

# **New Irrigation Technologies – The process of adoption and what influences it in Alberta, Canada**

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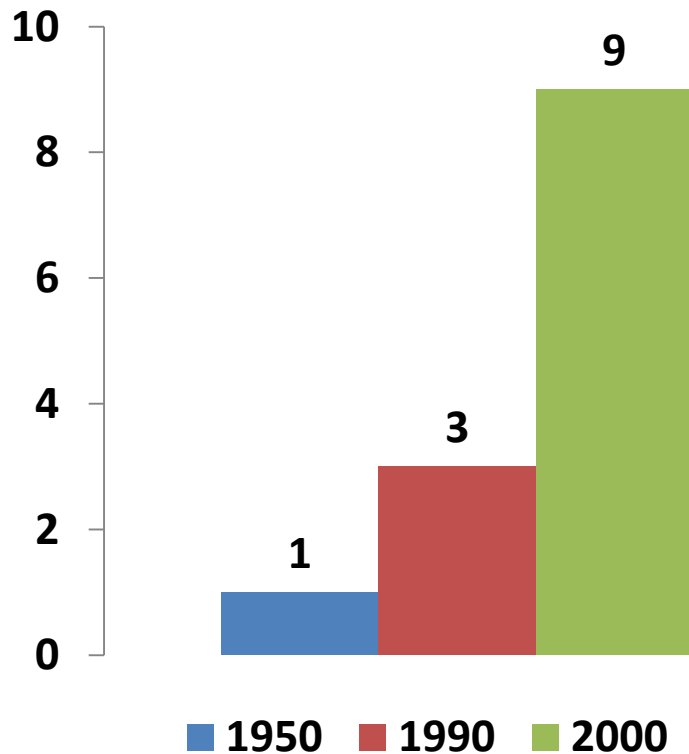
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# **Irrigation has played a substantial role in promoting socio-economic development in Alberta**

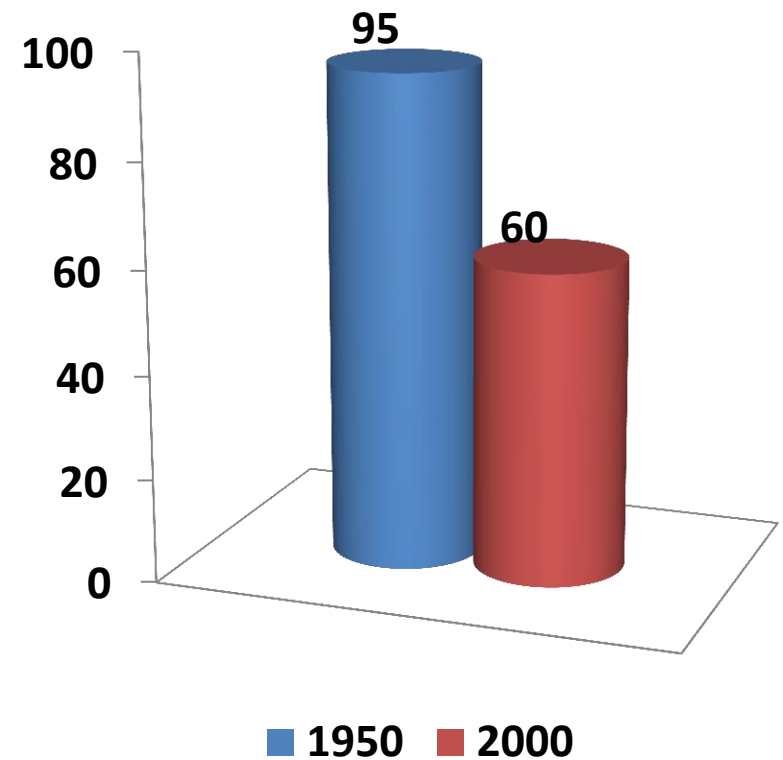
- **Alberta: the fourth largest province in Canada by population;**
- **Uneven distribution of water: most surface water supply in the north, while most water demand in the south;**
- **In southern Alberta: 13% of the gross domestic product, 19% of production, and 30% of employment opportunities are directly or indirectly associated with irrigated agriculture.**

# However, sustainable development of irrigation is threatened by growing demand and competition

Increase of surface water use in Alberta (billion m<sup>3</sup>)



Share of agricultural water use (%)



After the 1950s, in addition to expansion of irrigation, non-agricultural water uses also have increased greatly; in the future, water demand will continue to increase...

# Increasing water challenges have been addressed by government

- From 2001 to 2002, the Alberta government embarked on a **public review process** for developing a long-term provincial water management strategy;
- ***Water for Life strategy*** was released in 2003;
  - Proposes a strategy for the long term sustainable use of Alberta's water;
  - One of the key methods of achieving this is a 30 percent increase in water use efficiency and productivity.
  - largely depends on the ability and willingness of irrigators to keep adopting new irrigation technologies.

# Questions and Overall Goal

## Questions:

- What is the extent and intensity of adoption of new, improved irrigation technologies in southern Alberta ?
- Has the provision of information and other support services played a significant role in promoting adoption?
- Is adoption related to farmer and farm characteristics as well as social networking activities of farmers?

**Limited studies on these issues and only two based on descriptive statistical analysis.**

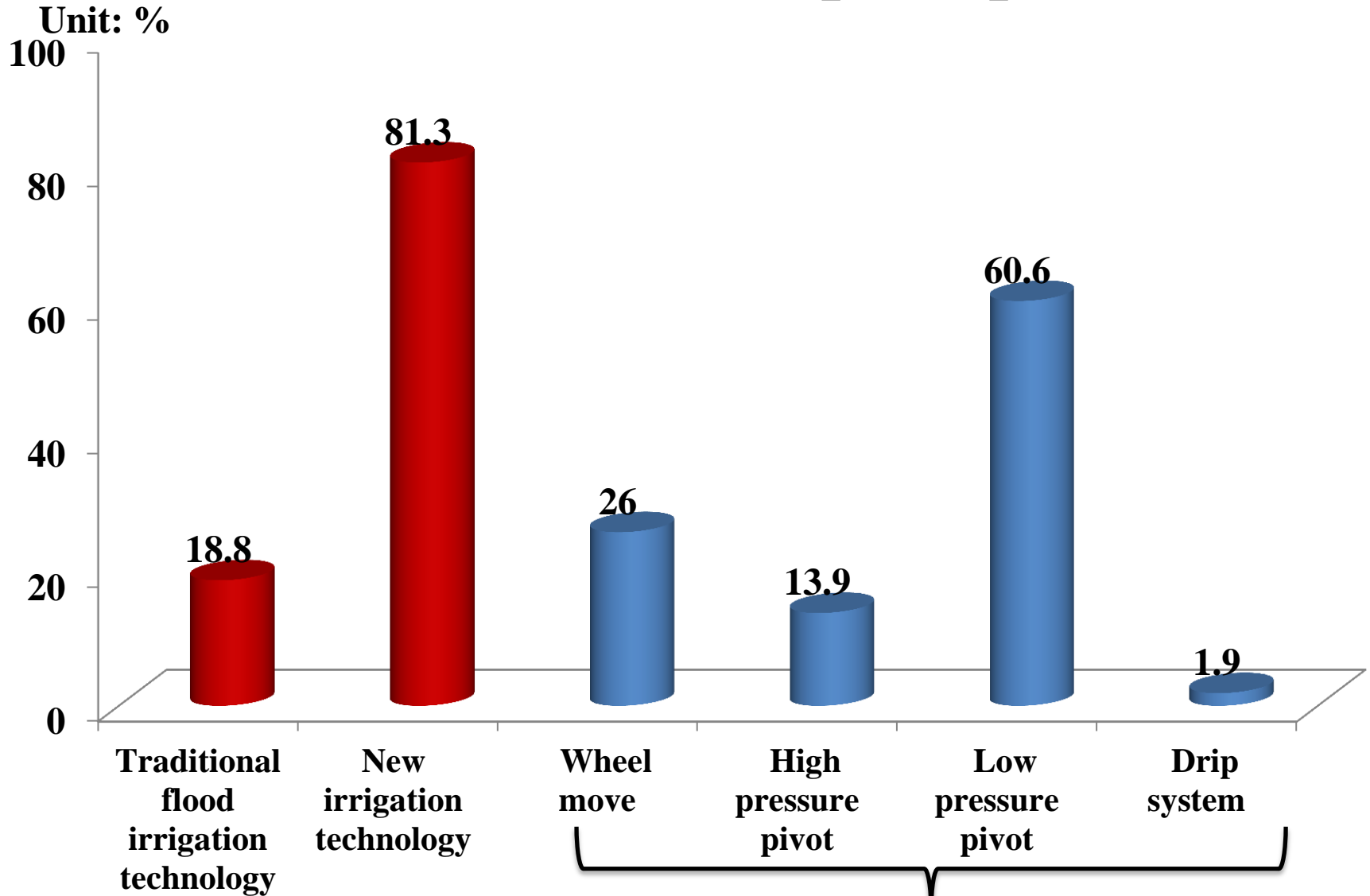
## Overall goal:

- To answer these questions by exploring the adoption behavior of farmers based on large field survey and quantitative analysis.

# Data

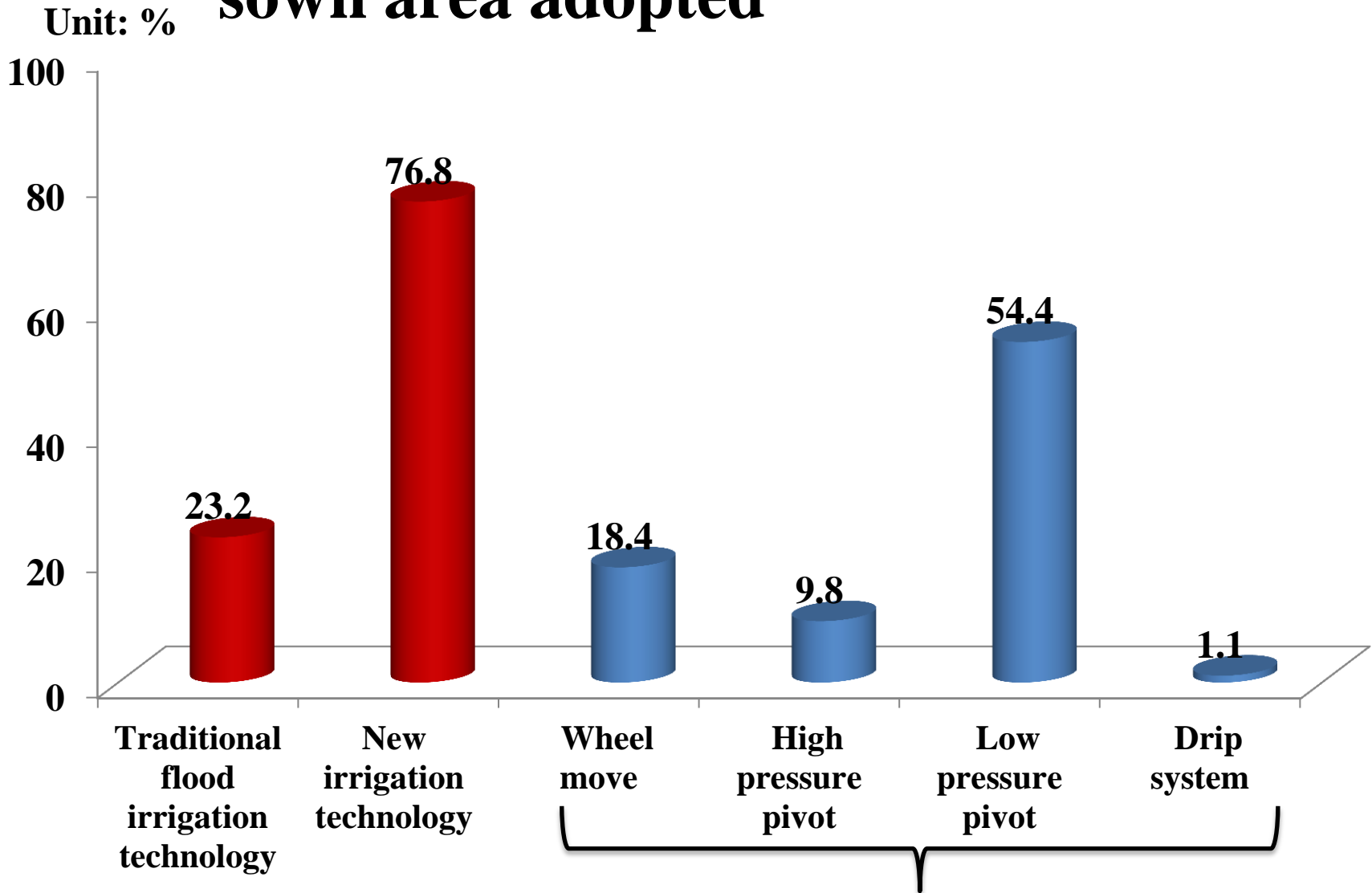
- **Large-scale farm household survey conducted at the University of Lethbridge during the summer of 2012;**
- **The survey covered 13 irrigation districts (IDs) and private irrigators in southern Alberta;**
- **Face-to-face interviews were conducted with the person responsible for the daily management of the irrigated operation;**
- **Respondents were recruited by a professional data collection company (the company);**
- **208 interviews were completed.**

# Adoption extent: proportion of farms that started the adoption process



**Of the new irrigation technology:**

# Adoption intensity: Proportion of crop sown area adopted



**Of the new irrigation technology:**



# **Analysis approach: Factors influencing the adoption extent and intensity**

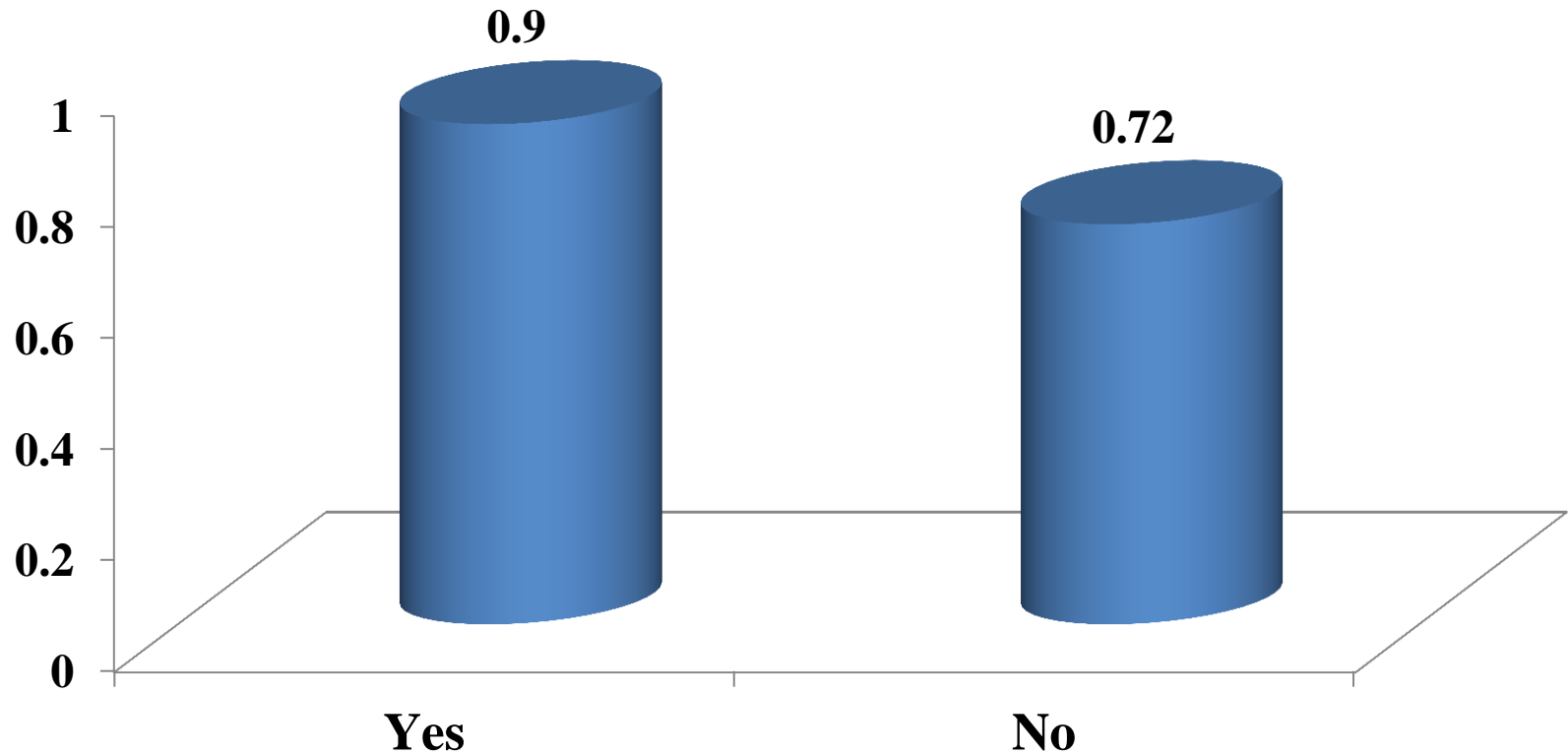
- **Descriptive statistical analysis**
- **Econometric model:**
  - **Determinants of farmers' dichotomous choice (whether to start the adoption process or not);**
  - **Determinants of farmers' multiple choice of adopting various irrigation technologies**
    - 1- representing the choice of traditional flood irrigation (the base for comparison);
    - 2-4: NEW ( 2 for wheel move, 3 for low pressure center pivot and 4 for high pressure center pivot);
  - **Determinants of adoption intensity (the proportion of the irrigated area on which a new technology is used)**

# Relationship between adoption and Information sources

		Farmers' choice:				Adoption intensity:
		Dichotomous choice	Multiple choice			Proportion of crop sown area adopted
		Whether or not adopted NEW <sup>a</sup>	Wheel move	High pressure pivot	Low pressure pivot	NEW
<b>Information sources</b>						
Extension agencies (1=yes; 0=no)	Yes	0.89	0.70	0.58	0.86	0.86
	No	0.71	0.46	0.29	0.61	0.64
Government (1=yes; 0=no)	Yes	0.8	0.6	0.33	0.69	0.71
	No	0.81	0.58	0.44	0.77	0.77
Individual farmers or farmers' association (1=yes; 0=no)	Yes	0.87	0.67	0.57	0.83	0.8
	No	0.78	0.54	0.36	0.73	0.75
Media (1=yes; 0=no)	Yes	0.91	0.67	0.64	0.89	0.86
	No	0.78	0.57	0.39	0.73	0.74

Farmers that obtained information from extension agencies and individual farmers are more likely to start the adoption process and also increased the intensity

# Relationship between support services and adoption intensity (Proportion of crop sown area)



Once the decision to adopt a NEW has been made, farmers can also obtain support to implement their decision, which might influence the intensity of adoption.

# Relationship between adoption and social capital

		Farmers' choice:				Adoption intensity:
		Dichotomous choice	Multiple choice			Proportion of crop sown area adopted NEW
		Whether or not adopted NEW <sup>a</sup>	Wheel move	High pressure pivot	Low pressure pivot	
<i>Social capital</i>						
Member of the Water Planning Advisory Council or Watershed Stewardship Group (1=yes; 0=no)	Yes	<b>0.79</b>	<b>0.55</b>	<b>0.38</b>	<b>0.69</b>	<b>0.78</b>
	No	<b>0.82</b>	<b>0.59</b>	<b>0.43</b>	<b>0.77</b>	<b>0.77</b>
Member of an environmental or conservation group (1=yes; 0=no)	Yes	<b>0.86</b>	<b>0.67</b>	<b>0.57</b>	<b>0.81</b>	<b>0.86</b>
	No	<b>0.81</b>	<b>0.57</b>	<b>0.41</b>	<b>0.76</b>	<b>0.76</b>
Member of a recreational or social organization (1=yes; 0=no)	Yes	<b>0.82</b>	<b>0.59</b>	<b>0.33</b>	<b>0.79</b>	<b>0.78</b>
	No	<b>0.81</b>	<b>0.57</b>	<b>0.48</b>	<b>0.74</b>	<b>0.76</b>
Attending farm meetings (1=yes; 0=no)	Yes	<b>0.88</b>	<b>0.68</b>	<b>0.47</b>	<b>0.85</b>	<b>0.83</b>
	No	<b>0.77</b>	<b>0.53</b>	<b>0.41</b>	<b>0.71</b>	<b>0.73</b>

Significant associations exist between attending farmer meetings or being a member of environmental related organizations and the probability of adoption

# Relationship between adoption and farm characteristics

		Farmers' choice:				Adoption intensity:
		Dichotomous	Multiple choice			Proportion of crop sown area adopting NEW
		Whether or not adopting NEW	Wheel move	High pressure pivot	Low pressure pivot	
Farm size (ha)	<180	0.61	0.39	0.18	0.45	0.57
	180-560	0.93	0.84	0.64	0.91	0.84
	>560	0.90	0.59	0.67	0.88	0.89
Farm type (legal structure)	Corporation	0.92	0.70	0.68	0.90	0.89
	Partnership	0.84	0.67	0.3	0.79	0.77
	Sole	0.69	0.49	0.31	0.58	0.64
Irrigated land as proportion of total land area	<0.365	0.74	0.49	0.4	0.62	0.73
	0.365-0.895	0.86	0.58	0.5	0.84	0.81
	>0.895	0.84	0.68	0.39	0.80	0.77
Have livestock enterprise that uses output of crops or forages (1=yes; 0=no)	Yes	0.82	0.64	0.43	0.77	0.77
	No	0.8	0.44	0.42	0.75	0.76

Farmers with larger farms are more likely to adopt and also increase adoption intensity; Adoption also seems to be related to farm type (legal organization) and intensity of irrigation

# Relationship between adoption and *Family characteristics*

		<b>Farmers' choice:</b>				<b>Adoption intensity:</b>
		<b>Dichotomous choice</b>	<b>Multiple choice</b>			<b>Proportion of crop sown area adopted NEW</b>
		<b>Whether or not adopted NEW</b>	<b>Wheel move</b>	<b>High pressure pivot</b>	<b>Low pressure pivot</b>	
<b><i>Family characteristics</i></b>						
<b>Family size (number)</b>	<3	<b>0.74</b>	<b>0.52</b>	<b>0.36</b>	<b>0.65</b>	<b>0.7</b>
	3-4	<b>0.87</b>	<b>0.63</b>	<b>0.53</b>	<b>0.84</b>	<b>0.8</b>
	>4	<b>0.97</b>	<b>0.89</b>	<b>0.75</b>	<b>0.96</b>	<b>0.94</b>
<b>Number of generations in which this farm has been in the family ownership</b>	0-1	<b>0.73</b>	<b>0.45</b>	<b>0.36</b>	<b>0.63</b>	<b>0.65</b>
	2	<b>0.83</b>	<b>0.6</b>	<b>0.38</b>	<b>0.80</b>	<b>0.78</b>
	>2	<b>0.87</b>	<b>0.69</b>	<b>0.54</b>	<b>0.84</b>	<b>0.85</b>

**Larger families are more likely to adopt and have higher adoption intensity**

# Relationship between adoption *Farmers'* *personal characteristics*

		Farmers' choice:			Adoption intensity:	
		Dichotomous choice	Multiple choice			Proportion of crop sown area adopted NEW
		Whether or not adopted NEW	Wheel move	High pressure pivot	Low pressure pivot	
Age (years)	<52	0.92	0.79	0.58	0.91	0.88
	52-59	0.76	0.45	0.4	0.70	0.72
	>59	0.76	0.56	0.38	0.68	0.71
Education (Bachelor's or higher degree) (1=yes; 0=no)	Yes	0.82	0.53	0.47	0.78	0.78
	No	0.81	0.59	0.41	0.76	0.76
Off-farm work (1=yes; 0=no)	Yes	0.73	0.47	0.39	0.63	0.70
	No	0.85	0.65	0.46	0.82	0.81
Farming experience (years)	<24	0.81	0.57	0.46	0.76	0.76
	24-36	0.84	0.63	0.5	0.79	0.8
	>36	0.79	0.55	0.32	0.75	0.75
Operating the farm before taking over its management (1=yes; 0=no)	Yes	0.85	0.64	0.43	0.82	0.81
	No	0.75	0.49	0.42	0.66	0.69
Current status of father/father-in-law (1=working farmer; 0=not working farmer)	Yes	0.82	0.58	0.38	0.79	0.79
	No	0.8	0.58	0.47	0.73	0.75

# **Analysis approach: Factors influencing the adoption extent and intensity**

- **Descriptive statistical analysis**
- **Econometric model:**
  - **Determinants of farmers' dichotomous choice (whether to start the adoption process or not);**
  - **Determinants of farmers' multiple choice of adopting various irrigation technologies**
    - 1- representing the choice of traditional flood irrigation (the base for comparison);
    - 2-4: NEW ( 2 for wheel move, 3 for low pressure center pivot and 4 for high pressure center pivot);
  - **Determinants of adoption intensity (the proportion of the irrigated area on which a new technology is used)**



# Logit and Multinomial logit regression results of the determinants of farmers' decision and choice on adopting new irrigation technology (NEW) and their marginal effects (**cont...**)

	Farmers' dichotomous choice on whether or not adopted NEW (1=yes; 0=no)		Farmers' multiple choices on NEW (versus traditional flood irrigation)		
	Model 1	Model 2	Wheel move	High pressure pivot	Low pressure pivot
<i>Information sources</i>					
Extension agencies (1=yes; 0=no)	0.083** (2.18)	0.081** (2.19)	0.038** (2.07)	0.028** (2.08)	0.040** (2.11)
Government (1=yes; 0=no)	-0.043 (0.80)	-0.037 (0.77)	-0.038 (0.44)	0.058 (0.06)	-0.134 (0.93)
Individual farmers or farmers' association (1=yes; 0=no)	0.072** (2.43)	0.069** (2.45)	0.096*** (2.73)	0.046*** (2.85)	0.039** (2.55)
Media (1=yes; 0=no)	0.048 (1.43)	0.042 (1.34)	0.067 (0.95)	0.004 (1.03)	0.122 (1.47)
<i>Social capital</i>					
Member of Water Planning Advisory Council or Watershed Stewardship Group (1=yes; 0=no)	-0.031 (0.58)	-0.013 (0.29)	-0.009 (0.21)	0.036 (0.15)	-0.061 (0.37)
Member of an environmental or conservation group (1=yes; 0=no)	-0.011 (0.22)	-0.029 (0.56)	-0.051 (0.22)	-0.010 (0.41)	-0.065 (0.49)
Member of a recreational or social organization (1=yes; 0=no)	-0.197*** (2.88)	-0.190*** (2.88)	-0.056* (1.91)	-0.084*** (2.68)	-0.161** (2.56)
Attending farm meetings (1=yes; 0=no)	0.128*** (2.77)	0.120*** (2.88)	0.030** (2.07)	0.040** (2.18)	0.121*** (2.59)

# Logit and Multinomial logit regression results of the determinants of farmers' decision and choice on adopting new irrigation technology (NEW) and their marginal effects (**cont...**)

	Farmers' dichotomous choice on whether or not adopted NEW (1=yes; 0=no)		Farmers' multiple choices on NEW (versus traditional flood irrigation)		
	Model 1	Model 2	Wheel move	High pressure pivot	Low pressure pivot
<i>Farm characteristics</i>					
Farm size (ha)	0.00005* (1.67)	0.0001* (1.84)	0.0001 (1.47)	0.0001** (2.14)	0.0001* (1.76)
Farm type					
Corporation (1=yes; 0=no)	0.080** (2.35)	0.141*** (3.21)	0.196** (2.25)	0.149*** (3.94)	0.221*** (3.48)
Partnership (1=yes; 0=no)	0.052** (1.97)	0.050* (1.78)	0.064 (1.49)	0.017 (1.09)	0.147** (2.03)
Interactive variables					
Farm size * corporation		-0.0001* (1.93)	-0.00002 (1.61)	-0.0001** (2.57)	-0.0001* (1.76)
Farm size * partnership		-0.00004 (0.42)	-0.00003 (0.28)	-0.0001 (0.60)	-0.00001 (0.32)
Irrigated land as proportion of total land area	0.098** (1.96)	0.093** (2.03)	0.118** (2.10)	0.100 (0.56)	0.106** (2.19)
Having livestock enterprise that use output of crops or forages (1=yes; 0=no)	0.023 (0.79)	0.011 (0.41)	0.177 (1.42)	0.002 (0.58)	0.155 (0.16)

# Analysis approach: Factors influencing the adoption extent and intensity

- **Descriptive statistical analysis**
- **Econometric model:**
  - **Determinants of farmers' dichotomous choice (whether to start the adoption process or not);**
  - **Determinants of farmers' multiple choice of adopting various irrigation technologies**
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  - **Determinants of adoption intensity (the proportion of the irrigated area on which a new technology is used)**

# Logit and Multinomial logit regression results of the determinants of adoption choice (cont...)

	Farmers' dichotomous choice on whether or not adopted NEW (1=yes; 0=no)		Farmers' multiple choices on NEW (versus traditional flood irrigation)		
	Model 1	Model 2	Wheel move	High pressure pivot	Low pressure pivot
<i>Information sources</i>					
Extension agencies (1=yes; 0=no)	0.083** (2.18)	0.081** (2.19)	0.038** (2.07)	0.028** (2.08)	0.040** (2.11)
Government (1=yes; 0=no)	-0.043 (0.80)	-0.037 (0.77)	-0.038 (0.44)	0.058 (0.06)	-0.134 (0.93)
Individual farmers or farmers' association (1=yes; 0=no)	0.072** (2.43)	0.069** (2.45)	0.096*** (2.73)	0.046*** (2.85)	0.039** (2.55)
Media (1=yes; 0=no)	0.048 (1.43)	0.042 (1.34)	0.067 (0.95)	0.004 (1.03)	0.122 (1.47)
<i>Social capital</i>					
Member of Water Planning Advisory Council or Watershed Stewardship Group (1=yes; 0=no)	-0.031 (0.58)	-0.013 (0.29)	-0.009 (0.21)	0.036 (0.15)	-0.061 (0.37)
Member of an environmental or conservation group (1=yes; 0=no)	-0.011 (0.22)	-0.029 (0.56)	-0.051 (0.22)	-0.010 (0.41)	-0.065 (0.49)
Member of a recreational or social organization (1=yes; 0=no)	-0.197*** (2.88)	-0.190*** (2.88)	-0.056* (1.91)	-0.084*** (2.68)	-0.161** (2.56)
Attending farm meetings (1=yes; 0=no)	0.128*** (2.77)	0.120*** (2.88)	0.030** (2.07)	0.040** (2.18)	0.121*** (2.59)

# Logit and Multinomial logit regression results of the determinants of adoption choice

	Farmers' dichotomous choice on whether or not adopted NEW (1=yes; 0=no)		Farmers' multiple choices on NEW (versus traditional flood irrigation)		
	Model 1	Model 2	Wheel move	High pressure pivot	Low pressure pivot
<i>Farm characteristics</i>					
Farm size (ha)	0.00005* (1.67)	0.0001* (1.84)	0.0001 (1.47)	0.0001** (2.14)	0.0001* (1.76)
Farm type					
Corporation (1=yes; 0=no)	0.080** (2.35)	0.141*** (3.21)	0.196** (2.25)	0.149*** (3.94)	0.221*** (3.48)
Partnership (1=yes; 0=no)	0.052** (1.97)	0.050* (1.78)	0.064 (1.49)	0.017 (1.09)	0.147** (2.03)
Interactive variables					
Farm size * corporation		-0.0001* (1.93)	-0.00002 (1.61)	-0.0001** (2.57)	-0.0001* (1.76)
Farm size * partnership		-0.00004 (0.42)	-0.00003 (0.28)	-0.0001 (0.60)	-0.00001 (0.32)
Irrigated land as proportion of total land area	0.098** (1.96)	0.093** (2.03)	0.118** (2.10)	0.100 (0.56)	0.106** (2.19)
Having livestock enterprise that use output of crops or forages (1=yes; 0=no)	0.023 (0.79)	0.011 (0.41)	0.177 (1.42)	0.002 (0.58)	0.155 (0.16)

# Logit and Multinomial logit regression results of the determinants of adoption choice (cont...)

	Farmers' dichotomous choice on whether or not adopted NEW (1=yes; 0=no)		Farmers' multiple choices on NEW (versus traditional flood irrigation)		
	Model 1	Model 2	Wheel move	High pressure pivot	Low pressure pivot
<i>Household characteristics</i>					
Family characteristics					
Family size (number)	0.034** (2.52)	0.033*** (2.58)	0.011* (1.91)	0.001* (1.89)	0.046** (2.36)
Number of generations in ownership of this farm	0.024 (1.16)	0.024 (1.24)	0.042 (1.42)	0.028* (1.85)	0.038 (1.05)
Farmers' personal characteristics					
Age (years)	0.002 (1.03)	0.001 (1.08)	0.003 (1.19)	0.002 (1.42)	0.003 (0.82)
Education (Bachelor's or higher degree) (1=yes; 0=no)	0.053* (1.82)	0.054** (2.10)	0.199 (0.70)	0.081** (2.29)	0.173* (1.96)
Off-farm work (1=yes; 0=no)	-0.038 (1.18)	-0.034 (1.11)	-0.077 (1.47)	-0.017 (0.70)	-0.008 (1.17)
Farming experience (years)	-0.002* (1.88)	-0.002* (1.94)	-0.001** (2.02)	-0.001** (2.08)	-0.001** (2.05)
Operating the farm before taking over its management (1=yes; 0=no)	0.003 (0.08)	-0.004 (0.13)	-0.060 (0.17)	-0.101 (1.17)	0.162 (0.45)
Current status of father/father-in-law (1=working farmer; 0=not working farmer)	-0.024 (0.92)	-0.019 (0.76)	-0.041 (0.26)	-0.041 (1.15)	-0.015 (0.52)
Irrigation district dummy (versus private region)	Omitted	Omitted	Omitted	Omitted	Omitted
Constant	-3.948 (1.64)	-4.995** (1.98)	-6.288** (2.34)	-8.313** (2.48)	-4.556* (1.82)
Observations	208	208	248	248	248
Pseudo R <sup>2</sup>	0.3815	0.4187		0.2800	

# Tobit regression results of the determinants of adoption intensity (cont...)

	Adoption intensity: Proportion of crop area sown after adopting NEW	
	Tobit	OLS
<i>Support services</i>		
Received support service (1=yes; 0=no)	0.146** (2.03)	0.115* (1.79)
<i>Information sources</i>		
Extension agencies (1=yes; 0=no)	0.157** (2.29)	0.134** (2.19)
Government (1=yes; 0=no)	-0.134 (1.28)	-0.120 (1.30)
Individual farmers or farmers' association (1=yes; 0=no)	0.189*** (2.77)	0.152** (2.52)
Media (1=yes; 0=no)	0.070 (0.89)	0.060 (0.86)
<i>Social capital</i>		
Member of Water Planning Advisory Council or Watershed Stewardship Group (1=yes; 0=no)	-0.010 (0.11)	-0.003 (0.03)
Member of an environmental or conservation group (1=yes; 0=no)	0.010 (0.10)	0.015 (0.16)
Member of a recreational or social organization (1=yes; 0=no)	-0.244** (2.41)	-0.194** (2.20)
Attending farm meetings (1=yes; 0=no)	0.263** (2.57)	0.203** (2.26)

# Tobit regression results of the determinants of adoption intensity (cont...)

	Adoption intensity: Proportion of crop area sown after adopting NEW	
	Tobit	OLS
<i>Farm characteristics</i>		
Farm size (ha)	0.0002 (1.60)	0.0001 (1.28)
Farm type		
Corporation (1=yes; 0=no)	0.285*** (3.30)	0.227*** (2.98)
Partnership (1=yes; 0=no)	0.105 (1.04)	0.068 (0.77)
Cross variables		
Farm size * corporation	-0.0002 (1.44)	-0.0001 (1.16)
Farm size * partnership	-0.0001 (0.41)	-0.00002 (0.17)
Irrigated land as proportion of total land area	0.234** (2.08)	0.182* (1.82)
Having livestock enterprise that use output of crops or forages (1=yes; 0=no)	-0.008 (0.13)	-0.003 (0.05)



# Tobit regression results of the determinants of adoption intensity (cont...)

	Adoption intensity: Proportion of crop area sown after adopting NEW	
	Tobit	OLS
<i>household characteristics</i>		
Family characteristics		
Family size (number)	0.043** (2.14)	0.035* (1.97)
Number of generations who has ownership of this farm	0.043** (2.14)	0.035* (1.97)
Farmers' personal characteristics		
Age (years)	0.005 (1.36)	0.003 (1.11)
Education (Bachelor's or higher degree) (1=yes; 0=no)	0.090 (1.26)	0.075 (1.19)
Off-farm work (1=yes; 0=no)	-0.050 (0.71)	-0.038 (0.61)
Farming experience (years)	-0.006*** (2.89)	-0.005*** (2.61)
Operating the farm before taking over its management (1=yes; 0=no)	0.039 (0.48)	0.029 (0.40)
Current status of father/father-in-law (1=working farmer; 0=not working farmer)	-0.025 (0.41)	-0.019 (0.34)
Irrigation district dummy	Omitted	Omitted
Constant	-0.036 (0.12)	0.170 (0.67)
Observations	208	208
Pseudo R <sup>2</sup>	0.2573	-
Adj R <sup>2</sup>	-	0.2111

# Concluding Remarks

- **Obtaining information on irrigation technologies through other farmers (either individual farmers or farmers' associations) and extension agencies significantly influences farmers' decision to adopt.**
- **Receiving support services following the adoption decision also plays an important role in increasing the intensity of adoption.**
- **If farmers increased their social networking activities through attending meetings related to agricultural production practices, they were more likely to adopt and adopt more intensively while farmers who participated in recreational or social organizations were less likely to adopt.**
- **Finally, the extent and intensity of adoption are higher for those with a corporate farm structure, larger families, more generations of farm ownership and higher education.**

# Policy Implications

- **Provide more effective support services for farmers once an adoption decision has been made and deliver it in a timely manner to reduce their perception of risk;**
- **Focus on supplying information about new technologies and their potential benefits and cost through extension officers and farmer organizations;**
- **Facilitate and encourage the development of farmer peer groups to exchange experiences;**
- **Expand the provision of extension officers;**
- **Provide advice and services that support farmers in developing the most efficient business structure for their farm business and secure farm succession;**
- **Provide programs that particularly target and accommodate small scale farmers.**

***Thank you!***