Agri-Environmental Beneficial Management Practices: Understanding the Policy Context

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The Issue

With growing awareness and concern regarding sustainability in agricultural systems, greater emphasis is being placed upon beneficial management practices (BMP's). Agronomic BMP's codify cropping practices that can generate specific environmental benefits and/or prevent/mitigate certain adverse effects. A growing list of environmental concerns entail BMP's as solutions, in some cases backed by annual incentives and cost-share funding initiatives. As federal greenhouse gas emission standards for agriculture roll out, policy nudges toward a swath of agronomic practices could be encouraged.

Yet, the rate at which BMP's are adopted, or are sustained over time, appears to vary widely. This is consistent with a combination of economic pressures on farm costs and returns, limitations imposed by farm machinery investments, uncertainty regarding the efficacy of specific BMP's and/or desired outcomes, and the prospect of unintended consequences of selected BMP's and combinations of BMP's. The diversity of agricultural BMP's and potential outcomes requires a more refined view; adopting more BMP's is not necessarily better if BMP's can work at cross purposes.

Our existing framework for agri-environmental policy is not well aligned with tradeoffs among BMP's or the breadth of environmental problems requiring a range of BMP's- instead tending to encourage increased adoption of any and all BMP's. This policy note explores the difficulties with approach and highlights some concerns.

Not All BMP's Work in Tandem

Remarkable environmental improvements can be obtained from agronomic BMP's. For example, use of urease and nitrification inhibitors with nitrogen fertilizers in corn production can significantly reduce emissions of ammonium and nitrous oxides (Drury *et al*, 2017). No-till can reduce sediments in runoffs waters by 50-80 percent in level fields versus conventional tillage (Wicklum and Gray, 2010). However, there are also some inconsistencies. For example, Ogle *et al* (2012) observes field studies in which no-till both increases, and does not affect, soil organic carbon versus conventional tillage. They conclude that the increased input of organic carbon through increased crop residue left on the surface in no-till systems can be accompanied by a corresponding reduction in soil carbon decomposition rates, mitigating accumulation of soil organic carbon.

BMP's can influence specific target outcomes, but others can be adversely affected. Consider, no-till crop production. No-till is effective at reducing soil erosion and leaching of nitrogen compounds from commercial fertilizers (Kleinman *et al* (2011), Rekha *et al* (2011)). No-till also decreases offsite loss of particulate phosphorus, but increases the loss of soluble reactive phosphorus due to stratification of phosphorus in the top layer of the soil (Jarvie *et al*, 2017, Renwick *et al*, 2018). Renwick *et al* conclude that "reduced tillage presents a potential tradeoff between reducing soil erosion (and associated particulate P) versus increasing dissolved P export".

The above example presents the prospect that BMP's that have certain public/private benefits (reduced soil erosion/nitrate leaching) could exacerbate other environmental costs (increased movement of soluble reactive phosphorus into water courses). There are

others- for example, cover crops help to anchor soil and prevent erosion (for example, Kettler, 2000); but some cover crops also have an episodic release of phosphorus at freeze-up (Lozier *et al*, 2017). BMP's such as no-till used effectively on more coarsely-textured soils may be much less effective and/or much more costly on finely textured soils.

Policy Must Address a Range of Environmental Problems

The problems addressed by agri-environmental policy range broadly, and can exhibit different priority rankings locally. Climate change is a broad national and international priority in which agriculture must be enlisted as a carbon-fixing industry to provide solutions, and one targeted for mitigation of existing emissions levels. Elsewhere, phosphorus losses from agricultural land and the accelerated eutrophication of surface water are a critical priority, manifest as periodic toxic algal blooms- such as in certain Great Lakes and Lake Winnipeg. In other areas, current and historic levels of nitrogen applications- both in the form of commercial fertilizers and livestock manure- threaten leaching of nitrate into groundwater. This confronts standards for safe drinking water and other issues of water contamination. A number of other major issues likely exist- such as biodiversity and wildlife disease mitigation such as Chronic Wasting Disease, etc.

Other issues are manifest more at the private level but are also matters for public concern and action. Soil erosion, compaction, and salinization are ongoing matters of agricultural sustainability and productivity. Alternatives for pest management that address both reduced tillage and concerns regarding use of pesticides and pest resistance are ongoing.

Targeting Priority Environmental Problems Requires Targeting BMP's

Because of the range in the efficacy of certain BMP's in certain contexts, and because certain BMP's can actually work at cross purposes and actually inhibit certain desirable outcomes, a more refined policy approach is required. This begins with a realistic assessment of priorities in terms of targets. To illustrate, reduction in greenhouse gas emissions in agriculture is an important objective everywhere; but in some areas the significance and urgency of phosphorus and water quality will be the priority. BMP's that address phosphorus may not help with greenhouse gas emissions much, or perhaps could exacerbate them. Nonetheless, a willingness should exist to allow priority local policy issues to be targeted with the right BMP's, with conflicting effects across targets perhaps addressed in enhanced efforts made elsewhere.

Secondly, the nature of interactions among BMP's in agricultural systems is still being learned. Ongoing research should be supported to better understand the processes and mechanisms at work, but equally some effects may only be evident at a watershed or landscape level. This lack of complete understanding needs to be acknowledged, and embraced in policy through active-adaptive management, in which the implementation of BMP's- alone or in combination- are viewed as a form of experiment. Policy implementing BMP's under this approach relies on careful documentation of results, and a willingness to be flexible to change policy or approach if unanticipated or adverse results are observed. Resources need to be made available for BMP policy implementation accordingly.

Nutrient management rules in Denmark provide broad examples- of BMP's used to address nitrogen and phosphorus, of resources used in monitoring of how BMP's are working, and also of strict regulation

to backstop BMP's.[1] It ranges from voluntary measures- such as extensive use of cover crops ("catch" crops) as BMP's- to monitoring using a mandatory fertilizer accounting system, and finally stricter regulatory quotas for nitrogen and phosphorus that have been tightened over time.

Conclusion

Agricultural researchers and extension experts- in economics/policy, and in all segments of agricultural sciences- have an appreciation built on experience that remarkable things are possible through certain practices codified as BMP's. At the same time, farmers and extension staff know, and researchers must admit, that BMP's can be fallible, and that they need to be implemented with attention to detail and caution. We are learning that some of the BMP's can come into conflict with one another, and can actually make some things worse- even as they attempt to make others better. At the same time, the pressure has never been greater to mitigate environmental problems associated with agriculture, and for agriculture to contribute to solutions for broader societal problems.

The policy response in this dynamic cannot afford to be simplistic. BMP's are generally not additive, and policies that simply support more adoption of more BMP's risk creating adverse outcomes and not meeting their objectives. Effective agri-environmental policy is more complex, requiring a clear priority ranking of problems to be targeted, and a means of consultation to arrive at priorities that is seen as effective and just. By nature, this is likely to be required at the sub-provincial level, regardless of whether the issues are under the jurisdiction/resource complement of provinces or the federal government.

Ideally, research will be clear on the efficacy of BMP's to target priority issues, and the unintended effects on others. However, most issues will not be so clear cut, implying the need both to support ongoing research, and to take an active-adaptive approach to policy for BMP's. This presents the risk that some BMP policy approaches will end up failing and require changes; governments need to be prepared appropriately.

The deep complexity of many agri-environmental issues, and environmental issues that agriculture can contribute to as a solutions provider, will create the temptation for governments to simply throw money at problems and be on record as having taken action. The understanding that BMP's can inhibit each other and produce adverse unintended effects should pose a caution to doing so. There is really no good alternative to the hard work of understanding the problem, establishing clear priorities, and then monitoring the success, failures, and unintended consequences of the BMP's enlisted as solutions.

Failure in this regard carries latent risks for agriculture. Funding of agri-environmental BMP's that disappoint, or that create unintended adverse effects will not only cause governments and the public to lose patience and confidence with agriculture as a solution to environmental problems. It could trigger draconian regulatory responses impacting perceived environmental impacts of agriculture, that agriculture is given little role in shaping.

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[1] See Overview of the Danish regulation of nutrients in agriculture & the Danish Nitrates Action Programme https://eng.mst.dk/media/186211/overview-of-the-danish-regulation-of-nutrients-in-agriculture-the-danish-nitrates-action-programme.pdf

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