

**RESPONSE TO HISA COMMENTS ON:
UPDATES TO QUANTIFYING GREENHOUSE GAS FLUXES IN
AGRICULTURE AND FORESTRY: METHODS FOR ENTITY-
SCALE INVENTORY**



Office of the Chief Economist
U.S. DEPARTMENT OF AGRICULTURE

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INTRODUCTION AND TIMELINE

The U.S. Department of Agriculture (USDA) Office of the Chief Economist (OCE) provides economic and policy-related analyses to inform current and upcoming issues impacting agriculture.

Under Section 2709 of the 2008 Farm Act, USDA was directed to prepare technical guidelines and science-based methods to measure environmental service benefits from conservation and land management activities, initially focusing on carbon and other greenhouse gases. In response, USDA OCE published *Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity Scale Inventory* (methods report) in 2014. The report included greenhouse gas flux estimation methods for the following sectors:

- Cropland and Grazing Land
- Managed Wetlands
- Animal Production
- Managed Forest
- Land-use and Land Change

USDA OCE is publishing a 2024 update to that report. USDA began working on the updated report in 2019. For Croplands and Grazing Lands, Animal Production, and Managed Forests chapters, expert authors were identified based on their expertise within their respective fields as well their representation of diverse backgrounds (for example, the author teams do not include all federal employees). For the Land-use and Land Change and Wetlands chapters, only minor edits were made from the 2014 versions, based on input from a subset of the 2014 authors.

The author teams revised the chapters to reflect advancements in available data or methodologies since the 2014 report. The Managed Forest chapter authors developed an Excel® workbook and workbook user guide to provide guidance for the calculations associated with the chapter. The draft revised report underwent a USDA technical review, a federal government interagency review, and a scientific expert technical review (performed by approximately 25 experts identified by the author teams and USDA).

In August 2022, USDA classified the *Updates to Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity Scale Inventory* as a Highly Influential Scientific Assessment (HISA). The HISA peer review of the draft document was performed in 2023 concurrent with a public review. This document summarizes the reviewer input from the HISA review.

SELECTION OF HISA REVIEWERS

Eastern Research Group, Inc. (ERG) is the contractor to USDA OCE under contract GS-00F-079CA and was tasked with identifying reviewers with appropriate expertise that had not been involved in the development or previous reviews of the report, and that did not have any conflicts of interest. ERG obtained curriculum vitae or resumes from each potential reviewer and asked each to submit a form detailing their potential conflicts of interest (see form in Appendix A). ERG selected final reviewers with no conflicts of interest and balanced expertise across sectors. Biographies for the reviewers are provided in section IV.

HISA REVIEW PROCESS

The HISA reviewers were provided with the most recent version of the report and Managed Forest calculation tool, a spreadsheet file to track their comments, and a list of charge questions. The charge questions are provided in Section V along with the reviewer responses to those questions. While charge questions were provided, reviewers were not required to answer each question directly or completely.

HISA REVIEWER BIOGRAPHIES

- **Dr. Charles Rice** is a distinguished professor at KSU. His research area is soil microbiology, carbon cycling, and climate change. Rice serves on the USDA Agriculture Air Quality task force, chairs the International Union of Soil Sciences commission on soils, food security, and public health. He is the co-recipient of the Nobel Peace Prize for his work with IPCC and recently served on the NASEM review committee for NCA5.
- **Chad Kruger** is the Director of WSU's Tree Fruit Research and Extension Center and the Center for Sustaining Agriculture and Natural Resources. He currently co-chairs the Sustainable Ag Committee for the Cascadia Innovation Corridor, *ex officio* for the Washington Tree Fruit Research Commission, the climate change subcommittee for the Northwest Horticultural Council, represents WSU on the Washington Food Policy Forum, and was the lead author of the multi-agency Washington Soil Health Initiative.
- **Dr. Kristan Reed** is an Assistant Professor of Animal Science at Cornell University. Her area of expertise includes animal nutrition and systems modeling, environmental impacts of dairy production, incorporation of uncertainty in decision tools, and ruminant protein nutrition.
- **Dr. Adam Moreno** is with the California Air Resources Board where he leads the science and modeling team to identify the role that natural and working lands can play in the state's efforts in becoming carbon neutral. He most recently led the natural and working lands component of California's Scoping Plan, the state's road map to carbon neutrality. Dr. Moreno also advises various other statewide efforts related to ecosystems and climate including serving on the governor's Wildfire and Forest Resilience Task Force science advisory panel. He was previously an earth scientist at NASA Ames, where he studied the climate change impact on North American forests. He has also been a Peace Corps volunteer in Paraguay, South America, and a wildland firefighter as a hotshot with the U.S. Forest Service.

INDIVIDUAL REVIEW COMMENTS AND RESPONSES

This section provides HISA reviewer comments and responses. Reviewer identities are masked in the tables below.

I. EXECUTIVE SUMMARY

Commenter ID	Comment Excerpt	Comment Response
C	"I don't agree that direct measurement is the most accurate way to estimate emissions across all parts of the agricultural system and believe there is still a lot of uncertainty and technical development that is ongoing to determine appropriate measurement methods for much of the emissions from agriculture including soil carbon sequestration and emissions from manure management systems, animal housing, and enteric emissions. I would revise the sentence claiming that measurement is the most accurate way to estimate emissions to say something like: For some parts of agricultural production direct measurement is the most accurate... However, for other agricultural emissions sources, no methods for entity scale emissions measurements exist.	The authors revised the text to address the reviewer's comment.

II. CHAPTER 1

Commenter ID	Comment Excerpt	Comment Response
B	Need to label the red and black arrows. Label the color of the arrows.	The authors revised the figure to reflect commenter's suggested edit.
B	Reorder nitrite and nitrate. The process of nitrification is first nitrite and then nitrate, so order the words to follow the process.	The authors revised the sentence to reflect commenter's suggested edit.
B	Why is energy consumed not accounted for in land conversion.	The authors attempted to align the report with the U.S. GHG Inventory. Accounting for energy consumed would be inconsistent with the GHG inventory estimates; therefore, energy consumed is not included in the methods.
C	Is the arrow for the 'Fertilizer, Manure N ₂ O' flux supposed to be pointing down?	The authors revised the figure to reflect commenter's suggested edit.

Commenter ID	Comment Excerpt	Comment Response
C	There is a typo in the 4th bullet point 'While the effect of these updates on emissions cannot be quantified or generally qualified as an increase or decrease because the effect is dependent on certain activity or ancillary data (e.g., animal diet), the updates are meant to offer increased accuracy.'	The authors corrected this typographical error in the text.

III. CHAPTER 2

Commenter ID	Comment Excerpt	Comment Response
C	Title page for Chapter 2 is missing author list like the other chapter intros.	Chapter 1 and 2 are introductory chapters. The sector chapters had author working groups, which is why those chapters included author lists.
C	Although it is somewhat clear from the bulleted list of the areas to consider in Animal Production systems, I think it would be helpful to provide a brief explanation here for what cropland is considered within or outside of the animal production system boundaries. In the last bullet point, for example, you reference that manure applied to cropland would be considered within animal production systems. Does this apply only to cropland owned by the entity? Only to crops that will be fed to the animals and not sold? Referencing the provided definition of an entity adds some clarity to this point but I think a statement here would be helpful.	The authors revised the sentence to "In some cases, such as for manure applied to cropland under the ownership and or management control of the entity, Chapter 3 methods will also be relevant."

IV. CHAPTER 3

Commenter ID	Comment Excerpt	Comment Response
B	Burning of native grasslands does not necessarily reduce SOC. In fact, it can increase SOC. The previous sentence states this fact but the second sentence is contradictory. Also burning may increase N demand in grasslands and thus increase a sink for N ₂ O. Reword for clarity. Burning for grassland have the potential to increase SOC and reduce N ₂ O emissions (maybe a sink).	The authors deleted the sentence about reducing C storage.

Commenter ID	Comment Excerpt	Comment Response
B	I am confused by this extensive discussion on accounting for herbaceous biomass in cropland and grazing lands. Vegetative C in cropland and grasslands is not considered sequestered and ephemeral. In fact in the herbaceous biomass is discounted in 3.2.2.	The IPCC has recommended addressing biomass C stock changes when there is a land use change. The herbaceous biomass does contain some C and can lead to a biased estimate of the effect of land use if it is not included. For example, if the amount of C in an annual crop field is not included in the calculation of C stock change from forestland to cropland, then there is a bias in the resulting estimate. You are correct that the C storage is ephemeral in herbaceous biomass, gaining and losing similar amounts each year. Therefore, it is not necessary to continue tracking C after the initial land use change.
B	Not sure how this table is used? Does this consider forages produce more roots which may lead to enhanced SOC?	Table 3-3 provides the factors to estimate biomass C stock change estimates associated with land use change as discussed in the previous text (Equations 3-1 to 3-3). Table 3-3 is not used to estimate SOC stock changes.
B	This section reads as if you can measure or estimate SOC changes in a year. Because of the high variability and background it is difficult to infer you can make changes in SOC within a year. Need a 5 to 10 year time frame that could be annualized.	The commenter is correct that that 5-10 years is needed to measure SOC stock changes due to the large amount of carbon in soils and the relatively small changes that are occurring with the background amount. However, we are not measuring the stock changes with this method, but rather modeling those changes. USDA's guidance on the methods in this report was to provide annual estimates for reporting.
B	Text read as though you can estimate SOC change by change in a single year. This is not possible. Even if modeled I would not trust it!	There are large uncertainties in the annual estimates, which could be reduced by estimating changes over longer periods as discussed in the uncertainty section. The authors have added more information in Chapter 3 about how to aggregate results, complementing the information in Box 8-2 about how uncertainty declines by aggregating results over space and time, for example, aggregating annual results to 5 years (or aggregating results across entities). This could be an option for implementation of the method.

Commenter ID	Comment Excerpt	Comment Response
B	Soybean is a low input residue. Studies have shown that continuous soybean even with no-till does not increase SOC and may even decrease SOC.	Soybeans have a medium level of residue production, similar to wheat but lower than corn and sorghum (which are in the high input group) (e.g., Garcia-Condad et al. GCB Bioenergy 2019 and Doran et al. SSSAJ 1984).
B	I am surprised that grass hay and alfalfa are considered medium input. As the roots may contribute more to SOC than above ground residue.	The authors agree with this suggestion and revised the text.
B	What about composted sewage sludge or food waste? There is a whole section related to biochar. But there are other amendments that may have just as much an impact as biochar.	Other amendments are considered in the Tier 2 method as described for the classification of input on page 3-32. The Tier 3 method includes organic amendments, and is more specific than the Tier 2 method, addressing the effect of composting and other amendments discussed on pages 3-37 and 3-38.
B	Discussion of manure.	The authors noted this comment but are unclear if there is a specific issue with the text's discussion of manure.
B	DNDC may be another model used around the world and has	The authors have noted this comment, Future revisions of these methods may consider other models as more testing is done. The USDA has funding through the IRA to test several models that may lead to revisions of the entity scale methods.
B	Does not consider split applications of fertilizer nitrogen.	The authors agree with the reviewer. The adapted Tier 1 method is limited in its ability to address some N management practices, such as split applications. The method may be expanded in the future when more data is available to support the inclusion of additional practices; another option is to incorporate more crop and grazing land into the Tier 3 method, which can address more practices.

Commenter ID	Comment Excerpt	Comment Response
B	Table separates out climate but should separate based on drainage or soil texture (sandy soil will not produce as much N ₂ O as a clay soil).	The authors agree with the reviewer that there are likely to be impacts of soil characteristics, such as texture, on N ₂ O emissions. However, there are insufficient data to address these impacts at this time. USDA has additional funding through the IRA to measure emissions at more sites that may allow further disaggregation of these impacts in the future with the adapted Tier 1 method.
B	Not sure why nitrate based fertilizer has any volatilization losses.	The nitrate-based fertilizers do contribute some NO _x emissions that are addressed with the volatilization losses factors.
B	Emission factors for synthetic fertilizer would vary by timing and placement method.	The authors agree with the review, but the Tier 1 method does not address the impacts from synthetic fertilizer use, and the Tier 3 models need further testing before they can be adopted for entity scale reporting of indirect soil N ₂ O emissions. Future iterations may be able to improve upon this method by developing a Tier 2 method.
B	What about DNDC as well as DayCent.	Noted, but DNDC was not evaluated. Future revisions of these methods may consider other models as more testing is done. In fact, USDA has funding through the IRA to test several models and may lead to revisions of the entity scale methods.
C	Equation number typo: Peak aboveground biomass for grazing land is estimated with Equation 3-33	The H _{peak} , i.e., peak aboveground biomass value is estimated with Equation 3-3. The authors revised the text to improve clarity.

V. CHAPTER 4

Commenter ID	Comment Excerpt	Comment Response
C	I really like this figure and especially how the section/chapter associated with each emissions are referenced.	The authors appreciate this comment.

Commenter ID	Comment Excerpt	Comment Response
C	<p>There is a relatively new method for estimating the impact of feeding 3-NOP (published by one of the study's co-authors (Kebreab et al 2023; 10.3168/jds.2022-22211). I am curious why this method was not used? Was it just timing? Is there an option to update it? My understanding is that the equations proposed in this work are a better option (more accurate, based on a larger dataset, etc) than those of Dijkstra 2018: Replace the method of Dijkstra 2018 with Kebreab et al 2023.</p>	<p>The authors updated the equation. At the time the chapter was originally revised, the equation was not available.</p>
C	<p>Overall I think the enteric emissions methods are appropriate and clearly explained. I appreciate that the author's included methods for mitigation via supplementation and the caveats associated with them even though some of the supplements are not yet approved. I think the description of the method for the lipid supplementation could be improved with minimal effort to add clarity. Specifically, it took some effort to realize that the proposed methods were to estimate the emissions reductions only and from there, I had to make an assumption that I should subtract that reduction from the emissions estimated from Eq. 4-1. I think this confusion partly arises from the multiple uses of 'baseline' in the method. If this is in fact the intended use, I think some minor additions to the diagram in Fig. 4-3 and the example presented in Box 4-3 would go a long way.</p> <p>I propose modifying the language in the boxes in Lipid Supplementation pathway in Fig 4-3 to the following: 1) 'Use Equation 4-6 to calculate enteric CH₄ yield from both the basal and modified diet to determine reduction in CH₄ per unit of DMI', 2) 'Subtract the basal diet from the modified diet enteric CH₄ yield estimates to get the reduction in CH₄ yield', 3) 'Multiply the CH₄ yield reduction by the DMI used in Eq 4-1 to calculate CH₄ emission reduction. Subtract CH₄ emission reduction from results of Eq. 4-1', 4) 'Multiply by the # of head of cattle to get total emissions'. In the Box 4-3 I suggest changing the references to the 'baseline diet' to 'basal diet' and adding two final steps in which 1) the total emissions reduction is calculated (e.g. 1.6 x DMI) and then 2) the total emissions reduction is subtracted from the baseline emissions estimated by Eq 4-1.</p>	<p>The authors revised the text to improve clarity.</p>
C	<p>I believe that dietary fat content (EE %) is also needed for lactating dairy cattle if lipid supplementation is used. Add fat content to the list of Ancillary data needed for lactating cattle.</p>	<p>The authors updated the activity and ancillary data sections.</p>

Commenter ID	Comment Excerpt	Comment Response
C	<p>I think there is a missing component from this equation? Should there be a (1- NH3%) in there somewhere to subtract the amount of manure N lost to ammonia emissions before multiplying by the N2O factor? Should the % of N lost to leaching also be accounted for in this equation?</p>	<p>This equation would be for determining direct N2O lost from housing. The emissions factors developed for these losses were based on the total N excreted and that is why the ammonia and nitrate losses are not subtracted off at this point. If this manure is then transferred to longer term storage, one would then subtract the ammonia and nitrate lost as shown in Equation 4-19. The authors clarified this in Figure 4-4.</p>
C	<p>I am also wondering if there is something missing from this equation. The statement on the previous page says 'remaining nitrogen excreted (Nex) that is not lost as N2O-N, volatilized as NH3-N, or lost via leaching from housing'. In this equation, the volatilized and leached N are there as is the loss through N2 gas (which is not mentioned in the description) but the loss via N2O is not there. Should the final component be (EFN2O *(1 + R_N2_N2O)) to account for both the N loss in N2 and N2O?</p> <p>Change the final component in the equation to be (EFN2O *(1 + R_N2_N2O)) to account for both the N loss in N2 and N2O</p>	<p>The authors revised the equation to reflect this suggestion.</p>
C	<p>Using a single VS rate for all dairy cows will over estimate the VS rate for non-lactating cows and heifers. If possible, have separate VS rates for lactating cows, non-lactating cows and heifers or use a VS equation based on intake.</p>	<p>The authors revised the values for lactating cows, non-lactating cows, and heifers.</p>
C	<p>To be in alignment with the level of detail provided in other sections, I suggest specifying the dietary and feed information needed. It is also not clear to me what the difference between dietary and feed information is in this context.</p> <p>Change two of the bullets to: 'Animal characteristics (e.g., body weight and stage of production) and feed intake information', and 'Diet crude protein content'.</p>	<p>The authors updated the bullets to: animal characteristics (e.g., body weight and stage of production); dry matter intake; and dietary crude protein.</p>

Commenter ID	Comment Excerpt	Comment Response
C	<p>The purpose/application of Eq 4-24 is not clear to me. Is the recommendation that 4-24 be used as an alternative to calculating both NH₃ emissions and Nex? Or can the first part of equation 4-24 be used without the second part? Should the first part of the equation to estimate NH₃ emissions only be applied on a monthly basis and then summed over the relevant months? Can annual average temperature and/or CP values also be used? The variable definitions define the conversion factor of 14/17 as the conversion from ammonia N to N₂ gas N so it is not clear to me how or why this formula can be used to estimate N excretion from the ammonia emissions. If the equation is in fact supposed to represent a way to estimate N excretion, I also recommend changing the variable name of the LHS of the section part of the equation from just 'N' to 'Nex' to be in alignment with the previous variables used to describe nitrogen excretion.</p> <p>Provide some more context for how equation 4-24 should be used and under what circumstances it would be appropriate to use instead of the previous methods for N excretion.</p>	Equation 4-24 should only include the top portion to estimate ammonia emissions via dietary crude protein and temperature. The authors removed the bottom portion of Equation 4-24.
C	I have the same question here as my question for Eq 4-17. Based on the equation, it appears that the N lost is accounting for ammonia, leaching, and N ₂ gas losses but not N ₂ O. Maybe I am misinterpreting the definition of the conversion factor? As written though, my understanding is that you are converting the loss of N ₂ O-N to N ₂ -N so it seems like the N ₂ O-N is missing from the total N accounting. Either modify the equation as suggested above or modify the description of the conversion factor.	The authors revised the equation to reflect this suggestion.
C	Second sentence is missing reference to table number 4-A-1. Add table number 4-A-1 reference.	The authors added a reference to Table 4-A-1.
C	Typo - Bovear should be Bovaer.	The authors corrected this typographical error in the text.
C	It is not clear to me why the covariance matrix was left blank. Is it not feasible to request the covariance matrix for the parameter estimates from the authors? Add recommended quantities for the covariance matrix.	The authors removed the referenced table because the data was not obtained to complete the referenced analyses.
C	The Bougouin reference should be 2022 instead of 2021.	The authors updated the reference.
C	Is it intended to have empty rows?	The authors removed the empty rows referenced by the reviewer.

VI. CHAPTER 7

Commenter ID	Comment Excerpt	Comment Response
A	Missing development (urbanization) as a land use change - add a section.	The methods in this report do not include settlements, and so the authors did not provide equations for conversions to settlements.

VII. GENERAL

Commenter ID	Comment Excerpt	Comment Response
A	"Limitations" sections only represent technical limitations of the method, and not appropriate/inappropriate application of the specified methods. Add a section and/or a paragraph in the limitations section that articulates appropriate or inappropriate - though this could never be completely predictable applications of the method.	The authors appreciate the suggestion to expand the limitation discussions. The list of inappropriate applications could be extensive in some cases and therefore the authors limited this discussion to the most pressing limitations (based on the current science). The authors will consider additions to the "limitations" sections in future versions of this report.

VIII. CHARGE QUESTIONS

Question 1: *Under Section 2709 of the 2008 Farm Act, USDA was directed to prepare technical guidelines and science-based methods to measure environmental service benefits from conservation and land management activities, initially focusing on carbon and other greenhouse gases. In response, USDA developed the 2014 report. The purpose of this update is to capture advances in the science and methodologies since the last report. Does this update to the report meet this objective? Do you have recommendations to improve what USDA has done to update the original?*

Commenter ID	Charge Question 1 Reviewer Comment
A	Yes. It meets the objective. It's a very useful resource that captures and presents available estimation methods for numerous different agricultural and land management situations. Unfortunately, there is still significant limitations (e.g. cost vs. accuracy) to implementing many of these measurement approaches in practice. One thing I think could be done more explicitly is providing some discussion regarding inappropriate applications of specific estimation methods. The limitations sections address some technical limitations of measurement, but they likely don't go far enough to reduce inappropriate application of estimation methods.

Commenter ID	Charge Question 1 Reviewer Comment
B	The report meets the original goal focusing on carbon and other greenhouse gases and provides updated materials since the 2014 report. The report does not go beyond greenhouse gases to include environmental service benefits from conservation Land Management.
C	While there is always room for improvement, I think the report does a great job incorporating new scientific outcomes into the methods where there is reliable consensus. In cases where there is still a high degree of uncertainty, the authors choice to use simpler methods (usually those of Tier 1 or 2 from the IPCC methodology) is a sound decision. As new information is generated by the scientific community to fill in the research gaps presented, there will be many things to update. In the immediate future, the recently published method for accounting for enteric methane mitigation from 3-NOP would be a meaningful improvement.
D	The methods are very comprehensive and contains much of the methods that can be used given different levels of data availability. However, the authors don't include the IPCC Tier 3 level modeling, which would include biogeochemical process-based models. Even though more many entities, this level of inventory analysis may be out of reach, it should be a standard that is considered as the highest level of certainty and most advanced inventory standard.

Response to Charge Question 1 Comments: USDA plans to periodically update this report and will account for the current science at those points but acknowledges this iteration strives to find the right balance of accuracy and complexity. The list of inappropriate applications could be extensive in some cases and therefore the authors limited this discussion to the most pressing limitations (based on the current science). In addition, the authors updated the 3-NOP equation. At the time the chapter was developed, the equation was not available. Chapter 3, which covers GHG sources and sinks in cropland and grazing land systems does offer Tier 3 methods for a number of emission sources, including soil carbon stock changes, direct soil N₂O emissions from mineral soils, methane fluxes for non-flooded mineral soils, and woody biomass carbon stock changes for agroforestry and woody perennial tree crops. These methods provide more accurate estimation of a range of influences on GHG emissions, and future refinements to the methods in this report will likely incorporate additional Tier 3 methods.

Charge Question 2: *Are the purposes of the report and the definitions clearly defined?*

Commenter ID	Charge Question 2 Reviewer Comment
A	Yes.
B	The purpose of the report and the definitions are clearly defined.
C	The purpose for the report to provide a methodology for entity level emissions estimates is very clear and I appreciate the references and comparisons throughout the report that clearly delineate where this methodology differs from an LCA or larger scale inventory.
D	Yes.

Response to Charge Question 2 Comments: USDA thanks the reviewers for their input.

Charge Question 3: *In the United States, several voluntary and regulatory markets have emerged which allow for purchases of carbon offsets. In many of these markets, agricultural conservation can be a source of offsets. How might the methods in this report be used in carbon markets? What are the strengths and weaknesses of using these methods in carbon markets?*

Commenter ID	Charge Question 3 Reviewer Comment
A	This is a very risky use of the methods given that market-based contracts could be legally binding and have expectations of performance that exceed the performance capabilities of existing estimation methods. Prior efforts to develop market-based mechanisms have struggled due to challenges with uncertainty in estimation methods. It seems the use of estimation methods from this report in market-based mechanisms should be limited to those situations where there are tight tolerances on the inherent uncertainties (e.g. methane destruction from stored manure) and/or estimation capabilities. It's not so much the strengths or weaknesses of the estimation methods as it is the underlying emissions variability of a practice and the tolerance of legal market contracts. It might be good to add a section to the report that recommends a conservative approach to applying these methods in market-based contract agreements.
B	Voluntary and regulatory markets in the United States are emerging for carbon offsets. The methods in this report provide one means of developing carbon offsets. However, there are many nuances of establishing carbon offsets besides emissions or carbon sequestration. The report is not designed for such purposes. If it was, then discussion should be included on project size, transparency, reversal, additionality, and processes to scale up site or field level to regional level estimates. This would take another complete report to discuss these issues. The report also is limited to using one model DayCent for the inventory. Other models could be used for greenhouse gas accounting methods.
C	I think these methods could be applied for use in carbon markets. Some of the strengths in the application of these methods are consistency across productions systems and treatment of uncertainty of the estimates. A downside of the methods for some producers are that the simplifications required to reduce complexity limit the number of management options. In addition the temporal boundaries will exclude early adopters who already have low emissions or high C sequestration.
D	For forests, yes. For ag, no. Especially in non-perennial agriculture, soil organic carbon and N2O emissions are currently too uncertain even with the most advanced models. If these lands were to be incorporated into something like a compliance offset market, empirical data collection has to be a larger component of the inventory method. Flux towers, and soil samples seem to be the only field methods available to fill this gap, and these are not mentioned in the methodology.

Response to Reviewer Comments on Charge Question 3: USDA acknowledges there are many nuances to establishing carbon offsets for carbon markets and appreciates the reviewer's input on the strengths and weaknesses of using the methods in this report in carbon markets.

Charge Question 4: *Projects for the Partnerships for Climate Smart Commodities may use methods described in this report to estimate GHG fluxes. The Inflation Reduction Act (IRA) will invest in helping farmers, ranchers, and forest landowners deploy climate-smart practices that will reduce greenhouse gas emissions and increase storage of carbon in soils and trees. This report may be used to estimate the impacts of these investments. Will the methods in this report be appropriate for these uses?*

Reviewer ID	Charge Question 4 Reviewer Comment
A	This reflects my earlier comment about potential inappropriate applications of estimation methods provided in this report. There will be situations where the application of a specific method from the report may not be appropriate due to limitations of that method that are not "technical limitations" as described in the report. For example, the COMET tools are not comprehensive for all crops in all regions and a user has to make and implement assumptions (e.g. select a different crop to represent the one they produce) that may provide results that are not accurate or supported. In a case like this, using one of the COMET tools would not be appropriate without another method also being deployed. That's not going to be intuitive for many users.
B	The methods described in the report could be used for the Partnerships for Climate Smart Commodities program. However, it is uncertain how complex rotations are included in the methodology which is needed for the Climate Smart Commodity program. Hopefully, the Climate Smart Commodity program will evaluate these methods so that the DayCent model or any other model can be improved. However, I do not see any intentional process to evaluate the individual grants and evaluate the different approaches.
C	Similar to above, the methods will only be appropriate when the relevant mitigation management practice is represented in this report. For example, even though I recognize there is a high degree of uncertainty in emissions from animal manure management, the simplicity of the method for estimating VS excretion from dairy cattle will preclude any reduction in manure methane emissions that results from feed efficiency from being represented in this method.
D	No. If we are talking about, in the end, aggregating benefits to the programmatic national scale, these methods do not take into account the inherent risk of reversals to much of this carbon. Additionally, what is the time horizon on which the IRA is hoping to achieve benefits? The permanence of ag carbon is very short, and if the IRA is a short term funding source then it is unlikely that in those lands, this will make a long term difference. So the point is, time frames over which you are deriving your policies makes a difference. Further, carbon dynamics over time are much more complex than quantifying current stocks and using growth and yield models. Longer term carbon storage over large landscapes can be gained through the reduction of carbon in the form of reducing wildfire, drought, pathogen, and bark beetle risk. Those feedbacks are not taken into account in these methods.

Response to Reviewer Comments on Charge Question 3: USDA acknowledges the various opinions on this topic and thanks reviewers for their input. Regarding the potential for inappropriate application of the estimation methods in this report by Partnerships projects, the COMET team will be working directly with awardees to provide technical support, which should reduce the likelihood that the methods in this report are misapplied.

Charge Question 5: *Do the methods have the appropriate level of detail to produce results that are accurate enough to be useful without being overly complex? In the future, what can USDA improve to make the methods even more accurate? What would you recommend USDA consider without making the methods overly complex?*

Reviewer ID	Charge Question 5 Reviewer Comment
A	This may not be a plausible compromise at this time for every possible carbon mitigation strategy. The reality is the overly simplistic estimation methods are less accurate, and careful evaluation of an estimation method in a specific context generally required an experimental data set to compare with that does not often exist. Many estimation methods themselves are simplifications and/or generalizations from specific experimental datasets and are frequently misapplied by users without adequate understanding of the method.
B	The methods have an appropriate level of detail to produce the results. However, I have concerns about accounting for herbaceous matter in crop and forage systems for greenhouse gas inventories. Most scientific literature considers vegetative biomass as ephemeral and is not genuinely sequestered in cropland and grassland systems.
C	Overall, yes. I believe there is an appropriate level of detail. I think there is room to increase the complexity in the animal production sections to be more in alignment with the Cropland and Grazing methods. I would recommend improving on ammonia emissions estimates by estimating these losses from urinary N excretion rather than total manure N. As mentioned above, VS excretion estimates that have some response to feed intake and diet composition will increase accuracy and expand the methods applications.
D	This depends on your questions. If you need simple estimates of your current carbon stocks and are not concerned with high levels of accuracy and don't need to quantify the impact that changes in management and climate have on your system, then these could be fine. To improve on the sensitivity and accuracy of estimates, more empirical information has to be incorporated. To elicit this in a practical sense, USDA should drive down the cost of inventory equipment that can speed up the data collection process, such as terrestrial scanning LIDAR, drones, and flux tower equipment.

Response to Reviewer Comments on Charge Question 5: USDA notes that the reviewers agree there is an appropriate level of detail assuming the level of accuracy provided is sufficient for the questions asked. This version is striving to find the right balance of accuracy and complexity. The authors attempted to reflect the most recent available science and align with the methodologies used in the U.S. GHG Inventory.

Charge Question 6: *Are there data gaps and research needs that USDA has not included in the chapter appendices that should be acknowledged? For example, does the report capture all currently available management practices, or are there others that should be included?*

Reviewer ID	Charge Question 6 Reviewer Comment
A	There are significant data gaps to support estimation methods for most specialty crop production systems, as well as limitations to available data to support robust estimation methods in some regions (and sub-regions) with high natural variability (e.g. US Pacific Northwest). For instance, the availability of robust experimental data sets to support estimation methods are often geographically concentrated near Land Grant University and USDA ARS campuses and research farms. Depending on the region, this can bias estimation methods. Additionally, SOC measurements at depth are inadequate.
B	It would be helpful if the report had some discussion of rotations. The scientific literature has shown a synergistic effect of more diverse rotations on soil carbon sequestration and reduction in nitrous oxide emissions.

Reviewer ID	Charge Question 6 Reviewer Comment
C	I thought these were very thorough!
D	In the ag space, open source biogeochemical models designed for landscape scales must be developed. In contrast to the forest space, ag only has 2 models that are widely used, DayCENT and DNDC, and neither have open source code. This limits innovation and competition as this code is only available to a select few. Further, the data required to run these models are extremely specific which make it difficult to do assessments over larger landscape with multiple management strategies. If instead new models were designed to ingest more generic data that could potentially be garnered through remote sensing, then these models could be scaled to larger and larger entities, up to the state and national scales. Forests, on the other hand have many complex models designed for many scales and the standard is that code is provided open-source. This has led to better contracting, more innovation, a better understanding of models and processes, and the incorporation of biogeochemical models with remote sensing products (such as with MODIS GPP/NPP/ET). This is lacking in the ag space and hinders both science and confidence in this sector as a climate solution.

Response to Reviewer Comments on Charge Question 6: USDA thanks the reviewers for their thoughts and notes about data gaps. The authors discuss the most significant model and data limitations in the report. As newer models are designed and additional data are collected, future versions of the report will evaluate their viability to be included. DayCent is a recommended method; rotations are represented in DayCent and there are plans for open-source code availability of DayCent in 2024.

Charge Question 7: *There are differences in the entity-scale methods compared to methods used in the national inventory (often due to the level of complexity and availability of entity-level data); see Table ES-2 for a high-level summary of how these methods compare to other GHG methodologies. Do you have any concerns about these differences, or are they appropriate for the various uses? For example: do the methods, emission factors, and provided data adequately capture differences in spatial and temporal variability of an entity-level estimate as compared to an inventory estimate? Are the emissions factors and provided data appropriate and valid for entity-level estimates?*

Reviewer ID	Charge Question 7 Reviewer Comment
A	This is one of my most significant concerns with the application of methods in the report. Most emissions factors are developed based on point-source measurements from an experiment or sampling study and then generalized to a region or production system by experts through analysis or modeling efforts. While there are limitations to generalization of point source data, the researchers who produced the point source data and regional/production system generalizations are usually domain experts who have the capability of making scientific judgement about the appropriateness of generalization and scaling up to develop a factor. Users who then apply those factors back to a different enterprise-level point scale often do not have the scientific training or expertise to discern whether such a decision is appropriate or not. Thus, entity-level estimates may be highly suspect.
B	No comment.
C	I do not have concerns about the different methods for the different objectives. I think there are places where a little more clarity about how to account for the temporal changes within the method will benefit future users (for example feedlot NH3 ammonia emissions).

Reviewer ID	Charge Question 7 Reviewer Comment
D	We should be stressing a much higher standard on entity scale estimates. Let us not forget that, for the most part, folks who will be doing these estimates are getting money to do some kind of nature base climate solution. If they are doing this as part of an offset scheme, then they are most likely getting in the order of millions of dollars. This reporting and inventory is a key factor to securing confidence that the money we as a government, or other entities are putting into removing carbon are real. For this reason, I would remove the option for using FIA data for entity level estimates or the use of national level remote sensing products for project level accounting. I acknowledge the balance between making something practical for a land owner, and making the best estimate that science can provide. However, it could be that the government provides technical assistance or expand the workforce for performing these calculations for these folks.

Response to Reviewer Comments on Charge Question 7: USDA notes there are conflicting opinions on the concern for using the current factors for entity-level calculations. This may be addressed in uncertainty efforts in future versions of the report. In addition, the authors attempted to balance complexity with accuracy in estimating emissions and therefore provided options for entities to use available data (such as FIA or remote sensing products) when needed in case the entity did not have entity-level data available or the resources to collect these data.

Charge Question 8: *How could COMET-Farm and the methods be used to evaluate the greenhouse gas and environmental justice implications of USDA actions? How could the methods be used to prioritize what work should be done?*

Reviewer ID	Charge Question 8 Reviewer Comment
A	More development of COMET-Farm applications to specialty crops and in specialty crop production systems (e.g. fruits, vegetables, urban farm applications). It is extremely difficult at this time to utilize COMET-Farm to represent many of the more diverse urban farming operations that are common to under-represented farming communities.
B	Comet Farm was not even discussed in the report. However, the methods and CometFarm could be used to prioritize practices that most impact greenhouse gases and carbon sequestration.
C	The methods could be used to quantify the total expected emissions reductions that result from practices directly supported by the USDA and the IRA. To prioritize future work, the expected total impact on emissions reductions and the uncertainty associated with each practices can be combined to rank priorities.
D	Comet-Farm can be used as an estimate of what may occur because of an action, but should not be conflated with estimating what is actually on the landscape. So first of all, for Environmental Justice purposes, we must focus on the real impacts on the ground. That being said, the major EJ issue that we hear all of the time is pesticide and herbicide reduction. Therefore, if you added metrics for projected pesticide use for practices within COMET that would be good. Additionally, synthetic fertilizer use, run-off, and water use and contamination are other concerns for EJ groups that COMET could potentially project.

Response to Reviewer Comments on Charge Question 8: USDA thanks the reviewers for these comments. In summary, the methods could be used to identify and prioritize the most impactful GHGs and carbon sequestration methods. In particular, ensuring fertilizer is addressed. Pesticide use and water contamination is outside the scope of the methods.

Charge Question 9: *Is the accuracy and uncertainty of the methods sufficiently transparent enough such that users can decide the method's applicability to different situations? Does USDA clearly list the strengths and weaknesses of the methods so that users can determine whether it applies to their situation?*

Reviewer ID	Charge Question 9 Reviewer Comment
A	I think you've done a good job in the report sufficiently and transparently describing estimation methods you have included. That's a different question then whether a user will make a good decision regarding a method's applicability to different situations. There-in lies the risk of building carbon mitigation programs. What could be added to the report is more discussion that focuses on the emerging discussion of more robust strategies for estimating carbon mitigation in the context of regulatory or market-based programs. Ideas like multi-method ensemble or comparative approaches for estimation, or ideas such as layering policy approaches within programs that utilize different estimation strategies to build robustness in carbon mitigation estimates. With the billions in public and private funding flowing to agricultural carbon mitigation, it's causing a rush to the proverbial feed trough so that producers and third parties can "cash in" while the money is flowing freely. My suspicion is we've bought some pretty expensive carbon with all the experimental programs that have been initiated - expensive in that the billions invested will not result in nearly as much carbon mitigation as has been estimated in proposals and contracts. I'm not sure that this is a risk that can be reduced with this report, but could maybe be something that regional working groups could help to reinforce - maybe something set up through the USDA Climate Hubs.
B	No comment.
C	In almost all cases yes! I think the report does an especially good job explaining why certain methods were chosen. There seems to be some sections where the information required for an uncertainty analysis is left up to the users/expert opinion. I think there is an opportunity for this report to fill in that expert knowledge before release.
D	It would still take an expert in inventory quantification to really understand the pros and cons, and when to use what method appropriately. But in the end, this is complex stuff that does require some expert knowledge, so this is not fault of this report. The report is great. But we can't expect farmers or forester owners to be able to do scientifically rigorous inventories by themselves.

Response to Reviewer Comments on Charge Question 9: USDA appreciates the reviewer input and concerns. Future versions of the report will continue to make the content as accessible as possible, particularly in regard to uncertainty.

APPENDIX A

CONFLICT OF INTEREST FORM

Please respond to the following questions:

		YES	NO
1	Have you participated in the development of the updates to the <i>USDA Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale</i> (USDA Methods Report), other than the provided review? If yes, please explain:	<input type="checkbox"/>	<input type="checkbox"/>
2	To the best of your knowledge, is there any connection between the methods, technologies, or management practices (e.g., feed additives) mentioned within the USDA Methods Report and any of you or your spouse's compensated employment including government employment, consulting, research support, or awarded research grants? If yes, please explain:	<input type="checkbox"/>	<input type="checkbox"/>
3	To the best of your knowledge, is there any other gain or benefit (financial or otherwise) that might be gained by you or your spouse as a result of this review? If yes, please explain:	<input type="checkbox"/>	<input type="checkbox"/>
4	To the best of your knowledge, is there any other information that might reasonably raise a question about an actual or potential personal conflict of interest or bias? If yes, please explain:	<input type="checkbox"/>	<input type="checkbox"/>

I hereby certify that I have read the above statements and, to the best of my knowledge and belief, no conflict of interest exists that diminished my capacity to provide an impartial, technically sound, object review of the subject matter to otherwise result in a biased opinion.

Name (print)

Signature

Date