

Stubble Subsoil Moisture – A Crop Planning Tool
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Introduction

The objective of the Saskatchewan Agriculture, Food and Rural Revitalization (SAFRR) Stubble Subsoil Moisture Project is to encourage producers to measure the stubble subsoil moisture of each field as part of their crop planning process.

Why measure stubble subsoil moisture? Moisture is the most limiting factor in crop production in Saskatchewan. Stored subsoil moisture is the buffer between rainfall events during the growing season.

Adoption of zero tillage and reduced tillage systems has helped producers focus on moisture conservation. In the 1991 census, about 64 per cent of the cropped acres were in conventional tillage, 26 per cent in minimum tillage and 10 per cent in zero tillage. In the 2001 census, about 32 per cent of the cropped acres were in conventional tillage, 29 per cent in minimum tillage and 39 per cent in zero tillage. This is reflected in the continued reduction of summerfallow acreage in Saskatchewan. According to the 2001 census, Saskatchewan reported 7.8 million acres of summerfallow. This is down from 14 million acres in 1991 and around 18 million acres in the late 1960's and early 1970's.

Along with adoption of reduced tillage, crop residue management remained important where straw is chopped and spread and the chaff is also spread. The ideal stubble height has been determined to be about the same as the row spacing of the seeder. The advancements in seeder technology has allowed for even taller stubble to be left standing. The taller standing stubble not only provided added protection against soil drifting but also provided additional snow trapping to further recharge the subsoil moisture. Seeding into very tall stubble is accomplished with disc type seeding machines. The tall stubble also provided a low moisture loss microclimate for the crop seedlings and reduced evaporation from the soil surface. This results in improved moisture use efficiency.

SAFRR has prepared two stubble subsoil moisture maps, one on November 1 and the other on May 1 of each year, since the fall of 1998. The November 1, Stubble Subsoil Moisture Map reflects the level of moisture recharge from precipitation received from mid August to November 1, plus any unused moisture received during the growing season.

The November 1 map is used by SAFRR to identify moisture concerns for the coming growing season and develop policy to address these concerns.

Producers, crop consultants or dealers should measure the subsoil moisture late in the fall. The measurements are used to assist with cropping decisions or used, along with soil testing, to set yield goals and determine the amount of nitrogen fertilizer for late-fall banding and crop planning over the winter months. Fall soil moisture measurement is used as a valuable source of information for securing supplies of fertilizer and other crop inputs through the winter months.

SAFRR produces a May 1, Stubble Subsoil Moisture Map, using measurements taken on May 1. The map reflected the level of moisture in the subsoil that resulted from the fall recharge, plus snowmelt and any early spring precipitation. The May 1 map assists SAFRR to identify areas of potential production concerns and aided in developing measures to help producers cope with potential concerns.

Spring measurements made by producers, crop consultants and dealers are used primarily to make adjustments to cropping plans, yield goals and fertilizer and crop input amounts.

Brief History of the Saskatchewan Soil Moisture Map

Dr. J. L. Henry and Dr. D. Wilkinson produced the first Stubble Soil Moisture Map in 1978, with the objective to provide a guide for fall and winter crop planning, and to encourage producers to check their own fields in the spring. Stubble soil moisture maps were produced by Dr. J.L. Henry, et al. from 1978 to 1989. The maps had four categories, Wet, Moist, Dry and Very Dry.

In the mid 1990's the advancements in computer technology and mapping software allowed SAFRR to prepare an array of maps such as weekly precipitation, cropping statistics, etc. This allowed reintroduce the Stubble Subsoil Moisture Map.

Material and Methods

The instrument for taking soil moisture measurements had to be robust enough to be used by producers, crop consultants and dealers. Other major considerations in selecting a moisture probe included the cost, ease of use and ease of calculating the amount of *plant-available water*.

A moisture probe based on the *Paul Brown* probe was selected. Dr. Paul Brown worked with Montana State University and USDA-Agriculture Research Service and patented his *Paul Brown* probe in 1958. This probe is still being used today.

The probe used in this project is made of a 3.5 to 4 foot long $\frac{1}{2}$ inch steel rod with a $\frac{3}{4}$ inch steel ball welded on one end and a handle on the other end. The probe is operated by being pushed it into the ground and when the steel ball contacted dry soil it stops.

To gain experience, producers are encouraged to probe each field about 10 to 15 times and record the average. With experience, the operator will find that the soil moisture recharge is quite uniform and the number of times required to probe a field can be greatly reduced. This enabled a producer to check a large number of fields in one day. It is also

easily linked to a soil testing operation where soil samples are drawn and the operator checks and records the subsoil moisture for each field.

If an operator is unsure about the depth of moist soil, a regular soil core probe or soil auger can be used to bring up soil to check for soil wetness and soil texture from various depths. A post hole auger can be used to bring up soil from the desired depth if a producer does not have access to a soil sampling tool. Soil wetness is determined by rolling the soil in ones hand to see if it will form a ball. If so, the moisture level is near field capacity. The surface soil texture is also determined for the field because this is needed to calculate the *plant-available water*.

Limitations to the use of the probe included: rocks, gravel, saline areas, knolls, depressions, cracks in clay soils, frozen soil surface in the late fall, frozen soil deeper in the profile in the spring. Experience allows the operator to identify shortcomings and make adjustments.

Other moisture sensors were considered but most were considered expensive, required periodic calibration and training for use and were more accurate than was required for this purpose. Most of these probes were better suited to in-crop soil moisture monitoring for irrigation purposes.

Volunteer, SAFRR Crop Reporters (300), SAFRR Extension staff (33), SAFRR Soils and Crops Agriologists (six), University of Saskatchewan, Agriculture and Agri-Food Canada, fertilizer dealers, crop consultants and the provincial soil specialist sample fields on November 1, and May 1, and reported depth of moist soil, soil texture and Rural Municipality (RM) # to the Crop Reporting staff in Regina. The data was compiled, proofed and converted to *plant-available water* by RM.

The data was plotted using ARC-GIS mapping software using a 50 kilometer radius from each RM center point. If there was missing RM data for the November 1 map it was estimated using accumulative precipitation from mid August to the end of October. Any missing data for the May 1 map was estimated by using a smoothing technique. Major towns, rivers and RMs were included on the base map as reference points. The Stubble Subsoil Moisture Map have been posted on the SAFRR Web site usually on the same day and can be viewed at:

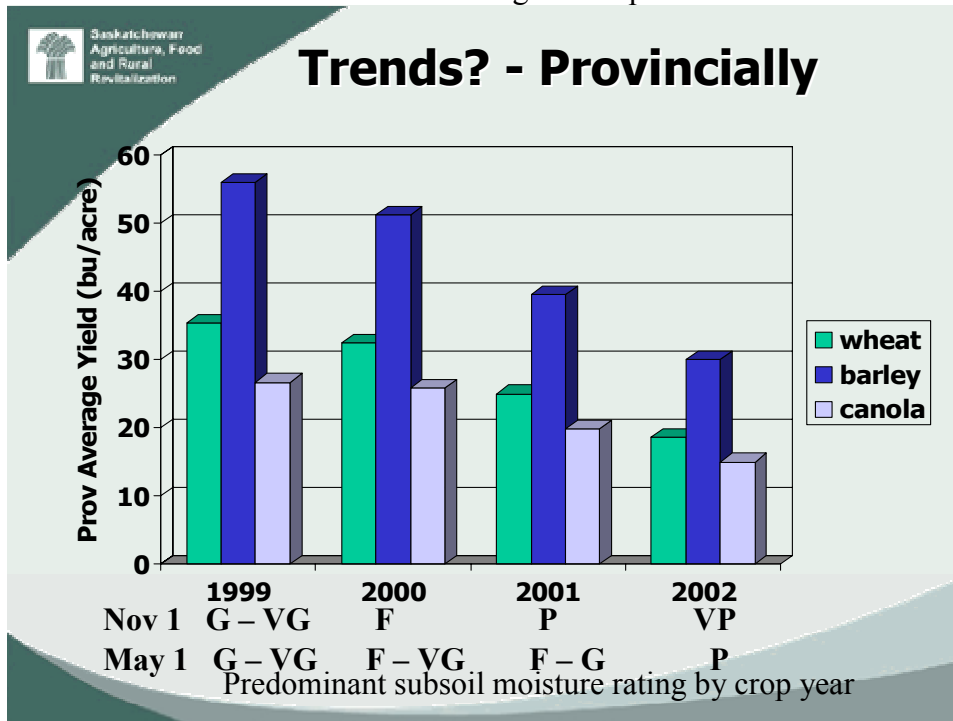
http://www.agr.gov.sk.ca/DOCS/crops/integrated_pest_management/soil_fertility_fertilizers/stubble.asp?firstPick=Crops&secondpick=Soil%20Fertility_Fertilizers&thirdpick=Null or at www.agr.gov.sk.ca then crops on the left hand menu, then soil fertility on the left hand menu, then stubble subsoil map in the centre page. See a sample a Stubble Subsoil Moisture Map below.

Since techniques used to smooth the transition between zones can affect the values in localized areas, the map should be used for regional purposes only. Producers, dealers and crop consultants are encouraged to use the map as a guide and measure subsoil moisture in their own fields for planning purposes.

Are there any trends? Discussion

Five years of data for fall and early-spring precipitation measurements is a small data base on which to make projections. As more years of data are collected, the relationship between soil moisture and yield may change. At a glance there appears to be a trend between the dominant subsoil moisture rating and the provincial average yield for wheat, barley and canola. At least another five years of data is needed to determine whether this relationship continues to hold true. See Figure 1.

Figure 1. Provincial average yield for wheat, barley and canola by crop year and dominant stubble subsoil moisture rating for the province of Saskatchewan.



Estimating Yields Using Available Water

Numerous studies have been conducted on moisture use by crops and on water use efficiency. An example of a typical water use equation is:

$$\text{Yield (bu/ac)} = (\text{WU} - 2.0) \times 4.0 \text{ (bu/inch of water)}$$

WU is the plant available soil water plus the growing season precipitation for the months of May, June and July. The first coefficient 2.0 is the amount of water in inches needed to grow a wheat crop from germination to heading in the Brown soil zone of Saskatchewan. The second coefficient 4.0 is water use efficiency in bushels/inch of water. A number of variations of this equation are published and used in crop production systems where moisture is a significant limiting factor for crop production (semiarid regions). This work was published by Karamanos, R.E. and Henry, J.L., Department of Soil Science, University of Saskatchewan, Soils and Crops Workshop 1991.

Summary

Moisture drives yield in Saskatchewan. It is important for producers to annually measure stubble subsoil moisture and keep long term rainfall records so that the *plant-available water* can be used for crop planning, and for securing the right amount of crop inputs. The subsoil moisture measurement is also a very important piece of information to be included on the soil testing information sheet when soil samples are submitted to a soil testing laboratory.

References

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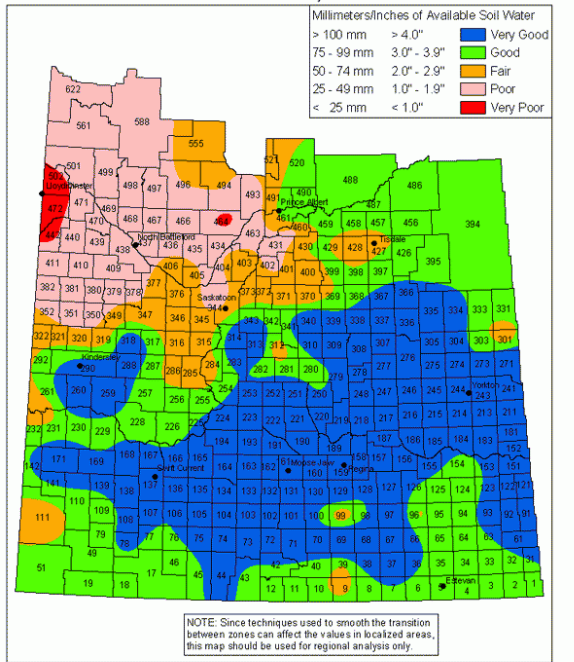
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Stubble Subsoil Moisture Map November 1, 2002



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