

This list of attributes, no doubt, is still incomplete. Even so, it is already daunting, and we are only now taking the first faltering steps toward building a set of metrics that might satisfy these criteria. So what is the way forward? Maybe our quest can be guided by the following questions, asked sequentially:

1. What functions do we ask of the land? And what functions will our successors, some decades hence, ask of it? In pondering this question, of course, we think of the full spectrum of uses, from the biophysical to the social.
2. What stresses may be imposed on our lands? And which lands are most vulnerable? We cannot know exactly how the future unfolds, but many of the coming challenges seem already apparent: demand for food, shrinking land area per capita, energy constraints, dwindling freshwater, for example. Enumerating these coming stresses might steer us to those parameters and places of our systems most vulnerable to adaptive pressures.
3. What, then, do we measure to see how well our lands can continue to furnish into the future all we ask of them in the face of coming stresses?

These questions, of course, are not merely academic and conceptual. They are best asked in parallel to measurements already begun, or needing to be started. It is as we measure performance of our lands, even with our still feeble and fragmentary metrics that we answer the preceding questions, and stumble on new ways of resolving them with better measures. And always we think: “What measures should we start today for those who will be monitoring success of adaptation tomorrow?; just as we have learned so much from the measurements begun by our far-sighted forbearers.

A system of metrics for measuring adaptation, as sketched above, may seem ideal, not soon fulfilled, if attainable at all. But the effort toward it still is warranted, for it will likely lead us to better science in understanding our ecosystems, and to more compelling visions about how we should live on our lands in a changing world.

What Kinds of Government Policies Will Help Us Adapt in 2050?

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A key role of government is to secure common goods and services that individuals cannot provide. This is done by developing a range of strategies, policies and plans to achieve outcomes that are implemented through legislation and regulations, through the use of instruments such as incentives or directives, or by using measures like standards or certificates. Although significant drivers are required for regulations, these may be set to trigger only at threshold changes in quality or supply of resources. Voluntary arrangements, education and outreach programs have also been successfully adopted to support strategic policies. Market-based instruments, such as taxes and tradable permits, have recently been used to alter price signals and create cost incentives. Although preference may be given to one approach, most jurisdictions rely on multiple policy approaches to achieve their goals.

Intensification of sustainable food production may be one of the better responses to climate change². Increased efficiency of resource use for increased agricultural productivity will be a key policy driver in this context, including the need to enhance the quality and accessibility of the biophysical resource base. Figure 1 illustrates the challenge of linking variations in both biophysical and human elements, highlighting the need to target management to minimize adverse impacts in vulnerable areas. Another important policy driver related to a changing climate will be sector and public preparedness for a range of possible scenarios, such as strategies for stabilization of farm incomes. Although recovery from impacts that are gradual and widespread allows time to fine tune adaptation approaches, recovery from severe and highly uncertain climatic impacts can require many years. Broader drivers of policy to support

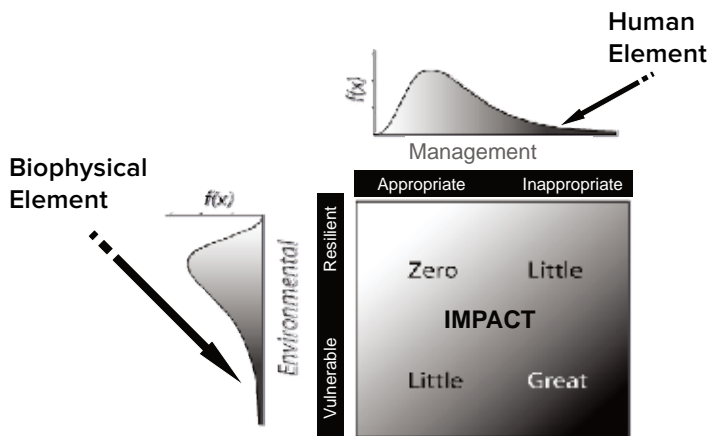


Figure 1: Linking two forms of variance to focus efforts for greatest impact (P. Nowak, personal communication, February 12, 2014).

adaptation include the need to diversify the economic base of the Canadian Prairies as well as external pressures, such as standards set in other countries and expectations arising from different cultural preferences.

Proactive government policy will anticipate change and balance long term goals of enhanced resource use with immediate term goals of competitiveness; proactive government policy will not simply respond to impacts. In view of the many uncertainties and influences on decision making, focus should be on enhancing resilience or ‘adaptive capacity’ that is the broader ability of agricultural producers, regions or sectors to cope with climate-related risks and opportunities³.

Current status: Government policies that promote a vibrant, growing agricultural industry on the Canadian Prairies are already enhancing the resiliency of agricultural systems to a changing climate. Increasingly, regional land use planning initiatives are taking unique watershed and socio-economic characteristics into account when designing strategies in consultation with key stakeholders and the public. Evaluation of recent flood disasters is informing new planning efforts to minimize future impacts. Areas of high vulnerability within regions are being recognized for targeted actions, such as controlling cattle access to streams to address water quality. Public funding supports technologies that provide real-time data about field conditions that are being integrated into early warning systems. Government-backed crop insurance programs are providing a broadening range of options to mitigate risks of crop failures for farmers. Policies at provincial and national levels have supported a strong science and technology basis for progress towards continuous improvement of farm-scale management through research and extension programs. There are signals; however, that the social licence to operate will be challenged if the public concerns, valuations

and expectations are not a part of the dialogue in future policy development.

Policies to heighten resiliency: In order to specifically increase resiliency to the highly variable and uncertain impacts of a changing climate, future government policy should develop a range of approaches to support outcomes that include: i) optimized management to ensure quality of biophysical resources, ii) sector and public preparedness for a range of possible climate change scenarios, and iii) diversification to broaden the basis for responding to change. A variety of simultaneous approaches can be used to support the development of innovations needed to address uncertainties and reduce risks, including incentives, market-based instruments, or tradable permits. Although regulation may be required in some cases, a range of approaches can be designed to meet specified outcomes, such as options to either change management or make payments into a fund to support future technological improvements. Outcomes that support resiliency will require innovation from a strong research base, the use of metrics to regularly gauge progress and fine tune policy approaches, as well as public and private sector involvement to apply existing momentum and increase the range of human and financial assets that are directed towards adaptation of the agricultural sector to a changing climate. Policies to increase the responsibility of Professional Agrologists to assess, assist with and document improved farm-scale management could also support outcomes of increased resiliency of agricultural systems.

Since moisture is scarce or arrives at inopportune times in many parts of the Prairies, optimized management to ensure high quality of water resources will be fundamental to enhancing the resiliency of agricultural systems to a changing climate. Efforts to increase food production and economic activity must target improvements and innovation in water use efficiency. Schreier and Wood⁴ outline various ways for government policy to support the development of a strategic approach to water use in Canadian agri-food production. In addition to creating incentives to promote innovations in water use efficiency, they note a need for research to develop methods to measure and analyse water footprints from a whole systems perspective. These measures may become a basis for identifying standards that can be used to encourage management that meets or exceeds specified criteria. Comprehensive assessment is needed to capture externalities and reflect full costs of production. Inventory and risk assessment tools are also needed to synthesize results and assess water use scenarios in different regions in order to target vulnerable areas for management that avoids or reduces adverse impacts. Support of on-farm pilot studies and farm level education are important components that support adoption of practice improvements to increase water use efficiency.



The Oldman River dam was constructed in 1992 in response to the many droughts experienced by Southern Alberta farmers.

(credit: D. Flaten)

Resiliency will be enhanced by policies that support the development of multiple approaches to encourage preparedness for a range of possible climate change scenarios. Area-specific contingency plans will help to operationalize a range of strategies and provide a basis from which to develop further innovations and improvements. Government initiatives to construct infrastructure to support increased resiliency will be needed, such as facilities that store water and increase irrigation capacity. Monitoring systems are also important components of preparedness strategies, allowing governments and industry to respond to risks in early stages, when issues are usually more manageable.

Policy instruments to target outcomes of increased diversification of agricultural production according to areas of strength will provide new opportunities from which to build success in uncertain futures. Incentives to leverage momentum and private investment through collaboration with other efforts to diversify the economic base on the Prairies will be an important means of bringing new ideas and assets from a broad range of industry, research, and stakeholder perspectives. Review of policies to support resiliency and adaptation to climate change in other areas than agricultural production, such as municipal development and health services, will identify new opportunities where momentum can be increased by collaboration and integration. A variety of policy approaches can be designed to reward progress towards attaining desired outcomes at multiple levels (e.g. farm, processor, distributors and general public). Policies to encourage integration of new knowledge and technology to optimize resource use and productivity will bring added benefits of increased competitiveness and reduced risk. These approaches will also require collaborative and transparent processes of assessment, planning and prioritization

with regular evaluation of metrics to measure progress towards identified outcomes of increased resiliency.

Although the challenges of adaptation to a changing climate are considerable and fraught with high uncertainty, comprehensive, dynamic and outcome-based government policy approaches can draw on past and current successes to heighten the resiliency of agricultural systems to impacts of future conditions on the Canadian Prairies.

How Will Technical Innovation Help Us to Deal With Climate Change Risk?

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Technical development is widely recognized as a substantial contributor to the capacity of Canada's agri-food industry to adapt to climate change³⁻⁷. Climate change will spur the development of a variety of technical innovations to deal with the challenges of variable weather and climate change directly, or indirectly through consequences such as high input prices, rising cost of transportation, or greenhouse gas emission penalties. New opportunities to earn carbon credits or grow new, higher-yielding crops in a warmer, longer growing season, will also encourage further innovation.

Continuous development and adoption will continue to be imperative: The agri-food sector is a highly competitive industry where, if we don't innovate as quickly or as well as



Red Queen Effect

"... Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!"

Lewis Carroll
Through The Looking-Glass

"we will need to continue to invest in a combination of measures that enhance our capacity to be flexible"

(credit: W. Reimer)