Get it Together! Innovating holistic potato production systems to protect groundwater

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Without rehashing the obvious, there are many reasons why coarse-textured, low organic matter soils are optimal for growing high quality potatoes. However, it's as well known that such a soil can be "leaky" – there's simply not much to prevent water from moving through the soil profile to groundwater. In recent years, this situation has been made worse by a really shallow groundwater table and variable but frequent high precipitation weather events. Unfortunately, this water sometimes isn't traveling alone – in certain conditions it can contain some of our agricultural inputs such as nitrates and pesticides. That's all well-traveled ground; the question we ask here is what can we do about it?

There are several ways that we might try to reduce the risk of groundwater contamination at the field level in such a potato production system, including but not limited to:

- Reduce the use of fertilizer and pesticide inputs or choose reduced-risk inputs that pose less of a human or environmental health hazard
- Choose inputs that are less susceptible to moving to the groundwater, such as less soluble pesticides or slow release fertilizers
- Manage irrigation and input timing carefully to avoid high precipitation weather events as much as is possible with current sensing and forecasting tools
- Develop and grow potato varieties that are pest tolerant or resistant, or that maintain production and quality with less nitrogen
- Create a "barrier" of sorts between the potato root zone and groundwater that catches potential contaminants

Much work has been done or is underway for the first four aspects listed above that "tweak" the current production system. The fifth piece – creating some sort of barrier that catches potential groundwater contaminants is both the most bold and challenging. It would require a wholesale production system change. Obviously, it isn't realistic to line a field with some sort of synthetic filter, but is there an economical way to integrate deep-rooted intercrops or perennial filter crops within a potato field that protect against groundwater contamination in the spring and fall "shoulder" seasons, pre- and post-harvest?

In 2021 we're going to take a shot at such an approach right where such bold creativity is meant to first happen – in a research field where the risks are low and failure is ok if we learn from it and continually advance. And, we won't be starting from scratch. Some of the pieces have already been researched and others are already in commercial practice elsewhere. The most important question is whether we can put them together in a holistic production system that's agronomical reasonable, economically feasible and actually makes a difference in protecting groundwater. We're going to start with agronomic and economic questions first, and here's a very short background on some of the existing knowledge and practices that we'll be pulling together in a complete system:

- Cereal rye cover crop. Let's start with the easy one – it's simply the norm in Wisconsin potato rotations to plant winter cereal cover crops post-harvest and won't require modification of current practices other than to emphasize early establishment that enhances pre-winter root growth. The ability of cereal rye to reduce nitrate leaching is well established in the peer-reviewed literature. For example, Brandi-Dohrn et al. reported that a winter cereal rye cover crop reduced nitrate leaching by 37% compared to bare ground in a high precipitation Western Oregon vegetable production system (Brandi-Dohrn et al., 1997, Journal of Environmental Quality 26:181-187).
- In-season living intercrops in potatoes. We've dabbled with between-row cover crops in potatoes over the years, looking for ways to suppress weeds without herbicides (Figure 1). However, there hasn't been a significant impetus to adopt such a strategy given the effectiveness of current herbicides, and it's a fine line between suppressing weeds and growing cover crops that can act as weeds, competing for water and nutrients in particular. However, here our objective is quite different and we can use what we've already learned to suppress rye top growth without killing the root system that's desired to reduce nitrate leaching risk.

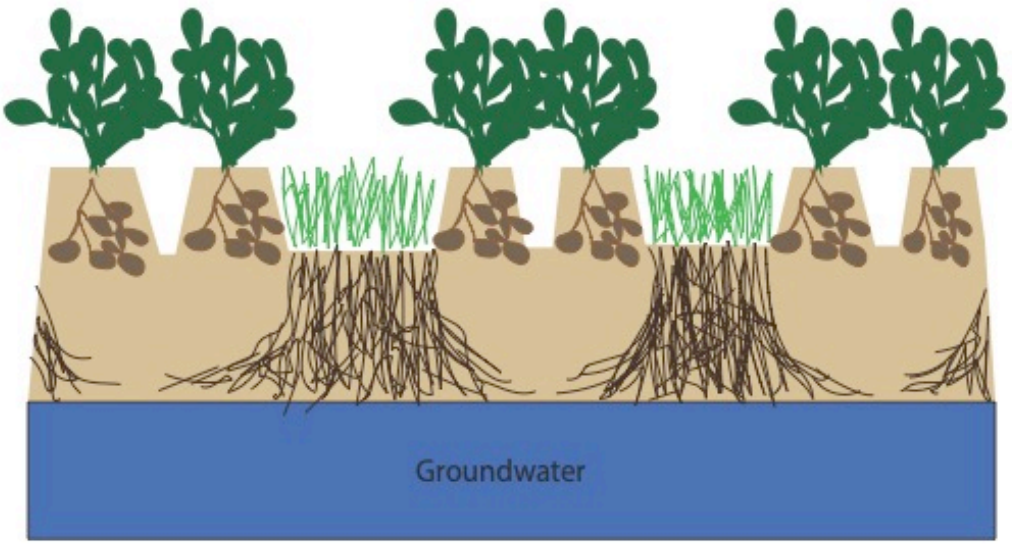
  Figure 1. Mustard living cover crop interseeded into potatoes in Hancock, WI.

- Reduced- or strip-tillage potatoes. Reduced-tillage potato production systems have been studied sporadically over the years and with varying results. For example, one study reported in the literature looked at reduced tillage and rye residue levels in potato (Lanconfroni et al., 1993, Weed Technology 7:23-28). The authors reported less yield in reduced tillage systems compared to conventional tillage in one year when early-season weeds weren't controlled well but greater yield compared to standard practices in the second year when reduced tillage was implemented and weeds suppressed.

Here's a general idea and timeline of a holistic production system that we'll begin testing next growing season, with a rough schematic below (Figure 2):

- Fall before potatoes: plant cereal rye cover crop as usual, emphasizing early establishment.
- Pre-plant: strip-till potato planting rows, leaving rye strips between rows (we'll test various rye strip frequencies and widths, ie. between every potato row, every other potato row, etc.).
- Plant potatoes in tilled strips.
- Hill potatoes and apply broadcast pre-emergent herbicides, choosing products that will suppress but not kill emerged rye (we have a good sense of that from work we've completed on carrot nurse crop susceptibility to herbicides, most of which are also used on potato).
- Continue to suppress but not kill rye with post-emergent potato herbicide choices.
- Vine kill and harvest potatoes as usual, with any remaining rye regrowth killed by the non-selective desiccant.
- Immediately broadcast replant rye cover crop to optimize shoulder season ground cover.

Figure 2. Rough schematic of a vision for an innovative, holistic production system with a living uptake mechanism and potential barrier to groundwater contamination with potato strip-tilled into an established cover crop.



Obviously, there's still much to be hashed out in such a system and a lot of "what ifs?", but as Mark Twain said "the secret of getting ahead is getting started." And, we certainly may fail, but innovation is needed to protect our groundwater AND our ability to farm profitably. We look forward to your assistance in refining these thoughts based on practical experience as we work together to find viable solutions.