AGRICULTURAL RESEARCH FOUNDATION
INTERIM REPORT
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TITLE: Effects of long-term tillage managements on nutrient stratification in wheat-pea systems: Implications for soil health indicator identification

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SUMMARY/ABSTRACT:

Limited precipitation (~420 mm with >70% precipitation in winter season) resulted in large-scale adoption of winter wheat-summer fallow rotational system (WW-SF) in the dryland PNW. In the WW-SF cropping system, winter wheat crop-year is followed by a fallow year and then, winter wheat crop is planted after the fallow year. However, due to adverse effects on soil health low biomass (organic matter) input to soil, and low crop diversity of WW-SF, cropping systems like wheat-pea rotational system (WW-P) were adopted as potential alternative to WW-SF with some potential benefits towards crop productivity, soil, and environment. Several agronomic practices (e.g., no-till, spring tillage, fall tillage, chisel tillage, etc.) were also combined with the WW-P system to maximize the benefits of this rotation. Acreage under no-till (NT) adoption is growing in the region due to several benefits such as increasing soil organic matter, reducing erosion, increasing microbial activity, reducing greenhouse gas emissions, and improving overall soil health. However, due to lack of mechanical mixing of soil under reduced tillage (NT, chisel tillage) leads to accumulation and stratification of soil nutrients (C, N, P, K, Ca, Mg, etc.) and in many cases, increased soil acidity in topsoil and rooting zone. *Stratification generally refers to the non-uniform nutrient distribution with depth usually resulting in nutrient accumulation in topsoil.* The increased soil nutrients and acidity in topsoil is of particularly interests under NT, mainly due to fertilizer placement and crop nutrient uptake. Soil acidity can pose hurdle to crop production and nutrient quality of the produce as it can significantly increase or decrease nutrient uptake by the plants. The reduced soil mixing and nutrient stratification under NT can further result in differential responses of other soil physical, chemical, and biological properties and thus, overall soil health. Soil nutrient stratification is a common occurrence and could be exacerbated through lack of soil mixing in no-till systems. This can result in mismatch among root location, nutrients pools, and water availability leading to potential hurdle in crop growth and reducing yield significantly. Since farmers in the region operate on extremely thin profit margins, a small yield reduction can result in a large negative economic impact. Further, mismatch in crop-accessible nutrients in soil profile, sampling depth, and fertilizer recommendations may lead to over or under applications of fertilizers, which can also result in

adverse economic impact on producers. ***Any opportunity for better quantification and management of nutrients would be an opportunity to maximize economic and environmental benefits (soil, air, and water quality) for producers.*** Similarly, identifying the soil health indicators is important in developing soil health measurement framework and promoting conservation tillage. These soil health indicators can guide the future soil health research in the region. ***Additionally, this study will produce preliminary results needed to acquire large-scale grants to develop a soil health assessment framework for the region.*** Findings from this study will add to the body of soil conservation knowledge needed to improve long-term economic and environmental benefits for the region.

OBJECTIVES:

This study is being conducted with these specific objectives:

1. To assess nutrient stratification/redistribution under different long-term tillage practices in winter wheat-pea system.
2. To identify the soil health indicators for the wheat-pea systems.
3. To analyze the effects of different tillage practices on soil health indicators in wheat-pea systems.

PROCEDURES:

The study will be conducted on an ongoing long-term experiment (initiated in 1963) under wheat-pea cropping system with two tillage treatments that includes Moldboard plow and No tillage. Two different types of soil sampling will be conducted, (i) Depth-wise soil sampling and (ii) Routine soil sampling.

- *Depth-wise* samples will be collected from a very short depth increments as 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, 15-20, 20-25, 25-30, 30-35, 35-40, 40-60, 60-80, and 80-100 cm.
- *Routine* soil samples will be collected at larger depth increments from 0-10, 10-20, 20-30, 30-40 cm.

Figure 1: Tractor mounted Giddings sampling probe for deep soil sampling

Sampling will be conducted using tractor mounted Giddings® probe (see figure 1). After sample collection, samples will be air-dried and processed for different analyses and analyzed for a range of soil physical, chemical, and biological properties/soil health indicators (see table 1 below). Sample will be analyzed at Oregon State University's Soil Health Lab at Corvallis, OR (https://cropandsoil.oregonstate.edu/shl/soil-health-osu). All the analyses will be conducted using protocols, equipment, and instrumentation from the OSU's Soil Health Lab (Details available at https://cropandsoil.oregonstate.edu/sites/agscid7/files/crop-soil/soilhealthlab/shl-sop-compilation.pdf). Upon completion of the soil analyses, collected data will be analyzed statistically to summarize findings from the study. These results will be

presented at regional/national/extension meetings. These findings will also be published in peer-reviewed publications.

Table 1: Proposed soil properties and soil health indicators to be analyzed in the study.

Soil chemical properties	Soil physical properties	Soil biological properties
Soil pH	Wet aggregate stability	Active C
Soil Electrical conductivity	Soil moisture	Soil respiration
Total C, N, and S	Soil texture	Potentially mineralizable N
NO_3-N & NH_4-N		
Soil P, K, Ca, and Mg		
Soil organic matter		

SIGNIFICANT ACCOMPLISHMENTS TO DATE:
Depth-wise soil sampling were completed last fall 2021. Samples were processed, packed, and shipped to Oregon State University's Soil Health Laboratory at Corvallis, OR for analyses of all the abovementioned indicators. Currently, the lab analyses are underway (as of January 2022) and will have results for all the analyses soon. Upon receiving results from lab, detailed statistical analyses will be conducted and results will be presented to growers at different regional extension national events.

ADDITIONAL FUNDING RECEIVED DURING PROJECT TERM: We utilized our lab resources and personnel for sample collection, processing, and shipping. Further, the lab resources will be utilized for statistical analyses, software, interpretation, and preparing and submitting extension presentations, extension publications, and peer-reviewed articles.

FUTURE FUNDING POSSIBILITIES: Oregon wheat Commission, WSARE, USDA, NRCS