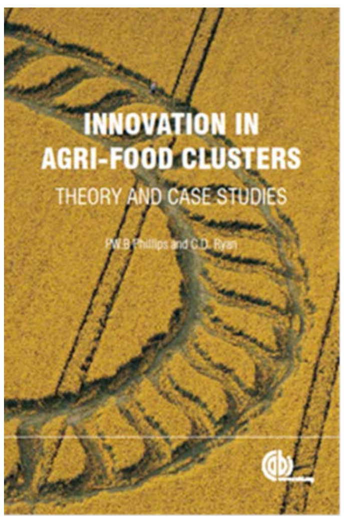
GenomeCanada

GenomePrairie

GIFS



The Global Digital Revolution and Canadian Agriculture and Mining

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The digital opportunity

- *Key Questions*
  - How does the diffusion of digital technology contribute to the overall dynamism and competitiveness of Canadian agriculture and mining?
  - Does it change value capture in our portion of the global production network?
  - Does it change the focus, speed and impact of innovation in our product areas?
  - Are we ready?

The industrial context

% distribution of GDP, 2014

Industry	Canada	AB	SASK	MB
All industries	100	100	100	100
Agriculture & FFH	1.7	2.0	**11.0**	4.2
Mining, quarrying, oil & gas	8.2	**23.1**	**24.2**	4.1
Utilities	2.5	1.6	1.9	2.3
Construction	7.2	10.9	7.6	6.5
Manufacturing	10.4	**7.3**	**6.4**	11.3
Services	69.9	**55.1**	**48.9**	71.7

Labour Productivity Growth (annual average 1997-2010)

Sector	Canada	AB	SASK	MB
Market Sector	**1.29**	**0.57**	**1.79**	**1.88**
Agriculture & FFH	4.55	**8.75**	**5.46**	5.59
Mining and Oil and Gas Extraction	-1.56	**-2.98**	**-4.52**	2.05
Manufacturing	1.65	**0.78**	**0.99**	0.75
Wholesale Trade	3.24	**2.47**	**4.59**	5.12
Transportation and Warehousing	1.21	**2.32**	**1.54**	1.06
Information and Cultural Industries	1.73	**4.33**	**3.97**	0.63
FIRE	1.46	**1.15**	**3.50**	1.84
Professional, S&T Services	1.11	**2.32**	**2.43**	0.03

Source: http://www.csls.ca/data/mfp2012.asp

Capital Productivity Growth (annual average 1997-2010)

Sector	Canada	AB	SASK	M B
Market Sector	**-0.47**	**-4.22**	**-2.46**	**-0.62**
Agriculture & FFH	1.91	**2.80**	**0.08**	2.51
Mining and Oil and Gas Extraction	-5.10	**-6.90**	**-6.57**	-2.72
Manufacturing	1.03	**-1.77**	**-1.45**	-0.37
Wholesale Trade	-0.85	**-3.45**	**2.84**	2.23
Transportation and Warehousing	-0.98	**-3.63**	**-1.05**	-1.53
Information and Cultural Industries	2.06	**0.52**	**-2.50**	-0.47
FIRE	0.09	**-2.01**	**-0.45**	-1.60
Professional, S&T Services	-2.38	**-5.51**	**-6.11**	-1.53

Source: http://www.csls.ca/data/mfp2012.asp.

Multifactor Productivity Growth (annual average 1997-2010)

Sector	Canada	AB	SASK	MB
Market Sector	**-0.24**	**-2.22**	**-1.17**	**0.46**
Agriculture & FFF	2.44	**4.07**	**1.01**	2.87
Mining and Oil and Gas Extraction	-4.64	**-6.10**	**-6.36**	-1.11
Manufacturing	0.60	**-0.53**	**-1.00**	0.03
Wholesale Trade	1.49	**0.29**	**3.58**	3.85
Transportation and Warehousing	-0.22	**-0.38**	**0.24**	0.11
Information and Cultural Industries	1.34	**2.11**	**0.91**	-0.09
FIRE	-0.11	**-0.52**	**1.21**	-0.32
Professional, S&T Services	-0.12	**0.30**	**0.43**	-0.04

Source: Http://www.csls.ca/data/mfp2012.asp

AGRICULTURE

12 disruptive technologies with $125T gross value and agricultural relevance

(McKinsey Global Institute)

- **Internet of Things ($40T)**
- **Mobile internet ($26T)**
- 3D printing ($11T)
- **Automation of knowledge work ($9T)**
- **Advanced Robotics ($8T)**
- **Next-generation genomics ($8T)**
- **Cloud Technology ($5T)**
- **Autonomous and near autonomous vehicles ($4T)**
- Advanced oil and gas exploration and recovery ($4T)
- Renewable energy $4T)
- Energy storage ($3T)
- Advanced materials ($1T)

The Digital Revolution in Agriculture

R&D

- **The Virtual Seed, Plant and Animal:** genomics, phenotyping, visualization, big data mining, Cloud based networks

DATA

Farm

- **Precision Farming:** GSP and geomapping, sensors and drones, scripting, biologicals, computer assisted production

DATA

Market

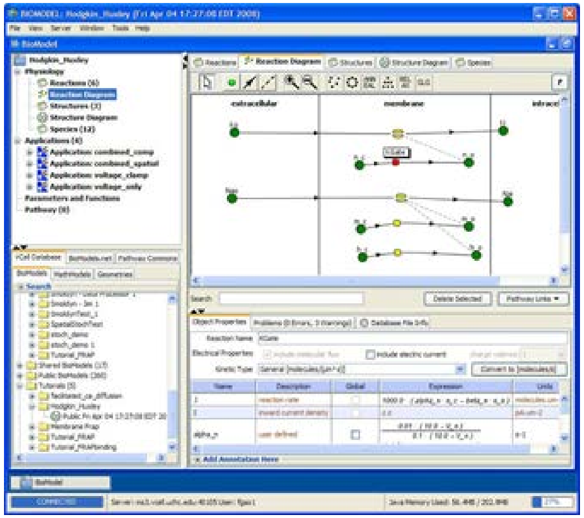
- **Just Right Foods:** integrated supply and demand ; traceability; demand fro provenance

DATA

The history—anchoring image

The reality—the virtual ______?

vCell 1997-

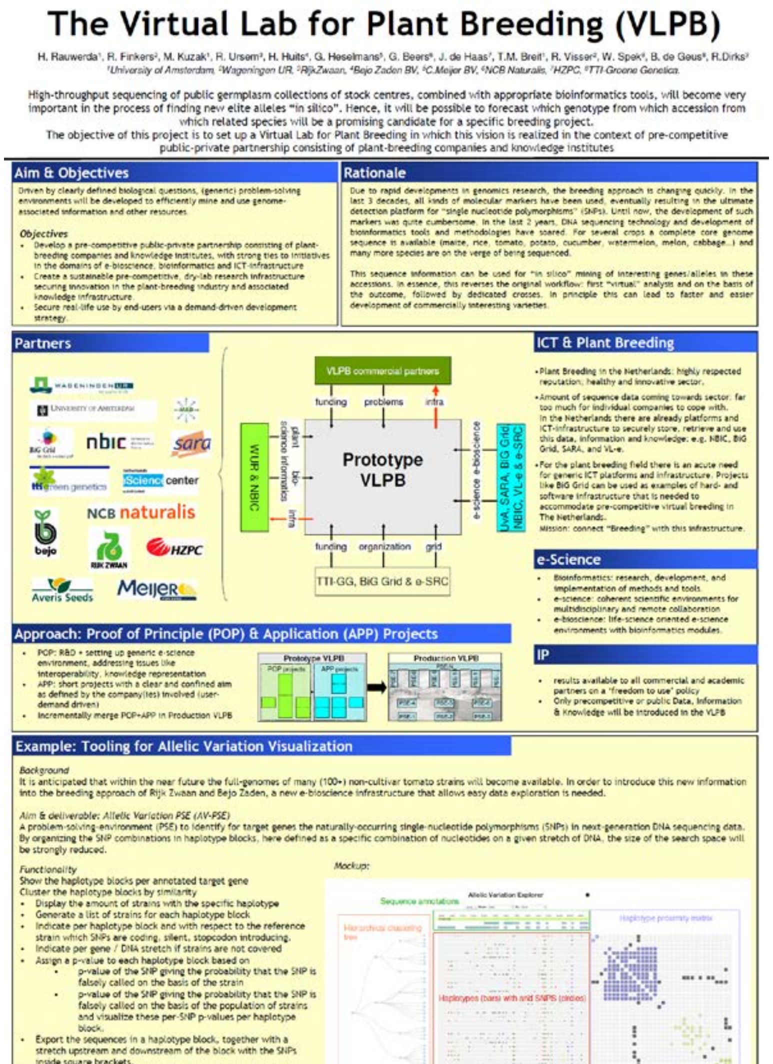


vPlant 2009-

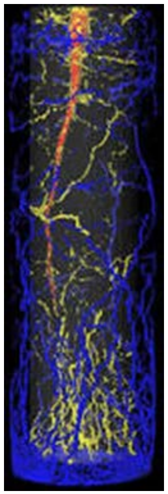
WAGENINGEN UR
For quality of life

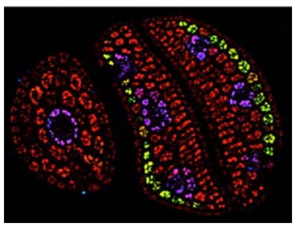
UNIVERSITY OF SASKATCHEWAN

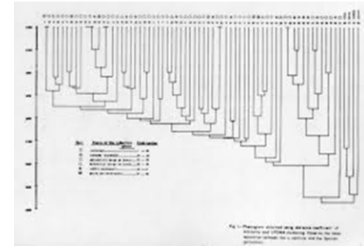
vLab for Plants 2012-



Endgame 2—designed crops







Genebank
Accessions & passport info

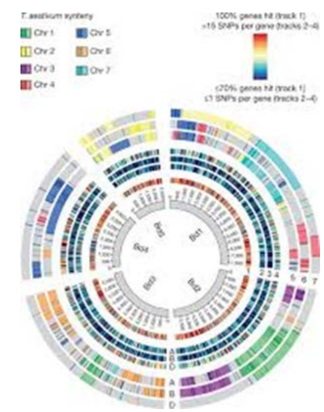
Imaging

Omics

DIVSeek
GIFS

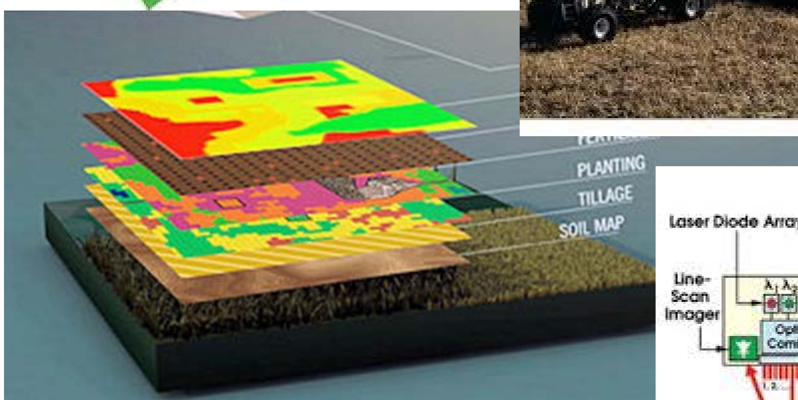
Data analytics

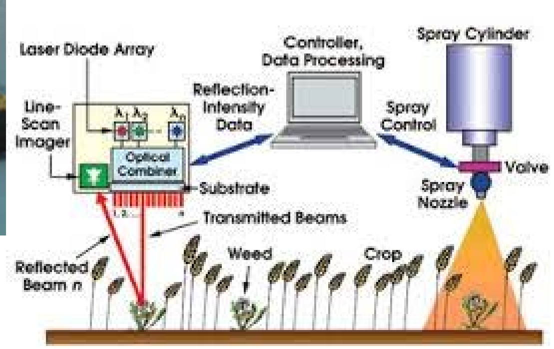
Real time pheno-typing

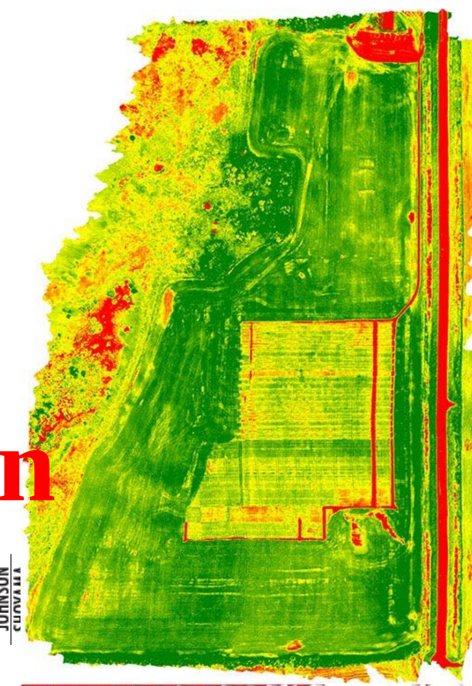


Endgame 2: on-farm scripted, precision ag

FieldScripts[SM]







6% gains = ~+100% gross margin

Preparedness

ICT penetration into Agriculture

Type of ICT service expense	Any outlays on ICT in past 3 years	Software as a service	Web site design or hosting	Data processing services	Database services
Private sector	**51.5**	**18.3**	**31.4**	**7.5**	**17.8**
Ag Production Network					
Scientific R&D services [5417]	66.4	25.9	38.8	8.2	21.6
Chemical manufacturing [325]	79.1	17.5	61.1	x	x
Machinery & equip wholesale-dist[417]	74.2	31.4	48.9	9.2	26.1
Insurance and related activities [524]	75.9	19.4	47.7	16.2	43.2
Management, S&T consulting [5416]	47.3	16.9	22.3	4.8	15.5
Agriculture (& FFH) [11] (1)	29.9	3.3	19.3	6.1	11.9
Securities & commodity contracts [523]	28.0	12.3	16.0	3.6	12.9
Farm product wholesale-distrib. [411]	23.7	2.0	18.5	3.5	7.7
Truck transportation [484]	24.9	6.6	7.1	0.7	6.6
Food manufacturing [311]	58.7	14.8	33.7	10.5	22.7
Accounting, tax prep, books (5412]	58.4	**21.0**	22.2	0.7	11.1

AG Digital technology and Internet use

Capital expenditures on types of ICTs by NAICS, 2012 (%)

	Firm size	Private sector	Agriculture & FFH
Any capital expenditures on ICT in the past three years	Total	51.3	**36.7**
	Large	85.5	**83.1**
	Medium	76.5	**73.0**
	Small	48.2	**34.0**
Computer hardware	Total	47.4	**34.3**
	Large	84.7	**59.1**
	Medium	73.8	**69.6**
	Small	44.2	**31.8**
Customized computer software	Total	15.6	**4.3**
	Large	52.5	**33.8**
	Small	12.5	**2.1**
Network Operating Systems or Equipment	Total	18.3	**13.9**
	Large	65.7	**66.3**
	Small	14.6	**11.6**
Off-the-shelf software	Total	32	**27.1**
	Large	62.6	**50.6**
	Medium	50.3	**61.4**
	Small	29.6	**24.6**

Barriers to use of ICT, 2012

BARRIER	Firm Size	Private sector	Agriculture +FFH
Cost of technology and implementation are too high	**Total**	**30.1**	**22.2**
	Small	*28.6*	***19.2***
	Large	*40*	***72.9***
Employee resistance to introduction of new technology	**Total**	**9.6**	**11.5**
	Small	*8.3*	***9.5***
Lack of technical expertise and skilled personnel in-house	**Total**	**29.5**	**54.5**
	Small	*29.3*	***53.7***
	Medium	*35.3*	***65.5***
New systems will not be compatible with existing systems	**Total**	**9.8**	**20.4**
	Large	*18*	***61.8***
Not enough evidence of a strong return on investment	**Total**	**21.8**	**17.1**
	Large	*22.4*	***11.9***
Security and/or privacy concerns	**Total**	**18.7**	**30.9**
	Small	*18.1*	***32.9***
Unaware of what technologies exist in the marketplace	**Total**	**16.4**	**20.1**

Hypothesized impacts

	Designed crops	Precision ag
Cost	High fixed; lower variable costs	Lower costs generate all returns
Benefits	New traits; more differentiation	Lower risk and uncertainty?
Timing	Faster	?
Discount rate	Lower due to more predictability? But also differentiated by uptake and use	
Location	Canada? Germany?	US first? Then …?
Diversity	Capital intensive but open and transferable?	Bias to larger farms

The policy challenge

Guesstimated Data Value

While there is hardware value (drones, sensors etc), the emerging fight is to control data and exploit its value

Equipment

Research & Seeds

Sensors linking genomics and real-time phenotypical data with real time images

Services offering weather, soils, sensors, real-time agronomics and logistics management

UNKNOWNS

Challenges of farmer skills, data ownership & mgt; cost v benefits

John Deere Wants To Be Able To File Copyright Claims Against The Way You Use Your Tractor

By Kate Cox April 22, 2015

http://consumerist.com/2015/04/22/john-deere-wants-to-be-able-to-file-copyright-claims-against-the-way-you-use-your-tractor/

(Matt McGee)

MINING

(NOT OIL & GAS)

12 disruptive technologies with $125T gross value and mining relevance

(McKinsey Global Institute)

- **Internet of Things ($40T)**
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- **Cloud Technology ($5T)**
- **Autonomous and near autonomous vehicles ($4T)**
- Advanced oil and gas exploration and recovery ($4T)
- **Renewable energy ($4T)**
- **Energy storage ($3T)**
- Advanced materials ($1T)

The Digital Revolution in Mining

R&D

- **Instrumentation and software design:** computer assisted exploration and seismic work; bid data; drones

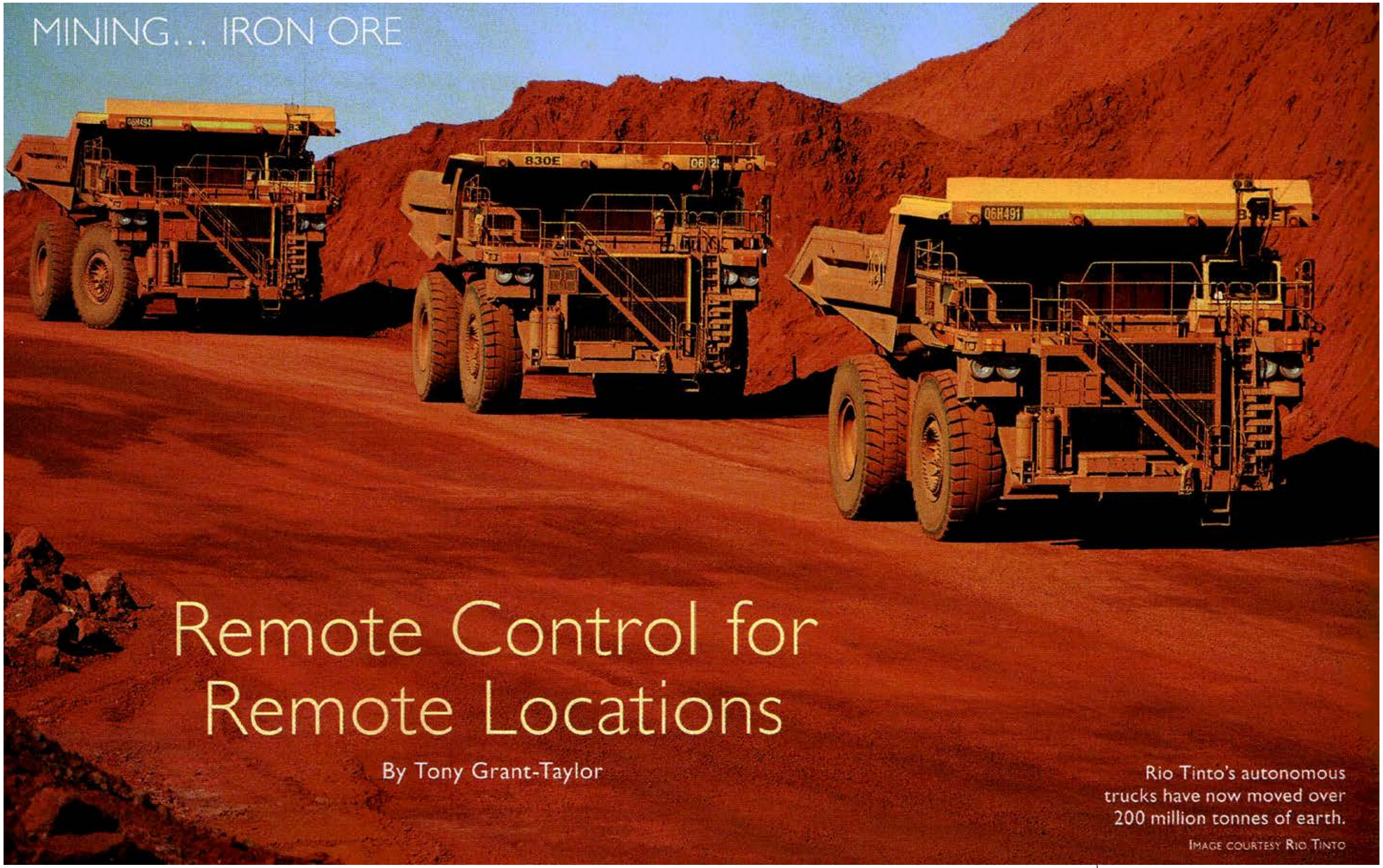
Mine

- **Workerless Remote Mining:** GSP and geomapping, sensors and drones, automation, computer assisted production, productivity gains

Market

- **Just-in-time delivery:**
- Market disruption

The Future Happened Yesterday —in Australia



Digital impact on mining

- Mining software and technology industry $150b global industry (Aust has 60%)
- Autonomous haul trucks (Rio Tinto alone has 63)
- Autonomous ore trains (start operation in 2015)
- Robotic drills (just beginning)
- Komatsu has no spare ‘autonomous capacity’
- BHPBiliton working with Caterpillar
- Remote centres of control (1500km+)
- Job shift to much higher qualifications

Expenses on ICT services

Type ICT service expense	Size of firm	Private sector	Mining, quarrying, and oil and gas extraction
Any expenditures on ICT services in the past 3 years	Total	51.5	51.6
	Large	88.7	99.2
	Medium	80.1	83.6
	Small	48.1	46.5
Data processing services	Total	7.5	1.6
Database services	Total	17.8	13.1
	Large	54.7	91.1
No ICT service expends	Small	32.2	34.4
Other ICT services	Total	12.2	24.7
	Large	32.4	6.3
Software as a service	Total	18.3	25.7
	Large	44.3	79.4
	Medium	29.9	50.9
	Small	16.7	20.3
Web site design or hosting	Large	69.3	93.4

Table 358-0202 Survey of digital technology and Internet use, expenses on types of ICT services, by NAICS and size of enterprise, occasional.

Capital outlays on ICT

Type of capital expenditure on Information and Communications Technology (ICT)	Size of enterprise	Private sector	Mining, quarrying, oil & gas extraction
Any capital expenditures on ICT in the past three years	Total	51.3	**46.4**
	Large	85.5	**96.1**
	Medium	76.5	**75.5**
	Small	48.2	**41.2**
Computer hardware	Total	47.4	**42.1**
	Large	84.7	**95.7**
	Medium	73.8	**74.7**
	Small	44.2	**36.5**
Customized computer software	Large	52.5	**23.3**
Network Operating Systems or Equipment	Total	18.3	**26.1**
	Large	65.7	**87.6**
Off-the-shelf software	Total	32	**22.9**
	Large	62.6	**90.7**

Source: Stats Can 358-0201

Investments in training

Enterprises investing in ICT training	Size of firm	Private sector	Mining, quarrying, oil & gas extraction
Businesses with ICT/IT specialists as of Dec 2013	Total	13.4	**27.2**
Businesses with ICT/IT specialists as of Dec 2013	Large	74.7	**96.9**
Businesses with ICT/IT specialists as of Dec 2013	Small	10.1	**12.7**
Training for ICT/IT specialists	Large	73.5	**95.3**
Training for other staff using ICTs	Large	77.8	**95.4**

Table 358-0233 Survey of digital technology and Internet use, enterprises investing in Information and Communications Technology (ICT) training, by North American Industry Classification System (NAICS) and size of enterprise, occasional

Barriers to ICT use

BARRIER	SIZE	Private sector	Mining, quarrying, and oil and gas extraction
Cost of technology and implementation are too high	Large	40	**8.6**
Employee resistance to introduction of new technology	Total	9.6	**17.6**
Lack of technical expertise and skilled personnel in-house	Total	29.5	**12.6**
Lack of technical expertise and skilled personnel in-house	Large	18.4	**6.8**
New systems not compatible with existing systems	Large	18	**5.5**
Security and/or privacy concerns	Total	18.7	**6.9**
Unaware of what technologies exist in the marketplace	Total	16.4	**5.8**

Interim Hypotheses for Theme 3

investigations of Agriculture and Mining

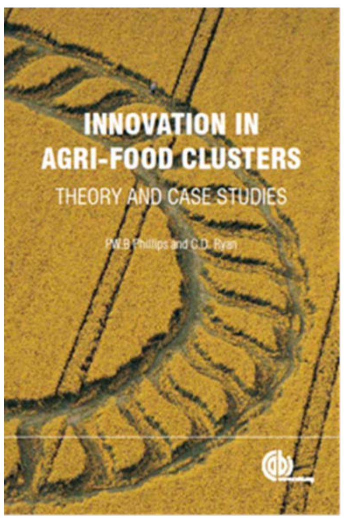
- Canadian ag and mining industries vulnerable – also affecting rural & First Nations people
- The global landscape is changing rapidly
- Transformative technologies have significant potential to change related GPNs and GINs
- Firms and farms are prepared but may need more focus to realize benefits
- If fail to secure critical role in digital world, value will migrate from Saskatchewan/Canada and R&D and innovation may work against Canadian interests

Existing Data Misleading

- Existing data on this topic of which we have shown some is actually worse than useless – it is actually fundamentally misleading.
- Existing ICT statistics are predicated on standalone expenditure. ICT as a discrete thing.
- The IOT and software-ization of everything is predicated on the concept that everything will have some ICT in it. We need a worldview shift

Theme 3 Methods (so far)

Method	Ag	Mining
Map ICT penetration in GPN and GIN	Secondary Data; producer survey; case studies	Secondary Data; tbc
Survey for ICT readiness	Stats Can and industry data; interviews	Stats Can and industry data; interviews
Policy readiness	GEM survey 2015; interviews	GEM survey 2016; interviews
Specific policy issues	On farm data management; case studies	Geospatial data management



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