Type, Credit Life, and Average Price in 2015

Location	Name of Program	Credit Type	Credit Life	Credit Source	Average Price	Total Value of Credits	Total Volume of Credits
Virginia	Chesapeake Bay Watershed	lbs N, lbs P	Annual	Point Sources or Nonpoint Sources	$3.05 N and $4.93 P	$1.7 Million	538,280
Pennsylvania	Chesepeake Bay Watershed Nutrient Credit Trading Program	Lbs N, lbs P	Annual	Point Sources or Nonpoint Sources	$0.97 N and $1.25 P	$30,000	34,598
Indiana, Kentucky, Ohio	Ohio River Basin Trading Project	lbs TN and TP	Annual	Nonpoint Sources	$10	$3,000	250
Connecticut	Connecticut Nitrogen Exchange	Lbs N	Annual	Point Sources	$6.73	$3.8 Million	566,845
California	Santa Rosa Nutrient Offset Program	Lbs Total Nitrogen (TN) and Total Phosphorus (TP)	Annual	Nonpoint Sources	$14.14	$330,000	23,345
DC	Stormwater Retention Credit Trading program	Stormwater Retention Credits	Annual	Nonpoint Sources	$1.90	$21,000	11,013

Source: Forest Trends Ecosystem Marketplace - *State of Watershed Investment, 2016*

IV. ESM CARBON CREDIT DEMAND POTENTIAL

A. Background

In support of Noble Research Institute's efforts to advance ecosystem service markets (ESM) that incentivize farmers and ranchers to improve soil health systems benefiting society, Informa conducted a detailed analysis to estimate the spectrum of potential demand for ecosystem service credits driven by corporate commitments related to carbon. Informa conducted extensive desk research and several interviews to evaluate this demand including:

- Bureau Veritas North America (BVNA) verification statements and other verifiers on greenhouse gas emissions (GHG) and renewable energy for selected companies depending on availability;
- CDP (formerly the Carbon Disclosure Project) Climate Change Information Requests to select companies depending on availability.
- CDP Climate study reports.
- Robecosam company sustainability rankings.
- Annual Corporate Citizenship Reports.
- Company press releases on sustainability.
- Ecosystem Market Place - Forest Trends website and reports.
- Sustainability news reports.

Informa conducted more than 30 interviews with contacts at different companies, primarily food and beverage companies. The interviews focused on the following:

- Their organizations environmental corporate commitments or goals and their value proposition to support those goals;
- Do they have a focus on soil health and improving water quality;
- Are they working with the agriculture sector within their supply chain;
- What is your view regarding ecosystem markets and would they be willing to buy ecosystem credits;
- What would they need to know about an ESM program to encourage them to engage it; etc.

Some of the takeaways from the interviews included:

- All interviewees have goals to reduce GHG emissions, reduce water use and improve water quality.
- Most of the interviewees emphasized that they might be interested in an ESM program if it had protocols that can confirm improvements have been made regarding soil health and water quality. However, essentially all of them said that before they would make any commitment to an ESM program they would like to know exactly how it would work and what protocols would be used.
- Many of the interviewees said they were working already working with groups such as The Nature Conservancy, Environmental Defense Fund and others to reduce GHG emissions and improve water quality. Some of them were concerned that an ESM program could be viewed as competition for the groups they are already working with such as the Environmental Defense Fund and The Nature Conservancy, etc.
- Interviewees emphasized they want to be directly involved with farmers in their value chain.
- Some of the interviewees indicated that they would be a greater likelihood they would participate in an ecosystem market for Scope 3 emissions because they did not think they could meet them on their own. They felt they could handle their reduction goals for Scope 1 and 2 on their own[12].

This study estimates GHG emissions in million tonnes of carbon dioxide equivalent (Mt CO_2e). CO_2e allows all greenhouse gas emissions to be expressed in terms of CO_2 based on their relative global warming potential.

GHG emissions were evaluated in terms of:

- Scope 1 - direct emissions from owned or controlled sources;
- Scope 2 - indirect emissions from the generation of purchased energy; and
- Scope 3 - all indirect emissions not included in Scope 2 that occur in the value chain of the reporting company, including both upstream and downstream emissions.

The GHG emissions data included in this report is the latest available data, which is mostly for 2017. Most of the largest companies in the world account and report on Scope 1 and 2 emissions.

[12] Interviewees who made these comments were already working with other groups such as EDF.

Many companies are starting to report on Scope 3 emissions involving their value chain. Scope 3 emissions usually represent a company's biggest GHG emission impacts. For scope 3, this study excludes international GHG emissions[13].

Informa evaluated the NRI total available market (NAM) for carbon credits based on desk research, company goals and interviews. Informa evaluated the segmented available market (SAM) that the NAM was based on. The SAM was broken out into the following sectors:

- Food and Beverage
- Energy
- Industrial
- Chemical, Fertilizer and Other Material
- Information Technology and Telecommunications
- Financial
- Utility
- Consumer Discretionary

Informa further breaks out the NAM and SAM between carbon offsetting and insetting potential.

- Offsetting – involves companies purchasing offset credits from a carbon reduction project that is not related to the company or its supply chain and are generated by projects around the world which reduce emissions through a variety of techniques and technologies.
- Insetting – directs investment of a company within its own value chain (up- and down-stream) to reduce its carbon footprint.

In this report, Scope 1 and 2 emission goals for this report are considered offsetting potential while Scope 3 goals is considered insetting potential because they are expected to occur within their value chain. Informa believes the greatest demand potential will be for companies to meet Scope 3 goals as a number of these companies have indicated there is no way they can meet those goals without buying carbon offsets.

[13] There is a chance there could be double counting using international Scope 3 emissions because Scope 3 emissions could be considered someone else's emissions as well. There is no way to eliminate double counting. The only check would be to make sure ESM credits are not sold twice for the same emissions.

B. Company/Sector Carbon Emissions

Informa focused on evaluating potential carbon demand for more than 100 companies across several sectors. Nearly all companies have goals to reduce their GHG emissions, especially for Scope 1 and 2. Informa estimates that these companies have more than 1.2 billion tonnes of CO2e Scope 1 and 2 emissions and nearly 3.2 billion tonnes of Scope 3 emissions[14] (Exhibit 28). Scope 3 emissions are larger because they involve a company's total value chain. Some sources indicate that many companies are underestimating their GHG emissions because they are difficult to measure, especially for Scope 3. In addition, some companies are only starting to report Scope 3 emissions.

The largest GHG emitters are the energy sector followed by the food and beverage sector[15].

Exhibit 28. Total & Selected Sector GHG Emissions, 2017

In Mt CO2e

	GHG Emissions	
Sector	**Scope 1&2**	**Scope 3**
Agriculture, Food & Beverage	107.1	725.2
Energy	372.5	1,404.0
Industrial	220.6	57.4
Chemical, Fertilizer & Other Materials	156.8	538.0
Information & Telecommunications	28.0	102.4
Utilities	315.8	63.1
Financial	5.2	5.9
Consumer Discretionary	12.3	286.3
Total Sectors	**1,218.4**	**3,182.2**

Notes: Emissions data are latest available and primarily 2017.
Emissions are domestic and international.
Source: Informa Agribusiness Consulting

[14] Based on the latest year available which is usually 2017.

[15] Only select companies in each sector were included, based on Informa's analysis of having the greatest potential to buy ecosystem credits.

C. Potential NAM Volume

Informa calculates potential demand for carbon credits based on desk research, interviews and company goals to reduce GHG emissions. Company GHG mitigation goals are commitments to limit GHG emissions at a future date to a specified quantity by a specified date from a designated base year. A base year is a specific year of historical emissions data and is the first year of the goal period. The goals have a target date to be achieved and vary by company with some set to be achieved by 2020 and others to 2030, 2050 or other years. The goals are either measured as a specified quantity in terms of absolute emissions or in terms of intensity and measured in emissions per unit of another variable such as sales, product output, etc. Scope 1 and 2 goals are measured in terms of a company's international emissions. Scope 3 goals are adjusted to reflect only the U.S. value chain. It is important to note that some companies have reached their stated goals and will likely be announcing new goals sometime in the future. Other companies are close to reaching their goals, so their potential demand is smaller since they have achieved a larger share of their goals to date. Companies with longer-term goals such as 2030 or 2050 will likely have larger potential demand since they are only starting to meet those goals.

Based on Informa's analysis, the total segmented market (NAM) for carbon reductions are 189.7 million tonnes of CO2e. This is equivalent to taking 40.7 million passenger vehicles off the road for one year. The SAM for Scope 1 & 2 carbon offsetting market is 100 million tonnes and for Scope 3 is 90 million tonnes (Exhibit 29).

Exhibit 29. Potential SAM for Carbon Credits, 2017

In Mt CO2e

	Company Potential	
Sector	**Offsetting**	**Insetting**
Agriculture, Food & Beverage	18.7	89.9
Energy	6.8	
Industrial	42.0	0.1
Chemical, Fertilizer & Other Materials	1.9	
Information & Telecommunications	3.9	
Utilities	23.0	
Financial	1.0	
Consumer Discretionary	2.5	
Total Potential	**99.7**	**90.0**

Notes: Blank data implies company GHG reduction goals. Many companies have not yet set goals for Scope 3. Scope 1 and 2 offsetting reductions are domestic and international. Scope 3 insetting reductions are adjusted to reflect only domestic emissions.
Source: Informa Agribusiness Consulting

The sectors which have the most potential for Scope 1 and 2 offsetting are industrial, utilities, chemical/fertilizer, and food/beverage companies. The sector with the most potential for Scope 3 insetting is the food/beverage sector. The food and beverage sector are the sector where companies are specifically focusing on Scope 3 goals and that is because they are heavily involved in their value chains. Regarding the other sectors, those sectors' goals focus on Scope 1 and 2 and many companies in those sectors are only starting to focus on Scope 3.

To meet goals, companies are:

- Pledging to improve their energy efficiency or increasingly power their operations with renewable energy.
- Using improved technology to either reduce or capture GHG emissions and use those captured emissions in other production processes.
- Striving to achieve sustainability throughout their supply chain by working either directly with their suppliers or indirectly through other organizations such as The Nature Conservancy, Environmental Defense Fund, World Wildlife Fund, Ducks Unlimited, etc.
- Changing their ingredients.
- Buying ecosystem service credits.
- Using other measures.

Companies in the food and beverage sector are engaging their suppliers to manage and reduce GHG emissions for several reasons including:

- To demonstrate their sustainability commitments and retain or enhance their brand's reputation, recognizing that supplier impacts extend to their overall environmental impacts.
  - Companies are aware that their reputation for sustainability impacts their brand.
- To reduce costs.
  - Companies seek to insulate their supply chains from sudden increases in energy costs or disruptions due to supply scarcity, as such risks affect the prices and availability of their goods and services.
- To mitigate risk and pursue new opportunities.
  - Companies understand they can gain competitive advantage by improving the environmental sustainability of their products and marketing this feature to consumers both domestically and for export.

- To respond to downstream corporate customer, individual consumer and, increasingly, investor queries and demands.[16]

D. NAM Potential Value

Activity in voluntary carbon offset markets has been increasing over the last decade. Forest Trends Ecosystem Marketplace[17] estimates in 2017 that 42.8 MtCO2e of carbon credits were retired. An Ecosystem Marketplace report, *Buying In: Taking Stock of the Role of Offsets in Corporate Carbon Strategies*, showed carbon prices (voluntary and compliance) ranging from $3.30 per tonne to more than $150 per tonne with the median internal price at $18 per tonne. The study also indicated the World Bank estimates the social cost of carbon at $30 per tonne.
Internal carbon pricing has emerged as an important mechanism to help companies manage risks and capitalize on emerging opportunities in the transition to a low-carbon economy. Some companies are putting a price on carbon emissions because they understand that carbon risk management is a business imperative. Companies disclose a variety of reasons for using an internal carbon price: to reveal hidden carbon risks and opportunities, or even as a deliberate tool to transition to a low-carbon business model. Many of the companies in the U.S. are doing internal pricing because they are multinational. Exhibit 30 includes companies in the U.S. currently doing internal pricing. Internal prices range from $5 to $60 per tonne CO2e. The average internal carbon price for companies that have internal prices are available is $27.70 per tonne.

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[16] *Emerging Trends in Supply Chains Emissions Engagement*, EPA

[17] Voluntary Carbon Markets Insights: 2018 Outlook and First-Quarter Trends

Exhibit 30. Companies Doing or Planning to Do Internal Carbon Pricing

In $ tCO2e

Sector	Company	Price US$/tonne CO2e	Companies Anticipating Using Internal Price
Consumer Discretionary	General Motors	5.34; 20	
	Walt Disney Company	5-10	
Consumer Staples	Archer Daniels Midland		
	Campbell Soup Company		
	Cargill	30	
	Dean Foods Company		
	Kellogg Company		
	Mars	5.94	
	Nestle		
	Hormel Foods		X
	Molson Coors Brewing Company		X
Energy	ConocoPhillips	9-43	
	Hess Corporation	40	
	Baker Hughes Incorporated		X
	BP	40	
	Chevron Corporation		
	Exxon Mobile	60	
	Occidental Petroleum Corporation		
	Shell	40	
Financial	BNY Mellon	21.87	
	World Bank Group	30; 80	
	Goldman Sachs Group		
	JP Morgan Chase		X
	Morgan Stanley		X
	Wells Fargo and Company		
Industrials	Cummins Inc.		
	Delta Airlines		
	General Electric Company		
	Owens Corning	10; 60	
	United Technologies Corporation	21.48	
	Wisconsin Energy Conservation Corporation	12.94	
	3M Company		X
	Republic Services, Inc.		X
	Waste Management Inc.		
Information Technology	Microsoft Corporation	10-20	
	Hewlett Packard Enterprise Company		X
	Yahoo Inc.		X
	Google	14	
Materials	The Dow Chemical Company		
	Monsanto Company		
	The Mosaic Company		
	Newmont Mining Corporation	25-50	
	Owens Illinois	13.22	
Utilities	The AES Corporation		X
	American Electric Power Company		
	Duke Energy Corporation		
	Exelon Corporation		
	Sempra Energy		
	WEC Energy Group		
	Xcel Energy	8-69	
Average		**27.70**	

Notes: Blanks under price data column means not available.

Sources: *Putting a Price on Carbon Integrating Climate Risk into Business Planning*, CDP, October 2017 and others.

This study estimates the potential carbon market at $5.2 billion based on an evaluation of carbon credit market prices and internal company prices. Carbon prices currently range from $3.30 to $150 per tonne CO2e depending on region and whether markets are voluntary or compliance. Internal company prices currently range from $5 to $60 per tonne CO2e. Carbon pricing has emerged as an important mechanism to help companies manage risks and capitalize on emerging opportunities in the transition to a low carbon economy. Some companies are putting a price on carbon emissions because they understand that carbon risk management is a business imperative. The average for internal carbon prices used by companies was $27.70 per tonne.

As indicated earlier buying offsets is one of the ways companies can meet their goals. Based on an Ecosystem Marketplace report, *Unlocking Potential, State of the Voluntary Carbon Markets 2017, Buyers Analysis*, ranked the *drivers* for buyers to purchase offsets as follows:

- Co-Benefits (35% of the sample) – with community benefits, protecting biodiversity and climate change adaption the most important.
- Cost (25%) – cost of the offsets compared with costs the company needs to incur to reduce emissions.
- Fit with the organization mission (18%).
- Project location (6%).
- Recommendations of partner or advisor (4%)
- Other (13%).

Based on Informa interviews, co-benefits and fitting with organization mission were also ranked as a high priority. These co-benefits strongly support the carbon sequestration, water benefits and soil health strategy under the ESM.

E. SAM Potential

1. Food and Beverage Sector

Over 40 companies were examined in this sector. Informa estimates GHG emissions by these companies at 107 million metric tons of CO2e Scope 1 and 2 emissions and 725 million tonnes of Scope 3 emissions[18] (Exhibit 31). Scope 3 emissions are larger because they involve a company's total value chain.

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[18] Based on the latest year available which is usually 2017.

Exhibit 31. Food and Beverage Sector GHG Emissions

In Mt CO2e

	GHG Emissions	
Company	**Scope 1&2**	**Scope 3**
Ahold Delhaize	3.8	0.4
Altria Group Inc.	0.3	
Archer Daniels Midland	17.9	6.5
Bunge	3.3	5.6
Campbell Soup Company	0.7	
Cargill	0.1	7.7
Chiptole	0.2	
CHS Inc.		
The Coca-Cola Company	0.6	3.5
ConAgra Brands	0.7	0.3
Constellation Brands, Inc.	0.2	
Costco	1.5	1.2
CVS Health Corp	1.4	0.1
Darden Restaurants, Inc.	1.1	
Danone	1.5	20.2
Dean Foods	1.0	
Dr Pepper Snapple Group Inc	0.4	
General Mills Inc.	1.0	14.5
The Hershey Company	0.3	
Hormel Foods	0.8	0.5
J.M. Smucker Company	0.3	
Kellogg Company	1.0	11.8
Kraft Foods	1.1	
Kroger	6.8	1.7
Mars	3.7	22.5
McCormick & Company, Inc.	0.1	
McDonald’s Corporation	2.0	29.0
Molson Coors Brewing Company	1.1	5.3
Mondelez International Inc	1.7	15.4
Nestle	3.7	105.8
Panera	0.3	1.9
PepsiCo, Inc.	5.7	62.8
Procter & Gamble Company	4.6	210.2
Safeway Inc. (Albertsons)	3.6	
Sysco Corporation	3.6	
Starbucks Corporation	1.3	
Target Corporation	2.9	0.0
Walgreen Company	2.2	0.1
Wal-Mart Stores, Inc.	21.4	192.9
Whole Foods Market, Inc.	0.8	
Yum! Brands, Inc.	2.2	5.4
Total	**107.1**	**725.2**

Notes: See footnote[19]

Source: Informa Agribusiness Consulting

[19] Includes all companies examined in this sector. Companies were selected by Informa based on best judgement. Emissions data are latest available and domestic and international. Blanks imply data not available or not reported.

Based on Informa's analysis the NRI total available market for food and beverage companies for Scope 1 & 2 carbon offsets is 18.7 million tonnes and for Scope 3 is 89.9 million tonnes if only domestic potential is included (Exhibit 32).

Exhibit 32. Food and Beverage Company SAM Potential for Carbon Credits

In Mt CO2e

	Company Potential			
		Insetting		
Company	Offsetting	Domestic	Foreign	Goal Year
Wal-Mart Stores, Inc.	3.8	35.0	31.0	2030
Nestle	2.3	20.0	39.0	2050
Mars	3.7	8.8	8.8	2050
Danone	1.5	3.0	3.0	2030
General Mills	0.4	5.0	2.0	2050
Pepsico	1.1	8.0	4.6	2030
Kellogg	0.6	2.5	3.4	2050
McDonald's Corporation	0.5	6.0	4.4	2030
Mondelez International Inc	0.6	0.8	0.6	2020
Cargill	0.0	0.5	0.3	2025
Other	4.2	0.4	0.6	
SAM Potential	**18.7**	**89.9**	**97.7**	

Notes: Data represents selected companies viewed with potential in the Food/Beverage sector. Other includes selected companies examined with small potential. Offsetting are domestic and International. Insetting are estimated by Informa and broken out between domestic and international.
Source: Informa Agribusiness Consulting

Some interviews of food and beverage companies noted there is a greater potential for their company to buy carbon credits for their insetting goals because those goals are much larger than they would be able to meet internally.

Many food and beverage companies are already committed to work with their suppliers, NGOs and their communities to reduce their carbon footprints.

- Cargill, Environmental Defense Fund, General Mills, Kellogg Company, Monsanto, PepsiCo, The Nature Conservancy, Walmart, and World Wildlife Fund (WWF) formed the partnership, The Midwest Row Crop Collaborative, to support, enhance and accelerate best management agricultural practices in Illinois, Iowa and Nebraska.
    - Agricultural practices include cover crops, conservation tillage and using nutrient management techniques. This collaborative is committed to raising $4 million over four years to accelerate the Soil Health Partnership – a farmer led initiative of the National Corn Growers Association.

- Some companies are forming partnerships with agricultural retailers to advise farmers on their practices.
  - Land O'Lakes Sustain is a business unit of Land O'Lakes that is working with farmers in partnership with companies such as Campbell Soup and Walmart to help achieve company-level sustainability goals.
  - For example, Campbell Soup has identified wheat as a priority ingredient to source more sustainably and is working with farmers to make soil health a norm because of environmental benefits and improve farmers' bottom lines.
- General Mills is committing $2 million over three years to help The Nature Conservancy improve soil health through The Nature Conservancy's reThink Soil initiative. General Mills is also investing in soil health practices on U.S. agricultural farmland with a 2017 contribution of $735,000 to the National Wheat Foundation who, together with the Soil Health Partnership, to advance widespread adoption and implementation. The funds will be used to conduct soil health research on wheat farms and education outreach to more than 125,000 wheat farmers across the Northern and Southern Plains.
- Mars is working with their supply chain partners to boost agricultural production without extending its overall land footprint. This requires a focus on efficient and sustainable land use, as well as the rehabilitation of degraded land and soil health. Mars is working with farmers to improve agronomic practices, reduce GHG emissions, and in some cases, sequester carbon. Mars intends to invest $1 billion in a campaign to help cut GHG emissions across its value chain 67% by 2050.
- Danone is focusing on protecting soil health through regenerative agricultural practices co-developed with its partners.
- Kellogg Company, United Suppliers, Inc., and Environmental Defense Fund (EDF) are collaborating to help growers improve fertilizer efficiency and soil health on their farms while maintaining high yields.
- Nestlé Purina PetCare Co. committed $1 million in 2017 over five years for The Nature Conservancy's reThink Soil initiative. The reThink Soil project is a national effort to help farmers improve soil health on cropland across the United States.
- Many of Subway's suppliers share their commitment to social responsibility and sustainability. They use sustainable agricultural practices such as cover cropping and crop rotation to restore nutrients to the soil and help maintain local ecosystems, minimize

pesticide and fertilizer use, and employ irrigation practices that reduce electricity and water use.

- Walmart encourages suppliers to develop fertilizer optimization plans for 14 million acres of US farmland by 2020 and optimize fertilizer use on 76 million acres of land by 2025. Walmart's goal is to foster improvements in food yields, water efficiency and GHG emissions through special projects and continuous improvement.
- Kroger is partnering with The Sustainability Consortium to assess key commodities using their commodity mapping tool, which is designed to help identify and further understand social environmental risks in upstream commodities.
- Tyson's Food goal to increase sustainable land stewardship practices on 2 million acres by 2020.
- Many companies are working with Field to Market, their suppliers and growers, to expand use of the Fieldprint Calculator to capture data about soil conservation, soil carbon and other sustainability impact metrics.

A concern brought up in the interviews is if a company decides to work with Noble's ESM, what will that mean for their relationship with the organizations they are already working with in their supply chains such as The Nature Conservancy, Field to Market, Environmental Defense Fund, Ducks Unlimited, and others.

2. Energy Sector

The energy sector has significantly large GHG emissions, estimated at 1.78 billion tonnes. The sector's CO2e Scope 1 and 2 emissions are estimated at 373 million tonnes and Scope 3 emissions are estimated at 1.4 billion tonnes (Exhibit 33).

Demand for the energy sector mainly focuses on Scopes 1 and 2 for offsetting, which are estimated at 6.8 million tonnes (Exhibit 34).

Although the energy companies are large GHG emitters, very few companies have GHG reduction targets. Also, companies that buy carbon credits, have been buying those credits for compliance reasons. These companies are primarily focusing on reducing their methane emissions and want to show that they are specifically reducing methane emissions. Shell reports indicated interest in reducing their carbon footprint by 50 percent by 2050, including their Scope 3 emissions. The tools Shell said it can use to reduce emissions include:

- Supplying gas for power
- Providing renewable power from solar and wind
- Using more battery electric vehicles.
- Developing gas markets for power and transport.
- Operational efficiencies
- Developing carbon capture and storage
- And working with forests and wetlands to help compensate for emissions still in the system.

BP has set a sustainable emissions reductions target of 3.5 million tonnes out to 2025. Their operating businesses will deliver this through improved energy efficiency, fewer methane emissions and reduced flaring – all leading to permanent, quantifiable GHG reductions. BP reports also indicate it will offset any increase in emissions above 2015 levels that's not covered by their sustainable reduction's activity.

Exhibit 33. Energy Sector GHG Emissions

In Mt CO_2e

Company	GHG Emissions	
	Scope 1&2	Scope 3
BP	50.5	
Chevron Corporation	61.6	368.0
ConocoPhillips	20.6	189.1
Exxon Mobil Corporation	126.0	253.9
Halliburton Company	2.1	0.1
Hess Corporation	5.2	13.9
Marathon Oil Corporation	21.6	
Shell	85.0	579.0
Total	**372.5**	**1,404.0**

Notes: Data represents selected companies and not all companies in Energy sector.

Emissions data are latest available and domestic and international.

No data implies the company does not report Scope 3 emissions.

Source: Informa Agribusiness Consulting

Exhibit 34. Energy Company SAM Potential for Carbon Credits

In Mt CO2e

Company	Potential SAM		Goal Year
	Offsetting	Insetting	
BP	3.50		2025
ConocoPhillips	3.10		2030
Hess Corporation	0.19		2020
Potential SAM	**6.79**		

Notes: Includes only selected companies viewed with potential.
Emissions data are latest available. Offsetting are domestic and international.
Source: Informa Agribusiness Consulting

Informa believes the energy sector could still have potential for voluntary carbon credits, despite limited or no goals to reduce emissions because of the large size of the sector's emissions.

3. Industrial Sector

Informa examined 20 companies in the industrial sector. These companies also have large GHG emissions, estimated at 278 million tons of CO2e. Informa estimates Scope 1 and 2 emissions at 220.6 million tonnes and Scope 3 emissions at 57 million tonnes (Exhibit 35). Not all companies in this sector report Scope 3 emissions.

Based on Informa's analysis the sector available market for industrial companies for Scope 1 & 2 carbon offsets is 42 million tonnes and for Scope 3 is 100,000 tonnes (Exhibit 36).

The companies within the industrial sector that have the most potential to buy carbon credits are the airline companies. The global aviation industry has pledged to stabilize carbon emissions from 2020 with carbon-neutral growth and to achieve a net reduction in carbon emissions of 50 percent by 2050 compared to 2005. Per analysis of Carbon Market Watch, CORSIA's aviation program will drive demand from now until the end of the measure in 2035 of approximately 3.3 billion tonnes of CO2e from all airlines.

Exhibit 35. Industrial Sector GHG Emissions

In Mt CO2e

Company	GHG Emissions	
	Scope 1&2	Scope 3
3M Company	6.0	9.1
American Airlines	42.3	0.2
Boeing Company	1.6	0.3
BSNF	15.2	0.0
Caterpillar	2.1	
CSX Corporation	4.9	0.2
Cummins Inc.	0.8	
Deere & Company	1.5	
Delta Air Lines	35.7	4.3
FedEx Corporation	15.1	2.6
General Electric Company	3.8	8.0
Honeywell International Inc	6.1	
Lockheed Martin Corporation	0.8	
Norfolk Southern Corp.	5.2	
Northrop Grumman Corp	0.5	
Republic Services, Inc	16.1	
Southwest Airlines Co	20.2	0.3
Union Pacific Corporation	10.3	2.9
United Technologies Corporation	2.1	
UPS	13.8	20.1
Waste Management, Inc	16.4	9.3
Total	**220.6**	**57.4**

Notes: Emissions data are latest available. No data implies the company does not report Scope 3 emissions or is only beginning to report Scope 3 emissions and data are incomplete. Emissions are domestic and international.

Source: Informa Agribusiness Consulting

Exhibit 36. Industrial Company SAM Potential for Carbon Credits

In Mt CO2e

Company	Company Potential		Goal Year
	Offsetting	Insetting	
American Airlines	13.5		2050
Delta Airlines	16.9		2050
Southwest Airlines	6.0		2050
Fedex	1.1		2020
UPS	2.3		2025
Boeing Company	0.6	0.1	2050
Caterpillar	0.6		2020
Other	0.9		
SAM Potential	**42.0**	**0.1**	

Notes: Emissions data are latest available. Offsetting is domestic and International and insetting is domestic. Other includes selected companies with relatively small potential.

Source: Informa Agribusiness Consulting

In 2017 Delta Airlines, for example bought 2.3 million tons of offsets. Delta Airlines supports projects in Zimbabwe and the Democratic Republic of the Congo aligned with the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+). The Florestal Santa Maria project, meanwhile, promotes improved forest protection in the Mato Grosso region of Brazil. All their offset purchases are verified by third parties. Delta also offers a carbon calculator to their airline passengers. Customers and other stakeholders can use the calculator to estimate the carbon emissions associated with their trips. Through Delta's partnership with The Nature Conservancy, passengers can then make financial contributions toward offset projects of their choice.

4. Chemical, Fertilizer & Other Material Sector

These companies also have large GHG emissions. Informa estimates that these companies have 156.8 million metric tons of CO2e Scope 1 and 2 emissions and 538 million tonnes of Scope 3 emissions[20] (Exhibit 37).

Exhibit 37. Chemical, Fertilizer and Other Materials Sector GHG Emissions

In Mt CO2e

	GHG Emissions	
Company	**Scope 1&2**	**Scope 3**
Alcoa Inc	22.9	38.7
BASF	20.6	420.0
CF Industries	14.4	
The Dow Chemical Company	34.6	75.7
Bayer/Monsanto Company	2.9	0.6
The Mosaic Company	4.4	0.0
Newmont Mining Corporation	4.7	
Nutrien	10.8	
PPG Industries, Inc.	1.2	
Praxair, Inc.	21.2	3.0
US Steel Corporation	19.1	
Total	**156.8**	**538.0**

Notes: Emissions data are latest available and domestic and international.

Source: Informa Agribusiness Consulting

Based on Informa's analysis the sector available market for chemical, fertilizer and other material companies for Scope 1 & 2 carbon offsets is just under 2 million tonnes (Exhibit 38).

[20] Based on the latest year available which is usually 2017.

Exhibit 38. Chemical, fertilizer & Other Material Company SAM Potential for Carbon Credits

In Mt CO2e

Company	Company Potential		Goal Year
	Offsetting	Insetting	
BASF	1.4		2020
Bayer/Monsanto Company	0.1		2020
The Mosaic Company	0.4		2020
Newmont Mining Corporation	0.1		2020
Praxair, Inc.	0.0		
SAM Potential	**1.9**		

Notes: Emissions data are latest available. Offsetting are domestic and international.

Source: Informa Agribusiness Consulting

The fertilizer industry is working to reduce its GHG emissions through investment in capital improvements, including upgrades to existing production facilities and the construction of new more efficient facilities.

- The industry is capturing CO2 emitted during ammonia production and re-using it during the urea production process. Excess captured CO2 from fertilizer production is also used for other industrial use, such as enhanced oil recovery and the carbonization of soft drinks. In 2016 eight members of The Fertilizer Institute reported capturing 8 million tonnes of CO2, or 25 percent of their total CO2 emissions, up from 13 percent in 2015.
- Many of the fertilizer companies are supporting best agricultural practices, including research and practices to minimize GHG emissions associated with the use of their crop nutrient products. They support the minimization of GHG emissions from the global food supply by encouraging stakeholders to enhance their understanding, adoption and promotion of 4R Nutrient Stewardship. By applying the right fertilizer at the right rate, right time and in the right place, farmers minimize environmental impacts associated with fertilizer use, including potential greenhouse gas emissions.
- CF Industries has generated carbon credits by voluntarily implementing nitrous oxide abatement technologies to reduce greenhouse gas emissions. The company began implementing the abatement technologies in 2008. In 2016 CF Industries sold carbon credits to Chevrolet and donated the net proceeds of $600,000 to the National FFA Foundation to support excellence in farmer education and fertilizer best management practices. CF Industries has also given a substantial grant to The Nature Conservancy from to fund the campaign, known as "4R Plus," based on the 4Rs of nutrient management. The campaign aims

to educate 90,000 farmers responsible for 23 million acres of crops, while creating a sustainable agriculture blueprint that can be applied to other states.

- Nutrien is a leader in supporting the Nitrous Oxide Emissions Reduction Protocol (NERP) and other technologies that help growers reduce their environmental footprint.

Because of the close working relationship of some of the fertilizer companies with farmers, this is a sector that should be looked at closely by NRI.

Chemical companies like Dow have a goal to keep the GHG emissions below 2006 levels. Currently Dow appears to be below their goal levels.

- By 2025, Dow is considering establishing a freestanding "Sustainability" Think Tank as a self-sustaining organization, trusted to tackle the most challenging sustainability issues facing the business and the planet and to help lead the transition to a sustainable planet and society.

5. Financial Sector

Informa examined more than 10 companies in the financial sector. These companies have relatively small GHG emissions relative to other sectors with Scope 1 and 2 emissions estimated at 5.2 million tonnes of Scope 1 and 2 and 5.9 million tonnes of Scope 3 (Exhibit 39).

Exhibit 39. Financial Sector GHG Emissions

In Mt CO2e

	GHG Emissions	
Company	**Scope 1&2**	**Scope 3**
Allstate Corporation	0.1	0.0
Bank of America	0.9	5.2
BNY Mellon	0.0	0.0
Capital One Financial	0.2	0.1
Citigroup Inc.	0.7	0.2
CoBank	NA	
Fifth Third Bancorp	0.1	
Goldman Sachs Group Inc.	0.2	0.1
HSBC	0.5	0.1
JPMorgan Chase & Co	1.1	
PNC Financial Services Group, Inc.	0.3	0.2
Rabobank	0.2	
Wells Fargo & Company	1.0	
Total	5.2	5.9

Notes: Emissions data are latest available. Emissions data are domestic and international. No data means data not reported or available.

Source: Informa Agribusiness Consulting

Based on Informa's analysis the sector available market for financial companies (including insurance) for Scope 1 & 2 carbon offsets is 1 million tonnes (Exhibit 40).

Exhibit 40. Financial Company SAM Potential for Carbon Credits

In Mt CO2e

Company	Company Potential		Goal Year
	Offsetting	**Insetting**	
Bank of America	0.4		2020
Goldman Sachs Group Inc.	0.1		CN
PNC Financial Services Group, Inc.	0.2		2035
Wells Fargo & Company	0.1		2020
Other	0.1		
SAM Potential	**1.0**		

Notes: Offsetting are domestic and international and insetting are domestic.
CN – carbon neutral
Source: Informa Agribusiness Consulting

Although emissions are relatively small, many banks in this sector have a strong interest in the environment.

- Citigroup has a $100 billion Environmental Finance Goal to lend, invest and facilitate $100 billion toward environmental solutions over ten years, between 2014 and 2023. The $100 Billion Environmental Finance Goal is the flagship initiative of Citi's Sustainable Progress Strategy, a global strategy that focuses on environmental finance, environmental and social risk management and our own operations and supply chain. So far, they have used $53.3 billion so far with $6.0 billion for water quality and conservation, $8.3 billion in green bonds, $35.3 billion in renewable energy, $1.9 Billion in green building, $4.0 billion in sustainable transportation, and $10.3 billion in public finance.
- Bank of America has committed $125 billion of low carbon financing and sustainable business activities and so far, have provided more than $70 billion in financing for low carbon and other sustainable business. In 2017 alone, they delivered $17 billion toward this goal. They have partnered with the Nature Conservancy.
- Although CoBank does not have specific goals for reducing GHG emissions, its energy portfolio includes outstanding loans and leases for renewable projects, making it one of the largest underwriters of renewable energy in the country—a leadership position CoBank is committed to maintaining in the future. CoBank's Power, Energy and Utilities Division provides financing to generation and transmission (G&T) cooperatives and regulated utilities across the country.

- HSBC has an objective to provide financing to enable the transition to a low-carbon economy and to help customers manage transition risk. Their goal is to provide $100bn of sustainable financing including providing credit and lending facilities, advisory services, investment products, and access to capital markets by 2025. HSBC has facilitated more than $10.5bn of green, social, sustainability bonds in 2017.

6. Information Technology and Telecommunication Sectors

Informa examined 13 companies in this sector. Informa estimates that these companies have 28 million tonnes of CO2e Scope 1 and 2 emissions and over 100 million tonnes of Scope 3 emissions[21] (Exhibit 41).

Exhibit 41. Information Technology & Telecommunication Sector GHG Emissions

In Mt CO2e

	GHG Emissions	
Company	**Scope 1&2**	**Scope 3**
Accenture	0.3	0.5
Apple Inc	0.6	27.1
AT&T Inc.	8.0	2.7
Cisco Systems, Inc	0.8	0.2
Google Inc.	3.0	1.3
Hewlett-Packard	0.4	36.9
Intel Corporation	2.5	12.3
International Business Machines (IBM)	1.2	
Microsoft Corporation	2.8	21.3
Texas Instruments Incorporated	2.3	
Verizon Communications Inc.	5.6	0.1
Xerox Corporation	0.3	
Yahoo! Inc.	0.3	
Total	**28.0**	**102.4**

Notes: Emissions data are latest available. Emissions data are international and domestic.

Source: Informa Agribusiness Consulting

Based on Informa's analysis the sector available market for information technology and telecommunication companies (including insurance) for Scope 1 & 2 carbon offsets of 3.9 million tonnes (Exhibit 42). Some of these companies have carbon neutral goals and one way they are remaining carbon neutral is buying carbon offsets.

[21] Based on the latest year available which is usually 2017.

Exhibit 42. Information Technology & Telecommunication Company SAM Potential for Carbon Credits

In Mt CO2e

Company	Company Potential		Goal Year
	Offsetting	Insetting	
AT&T Inc.	0.1		2020
Cisco Systems, Inc	0.3		2022
Google Inc.	1.9		CN
Hewlett-Packard			MG
Intel Corporation	0.1		2020
International Business Machines (IBM)			2020 MG
Microsoft Corporation	1.0		2030 CN
Texas Instruments Incorporated	0.5		2020
Xerox Corporation			MG
SAM Potential	**3.9**		

Notes: Offsetting are international and domestic and insetting are domestic.
CN – carbon neutral; MG – met goal.
Source: Informa Agribusiness Consulting

- Google committed in 2007 to being carbon neutral, and they have met this goal every year since then. They reach carbon neutrality via three steps. First, they work to reduce their total energy consumption by pursuing aggressive energy-efficiency initiatives. Second, they purchase significant amounts of renewable energy. Third, they buy carbon offsets for any remaining emissions they haven't yet eliminated. When they do purchase carbon offsets, they follow stringent principles. They invest in high-quality, third-party-verified offsets.
- Apple responded to the U.S. withdrawing from the Paris Accord by issuing a $1 billion green bond for environmental projects. Apple is also partnering with other organizations. For example, Apple partnered with The Conservation Fund to protect 36,000 acres of forest in the Eastern United States that are certified as sustainably managed. In 2015, Apple did a five-year partnership with World Wildlife Fund to transition up to one million acres of forest, across southern provinces of China, into responsible management by 2020.
- Microsoft has achieved carbon neutrality annually by improving operational efficiency, buying clean energy, and investing in carbon offset community projects.
  - For example, in 2017 Microsoft bought offset credits from rice farmers in Arkansas, Mississippi and California to stay carbon neutral. The seven growers that took part in the trade used these practices on 2,000 acres of farmland, ultimately generating reductions of 600 tons of carbon dioxide equivalent. The protocol process was done by the Environmental Defense Fund, funded by the U.S. Department of Agriculture and southern

power company Entergy, and overseen by a San Francisco-based investor called Terra Global, among others.

- Microsoft's efforts are funded by their internal carbon fee, which charges all our business groups for their carbon footprint.
- In 2017, Microsoft has also pledged to reduce its operational carbon emissions 75 percent by 2030 and is on target to achieve this goal.

7. Utilities Sectors

Informa examined seven companies in this sector. Informa estimates that these companies have 316 million tonnes of CO2e Scope 1 and 2 emissions and 63 million tonnes of Scope 3 emissions (Exhibit 43).

Exhibit 43. Utility Sector GHG Emissions

In Mt CO2e

	GHG Emissions	
Company	**Scope**	**Scope 3**
American Electric Power Company, Inc.	72.0	8.4
Consolidated Edison, Inc	2.7	41.1
Duke Energy Corporation	105.0	
Entergy Corporation	33.3	4.2
Exelon Corporation	17.4	
Wisconsin Energy Corporation	33.3	
Xcel Energy Inc.	52.1	9.4
Total	**315.8**	**63.1**

Notes: Emissions data are latest available. Emissions are domestic and international.
Blank data means not available or not reported.
Source: Informa Agribusiness Consulting

Climate change is one of the most significant sustainability issues facing utility companies. These companies are subject to extensive environmental regulations affecting past, present and future operations, and incur significant expenditures in complying with these environmental requirements, including expenditures for pollution-control equipment, environmental monitoring, emissions fees and permits at all generating facilities. Many of the emission reduction goals are expected to be met in response to compliance requirements. However, some company goals are aggressive and may necessitate the voluntary purchase of carbon credits to meet those goals. For example:

- AEP, in response to growing concern over climate change and the risks it presented to its business model, took early, voluntary steps to reduce greenhouse gas emissions. These efforts included planting millions of trees and accepting a binding emission reduction requirement as a member of the Chicago Climate Exchange, to building the world's first carbon capture and storage validation facility in West Virginia. AEP's goal by 2050 is to reduce their GHG emissions by 80% from 2000 levels. AEP is anticipating in using trading schemes in the future. AEP uses a carbon price within its Integrated Resource Planning (IRP) process to appropriately capture the potential future policy and regulatory risk associated with scope 1 and 2 carbon emissions.
- Wisconsin Energy Corporation has set a long-term goal to reduce CO2 emissions by approximately 80 percent below 2005 levels by 2050.
- Xcel Energy Inc. has a goal to reduce carbon emissions by 60 percent by 2030 from 2005 levels.
- Duke Energy Corporation's goal is to reduce their CO2 emissions from their generation fleet by 40 percent from the 2005 level by 2030.
- Exelon Corporation's goal is to reduce emissions 15 percent by 2022 from a 2015 base year.

Based on Informa's analysis the sector available market for utility companies for Scope 1 & 2 carbon offsetting are 23 million tonnes (Exhibit 44). Most offsets needed by this sector will be compliance offsets. But, because of the large size of some of the company goals, there likely would be some voluntary buying of offsets. The 23 million tonnes in Exhibit 45 represents the voluntary potential, which is only a fraction of the amount of emissions these companies will need to reduce in the future based on their total goals.

Exhibit 44. Utility Company SAM Potential for Carbon Credits

In Mt CO2e

Company	Company Potential		Goal Year
	Offsetting	**Insetting**	
American Electric Power Company, Inc.	7.00		2050
Duke Energy Corporation	8.00		2030
Exelon Corporation	1.00		
Wisconsin Energy Corporation	3.00		2050
Xcel Energy Inc.	4.00		2030
SAM Potential	**23.00**		

Notes: Offsetting data is international and domestic.
Source: Informa Agribusiness Consulting

8. Consumer Discretionary Sector

This sector was a catchall category for three companies. Informa estimates that these companies have 12.3 million metric tons of CO2e Scope 1 and 2 emissions and 286 million tonnes of Scope 3 emissions[22] (Exhibit 45).

Exhibit 45. Consumer Discretionary Sector GHG Emissions
In Mt CO2e

Company	GHG Emissions	
	Scope 1&2	**Scope 3**
Ford Motor Company	4.4	
General Motors Company	6.0	286.3
Walt Disney Company	1.9	
Total	**12.3**	**286.3**

Notes: Emissions data are latest available. Emissions data are international And domestic.
Source: Informa Agribusiness Consulting

Based on Informa's analysis the sector available market for discretionary companies for Scope 1 & 2 carbon offsetting are 2.5 million tonnes (Exhibit 46).

Exhibit 46. Consumer Discretionary Company SAM Potential for Carbon Credits
In Mt CO2e

Company	Company Potential		Goal Year
	Offsetting	**Insetting**	
Ford Motor Company	MG		2050
General Motors Company	1.4		2050
Walt Disney Company	1.1		LT
SAM Potential	**2.5**		

Notes: Offsetting is international and domestic. MG – Met goal. LT – longer term, a year is not designated. Blank data mean data not reported.
Source: Informa Agribusiness Consulting

Both Disney and General Motors are looking at zero net GHG emissions in the longer term so there is potential for them buying carbon credits. Disney has bought carbon credits in the past and Chevrolet has teamed with Ducks Unlimited and has participated in preserving grasslands.

[22] Based on the latest year available which is usually 2017.

- Walt Disney’s goal by 2020 is to reduce emissions by 50 percent from 2012 levels, a goal which they have already reached. Their longer-term strategy is to achieve net greenhouse gas emissions. That goal focuses on: avoiding emissions, reducing emissions through efficiencies, replacing high-carbon fuels with low-carbon alternatives, seeking alternative technologies, then using certified carbon credits for remaining emissions. Disney has a history of buying carbon credit (retiring more than 600,000 tonnes of credits over each of the last three years) and could potentially buy credits to meet their goals.
- General Motors goal is zero emissions by 2050. Their global vehicle fleet represents 77 percent of their CO2 emissions and they will reduce those emissions through electric vehicles, improved fuel efficiency. Still there could be some room for GM buying carbon credits.
  - Chevrolet is helping to preserve up to 11,000 acres of grasslands by agreeing to purchase carbon credits from the land owners.
  - For up to 6,000 acres of the North Dakota grasslands, Chevrolet teamed with Ducks Unlimited to calculate the amount of carbon kept in the soil rather than emitted into the atmosphere by ranches.

V. ESM WATER CREDIT DEMAND POTENTIAL

A. Water Quality

Informa examined both the voluntary and compliance markets for companies that could potentially buy water quality credits. Informa conducted several interviews and extensive desk research. On the voluntary market side, many companies have active programs to voluntarily reduce the impact of their operations on water quality, but it is very difficult to quantify those goals. Private company activities often included reducing and improving the quality of discharges in their own operations and many of the companies in the food and agriculture sector are working with farmers to reduce the impact of agriculture on water quality:

- The fertilizer industry has programs to reduce the impacts of fertilizer use by farmers;
- Food and beverage companies are working directly with producers in their supply chains to implement practices that improve water quality. They are also working with farmer groups, environmental organizations, and other groups to reduce the impact of agriculture on water quality.

To better quantify potential demand for water quality credits, Informa used data on estimated nitrogen and phosphorus discharges from facilities permitted under the National Pollution Discharge Elimination System (NPDES). This analysis sought to provide an understanding of the potential demand for water quality credits that may come from private companies and public agencies as offsets to their facilities' discharges into lakes and streams in the United States.

The data for the analysis was created by the EPA as part of the Hypoxia Task Force (HTF) [23], which is a coalition of 12 states, federal agencies, and a representative for tribes that is working to reduce nutrient pollution in the Mississippi/Atchafalaya River Basin (MARB), and the extent of the hypoxic zone in the Gulf of Mexico. In creating the data, the HTF modelled discharges of nitrogen and phosphorus of facilities with permits issued under the NPDES. The dataset has reported or estimated annual discharges of nitrogen and/or phosphorus, average annual concentration for the discharges, and information on the size of the facility, the type of facility, and the location of the facility. The dataset has information for 24,720 facilities across the United States for 2017.

[23] https://www.epa.gov/ms-htf

Informa also used a dataset published by the EPA of watersheds that included information on the number of waters listed for nitrogen and/or phosphorus impairments in the watershed to identify those watersheds that may have a higher potential demand for water quality credits.

1. Annual Discharges from All Facilities to All Waterways by Region

(a) Nitrogen

Total nitrogen discharges in 2017 from all facilities to all waterways is estimated at 2.16 billion pounds (Exhibit 47). The Northeast is the region with the largest discharge, with an estimated 558 million pounds discharged. The Corn Belt also had significant estimated discharges of more than 420 million pounds.

Exhibit 47. Estimated Nitrogen Discharges from NPDES Permitted Facilities, 2017

Region	Nitrogen (mil. Lbs/yr)
Appalachia	155
Corn Belt	422
Delta	166
Lake States	146
Mountain	88
Northeast	558
Northern Plains	57
Pacific	210
Southeast	149
Southern Plains	209
Total	**2,160**

Source: EPA

(b) Phosphorous

Total phosphorus discharges from all facilities is estimated at 3.15 billion pounds in 2017. The Corn Belt had the highest estimated discharges of 2 billion pounds. The Mountain region had the next highest estimated discharges with 884 million pounds.

Exhibit 48. Estimated Phosphorus Discharges from NPDES Permitted Facilities, 2017

Region	Phosphorus (mil. Lbs/yr)
Appalachia	23
Corn Belt	2,000
Delta	39
Lake States	7
Mountain	884
Northeast	80
Northern Plains	47
Pacific	22
Southeast	27
Southern Plains	24
Total	**3,152**

Source: EPA

2. Annual Discharges by Facilities into Watersheds with Waters Impaired by Nitrogen or Phosphorus by Region

To identify areas where the demand for water quality credits may be high Informa used a dataset created by the EPA of watersheds with waters listed for nitrogen or phosphorus impairment and selected the facilities located in these watersheds. There were 15,015 facilities with data for nitrogen discharges and 17,290 facilities with date on phosphorus discharges in these watersheds in 2017. Summaries of the total discharges by region follow.

(a) Nitrogen

In this restricted set the total estimated discharge by facilities of nitrogen is 1.73 billion pounds. Similarly, to the full dataset, discharges are highest in the Northeast region at 553 million pounds, followed by the Corn belt with an estimated 321 million pounds. Appalachia, the Lake States region, the Pacific region, the Southeast region, and the Southern Plains region all have estimated discharges of more than 100 million pounds in 2017.

Exhibit 49. Estimated Nitrogen Discharges from NPDES Permitted Facilities in Watersheds with Waters Impaired by Nutrients, 2017

Region	Nitrogen (mil lbs/yr)
Appalachia	127
Corn Belt	321
Delta	76
Lake States	126
Mountain	49
Northeast	553
Northern Plains	49
Pacific	147
Southeast	109
Southern Plains	173
Total	**1,730**

Source: EPA

(b) Phosphorous

Phosphorus discharges into watersheds with water impaired by nutrients also follow a similar pattern to the estimated discharges of all facilities. Estimated discharges were highest in the Corn belt region at almost 2 billion pounds, followed by the Mountain region with an estimated 880 million pounds discharged by NPDES facilities in 2017

Exhibit 50. Estimated Phosphorus Discharges from NPDES Permitted Facilities in Watersheds with Waters Impaired by Nutrients, 2017

Region	Phosphorus (mil lbs/yr)
Appalachia	17
Corn Belt	1,973
Delta	34
Lake States	6
Mountain	880
Northeast	78
Northern Plains	44
Pacific	15
Southeast	20
Southern Plains	19
Total	**3,087**

Source: EPA

3. Types of Facilities Discharging into the Waterways by Region

The facilities discharge dataset included information on the type of each facility, including the facility industry classification using Standard Industry Classification (SIC) scheme. The dataset also classified the facilities into 3 broad facilities types: federal facilities, a publicly owned treatment works (or public wastewater treatment plant) and other facility types. A summary of the estimated discharges by facilities in watersheds with nutrient impaired waters show that publicly owned treatment plants are the main source of nutrient discharges into lakes, rivers, and streams, accounting for approximately 63 percent of nitrogen discharges and 94 percent on phosphorus discharges in 2017.

Exhibit 51. Estimated Discharges from NPDES Permitted Facilities in Watersheds with Waters Impaired by Nutrients by Facility Type, 2017

Facility Type	Nitrogen (mil lbs/yr)	Phosphorus (mil lbs/yr)
Federal	10	2
Non-POTW	788	212
POTW	1,362	2,938
Total	**2,160**	**3,152**

Source: EPA

The information on the industry sectors contained in the SIC codes were used to provide an overview of discharges by selected industry sectors on a regional basis.

(a) Municipal Waste Water Treatment Plants

On a regional basis the Northeast region and the Corn Belt production regions are the primary source of discharges of nitrogen from NPDES permitted facilities, with estimated discharges of an estimated 283 million pounds, and 252 million pounds respectively in 2017, which combined represented 48 percent of the total estimated discharges. The Pacific region accounted for 13 percent of the discharges, with an estimated nitrogen discharge of 141 million pounds.

Exhibit 52. Estimated Discharges from Publicly Owned Treatment Works in Watersheds with Waters Impaired by Nutrients by Facility Type, 2017

Region	Nitrogen (mil lbs/yr)	Phosphorus (mil lbs/yr)
Appalachia	78	11
Corn Belt	252	1,921
Delta	29	6
Lake States	98	4
Mountain	44	877
Northeast	283	39
Northern Plains	30	7
Pacific	141	14
Southeast	69	13
Southern Plains	90	15
Total	**1,115**	**2,906**

Source: EPA

For phosphorus the Corn Belt production region, and then the Mountain region had the most phosphorus discharges in 2017. The Corn Belt region discharges were estimated at 1,921 million pounds, and the Mountain region had an estimated 877 million pounds of phosphorus discharges from NPDES permitted facilities.

(b) Other Facilities by Sector

Several other industry sectors were also evaluated to assess the potential demand for water quality credits as offsets for the nutrient discharges from their facilities.

Manufacturing Sector Facilities

Total estimated discharges from the manufacturing sector were 277 million pounds of nitrogen and 85 million pounds of phosphorus in 2017. The nitrogen discharges were 16 percent of total discharges in watersheds with waters listed for impairment from nitrogen and phosphorus and 46 percent of non-public facility discharges. The phosphorus discharges were approximately 3 percent of total discharges in the same watersheds and 47 percent of discharges from non-public facilities.

Exhibit 53. Estimated Discharges from Manufacturing Facilities in Watersheds with Waters Impaired by Nutrients by Facility Type, 2017

Region	Nitrogen (mil lbs/yr)	Phosphorus (mil lbs/yr)
Appalachia	25.1	3.7
Corn Belt	29.2	3.3
Delta	32.7	25.7
Lake States	26.1	1.8
Mountain	2.4	0.3
Northeast	35.6	4.4
Northern Plains	14.6	37.0
Pacific	4.3	0.4
Southeast	26.6	4.9
Southern Plains	80.0	3.1
Total	**276.7**	**84.5**

Source: EPA

Nitrogen discharges were mostly spread across all production regions, except for the Pacific and Mountain regions. Estimated discharges were highest in the Southern Plains region. For phosphorus discharges from manufacturing facilities most discharges came from facilities located in the Northern Plains and then the Delta region.

Within the manufacturing sector Informa also examined discharges from manufacturing activities in sectors related to agriculture: the food and beverage and agricultural product processing sector; and the agricultural chemical sector.

Food and Beverage Manufacturing and Agricultural Product Processing Facilities

The food and beverage manufacturing sector include meat and poultry processing plants, dairy product processors, fruit and vegetable processing facilities, oilseed processing facilities, along with general food and beverage manufacturers. The agricultural product processing facilities include a variety of facilities related to agriculture including egg and poultry production facilities and other miscellaneous activities.

Exhibit 54. Estimated Discharges from Food and Beverage and Agricultural Product Prosessing Facilities in Watersheds with Waters Impaired by Nutrients by Facility Type, 2017

Region	Nitrogen (mil lbs/yr)	Phosphorus (mil lbs/yr)
Appalachia	1.9	0.4
Corn Belt	5.2	0.9
Delta	3.4	0.5
Lake States	12.1	1.4
Mountain	0.6	0.1
Northeast	1.3	0.2
Northern Plains	2.3	1.0
Pacific	0.2	0.1
Southeast	2.0	1.0
Southern Plains	66.2	0.3
Total	**95.1**	**5.7**

Source: EPA

Total nitrogen discharges from facilities in this sector were estimated at 95 million pounds in 2017. This represented 5.5 percent of the estimated total discharges of nitrogen from all facilities in watersheds with waters listed for impairments by nitrogen or phosphorus, and 16% of estimated discharges of facilities other than the publicly owned treatment works and federal facilities. The Southern Plains region was the region with the highest estimated discharges from this sector, with an estimated 66.2 million pounds of nitrogen discharges, representing more than two thirds of total discharges. The Lakes States region was the only other region with estimated discharges above 10 million pounds in 2017.

For phosphorus discharges total sector discharges are estimated at 5.7 million pounds from facilities in watersheds with waters listed for impairments by nitrogen or phosphorus. This is less than 1 percent of the total phosphorus discharges from all facilities located in these watersheds, and 3.2 percent of estimated discharges from the non-public sector. The Lake States was the region with the highest discharge, with an estimated 1.4 million pounds. The Northern Plains and the Southeast region had estimated discharges of 1 million pounds.

Agricultural Chemical Sector Facilities

This includes manufacturers of nitrogen and phosphorus fertilizers, fertilizer blending facilities, and pesticides and agricultural chemicals. Total estimated discharges for nitrogen and phosphorus in watersheds with waters listed for impairment by nitrogen or phosphorus were approximately 5 million pounds each. The Delta production region was the location of most of discharges for both nutrients.

Exhibit 55. Estimated Discharges from Agricultural Chemical Manufacturing Facilities in Watersheds with Waters Impaired by Nutrients by Facility Type, 2017

Region	Nitrogen (mil lbs/yr)	Phosphorus (mil lbs/yr)
Appalachia	0.0	0.0
Corn Belt	0.8	1.5
Delta	3.4	2.4
Northern Plains	0.1	0.0
Pacific	0.0	0.1
Southeast	0.6	0.6
Southern Plains	0.2	0.1
Total	5.1	4.7

Source: EPA

4. Potential Value of Discharges as Credits by Region

Using the prices paid for nitrogen and phosphorus credits in Virginia in 2015 (see section on water quality markets under Water Credit Supply Potential earlier in the report) the potential value of discharges is substantial. At $3.05 a pound for nitrogen and the total potential value of credits is $5.2 billion. For phosphorus the price paid in Virginia was $4.93 a pound, resulting in a total potential value of $15.2 billion (Exhibit 57). This represents the value if all discharges from NPDES facilities were offset with credits. It is likely however that actual demand would be much lower, especially in regions where demand sharply exceeds supply. Although watersheds can cross regions, the study assumes regions are somewhat representative of watersheds. Supply and demand need to be in the same watershed for trading of water quality credits Water quality trading faces considerable challenges and trading activities to date have been limited.

5. Takeaways

Based on the total discharges in 2017 from facilities with NPDES permits the largest potential demand for water quality credits would likely come from publicly owned treatment works. For nitrogen the largest potential markets are the Corn Belt and Northeast production regions. For phosphorus credits the largest potential markets are the Corn Belt region, and then the Mountain region. Focusing on facilities with activities closely related to agricultural production the largest potential demand would likely be the Southern Plains region for nitrogen credits.

Exhibit 56. Potential Value of Discharges as Credits by Region in Watersheds with Waters Impaired by Nutrients by Facility Type, 2017

Region	Nitrogen ($Mil)	Phosphorus ($Mil)
Appalachia	386	84
Corn Belt	979	9,727
Delta	231	167
Lake States	384	30
Mountain	149	4,340
Northeast	1,688	386
Northern Plains	148	218
Pacific	449	75
Southeast	334	99
Southern Plains	528	93
Total	**5,278**	**15,217**

Source: Informa Agribusiness Consulting

B. Water Quantity

There are three areas of water quantity credits[24]:

- Water Efficiency (Using Less)
- Water Conservation (Preserving the Downstream Market)
- Flood Reduction (Increasing the Upstream Water Holding Capacity / Floodplain Strengthening)

This study considered the impact of all three, both separately and in conjunction.

1. Water Efficiency

Water efficiency credits involve the reduction in water withdrawals from a water source by farmers relative to a historical baseline. Farmers can reduce their water needs by implementing soil health conservation practices that improve the water holding capacity of the soil and the credits can be sold to entities looking to offset water diversions and use for public relations reasons but outside the regulatory environment.

Many of the companies Informa examined in the study had active programs to reduce water use within their own operations and were often working within their supply chains to reduce water use. The beverage companies were focused on water use and many had pledged to replace or

[24] Kieser & Associates – Technical Brief v.2.3

restore the water used in their operations. These programs generally took place in watersheds that the water extractions were taking place. None of the beverage companies had reported purchasing water offset credits, and in general it is very difficult to quantify the water reduction goals and the demand for credits.

2. Water Conservation

Efforts to conserve water from the farm sector and transfer the conserved water to a beneficial use (whether instream or otherwise) have been active for decades. Unlike markets for carbon and water quality, the farm sector has been the target of focused water conservation programs for many years. There are active programs run by The Nature Conservancy, National Fish and Wildlife Foundation, Trout Unlimited, Ducks Unlimited, and other environmental organizations which are dedicated to water conservation in the farm sector. Typically, these programs develop out of instream flow needs in specific river systems. Monetary resources available to these programs are targeted at critical rivers and habitat.

A Water Conservation Credit is applicable only within the 17 western states where water rights are administered by state governments. As described above, a Water Conservation Credit is generated by conserving water on farmland and rangeland, using practices that also benefit soil health, and protecting the conserved water from diversion and use by others. This protection is achieved through water rights and would be difficult to achieve outside of strict water rights administration. A Water Conservation Credit is also applicable only to irrigated farmland and rangelands because irrigation use defines the water right to be transferred. As described above in the discussion on aggregation, there are competing concepts on the issue of scalability for a Water Conservation Credit. On one hand, scalability is negatively affected by the fact that each credit and transfer process is individualized and not replicable. Each water transfer and credit transaction will likely be an isolated action, with common methods and protocols employed. On the other hand, the engineering and legal costs (transaction costs) of a water transfer are significant enough that it is common practice to attempt to pool several irrigated farmlands (with a common water source) together as part of a transfer application. The transaction costs motivate larger-scale activities.

The water transfer process embedded in a Water Conservation Credit will have to be scientifically rigorous to comply with state laws and overcome objections. Administrative water transfers are public-facing actions and it is quite common to have other water users object to a water transfer to ensure that their water rights are protected. The result is that water transfer applications often get put through some degree of scientific objection and debate, resulting in a high level of scientific support when (if) the application is approved.

There are some practices that can achieve both soil health and water conservation outcomes; however, it is important to understand that water conservation requires that farm productivity (yields) will be reduced. Water conservation for purposes of transfer is isolated to the volume of historical consumptive use (crop ET), which is linearly related to yield. As a result, there can be farmer resistance to engaging in water conservation practices unless adequately compensated for the lost productivity plus a premium. A Water Conservation Credit can be financially beneficial to the farm operation, while also providing soil health benefits, but it will likely entail fallowing fields and changing historic practices. Whether or not water conservation activities are friendly to the farm sector usually depends on the farmer's perspective.

There are over 25 established and emerging regional markets across the Western United States that have developed as a response to ongoing scarcity concerns and other factors. These markets have emerged over the last thirty years to meet growing demand. Traditional large-scale water users like municipal utilities, environmental groups and farmers are increasingly turning to water markets as an alternative to constructing costly new infrastructure projects to address growing water demands. Each regional market has distinct market drivers, pricing, and levels of trading activity. The most active market regions include California's Central Valley, the Northern front range of Colorado, the Edwards Aquifer, the Lower Rio Grande River basin in Texas, and the Pacific Northwest. It is anticipated that additional market regions will continue to emerge in the coming years in response to numerous market drivers. Over the last 10 years the annual value of water rights transactions in the Western United States has averaged $385 million dollars[25]. This suggests there would be demand for water conservation credits generated by the ESM if they can meet the legal requirements of these markets.

3. Flood Reduction

There are three considerations which make flood reduction credits difficult:

[25] Water Market Insider 2017 Water Market Outlook, WestWater Research.

(a) Lack of Commercial Economic Incentives (The Tragedy of the Commons & The Free Rider Dilemma)

There is likely zero commercial demand for flood reduction credits currently. This is because the flood insurance and reinsurance marketplace, which constitutes the main stakeholders for flood damage mitigation do not currently have a mechanism to pass additional costs for flood reduction credits to their customers (especially without a broader mechanism to compel collective action across the industry and regions). Furthermore, assuming these organizations efficiently price for flood risk within their models, an increased risk is a source of additional profit through premiums. This leads to a perverse economic incentive to treat the symptoms and not the underlying problem. This concern was validated in discussion with the USDA Risk Management Agency wherein they communicated a view that in terms of crop insurance any reduction in losses would result in lower premiums. In terms of the general insurance market overall, they saw problems related with the scale of implementation and coordination required.

Finally, the costs for implementing flood reduction credits may not be justified. It is possible to make a Flood Reduction Credit scientifically rigorous, but the costs of achieving this objective will likely dissuade interest in such a credit, as compared against other alternative methods of achieving flood reduction benefits. Reducing the rigor of analysis does not diminish the generally accepted idea that soil health practices can reduce flooding, but less data and information would be available to support the benefits for a location.

The United States Army Corps of Engineers conducted a study on the effects of different conservation measures which suggested that while flood stage heights were reduced, and flood damage costs could be reduced the costs of implementing the practices exceeded the savings. This was because the reduced costs were mostly associated with storm events with a low frequency (i.e. larger storm events). The study was focused on CRP type practices such as wetland and riparian reserve programs and not tillage or cropping practices.

(b) Non-Transferability of Downstream Community Benefits

Flood reduction benefits are local and cannot be transferred outside of the watershed. The national applicability of flood reduction credit will depend on the annual downstream flood risk of the farmland provider. These downstream beneficiaries would likely be communities or high-value industries prone to regular flooding and with substantial financial risks from flood damage.

The most likely partners (buyers) would be communities that are located downstream of significant farmland and rangeland that also see regular (10 to 20 year) flood damages.

(c) Complex Localized Analysis Requirements

Floodplain mapping and flood hydrologic analysis is highly localized, which helps to explain the FEMA regulatory process around flood insurance mapping. One aspect of scalability that should be considered is the lack of transferability of data and information from one location to another. A significant amount of analysis and effort must be applied to any single location and watershed under consideration for a Flood Reduction Credit.

Flood reduction credits are still in the early stages of development so quantifying the market is difficult. That said as the concept becomes better understood it is likely to become a viable market for ESM credits.

VI. CARBON AND WATER SUPPLY AND DEMAND RECONCILIATION AND RECOMMENDATIONS

A. Water Quality Market Potential

1. Nitrogen Supply and Demand Credit Potential

(a) Impaired Waterways

Based on interviews and requirements for compliance markets the supply of water quality credits will need to be in the same waterways (such as watersheds) as demand for credits. The greatest potential for an ESM will likely be in impaired waterways. For nitrogen the total potential credit supply is more than double potential demand (Exhibit 57). Potential supply exceeds demand in the Corn Belt, Appalachia, Lake States, Mountain States, Northern Plains and Southeast and accounts for half the U.S. potential demand for nitrogen credits. Although demand exceeds supply in the Southern Plains and Pacific states that difference is not considered significant. However, potential demand in the Northeast is more than triple the supply because agriculture production and farmer fertilizer use in the Northeast is significantly smaller than in other regions.

Exhibit 57. Nitrogen Potential Credit Supply and Demand in Impaired Waterways

In Million Pounds

Region	Supply	Demand
Appalachia	384.2	126.7
Corn Belt	1,303.9	320.8
Delta	214.4	75.9
Lake States	409.8	125.9
Mountain	263.5	49.0
Northeast	129.7	553.5
Northern Plains	514.8	48.6
Pacific	100.7	147.4
Southeast	267.5	109.5
Southern Plains	168.9	173.2
Total	**3,757.5**	**1,730.5**

Source: Informa Agribusiness Consulting

Although impaired waterways have the most potential for selling nitrogen ESM credits, other waterways not currently considered impaired could be impaired in the future and should also be considered. Potential demand for nitrogen credits increases by 25 percent to 2.16 billion pounds if all waterways are considered (Exhibit 58). The largest increase is in the Corn Belt.

Exhibit 58. Nitrogen Potential Credit Supply and Demand in All Waterways

In Million Pounds

Region	Supply	Demand
Appalachia	384.2	155.1
Corn Belt	1,303.9	421.6
Delta	214.4	166.0
Lake States	409.8	146.0
Mountain	263.5	87.9
Northeast	129.7	558.5
Northern Plains	514.8	56.8
Pacific	100.7	210.4
Southeast	267.5	149.1
Southern Plains	168.9	208.8
Total	**3,757.5**	**2,160.2**

Source: Informa Agribusiness Consulting

Matching supply with demand for all waterways[26] indicates that 1.58 billion pounds of nitrogen credits could potentially be bought through ESM valued as high as $4.8 billion, using current Virginia water quality market prices.

2. Phosphorous Supply and Demand Credit Potential

For phosphorous the situation is the opposite of nitrogen as the total potential credit demand is more than double the potential credit supply in impaired waterways (Exhibit 59). More than 90 percent of potential phosphorous demand credits are in the Corn Belt and Mountain States where supply can only meet about 20 percent of that demand. Potential supply though does exceed demand in Appalachia, Delta States, Lake States, Northern Plains, Southeast and Southern Plains.

Potential demand for phosphorous credits increases by only 2 percent to 3.15 billion pounds if all waterways are considered (Exhibit 60).

Matching supply with demand for all waterways indicates that 798 million pounds of phosphorous credits could potentially be bought through ESM valued as high as $3.9 billion, using

[26] If supply exceeds demand in a given watershed, the maximum amount of water quality credits that can be bought/sold equals demand. If demand exceeds supply in a given watershed, the maximum amount of water quality credits that can be bought/sold equals supply.

Virginia water quality market prices. It is important to note that since demand sharply exceeds supply in the Corn Belt and Mountain States, water quality credit prices would likely be much higher in those regions.

Exhibit 59. Phosphorous Potential Credit Supply and Demand in Impaired Waterways

In Million Pounds

Region	Supply	Demand
Appalachia	62.7	16.9
Corn Belt	565.6	1,973.0
Delta	125.0	33.9
Lake States	157.0	6.0
Mountain	24.7	880.3
Northeast	36.9	78.2
Northern Plains	288.5	44.2
Pacific	4.2	15.2
Southeast	33.5	20.0
Southern Plains	30.9	18.8
Total	**1,329.1**	**3,086.6**

Source: Informa Agribusiness Consulting

Exhibit 60. Phosphorous Potential Credit Supply and Demand in All Waterways

In Million Pounds

Region	Supply	Demand
Appalachia	62.7	23.5
Corn Belt	565.6	1,999.6
Delta	125.0	38.7
Lake States	157.0	6.8
Mountain	24.7	883.9
Northeast	36.9	79.9
Northern Plains	288.5	46.8
Pacific	4.2	22.0
Southeast	33.5	26.6
Southern Plains	30.9	24.2
Total	**1,329.1**	**3,152.0**

Source: Informa Agribusiness Consulting

3. Nitrogen and Phosphorous Marketplace Considerations

(a) Compliance based markets

While the apparent large numbers of nitrogen and phosphorous emissions into impaired waterways would imply a robust level of demand for an emissions marketplace, there are several market inefficiencies in the way nitrogen and phosphorous emitters operate that explain why vibrant ecosystem credits marketplaces have not yet been realized for nitrogen and phosphorous emissions. As regulations guide the entire marketplace for discharges, there are perverse incentives that make a market-based approach less practicable, even if it does offer a lower-priced alternative to compliance. Furthermore, there is a lack of large, liquid, trusted marketplaces for nitrogen and phosphorous discharge credits.

Perverse Incentives and Lack of Trust in Markets

POTW's are ideal candidates for a credit marketplace, as many have dated infrastructure and their cost of compliance to remove the next pound of phosphorous can be very high, as the facility is maxed out and the regulatory obligation may go beyond what the facility can do today. Operators might want to modernize to reach compliance, but sometimes these facilities, especially if they are public, will not have a strong enough source of finances to modernize. Thus, the owners must decide to either undergo an expensive modernization or seek alternative method of compliance; this is where the potential of water quality credits exists. For these older facilities, farmers may be able to offset additional pounds of nitrogen and phosphorous emissions in their fields much less expensively (sometimes 1-2 orders of magnitude cheaper). However, stakeholder interviews suggest that compliance officers for these POTW facilities typically may not pursue marketplace credits for three reasons:

- Compliance officers do not trust the marketplace enough to place their compliance in the hands of a third party; to do this you have to satisfy the Clean Water Act, which has a clear legal hurdle, as opposed to a voluntary water quality credit.
- Compliance officers for POTW can pass their costs of compliance through to the public very easily.
- In many cases the need to continually meet large compliance costs are the best leverage compliance officers have to modernize their facilities

(b) Voluntary-based Markets

The potential for voluntary-based markets for water quality credits is that companies will voluntarily raise their costs (or those of their supply chain) to meet sustainability or Corporate Social Responsibility (CSR) commitments. This is well documented in areas like water usage. However, the responsibility for water quality compliance sits with facility compliance managers, which are often not under the same corporate reporting structure as the sustainability staff who are often aligned at the corporate headquarters level and are operate more like a marketing function than an environmental compliance function within the company.

B. Carbon Market Potential

1. Carbon Supply and Demand Credit Potential

This report estimates total potential supply of carbon credits at 326 million tonnes CO_2e compared with potential demand of 190 million tonnes including Scope 1 and 2 emission goals and only domestic Scope 3 emission goals.

Field crop producers should be the number one focus because they account for 60 percent of the total the potential credit supply. The Corn Belt, Northern Plains and Lake States account for two-thirds of the potential field crop credit supply. Rangeland and pasture combined, rank second in potential with 35 percent of the total potential supply. The regions that will be the most important for pasture and rangeland are the Mountain States, Southern Plains and Northern Plains, accounting for 75 percent of the potential carbon supply. Specialty crops are less important because they account for only about 4 percent of the total potential supply of credits because of the relatively small acreage devoted to these crops.

In terms of carbon demand, the focus should be first on the food and beverage sector, which accounts for 57 percent of total potential demand from all sectors. The industrial sector ranks second accounting for 22 percent of total potential demand. Although the share of total potential demand in other sectors is less, there are other factors that need to be considered for ESM. For example, many banks in the financial sector have a strong interest in the environment and could help in establishing an ESM.

- Citigroup has a $100 billion Environmental Finance goal to lend, invest and facilitate environmental solutions over ten years between 2014 and 2023.
- Bank of America has committed $125 billion in low carbon financing and sustainable businesses.
- CoBank's portfolio includes loans and leases for renewable projects making it one of the largest underwriters of renewable energy in the country.
- HSBC provides financing to enable the transaction to a low-carbon economy and to help customers manage transition risk.

C. Recommendations to Establish ESM

- **Work with other NGOs** and other groups jointly to make the ESM work.

- A number of interviewees are concerned that if they participate in NRI's ESM it will jeopardize their current working relationship with other groups.
  - Groups such as the Environmental Defense Fund, The Nature Conservancy, World Wildlife Fund, Field-to-Market and Ducks Unlimited as well as individual companies such as food and beverage companies and fertilizer companies to improve soil health including improving water quality and reducing GHG emissions. Many are using protocols.

- **Allow potential ESM credit buyers to work directly with NRI within their own supply chain**.
  - Many interviewees, primarily food and beverage companies, want to be directly involved with their supply chain and have their own imprint included in improving the environment, especially for water quality.

- **Soil health requires long-term investments and collaborations**.
  - Farmers need long-term commitments for soil sequestration to be successful.

- **Focus of GHG emission reductions:**
  - Major focus should be on food and beverage companies in terms of demand.
    - These companies account for 57 percent of all potential GHG reductions.
    - Nearly all these companies have long term goals to reduce GHG emissions.
  - Major focus should be on field crops in terms of supply.
    - These crops account for more than 60 percent of potential GHG reductions.
    - Major focus should be on the Corn Belt, Northern Plains and Lake States in terms of region.
      - These regions account for two-thirds of the potential field crop credit supply.

- Focus on improving water quality
  - Major focus should be on compliance and on waste water treatment plants in terms of demand.
    - These entities account for a large share of nitrogen and phosphorous discharges.
  - Major focus should be on the Corn Belt and Mountain States which combined account for more than 86 percent of potential phosphorous reduction demand
    - But these regions are where supply can only meet about 20 percent of that demand which can lead to higher prices.

- For nitrogen the total potential credit supply is more than double potential demand.
  - Potential supply exceeds demand in the Corn Belt, Appalachia, Lake States, Mountain States, Northern Plains and Southeast and accounts for half the U.S. potential demand for nitrogen credits.

- **Create Protocols** for emissions and water quality trading that can accurately measure reductions in GHG emissions and improvements in water quality from agriculture production.
  - The priority interest from potential buyers is whether the ESM has accurate protocols. Protocols are considered a game changer for trading credits.
  - Protocols will need to vary by crop, field, region, management practice, soil type, etc.
  - Protocols will need to include specified management practices that farmers need to do.
  - Protocols will allow farmers to generate a new revenue stream through either carbon credits or water quality credits without impacting yields.
  - Improvements in water quality and emissions reductions will need to be measured annually.
  - Producers will need to provide historical information to create a baseline. Producers will need to provide records collected throughout the growing season to quantify water quality improvement (in terms of reduced nutrient runoff) and reduced GHG emissions.

Protocols and protocol development for emissions and air quality trading are a significant part of the process of developing a trading-based credit system. In fact, the development of protocols and need for protocols was brought up several times in the interview process conducted for this study. This is understandable as successful trading systems for every type of commodity and good traded are based on well-defined protocol systems, often set up, implemented and regulated by groups or industry associations. For example, CME traded products in the agricultural sphere (i.e. corn, soybeans, wheat, payment terms etc.) are traded under the strictest of protocols where every aspect, except price, of the trading system (i.e. grade/quality, location/delivery point, platforms used to trade, etc.) are defined by the CME. In fact, the CME, through its clearing house structure, becomes party of every trade and as such can facilitate entry and exit by market participants and reduce to almost zero counter-party risk. In this way, there is a high degree of underlying confidence in what is being trading and who participants are trading with. Bringing this back to trading credits, establishment of clear protocols and an understanding of who stands behind the protocols was raised as a critical step by potential market participants.

D. Potential Value of Carbon and Water Quality Credits

In summary, Informa estimates the potential (NAM) demand volume of credits for carbon at 190 million tonnes of CO2e, demand for nitrogen credits at 1.58 billion pounds and demand for phosphorous credits at 798 million pounds.

Informa estimates the combined potential value of carbon and water quality credits at $13.9 billion with carbon credits valued at $5.2 billion (using Informa's high end of its range) and water quality credits valued at $8.7 billion (nitrogen and phosphorous credits combined).

Another study will evaluate the SOM (NRI Share of the Market and a subset of SAM) or how much of this potential market NRI can capture.

Exhibit 61. Potential NAM for Carbon and Water Quality Credits

	Demand	
Credit Type	**Volume**	**Value ($bil)**
Carbon (vol in MMt Co2e)	189.7	5.2
Water Quality (vol in bil pounds)		
Nitrogen	1.58	4.8
Phosphorous	0.8	3.9
Total		**13.9**

Source: Informa Agribusiness Consulting

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