Adaptability of Alternate Field Crops to Saskatchewan

Henry C. de Gooijer
Saskatchewan Centre for Soil Research
University of Saskatchewan

What is an Alternative field Crop?

An alternative field crop may be simply defined as any crop, not currently being grown, which can be considered as a viable crop option within the farmers cropping system. For most, this definition of alternative crops conjures up images of exotic specialty crops, however the actual list of alternative crops for any one farmer will vary depending on the production system in place, the economic environment and physical environment in which the farmer operates.

In general, the search for alternative crops has existed since the first plow cut prairie sod and will continue as long as farmers continue to grow crops in this province. This never ending search for improvement is the norm in most areas of civilization and not unique to agriculture. Also not unique to agriculture is the apprehension caused by this constant evolution and change. For a culture and society bent on improving the human existence, the individuals within are often reluctant to change. Part of this apprehension of change is based on the fact that all change does not mean progress or improvement. Setbacks often occur in this overall evolution from which valuable lessons can be learned and redirection and re-emphasis can take place. Our role as Agrologists is to limit the setbacks while continuing the evolution in new cropping systems and crop alternatives.

The Ultimate Alternative Crop !

What is the desired ultimate goal in crop development? What would the ultimate new crop be like? The ultimate new crop would have most if not all of the following characteristics:

- occur in any rotation in any sequence.
- fix all its own nitrogen.
- compete with or eliminate pests including weeds, insects.
- resistant to all plant diseases.
- supply ample crop residue for erosion control and increase organic matter but not restrict seeding capabilities.
- grow equally well on hill tops as on lower slopes and depressions.
- grow equally well on any soil type. Be drought and flood tolerant.
- have a relatively short growing season, be frost tolerant and hold its grade at harvest through any type of weather.
- preferably, it would only grow in Western Canada.
- world demand is unlimited.

But since we live in the real world, where all conditions of growth and marketing cannot be built into the crop, we have to consider the environment in which we operate. Environment, not only includes the physical environment but also the economic and social environment as well. This evaluation of the environment is based on the information collected characterizing these various aspects.

The Push to Diversify

One of the most common words heard over the past number of years has been "diversification". Producers are encouraged to diversify on the farm, off the farm, diversify their investments, their marketing techniques, their crops grown, and their ability to do on farm processing. Often farmers were diversifying in crops or ventures with insufficient forethought or information. Some were successful, some not so. Often these successes or failures were based not only the farmers initiative or management skills but rather the environment in which the producer was operating. Very often, the ventures were very much void of critical information to ensure success. This information often related to the areas of agronomy, economics, critical crop characteristics, and its adaptability.

With the move to diversification, many new crops and many new varieties have been introduced into the province. In many situations these crops come with very little in the way of agronomic information for the grower. Often, the growing of the crop is linked to one producers personal initiative, while others, the crop is a result of a well organized and researched plant breeding and agronomic program.

As an example, Canola must really be considered a monumental success. Observing its development and rise in acceptance across the prairies one must be impressed at the success and achievements of the crop. To this day, canola remains the focus of a very large research and breeding program. The realization has been made that in order to attain the full potential of this crop, a well rounded agronomic research program was and is still required to bring the crop to its full potential.

However many new crops are targeted at the specialty or niche markets. The existence of sufficient plant breeding and agronomy research program will very much be based on the crops ability to "prove" itself in its first early years of production. If a new crop variety is not particularly suited to the province or if the experimental grower is not blessed with the proper climatic and soil conditions, the success in introducing a new crop may be somewhat limited.

Evaluating Alternative Cropping Options.

How does a producer decide if a new crop is a viable alternative for their farm operation? Farmers must weigh a number of factors dealing with their cropping system, machinery, economics and new crop characteristics.

Agronomics and Crop Characteristics

The producer must consider a number of agronomic factors when considering a new crop alternative:

- the current harvest system and any special harvesting requirements of the new crop.
- physical attributes of the crop. How tall will it grow? Does it have pods, heads?
- What are the crop's growing requirements - length of growing season, heat, rainfall requirements, susceptibility to frost, drought or flooding periods, nutrient requirements or germination temperature. In the end, how fragile is the crop?
- the current seeding system. Will the new crop fit in with the current seeding techniques and equipment?
- How will the new crop fit into current Crop rotations ? Are radical changes required or can easy substitution of cropping options occur?
- Pest Control. Are there associated weed control problems? Insect Problems? Or Crop

Disease Problems? Are specialized chemical applications required?

- Fertilization requirements. Will this crop fix any of its own nitrogen? Does it show sensitivity to certain micronutrient deficiencies or nutrient imbalances?
- How does the new crop store? Will it require drying or aeration?
- What is the yield potential?
- Will it require any special residue management techniques? Too much or too little residue?
- What level of management is required?

Economic

Economic factors are always major considerations in new crop selection. Crop prices combined with the yield potential must be sufficient to supply enough incentive to overcome any associated risks with growing the new crop. The market potential is also very important. Prices may quickly fall if too many growers enter the market. Marketing time and specialization also becomes a major factor, if the time and development work is too great. A more precise understanding of specialty markets may also required. As a specialized crop the number of buyers and marketing opportunities may be less frequent. It will be important, to have the highest quality crop possible to fill the needs of the market.

It is also important to consider the alternative uses of any alternative crop to be grown in the event that the crop does not meet the specific requirements of a special use. Barley not making the grade for malt can always fall back into the lower priced, (and higher freight rate) feed market. What about other crops, too highly contaminated with weeds, or with too low an oil content? If they are not selected, is there any opportunity to market these crops for any value?

Social Aspects

What will my neighbours think? As farms get larger and larger and neighbours get farther apart, the social pressures may be somewhat diminished. However, the inclusion of new crops into a rotation may be frowned upon by neighbouring farms if they perceive that the new crop may be a serious volunteer weed, introduces unpleasant odours, or may somehow have a deleterious effect on their adjoining operation.

More social pressures may be applied in the future by society as a whole, through environmental legislations, expectations on land stewardship and changing life styles. What were acceptable farming practices yesterday or today, may not be socially acceptable tomorrow.

Adaptability

Another major concern, which is different for each and every farmer, is the physical environment in which the farm is situated. How adaptable is a crop to the area in which the farmer lives and operates? The farmer evaluates his lands ability to produce a certain crop based on soil characteristics such as texture, salinity, erodibility, how steep are the slopes, how many stones are there to clear and any other special soil problems or concerns. Climate is also a major consideration, and in the short term weather is also a concern. How long is the growing season? How much rain is usually received? When are the last frosts of the spring and the first frosts of the fall? Weather becomes a consideration in the late planning stages as the farmer considers the lateness of the spring, moisture conditions and the spring temperatures and wind conditions.

As agrologists, dealing with areas much larger than the typical farmer can pose special problems. Generally the luxury of time and budget to be personally familiar with all areas of the province or region or district is not available. Evaluations and recommendations must be based on information gathered through reading publications, personal correspondence, reading reports or papers, referencing maps or accessing databases of information.

Saskatchewan Is A Diverse Province!

Although viewed from abroad as being monotonous, uninteresting and relatively flat wheat growing land, we know Saskatchewan as a diverse province with a variety of soils, landscapes and climates. This diversity has lead to the evolution of many "production systems" in what is considered agricultural Saskatchewan. These systems have been evolved by farmers in response to local conditions and by growing crops over a long period of time. Wheat has been grown since the time of settlement, but no one can really claim that the perfect production system has been found. The way farmer's manage the land and grow crops varies greatly if you were to draw a cross section from Frontier to Carrot River. Farmers have adapted their practices in response to local growing conditions and availability of cropping options.

What information do we have, which will help us evaluate on a provincial scale, our ability to grow new crops or the potential to introduce new crops in the province?

The State of Soil Inventory in Saskatchewan

Who is the Soil Survey?

The Soil Survey Unit is comprised of the staff from the Saskatchewan Centre for Soil Research and the Federal Land Resource Unit of the Centre for Land and Biological Resources Research of Agriculture Canada. The major role of the Soil Survey has been the inventory and classification of soils in the province, as well as roles in extension, education and research. Over the years, the federal and provincial governments have played a role in funding these surveys in part resulting in the formation of the Saskatchewan Institute of Pedology at the University of Saskatchewan in the 1960's. Today the SIP is now known as the Saskatchewan Centre for Soil Research.

A brief history

In the 1920's, the recognition for the need for soil information prompted the dominion government to initiate soil surveys in Saskatchewan.. These initial broad reconnaissance surveys were carried out over a number of years leading in the eventual compilation of Soil Report Number 12. This report and map are still available and widely used today as often, this was the only soil map and report available for certain areas of the province. Areas north of Tp 48 to the northern limits of agriculture at the time were published under the Soil report and Maps # 13. In the late 1950's a program of semi-detailed resurvey was initiated. This resurvey proceeded with more detail than the earlier number 12 soil report and map and collected greater amounts of information, Maps up to the 1970's were published on a National topographic Sheet basis at a scale of 1:125,000 or approximately 1 mile to the inch. In 1980 a change in style and format of reports resulted in soil reports and beings being published on an RM or groups of RM basis. Increasing publication costs and an acceleration of the soil survey in the 1980's and 90's through

programs such as **NSCP, ERDA, ADF,** and the Green Plan also forced a more streamlined, more cost effective method of producing reports. As a result, the location in the province will very much dictate what type of report is available. Approximately 20 million acres have been mapped and published as map sheet publications. 46.6 million acres have been mapped and published on an RM basis.

In the summer of 1995, through monies supplied by the provincial department of agriculture, Agriculture Canada and the Green Plan, the final mapping of the province at the semi-detailed scale was practically completed in the agricultural areas of the province.

The Development of the Soil Information Databases

In the 1980's, the Saskatchewan Soil Survey in conjunction with the Land Resource Research Centre In Ottawa began a program of map digitization and electronic database preparation. This process involved moving all information currently on the paper soil maps and reports and converting them into a digital form. As a result, today, Saskatchewan has an extensive and integrated soil information database linked to digital soil maps at 1: 100,000, 1: 1 million and 1:2,000,000 scales. This database is not yet complete for the province as the latest soil information gathered (1995) has yet to be processed. Earlier surveys did not collect the wider range of information collected in later surveys. As a result, some gaps still exist in the database for certain areas of the province. As much of the soil information was converted to digital formats before a Saskatchewan GIS standard existed, a program is now being initiated to make the Digital soil maps at the 1 :100,000 scale Sask GIS compatible. Once complete all digital soil information will be completely compatible with provincial base maps (1:50,000 and eventually 1:20,000 level township fabric for the province.) at CSMA.

The Soil Survey Databases

Level 1 The Ecoregions of Saskatchewan (LRA 1:2,000,000)

Land Resource Areas are biophysically homogenous units at a scale of 1:2,000,000 based on ecoclimatic zonation, landform and soil characteristics. These units can be used to study agricultural systems, land use, conservation, and the impacts of various management and socio-economic practices. They are a convenient planning unit upon which to develop databases for use in agricultural research.

Data files associated with the Agroecological Resource Area maps for Saskatchewan include compiled data on soil and landform, regional climate, soil moisture conditions, simulated wheat yields under dryland conditions and farm economics and land use information from the Census of Agriculture.

Basic Climatic data was derived from Atmospheric Environment Service (AES) station normals data from 195 1- 1980 using a combination of Thiessen polygon routines and expert knowledge. The LRA map for Saskatchewan is comprised of approximately 120 unique areas.

Level 2 - Soil Landscapes of Canada (1: 1 Million)

Planning suitable uses for land often requires a wide perspective that is not possible with the large scale (1: 100,000 scale maps). Consequently, the Soil Landscapes of Saskatchewan Map was derived by generalizing the larger scale maps to a level more conducive to wide perspective planning approximately 1000 polygons or soil areas. Attributes stored are the factors

considered most important for plant growth, general land management, and terrain sensitivity. The full array of attributes that describe a distinct type of soil and its associated characteristics such as slope, water table and landoform is called a soil landscape.

The Soil Landscapes of Saskatchewan Map may be typically used for finding areas that have actual or potential problems affecting land use, such as salinity or susceptibility to erosion and to assess their severity; to locate general areas that may be suitable for particular types of land use, which can be selected for more detailed investigations; to apply general research findings and agrotechnology procedures that are successful in one part of the province to areas that have similar attributes, or to link soil and land information with other databases such as information on climate, economics, or census data, in order to assess land use on a regional or provincial scale.

Level 3 - Semi-detailed Soil Surveys

A set of standard databases were prepared for all areas mapped between 1958 and 1996 at the semi-detailed or 1: 100,000 scale. These are generally the most detailed soil maps and databases available in the province. They are part of the National Soil Database (NSDB) and are standard in format all across Canada. These databases include the Soil Mapunit file (SMUF), the Soil Names file (SNF) and the Soil Layer File (SLF).

The Soil Mapunit File contains information about the mapping unit used to describe the soil area or polygon. It includes the map symbol, the proportion of up to the three dominant soil series present, the slope and stone content of each series.

The Soil Names File contains information about the soil series. It includes the classification, parent material, drainage and other characteristics of the particular soil series.

The Soil Layer File contains information about the soil horizons present in the Soil series. The chemical and physical data are average values for the specific attribute and may be either measured or estimated data.

In addition to the NSDB standard databases, Saskatchewan has also prepared interpretive soil databases. The interpretive soil databases contain unique information for each and every soil polygon in the semi-detailed mapping of the province. This interpretive database contains both information collected during the soil mapping and also interpretive information prepared by using various models. The extra information collected in the field included slope length, pH class, past erosion, agricultural capability, salinity, and wetland ratings. For inventories completed between in 1958 and 1984, some of this information was derived by using other sources of field information and very limited field sampling programs.

Other interpretive information, such as wind and water erosion, irrigation, and deep ripping ratings were derived by employing various models.

The collection of soil information as first stated, when the initial surveys began in 1920, was not an “End in itself, But rather a Means to an End.“. More precisely, to make full use and advantage of the soil information collected, it must be interpreted and linked to other sources of information or models to solve problems. Simply diagnosing a condition does not remedy the situation. The knowledge gained must be applied to gain full potential. The value of data integration has also been recognized in making better utilization of data. All soil polygon information processed to date in the agricultural areas of the province have been linked to the quarter-section legal location. The quarter section database contains each quarter section in the province and the proportions of up to three soil polygons in the quarter section. This legal

location link allows soil information to be more directly related to other databases of information collected on a quarter section basis such as municipal assessment information and Crop Insurance land ratings and productivity indexes.

The Soil Survey Land Resource Information Centre has ventured to diversify the types of soil products available and to increase its capabilities in utilizing the information. The types of products now available include, GIS products (digital soil maps), electronic databases, conventional paper maps and reports, specialized projects and maps for special interest areas or topics such as soil pH or Deep Ripping and Plowing, and the LANDBASE soil information system.

Considering the Suitability of a new cropping alternative.

How well have we done in the past in determining what crops should be grown and where? Initial settlers picked land that was easy to plow, This often meant the lighter soils, requiring less horse or oxen power. The more suitable heavy or clay soils were preferentially settled later. Detrimental to the lighter soils and of course to the economic viability of the settlers on these lands.

When considering a new crop alternative the producer must consider the agronomics and economics of the crop. Agronomic considerations include harvest system, seeding system, rotations, weed control, insect control, disease control, fertilization, storage requirements, yield potential, and residue management. The producer must also consider crop characteristics such as life cycle (annual, Perennial), length of growing season, heat, rainfall requirements susceptibility to frost, nutrient requirements and germination temperature.

The producer must also consider some very limited information on new crops which is often from completely different production areas of the world. This information is not well documented like a Canola Guide, or Pulse Growers Manual. The more obscure the crop, generally the less information there is available. It is also important to be able to qualify the information that is received, especially in world wide searches where local terms such as “over winters well” , or “does well in cool growing conditions” are used. How these terms are interpreted depends on where the information is from, Texas or from North Dakota, directly impacts on the meaning of the term.

The Food and Agriculture Organization of the United Nations has created what is called, the “Adaptability level of crop environment requirements database.” This database contains general climate and soil requirements for crops from all over the world. However, databases such as this tend to contain world averages. In reference to many of the crops including those such as wheat or barley, the Canadian Prairies often are very marginal as suitable for production. When developing new markets, it may also create a potentially false impression that we may not be a consistent supplier if western Canadian growing conditions are considered marginal at best. However, when operating in a world economy , we are judged by world criteria.

Studies

The Centre for Soil Research has been involved with two projects which may be used as examples of using soil, landscape and climate information to determine adaptability of new crops to the province.

The first project involved the production of provincial Scale suitability maps for a series of 15 Herb and Spice Maps found in the Grower’s Guide to Herbs and Spices. Evaluation was

based on commercial production, under field conditions. The Soils Landscape of Canada Map for Saskatchewan was used as the soil base for the mapping project. Soil conditions considered included soil pH, soil texture, soil salinity, stones, and slope class (landscape). Maps were produced at a scale of 1:5,000,000 in both black and white and color versions. A general legend based on color indicates the major limitation for the growing of a crop in a particular area of the province.

The second project involved the production of 1: 175,000 scale soil and landscape suitability maps for dry beans, potatoes and irrigation for approximately 18 million acres along the South Saskatchewan, North Saskatchewan and Qu'Appelle River systems in the province. Technical expertise to determine growing criteria was supplied by specialists of Sask Water Corporation, PFRA, Saskatchewan Irrigation Development Centre and the University of Saskatchewan. The 1: 100,000 semi-detailed soil maps were used as the base of soil information for the project. Soil conditions considered included the soil mapping unit, profile disconformities, salinity, texture, stones, drainage, pH, slope class and landscape form, and erosion potential. Maps were produced at a scale of 1: 175,000 for seven different study areas along the major water systems listed above. Detailed reports of methodology and study results accompany each series of maps.

Summary

The use of soil information at various scales allows for a good first approximation of the adaptability of a crop to the province. When combined with information on agronomy, crop characteristics and marketing, it forms the basis for determining the viability of adapting a new crop to a particular region and helps to avoid costly setbacks in trying to grow new crops.

The current set of soil information products along with the new digital soil products evolving, provides managers with useful information products which may be integrated into decision making processes to help manage one of the most basic of the provinces resources, our soils.

References:

Agroecological Resource Area Databases for the Prairies: User's Manual - Centre for Land and Biological Resources research. V. Kirkwood, A. Bootsma, R. DeJong, J. Dumanski, J.C. Hiley, E.C. Huffman, A. Moore, C. Onofrei, W.W. Pettapiece, B. Vigier. Technical Bulletin 1993-13E

Canada Soil Inventory. 1992. Soil Landscapes of Canada- Saskatchewan, Centre or Land and Biological Resources Research, Research Branch, Agriculture Canada. Agriculture Canada Publication 5243/B.

History of the Saskatchewan Soil Survey 192 1- 1959. H.C. Moss. Saskatchewan Institute of Pedology, University of Saskatchewan. 1983