



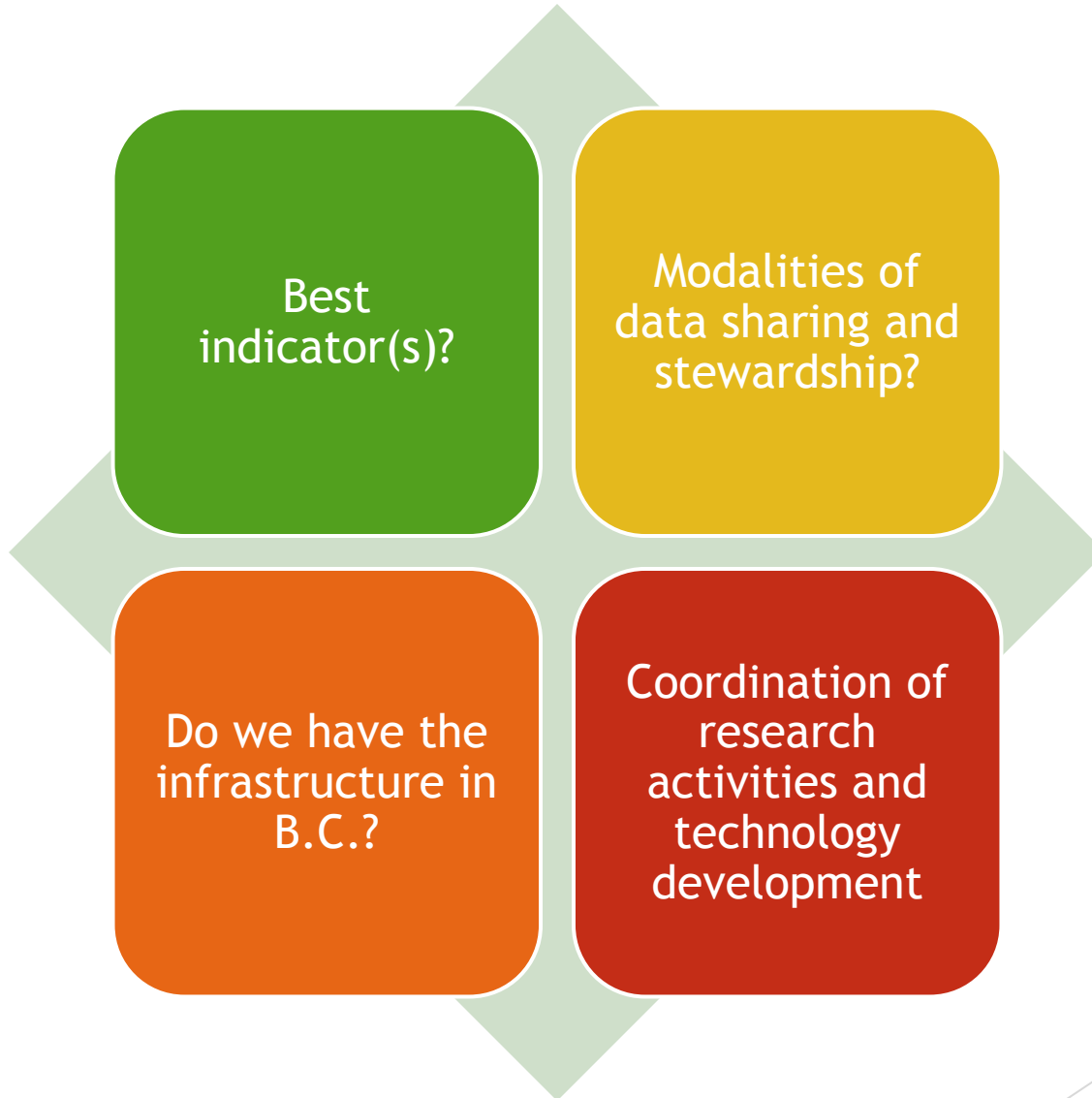
SOIL HEALTH AND
CARBON
SEQUESTRATION
PROTOCOL FOR
B.C.



Objectives of Indicators of Soil Health and Carbon Sequestration

- ▶ Assess soil health and carbon sequestration in response to practices (regenerative agriculture)
 - ▶ Evaluate impact on soil health
 - ▶ Evaluate impact on soil carbon
 - ▶ What is the impact of climate change?
- ▶ *In order to*
 - ▶ *Select most effective practices, ... and damage control*
 - ▶ *Target intervention*
 - ▶ *Promote adoption - demonstrating effectiveness to industry (and policy makers)*
 - ▶ *Have baseline information for planning and reporting*
- ▶ Discussion: Others?

WHAT ARE THE QUESTIONS?



Other?

INDICATORS

1. WHAT DO WE NEED TO KNOW?

2. WHICH INDICATORS ARE MOST SUITABLE TO GIVE THE ANSWER?

SOIL PROPERTIES

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graph TD; A[SOIL PROPERTIES] --> B[RELEVANT INDICATORS]; B --> C[PRACTICAL METHODS];
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RELEVANT INDICATORS

PRACTICAL METHODS



What are “Best” Indicators?

- Accurate and Precise
- Relevant
- Sensitive but at the same time sufficiently robust
- (Universal)
- Stand-alone and not overlap or correlate with other indicators
- Based on sufficient data/knowledge of the optimal range and critical values
- Easy to interpret and allow to be “translated” into management actions
- Other?

Two-Tier Approach: Best of Two Worlds?



TIER 1

- ▶ Data collection by non-scientists
- ▶ Does not require
 - ▶ significant training and/or
 - ▶ costly equipment and/or
- ▶ Can be “piggy-backed” on routine soil testing
- ▶ Can be done in field
- ▶ Can be used to ground-truth Tier 2 approaches

TIER 2

- ▶ Data collection requires
 - ▶ specialize skillset and/or
 - ▶ costly equipment;
- ▶ Typically done in laboratories
- ▶ Can be used to correct/calibrate Tier 1 data



Best Soil Health Indicators: Survey

- ▶ Send to 40 persons knowledgeable in soil health
 - ▶ 19 academia
 - ▶ 7 government
 - ▶ 7 industry
 - ▶ 7 research
- ▶ 18 completed survey
- ▶ Proposed Indicators
 - ▶ 12 Physical
 - ▶ 14 Chemical
 - ▶ 16 Biological
 - ▶ Selection based on literature study and communication with soil health experts ... but there are many, many more
- ▶ Caveat
 - ▶ Not all participants answered all questions

Survey Questions



- ▶ Specific to each proposed indicator
- ▶ Is the indicator
 - ▶ Suitable as Tier 1 indicator
 - ▶ Suitable as Tier 2 indicator
 - ▶ Not suitable as a soil health indicator because
 - ▶ there is no sufficient knowledge/data (yet)
 - ▶ method is extremely laborious, expensive or impractical
 - ▶ Not a good indicator of soil health to begin with (for example irrelevant to soil health)

Indicator	Votes	Votes %
SOIL STRUCTURE	14	78%
SOIL PH	13	72%
SOIL EC	12	67%
BULK DENSITY	12	67%
PENETRATION RESISTANCE	10	56%
DEPTH OF "A" HORIZON	10	56%
TOTAL ORGANIC C	9	50%
SOIL ORGANIC MATTER	8	44%
ODOUR	8	44%
SOIL INFILTRATION	8	44%

TIER 1
Indicator should
be included *and*
can be conducted
by non-scientist

Indicator	Votes	Votes %
POTENTIALLY MINERALIZABLE NITROGEN	14	78%
SOIL FERTILITY: MICRONUTRIENTS	13	72%
CATION EXCHANGE CAPACITY	13	72%
BASE SATURATION	12	67%
PARTICLE ORGANIC MATTER	12	67%
SOIL FERTILITY: MACRONUTRIENTS	11	61%
REACTIVE CARBON	11	61%
HOT WATER EXTRACTABLE CARBON	11	61%
HOT WATER EXTRACTABLE NITROGEN	11	61%
SODIUM ADSORPTION RATIO	10	56%
MICROBIAL BIOMASS	9	50%

Tier 2

Indicator should be included but can't be conducted by requires special skillsets and/or equipment

Indicator	Votes	Votes %
ODOUR	2	11%
METABOLIC QUOTIENT	2	11%
MICROBIAL COMMUNITY	2	11%
WEED PRESSURE	2	11%
PROTEINS	2	11%
ARGININE AMMONIFICATION	2	11%
All others 1 (6%) or no vote		

Indicator not recommended due to Inconclusive Current State of Knowledge or Data

Indicator Not Recommended Because Assessment Methods are Extremely Laborious or Impractical

Indicator	Votes	Votes %
SATURATED HYDRAULIC CONDUCTIVITY	5	28%
EROSION	5	28%
METABOLIC QUOTIENT	5	28%
MICROBIAL COMMUNITY	5	28%
PHOSPHOLIPID FATTY ACID	5	28%
MICROFAUNA	5	28%
PLANT AVAILABLE WATER	4	22%
ENZYME ACTIVITY	4	22%
FUNGI: BACTERIAL RATIO	4	22%
MACROFAUNA	4	22%
INFILTRATION	3	17%
RESPIRATION	3	17%
PROTEINS	3	17%
ARGININE AMMONIFICATION	3	17%
All others 2 (11%) or less		

NOT A GOOD INDICATOR OF SOIL HEALTH



- ▶ NONE GOT MORE THAN 1 VOTE

PERSONAL PREFERENCES (SO FAR)



INDICATOR	RATIONALE	Tier 1	Tier 2	“NO”
Total carbon (dry combustion, corrected)*	Carbon sequestration, SHI indicator	50%	39%	0%
Soil organic matter	Widely available, link to the past	44%	33%	6%
(Re) Active carbon (tbd: POx-C, carbon mineralization potential*)	Indicator of carbon that may not stay	11%	61%	1%
Macronutrient, pH, EC	Need to be tested anyways	17%	61%	6%
Aggregate stability in field: portable rainfall simulator*	Aggregate stability is <u>the</u> indicator of soil health; method easy but practicality needs to be tested			
Aggregate stability in lab: Eijkelkamp wet aggregate test*	Same rationale as above; method is off-the-shelf and could be deployed in many labs; big question is transport of samples from field to lab!	78%	6%	11%
Plant available water	Very relevant for grower, good indicator	11%	39%	22%
Bulk density	Needed for correction carbon and soil nutrient concentrations (depth equivalent)	67%	28%	0%

*Recommended by Soil Health Institute as part of minimal suite of three measurements to assess soil health.

Other data?

- ▶ Management practice
 - ▶ Tillage
 - ▶ Amendments
 - ▶ Crop and cover crop
 - ▶ Livestock
- ▶ Environment
 - ▶ Climate data
- ▶ Economics
 - ▶ Inputs
 - ▶ Yield/quality

Score Rating

Development of standard ordinal/interval scales for indicators that (for example odour)



Next question: DATA COLLECTION, STORAGE AND ANALYSIS

- ▶ Who is doing field work? (see following slide)
- ▶ **Where** will data be stored? Who will maintain them? Who will do QC/QA?
- ▶ **Who** is analyzing data?
 - ▶ Without **analysis**, soil health assessment is pointless
 - ▶ Potentially “messy” data - huge workload
- ▶ **Reporting:** who will do it and in what format (reports, maps, data base...)? to whom?
- ▶ Ensuring BC data is **compatible** with international data and communication with partners - data requirements
- ▶ **Confidentiality and legality**
 - ▶ What data can we collect, what data can we share
 - ▶ Communication with policy makers
 - ▶ How do we include FN?
 - ▶ Sharing with technology providers of research?



TWO-TIER APPROACH 2.0

- ▶ Few methods are truly suitable for crowdsourcing - but will they be done?
- ▶ Third party (contractor, farm advisor, etc.) perhaps better choice
 - ▶ More consistent quality and quality control
 - ▶ More committed (money, money)
 - ▶ Can also conduct concurrent in-depth study
 - ▶ Can be private company, farm advisor, or farmer themselves (honorarium)
 - ▶ Additional data - climate, economics, management
 - ▶ Less people - easier management



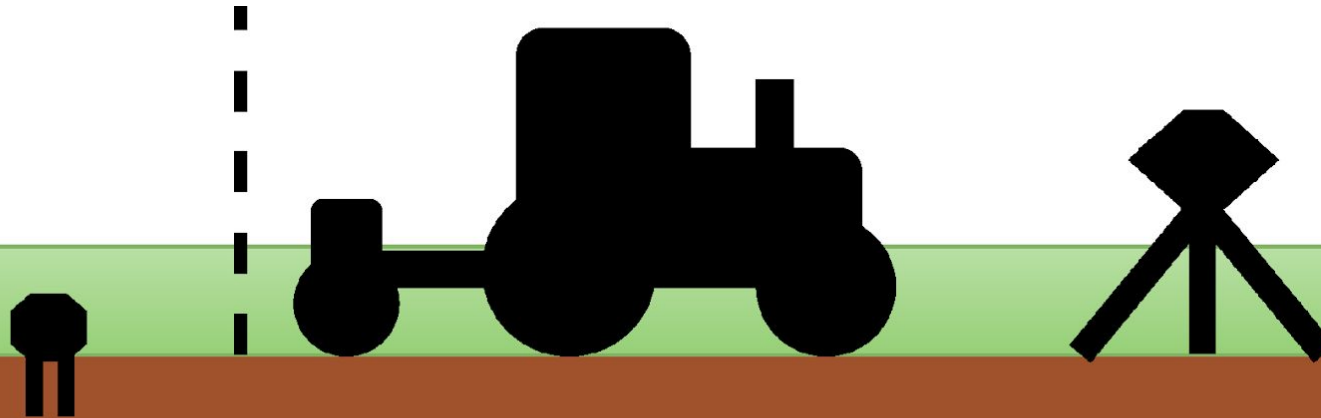
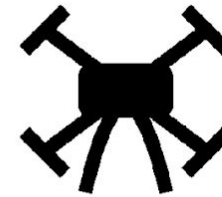
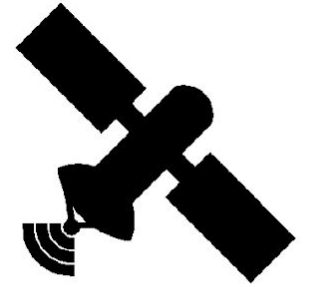
Next Question IS THE INFRASTRUCTURE IN PLACE?

- ▶ Do we have enough contractors or planning advisors
 - ▶ Who is training them
 - ▶ Who pays for sampling
- ▶ Are labs on board and equipped?
 - ▶ Development of BC soil health and carbon package with MOE lab?



IS THE FUTURE COVERED?

- ▶ Coordination of research activities to enhance knowledge, improve methods, fill gaps and target research (and resources), review methods and interpretation of data
- ▶ Support development of technology
 - ▶ technology that makes our life easier: proximal and remote sensors technology
 - ▶ New technology for soil management (termination, weed control, direct seeding, etc.)
- ▶ Can we share data (see data stewardship)
- ▶ Can researchers/suppliers piggy-back on data collection/concurrent trials?



Proposed Next Steps

- ▶ MAF contracts Manager for four task forces
 - ▶ Task Force 1: Indicator and Protocol
 - ▶ Task Force 2: Infrastructure
 - ▶ Task Force 3: Data collection and stewardship
 - ▶ Task Force 4: Partnership research and technology
 - ▶ Task forces are core of provincial permanent soil working group
- ▶ Manage mean:
 - ▶ Establish the task force
 - ▶ Organize meetings
 - ▶ Coordinate activities
 - ▶ Note taking, report writing, internal (monthly) newsletter
- ▶ Involvement of FN at very least on permanent provincial soil working group

