Cropland Irrigation Expert Panel Recommendations Report

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On Behalf of the **Water Quality Goal Implementation Team**
Introduction from Dinorah Dalmasy, WQGIT Co-Chair

Presentation to the Management Board

July 11th, 2019

Summary:

Panel Purpose

To provide scientifically justified recommendations that could replace the interim BMP efficiency associated with cropland irrigation for the Delmarva Peninsula.

Results

- Most studies reviewed were done in the Mid-West, and were done to compare the effectiveness of various types of irrigation technologies, not looking at nutrient fate and transport.
- Findings were inconclusive and even suggested potentially higher loss of nitrogen on irrigated lands.

Agriculture Workgroup

- No consensus on approving panel recommendation.
- No consensus on keeping current interim BMP efficiency.

Water Quality GIT

- No consensus on approving panel recommendation.
- Consensus (no objections) on keeping current interim BMP efficiency.

History of Cropland Irrigation at CBP

Interim BMP: "Cropland Irrigation"

- Approved for planning purposes: Phase 5.3.2 watershed model (circa 2012)
- Definition: "*Cropland under irrigation management is used to decrease climatic variability and maximize crop yields. The potential nutrient reduction benefit stems not from the increased average yield (20-25%) of irrigated versus non-irrigated cropland, but from the greater consistency of crop yields over time matched to nutrient applications. This increased consistency in crop yields provides a subsequent increased consistency in plant nutrient uptakes over time matched to applications, resulting in a decrease in potential environmental nutrient losses*"
- 4% nitrogen efficiency (loss reduction)
  - Documentation for this efficiency value not available

What is an interim BMP?

Requested by the states/partners for planning purposes

- Can be used in planning scenarios only (milestones and WIPs)
- Cannot be submitted for annual progress in order to judge if states fulfilled milestone and WIP commitments
- Should have scientific justification

Comparability to future approved BMP is important

- EPA and states should have confidence that the mechanics (model representation, reporting units, load source, etc.) of the interim BMP will be similar/identical to the future approved BMP
- Load reductions and/or efficiency values associated with interim BMPs must lean conservative
  - Because values and assumptions have not been reviewed by an Expert Panel

Often referred to as a "placeholder" BMP

- Creates expectation that there will be a partnership-approved BMP in the future

Partnership-approved BMPs must go through an Expert Panel

- Interim BMPs have not gone through an Expert Panel
- Interim BMP status does not guarantee future approval of the BMP for crediting towards load reductions

History of Cropland Irrigation at CBP cont'd

Expert Panel: Cropland Irrigation

- CBP expert panel membership approved and convened August 2016
  - Primary Charge: determine water quality benefits of cropland irrigation related to nitrogen, phosphorus, and sediment
- Panel membership included representatives from:
  - VA DCR
  - USDA-ARS (Beltsville, MD)
  - University of Delaware Extension
  - USGS (Dover, DE)
  - USDA-NRCS (Easton, MD)

Date	Action
January 16, 2019	Recommendations Report released for review
February 26, 2019	Webinar and Public Meeting: Recommendations of the Cropland Irrigation Expert Panel
March 12, 2019	Final day for partnership feedback (no feedback received)
March 21, 2019 (AgWG meeting)	Panel Chair requests approval from AgWG; decision postponed pending DE feedback
April 15, 2019	DE feedback submitted to AgWG leadership and Expert Panel
April 18, 2019	Panel Chair acknowledges receipt of DE feedback and anticipated panel review in time for decision for approval at May AgWG meeting.
April 18 – May 7, 2019	Draft responses compiled and shared with panel; panel convenes to discuss feedback and responses; consensus from the panel on the responses and acceptable revisions to the report
May 9, 2019	Revised report and responses from panel distributed for AgWG
May 16, 2019 (AgWG meeting)	Panel Chair requested approval from AgWG, captured lack of consensus for WQGIT
June 10, 2019 (WQGIT)	Panel Chair proxy requested approval from Water Quality GIT, captured lack of consensus for MB
July 11, 2019 (MB)	**WQGIT requests decision from the MB regarding approval of recommendations report**

Summary of Findings on Cropland Irrigation

120+ peer-reviewed research papers considered (most outside CBW)

- Very limited research addressing WQ Issues on irrigated land
- Limited applicability due to different climatic/soil conditions
- Limited research on irrigation systems other than center pivot
- Limited research on crops other than corn

Primary intention of irrigation practices is to maximize crop yield

Rainfall unpredictable within the watershed, influencing dynamics of irrigation

Soils vary across the watershed, influencing dynamics of irrigation

All aspects of irrigation influence the amount of nitrogen loss

Current research does not sufficiently show a water quality benefit

Panel Recommendation

The Expert Panel agreed that **there is not sufficient science-based research available to indicate a reduction in N losses due to irrigation of corn**, therefore an N efficiency value cannot be established at this time.

This does not preclude the possibility of revisiting cropland irrigation as a BMP for a future expert panel, should a more robust catalogue of scientific research literature addressing cropland irrigation management and its water quality impacts emerge.

The panel strongly **encourages further research** on the impacts of cropland irrigation on nutrient and sediment loss and encourages the readers to review the ***Ancillary Benefits and Unintended Consequences*** *and* ***Future Research*** **and** ***Management Needs Section*** of the recommendations report (p. ii).

Recommendations: Future Research

Better understanding of phosphorus behavior under irrigated conditions

Crop response and nitrogen use efficiency (NUE)

- Data collection on crop response to irrigation rate on the Coastal Plain
- Field tests of NUE assumptions regarding non-irrigated vs. irrigated plots under Delaware field conditions (Sims et al. 2012) and the impact of those assumptions on nitrogen loss.
- CBW field research on supplemental irrigation.
    - Inconclusive data limits the assertion that increased crude protein in corn is an indication of less nutrients subject to leaching.

Nutrient source

- Explore the impact of litter and manure application under irrigated conditions

Nutrient Management

- Research on most efficient nitrogen rates for irrigated corn and other crops to ensure that nutrient application recommendations are based off the latest scientific data.

Recommendations: Future Research cont'd

Water Quality

- Sensitivity analyses of studies looking at nitrogen leaching associated with irrigation to account for potential noise in the observed data.
- Development of model scenarios to address impacts of various environmental conditions on potential for nutrient leaching and transport.
  - Identification of modeling data that does exist that can inform evaluation of irrigation under different environmental conditions.
- Monitoring water and land management practices in a strategic manner to collect the data most critical to informing modeling scenarios.
  - A long-term (5-8 year) study with broad participation is needed to get a better sense of average conditions.
- Research and data informing the conditions under which a water quality benefit could be expected from cropland irrigation .
  - (e.g., weather, water management, nutrient management, healthy soil practices, soil organic matter content).

Recommendations: Future Research cont'd

Irrigation management

- Bay watershed research on variable rate irrigation to address irrigation on fields encompassing wetlands or uneven soil moisture conditions.
- Bay watershed research on the interaction of irrigation management with other measurable variables.
  - (e.g., yield, biomass, soil moisture)

DE Feedback & Panel Response Summary

Recurring Comment	Panel Response (abridged)
#1: Edits for clarity or substance	• Considered minor clarifying edits on a piecemeal basis • Will not accept inserted/revised text that is not adequately cited/supported • Will not accept any edits that change the substance of the panel's reasoning or conclusions.
#2: (MODELING) DE expects that a modeling exercise be undertaken either by this expert panel or by a new expert panel before a final report be approved without an efficiency estimate. This effort is endorsed by the BMP EP Protocol and there is no justification in this report why such an exploration was not attempted by this panel.	• Disagrees with the commenter and feels that the report, as written, appropriately justifies its conclusions. • A new panel cannot be considered until the partnership finalizes the current report and releases the current panel for the completion of its charge.
#3: (RESEARCH APPLICABILITY) Studies of irrigation in the Midwest or other regions have limited applicability in the CBW or the Delmarva; should not be included or considered in the report or the panel's conclusions.	• Limitations of the available research studies acknowledged throughout the report. • Will not remove sections or statements that summarize such studies - serves as useful documentation for future expert panels or research efforts.
#4: **(NUE as water quality determinant)** The panel should recommend a nitrogen efficiency for cropland irrigation based on estimates of improved nitrogen use efficiency (NUE); the panel confused or did not fully account for NUE.	• Data considered from Virginia Tech field trials presented by Wade Thomason (p. 25; Figure 8). • There was not sufficient data for the panel to define an overall nitrogen efficiency based solely on changes in NUE of corn.
#5: Various edits/comments pertaining to section summarizing University of Delaware study (Shober et al., 2018).	The panel appreciates the suggested edits from the study author (Amy Shober) and will incorporate these cumulative edits in its revised draft. (Note: revisions to this section were made and accepted, therefore not marked up in May 9 version for readability)

Decision Recap

Decision Item	Agriculture Workgroup	Water Quality GIT
#1. Approval of panel report and recommendations	**Non-consensus** *Stop:* DE *Hold:* PA *Stand Aside:* MD, WV *Agree w/ Reservations:* NY, CBC *Endorse:* EPA, Ken Staver*, Paul Bredwell*, Jeremy Daubert*, Gurpal Toor*	**Non-consensus** Objections: *Stop:* DE *Hold:* PA *Stand Aside:* MD
#2. Keep or remove interim BMP	**Non-consensus** *Keep:* DE, MD, NY, PA, CBC, Jeremy Daubert *Remove:* VA, EPA, Ken Staver, Paul Bredwell, Gurpal Toor *No vote/Abstain:* WV	**Consensus** *No objection to keep interim BMP*

**at-large members*

Management Board Decision Item

Decision Requested: The MB is asked for a final decision on the approval of the recommendation report.

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Consensus Continuum

Stop	Hold	Stand Aside	Agreement with Reservations	Endorsement
"I do not agree and feel the need to stand in the way of this decision"	"I believe more work is needed before we make a decision"	"I trust the group and will not block this decision but need to register my disagreement"	"I can live with it"	"I like it"

DE Letter to Panel

DE Comments	Panel Response
The report both dismisses (p16) and embellishes (pp16-25) the relevance of mid-west research studies as a proxy for CBW effects for irrigation. As the report states, the ubiquity of irrigation in the mid-west limits the applicability of the results to our region and systematically limits the comparison to dryland production, which for the CBW is a baseline condition. These papers, rather than be categorically summarized and cited, should merely be referenced as the independent variables are insufficiently similar to CBW to influence the report's findings, again stated on page 16 of the report. ***[DE questions inclusion of limited-applicability research]***	The panel worked to summarize available information. Given the panel's recommendations for future research needs, it was important to document information even if obtained from studies in other regions. **This section will be kept as-is.**

DE Letter to Panel

DE Comments	Panel Response
The term of baseline conditions are used interchangeably to refer to regional agriculture status quo, model conditions without a BMP, irrigation system parameterization and soil moisture/background N levels. ***[DE questions inconsistent use of "baseline" throughout report]***	The panel acknowledges that terms like "baseline condition" are used with variable meanings, especially in CBP technical documents and discussions that span modeling and real-world considerations. **The panel feels that its usage of "baseline conditions" is appropriate when viewed in context of the respective statements, but we will consider editing specific instances for clarity.**

DE Letter to Panel

DE Comments	Panel Response
The report should diligently list for all studies whether antecedent groundwater (used as irrigation) nitrate was measured, reported or corrected for when considering the nutrient use efficiency of irrigated crops compared to dryland acreage. Also reported consistently should be the method by which irrigation rates were determined. [***DE questions consistency of inclusion of research methods for cited studies***]	**In the cases when studies did account for this, it was noted in the report.**

DE Letter to Panel

DE Comments	Panel Response
The final version of this report, perhaps inadvertently, largely ignores the other major pathway for nutrient loss, overland flow. This component should be carefully considered and added as a parameter for rating irrigation. Improper sprinkler irrigation can promote overland loss according to newly cited research presented in these comments and some measure was taken to better incorporate this concept in the marked up report. [***DE questions absence of overland flow as a considered pathway for nutrient loss.***]	**The panel focused primarily on nutrient losses below the root zone (the primary pathway for N loss), as other BMP panels have done for cropland BMPs.** The panel chair reached out to irrigation experts for research on overland flow related to irrigation, but could not find anything that would affect the panel's existing conclusions. Anecdotal information indicates that nutrient loss by overland flow is magnified when irrigation is not managed based on soil moisture or weather forecasts.

DE Letter to Panel

DE Comments	Panel Response
The report's scientific literature review mixes approaches for assessing nitrogen benefits on irrigation. Nitrogen use efficiency (NUE) is a proxy for the reduced leaching or overland flow of nitrogen, and measured soil nitrate below the root zone is an acceptable direct measure for leaching loss. These approaches for effectively measuring an irrigation treatment would rarely if ever be mixed and the report should consider them separately. The comingling of approaches may have resulted in confusion when searching for effectiveness because no study reviewed had both. [***DE questions the panel's narrative approach to discussing NUE and soil nitrate measurements below the root zone.***]	The panel considered data from Virginia Tech field trials presented by Wade Thomason (p. 25; Figure 8). **There was not sufficient data for the panel to define an overall nitrogen efficiency based solely on changes in NUE of corn.**

DE Letter to Panel

DE Comments	Panel Response
Additionally, Delaware would like to reiterate, commensurate with the BMP Expert Panel review protocol, modeling exercises can be used to justify the benefit of a BMP where peer-reviewed or unpublished data fail to provide a reliable estimate. The CBPO submitted version of this report states that there was not sufficient science-based evidence to indicate a reduction (p16). While we believe there is this evidence, as presented in this letter, further simple model experimentation calculating N savings as prevented loss of N from drought induced underperformance in cropland under regional nutrient management can be cited as evidence for an efficiency so long as it is weighted less than other local, science-based research. Delaware expects that this effort be undertaken either by this expert panel or by a new expert panel before a final report be approved without an efficiency estimate. This effort is endorsed by the BMP EP Protocol and there is no justification in this report why such an exploration was not attempted by this panel. [***DE questions panel's decision not to engage in a modeling exercise to justify cropland irrigation as best management practice for water quality.***]	The panel agrees that future modeling analysis should be done to supplement future research and improve our understanding of nutrient leaching and transport. However, this panel strongly disagrees that it is the appropriate forum for such analysis. The panel report documents the panel's thought process and logic for its existing conclusion and it will not consider such additional analysis on its own. The panel stands behind its conclusion and furthermore does not have available time or resources to continue such work that it undertook starting in 2016. **The panel disagrees with the commenter and feels that the report, as written, appropriately justifies its conclusions.** Furthermore, a new panel cannot be considered until the partnership finalizes the current report and releases the current panel for the completion of its charge.

DE Letter to Panel

DE Comments	Panel Response
Degree-earning research is recommended by Delaware reviewers as references to be subsequently and natively added to this report. The suggested 15% nitrogen efficiency, justified by Soroka (2015), has been added in a red-line review of the report, but the Panel is the only body empowered to dictate a summary of the newly provided research in the appropriate sections of the report. [***DE recommends a 15% N efficiency based on Soroka (2015 master's thesis from University of DE)***]	The panel thanks Delaware for providing the thesis paper. However, the panel firmly rejects the suggested 15% nitrogen efficiency value. This value, derived from analysis of 35 years of corn variety trials at the University of Delaware, suggest that rainfed plots are "80 and 85% as efficient as irrigated plots in converting applied N to grain yield." The panel considered NUE as described in the Virginia Tech sub-section of the *Recent Irrigation Research in the Chesapeake Bay Watershed* section. **The panel's best professional judgment led them to conclude that a nitrogen efficiency cannot be determined at this time.**

DE Letter to Panel

DE Comments	Panel Response
Included as an attachment to this letter is an itemized summary of comments from the two named reviewers to facilitate the Expert Panel's response. Delaware hopes concurrence of the suggested changes can be accommodated by the expert panel and is dually supportive of on-going research to continue to justify the water quality benefits and limitations of this practice. The comments, suggestions and concerns raised in these documents shall in no way diminish the effort of the Expert Panel convened to tackle this scientific question. [***DE included an itemized summary of the suggested edits for the Expert Panel Recommendations Report***]	The comments are summarized below in this table (See Appendices D-E) alongside responses. The panel thanks Delaware for its extensive review and feedback, but under the BMP Protocol is empowered to reject or disagree with suggested revisions to the report. If the Partnership wishes to include changes over the objection of the expert panelists, the BMP Protocol provides for that option. **The panel stands behind its conclusions and recommendations as written and with the acceptable minor changes acknowledged within this table (See Appendices D-E)**