Sustainable Water Management and Agriculture: *Challenges and Opportunities for Mexico*

Valeria Pineiro and Claudia Ringler
International Food Policy Research Institute

50 YEARS OF IFPRI
LOOKING TOWARD 2050
CGIAR

Global Water Crises also Affect Mexico

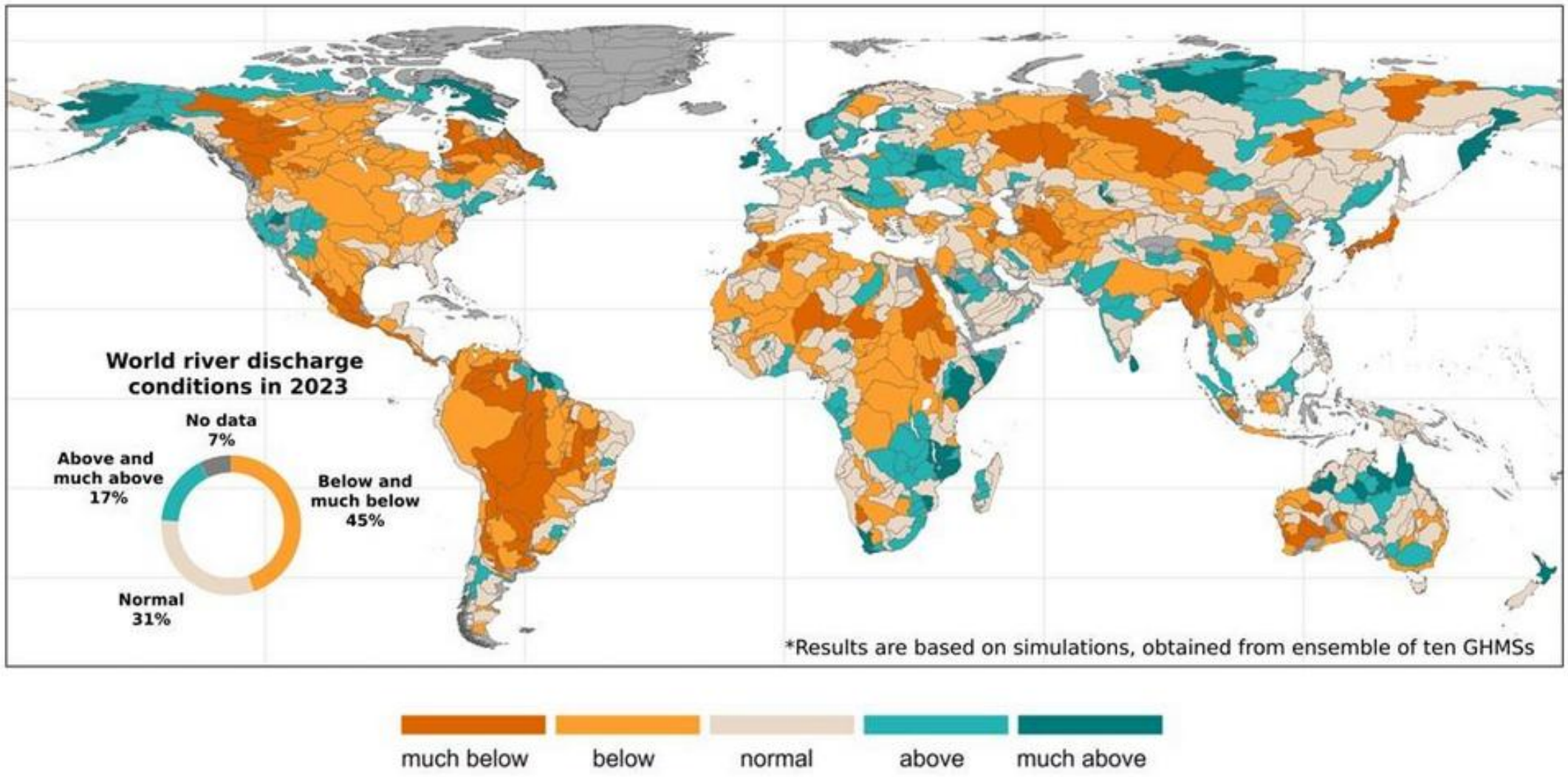
1. Rapidly increasing water scarcity affecting water and food security, agricultural and economic growth [due to climate change/extremes; population/economic growth, poor water management]
2. Large-scale systems inefficient; farmer-led systems not adequately supported
3. Challenges with groundwater management and sustainability

Credit: CIMMYT

→*Solutions adopted elsewhere can be considered in Mexico*

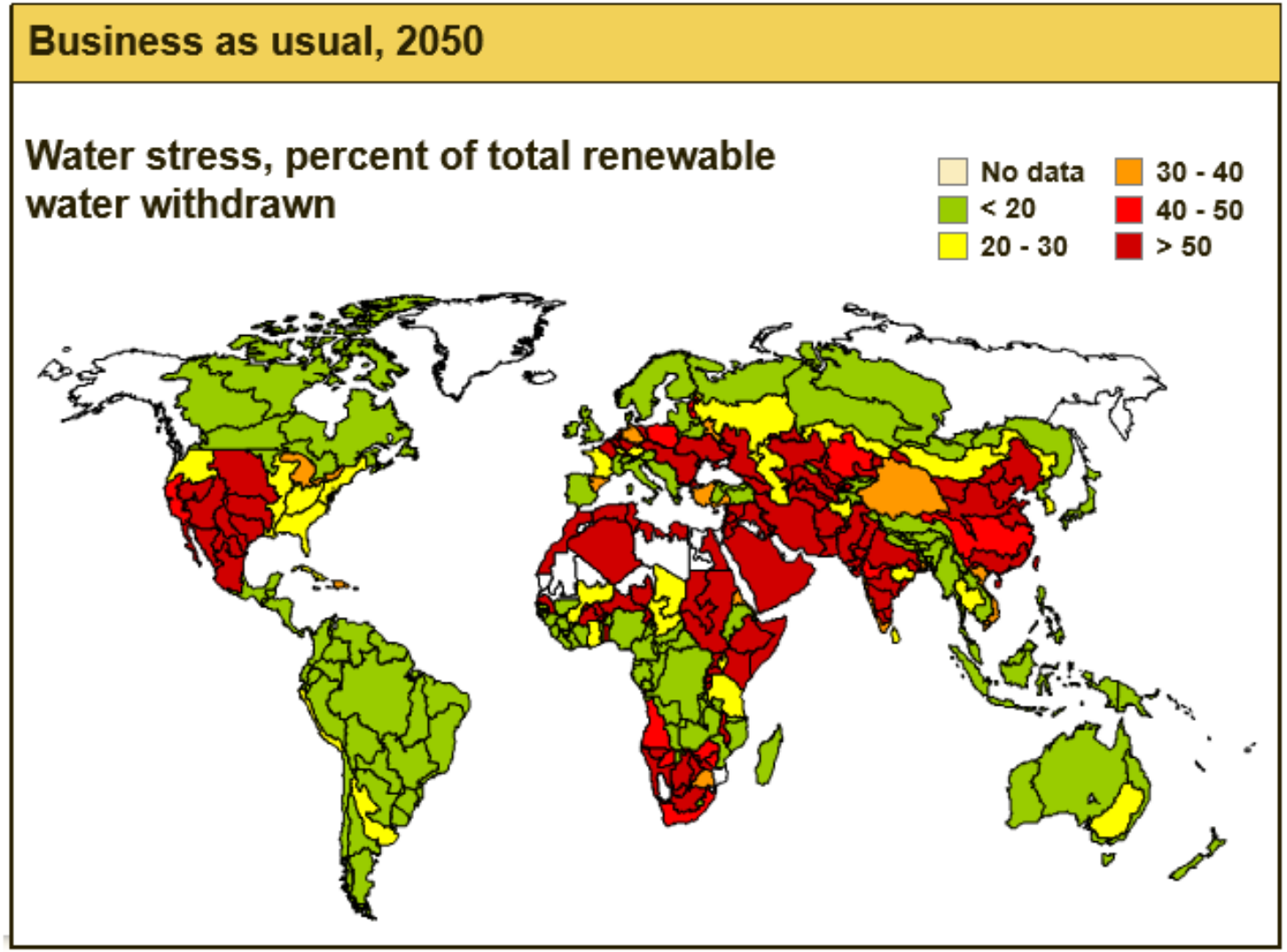
IFPRI

1. Close to half of all rivers experienced much below average flows in 2023 [including much below in parts of Mexico]



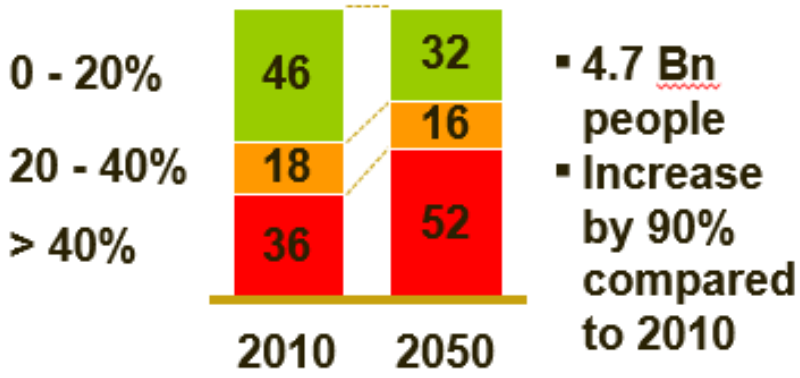
Source: WMO (2024)

1. Under BAU, 52% of the population, 49% of cereal production and 45% of GDP will be at high risk due to water stress by 2050, inc Mexico



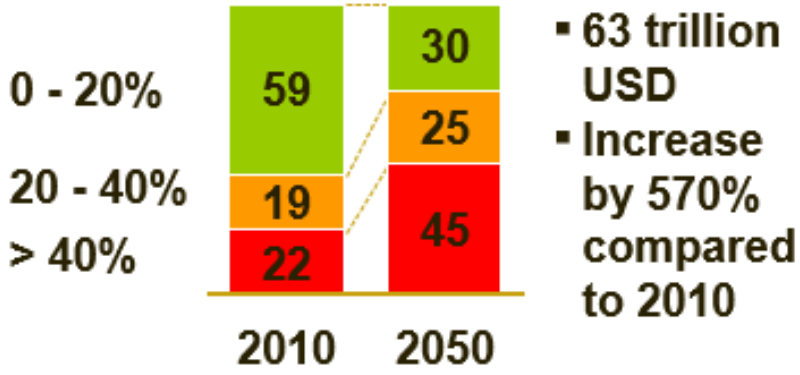
Source: Ringler et al. (2016)

How many people live in water short areas?



- 4.7 Bn people
- Increase by 90% compared to 2010

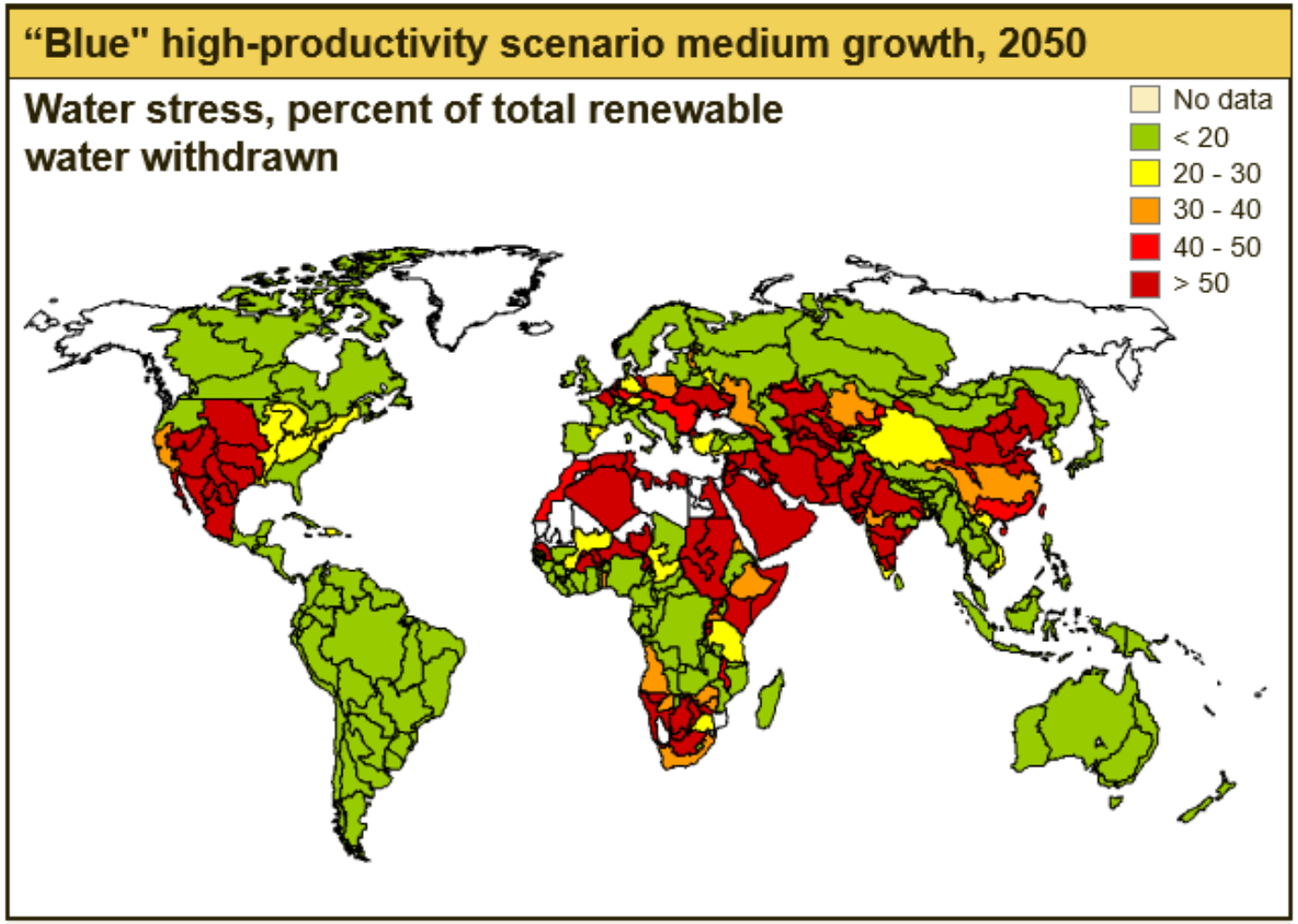
How much GDP is generated in water scarce regions?



- 63 trillion USD
- Increase by 570% compared to 2010

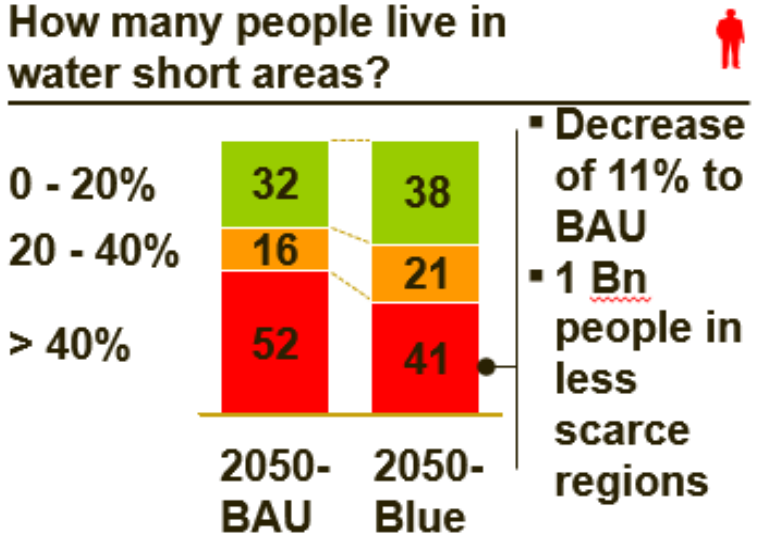
IFPRI

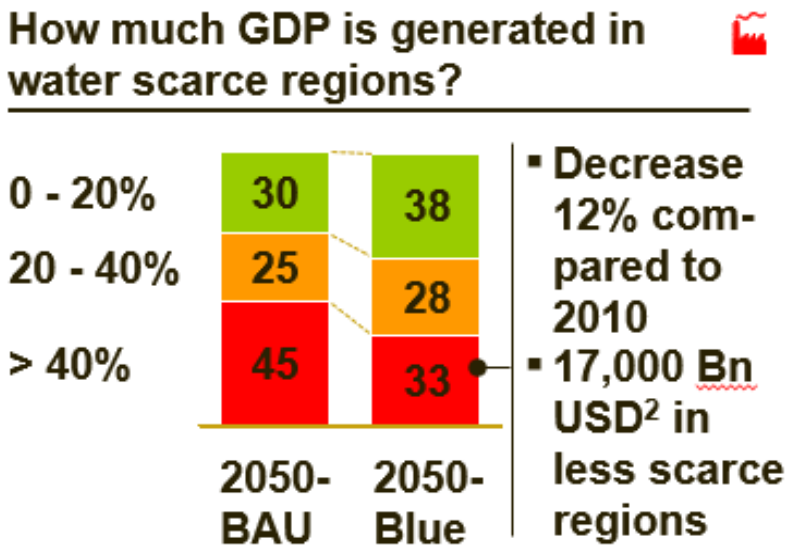
1. With significant water productivity investments, ~1 bn people and 17 trillion USD[2] GDP can be moved into areas of lower water scarcity[1] but limited potential for Mexico



[1] below >40% water stress
[2] Based on year 2000 prices

Source: Ringler et al. (2016)





IFPRI

2. Large-scale systems can be improved through stronger agency of Water User Associations [Ex. Pakistan]

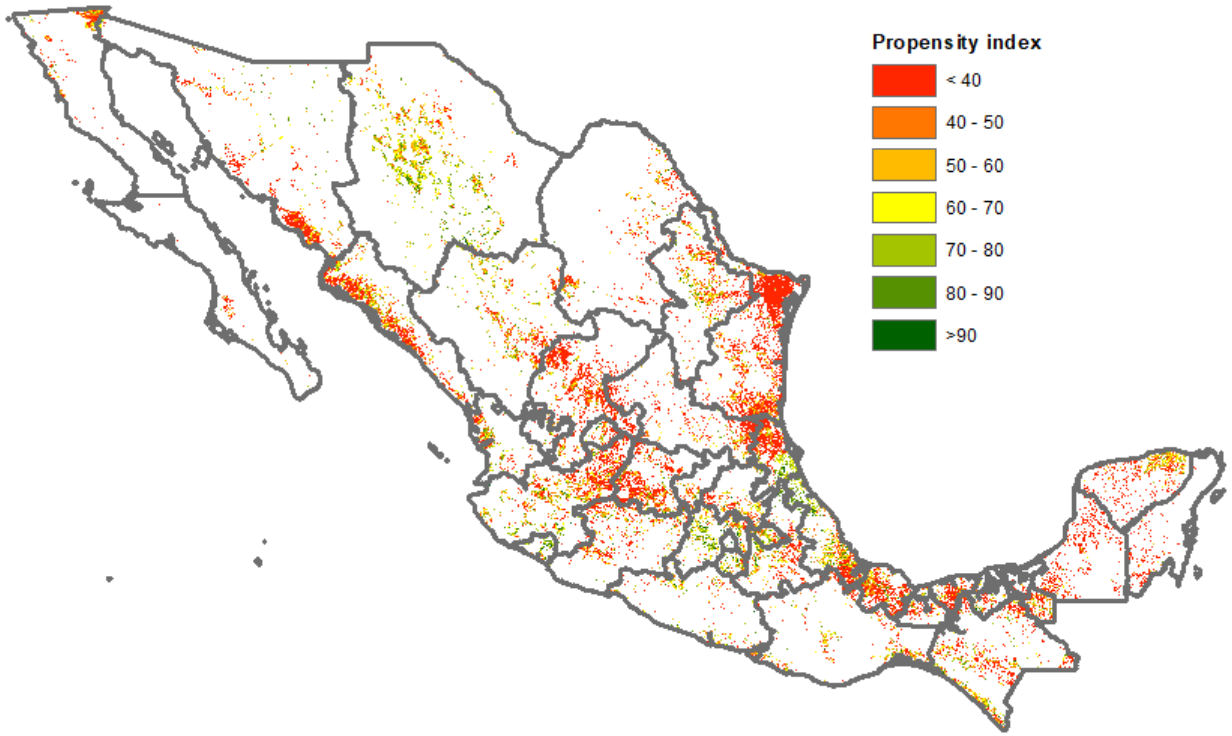
- Pakistan: Largest contiguous irrigation system irrigates around 19 million hectares, increasingly conjunctive use between surface and groundwater; 60% of agricultural production from groundwater, mostly wheat, rice, sugarcane & cotton
- Based on a two-round household survey, we find that water course level Water User Associations (WUAs) led to a productivity increase of about 10% for farms at the tail end of the watercourse, and an 8% productivity increase for those farmers who solely rely on groundwater.
- Thus, WUAs can improve equity in water allocation and use
- This WUA type has, however, since been abolished

Source: Mekonnen et al. (2015)

→*Are there similar findings for Irrigation District Water User Associations in Mexico?*

IFPRI

2. Support to farmer-led irrigation requires identification of areas best suited to uptake: Potential to adopt irrigation pumps high on 1.6 million hectares



- Potential particularly high in Chihuahua, Veracruz de Ignacio de la Llave, Jalisco and México

Source: IFPRI 2024

	Marginal (<40)	Low (40-60)	Medium (60-80)	High (>80)
Aguascalientes	90,549	36,755	23,795	6,646
Baja California	176,351	126,359	59,229	22,864
Baja California Sur	52,993	18,802	8,892	2,541
Campeche	550,894	54,865	21,078	1,260
Chiapas	512,766	279,622	191,761	65,267
Chihuahua	157,312	498,622	688,347	284,476
Coahuila de Zaragoza	283,379	151,177	86,263	26,303
Colima	5,667	22,030	45,838	45,837
Distrito Federal	2,490	2,730	2,823	3,165
Durango	287,574	238,009	201,799	61,279
Guanajuato	514,295	184,513	95,370	31,726
Guerrero	140,563	172,911	150,492	69,443
Hidalgo	115,992	126,218	80,587	31,589
Jalisco	733,235	371,492	259,608	120,271
México	63,652	152,282	164,729	103,280
Michoacán de Ocampo	401,395	222,753	143,204	48,706
Morelos	14,826	43,904	44,341	23,381
Nayarit	136,202	107,923	83,834	34,090
Nuevo León	410,226	214,420	150,579	54,206
Oaxaca	285,868	232,366	168,247	66,568
Puebla	230,905	133,235	111,355	76,065
Querétaro de Arteaga	35,677	44,475	24,339	8,072
Quintana Roo	203,561	26,395	12,404	1,089
San Luis Potosí	479,678	128,327	69,169	16,693
Sinaloa	677,365	308,361	228,098	23,105
Sonora	559,156	161,088	132,171	45,071
Tabasco	416,554	172,256	119,270	19,713
Tamaulipas	1,710,378	307,499	180,985	20,344
Tlaxcala	31,281	47,034	44,402	29,279
Veracruz de Ignacio de la Llave	1,101,658	615,058	628,151	227,067
Yucatán	308,892	183,823	99,859	7,054
Zacatecas	945,671	220,364	70,761	26,354
Total	11,637,006	5,605,670	4,391,779	1,602,805

IFPRI

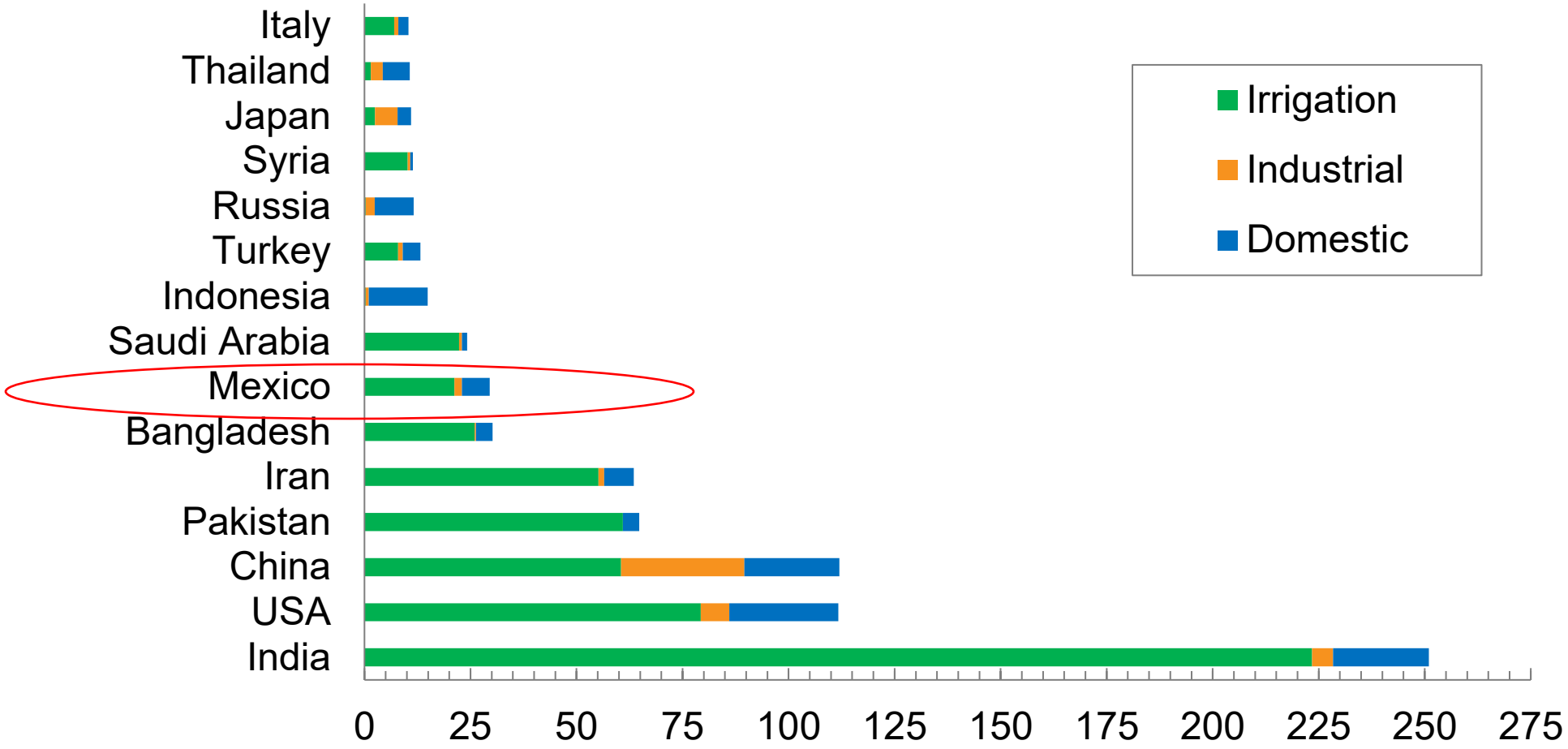
2. Calculations underlying propensity to adopt irrigation pumps in Mexico

	Very high	High	Moderately high	Moderate	Low	Unsuitable
Slope (%)	<2	2-4	4-6	6-8	N/A	>8
Travel time (minutes)	<15	15-30	30-45	45-60	>60	N/A
Soil drainage class	Well	Moderate	Excessive, Somewhat excessive	Imperfect	Poor, Very poor	N/A
Distance to surface water bodies (m)	<200	200-500	500-1000	1000-1500	1500-3000	>3000

Factor	Weight (w)
Slope	0.186
Travel time	0.097
Soil drainage class	0.186
Distance to surface water bodies	0.532

Source: IFPRI 2024

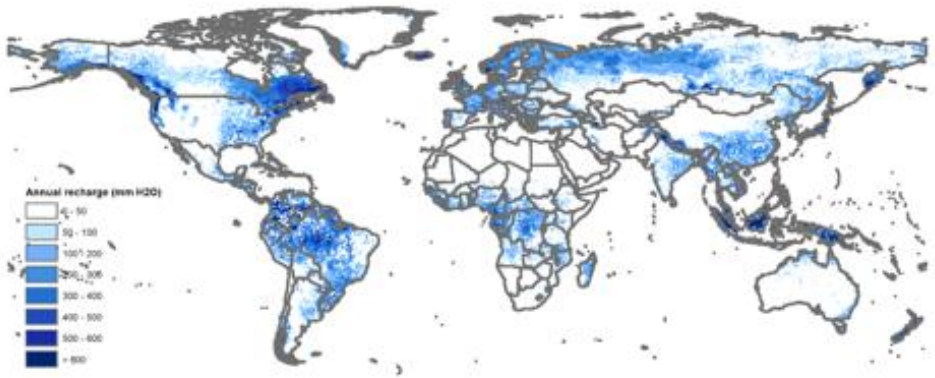
3. Mexico is a top groundwater user, mostly for irrigation



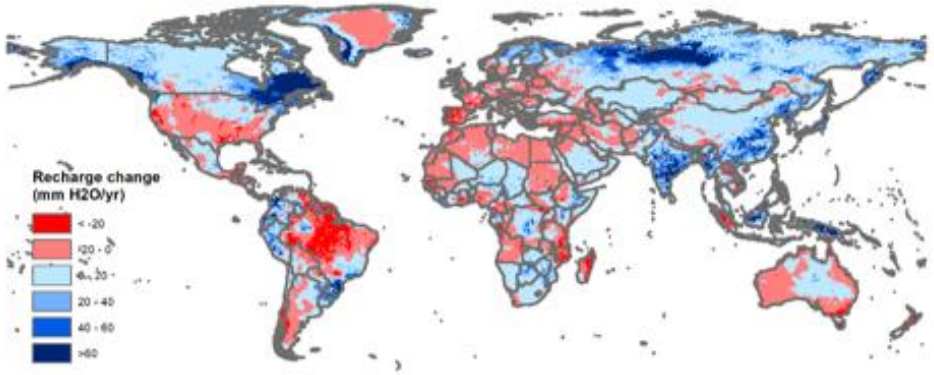
Source: Margat and van der Gun (2013).

3. Groundwater resources are under growing threat [Figures show changes in recharge under climate change]

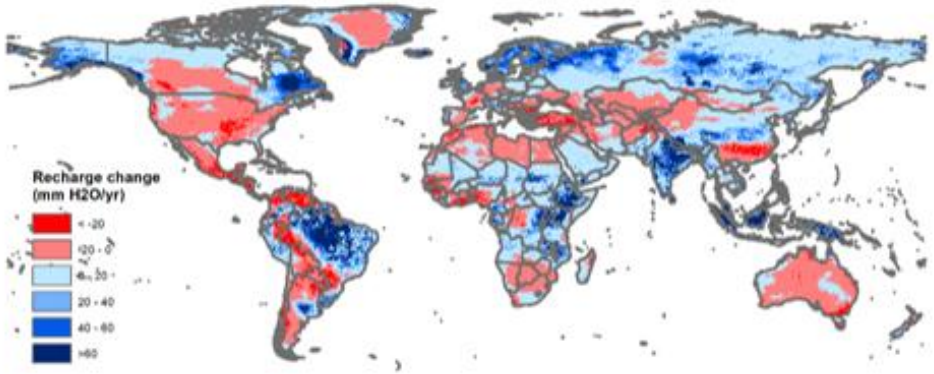
Annual recharge in base year



Annual recharge change [2050] – HADGEM+RECP8.5



Annual recharge change – IPSL+RECP8.5

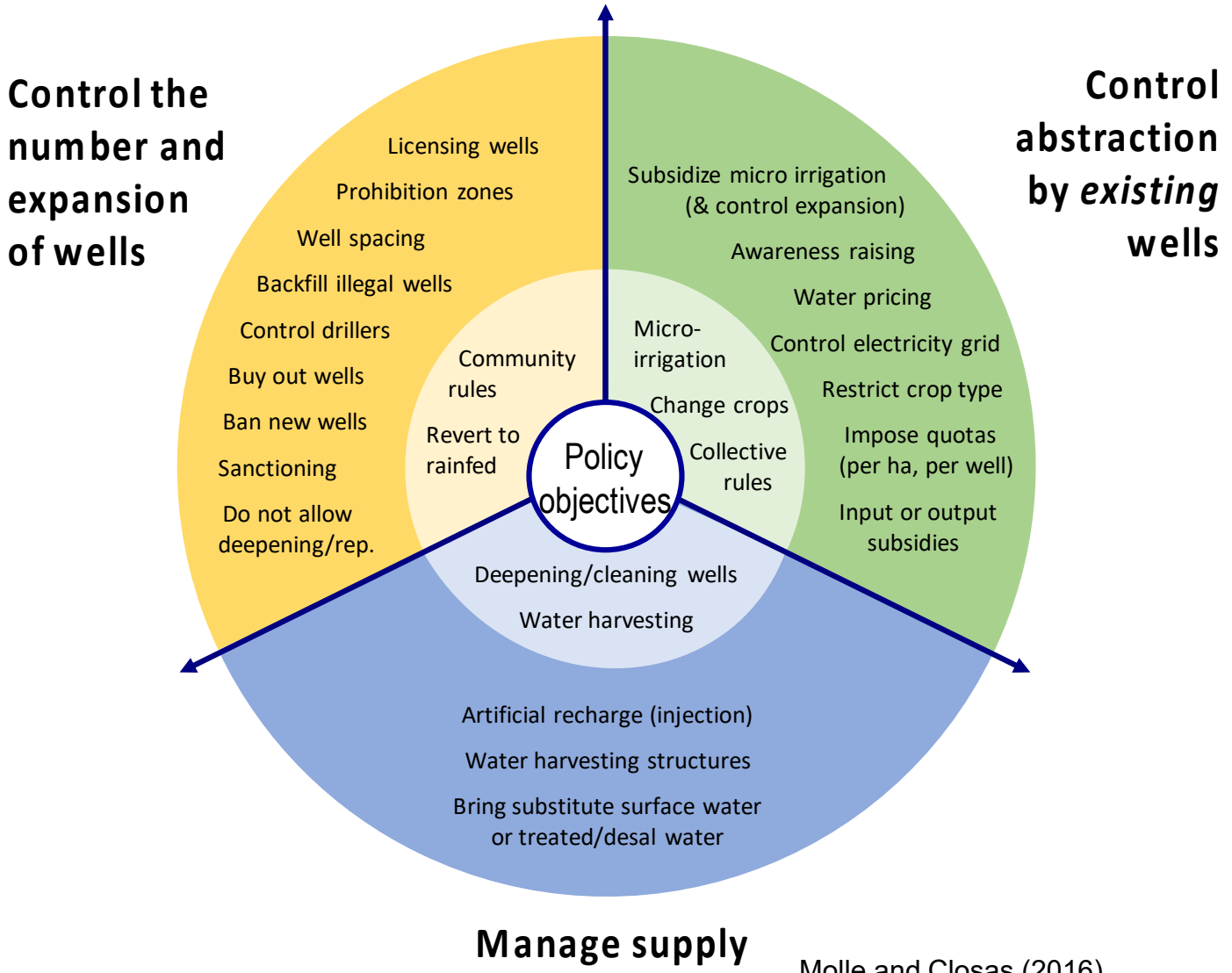


Source: IFPRI IMPACT

IFPRI

3. Groundwater governance is therefore essential

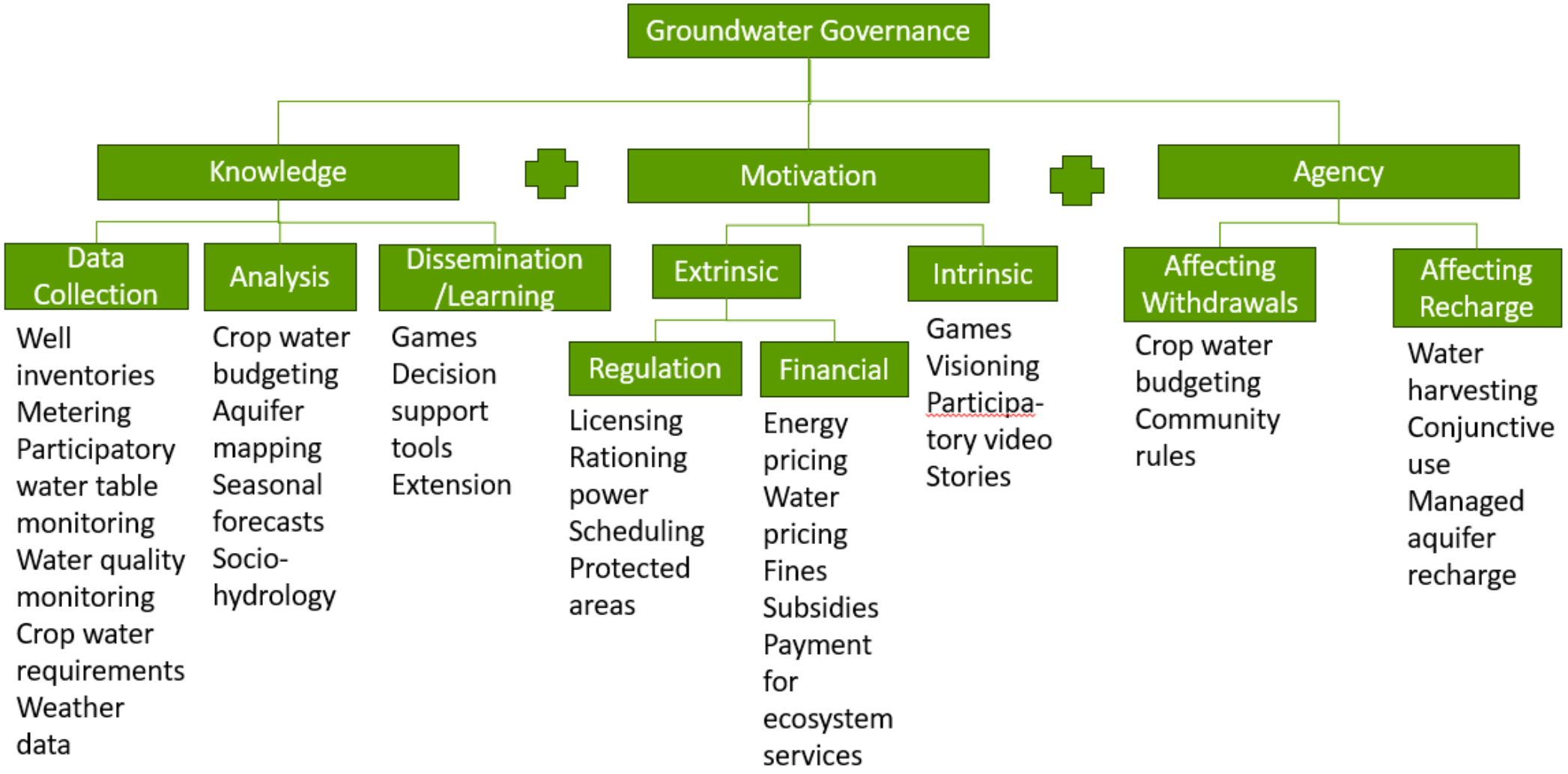
- Challenges: classic common pool resource
- Many tools exist, but few examples of success: Main types of management: Control well expansion, control abstraction, increase supply to wells [see figure]
- Need for governance (institutions) to coordinate across actors



Molle and Closas (2016).

IFPRI

3. Successful groundwater governance interventions combine improved knowledge with motivation and agency



IFPRI

3. Examples of groundwater management interventions

- Upper Republican Natural Resources District (URNRD) in Nebraska: moratorium on drilling new wells, a well permitting system, land occupation taxes, a cap on groundwater pumping, formal and informal water markets, stream augmentation projects, and subsidized soil moisture probes to provide incentives
- **Kansas water bill**: Districts need to identify areas where the aquifer has fewer than 50 years of usable lifetime remaining by 2024. Plans on how water use will be cut finalized by 2026. Otherwise, state steps in to manage. Huge investment in MAR and advanced irrigation to sweeten the pie.
- LMIC examples: banning new wells, metering wells, capping withdrawals, and incentives for growing less water-intensive crops, compensation for land fallowing, buyback of wells or water marketing mechanisms

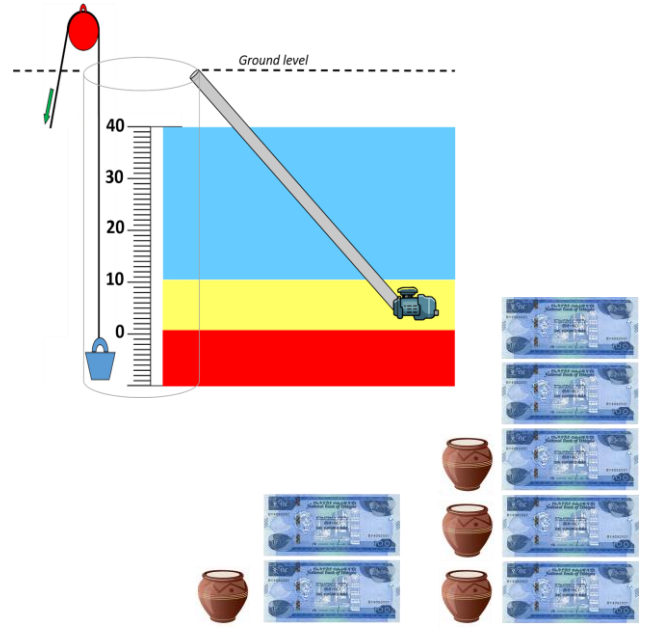
Ascription of Responsibility												
	Irrigators (n = 578)						Dryland (n = 513)					
	Response (%)						Response (%)					
Questions	SD	D	N	A	SA	NA	SD	D	N	A	SA	NA
Q16h: I feel personally responsible for groundwater depletion in my area.	24	30	26	12	3	5	36	25	16	5	2	16
Q16i: I should reduce or minimize my groundwater use.	12	21	38	20	4	6	23	15	29	9	5	18

SD = strongly disagree. D = disagree. N = neutral. A = agree. SA = strongly agree. NA = no answer.

Kansas survey

IFPRI

3. Successful groundwater governance interventions in India, Ethiopia and Ghana

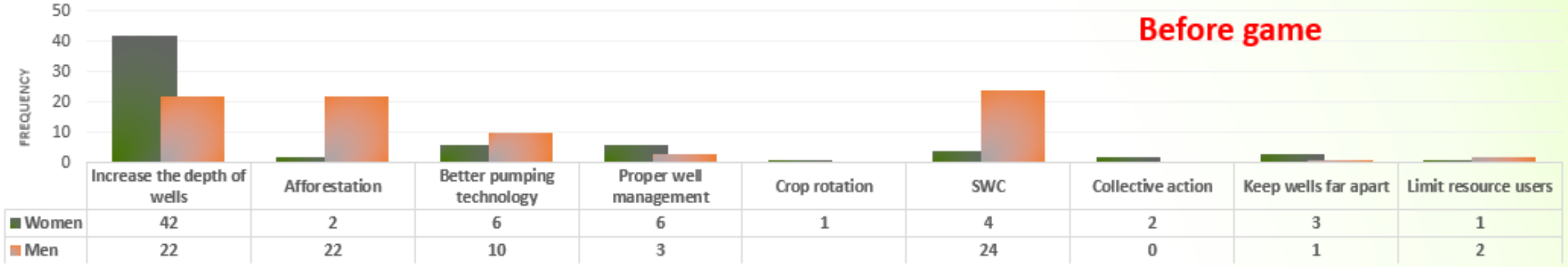


- Experiential games where groups of women and men farmers, over several rounds of interactions choose either a more profitable, more water consuming crop, or a less profitable, less water consuming crop. Farmers can choose individually, or discuss selection; based on selections, groundwater availability changes; these behavioral change interventions are accompanied by Focus Group Discussions and Surveys before and after the interventions; with follow ups 6 months to 2 years after the intervention
- Impacts:
  - Andhra Pradesh, India: Intervention groups [compared to control groups with out the behavioral change interventions (only surveys) more like to adopt water registers and rules for using groundwater;
  - Rajasthan, Madhya Pradesh, Andhra Pradesh, India: Intervention groups adopted less water consumptive crops or varieties and irrigation scheduling
  - 5 states in India: Intervention groups showed increased women's participation in decision-making, investment in water harvesting

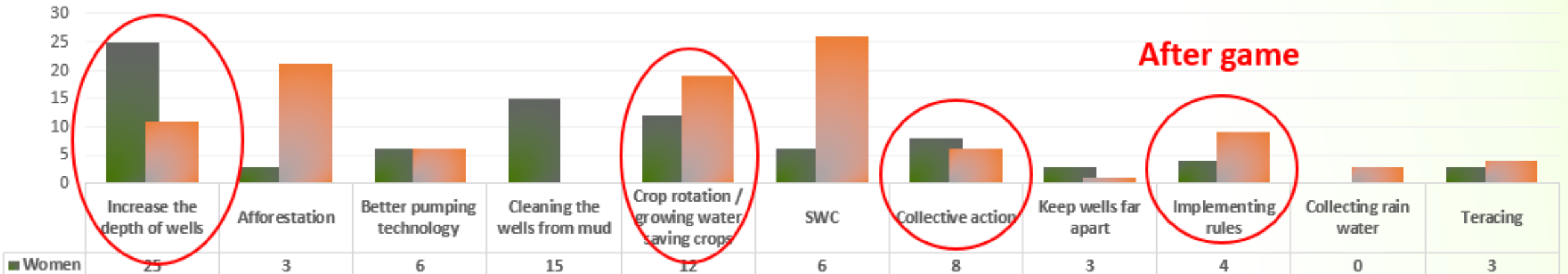
IFPRI

3. Sample result from experiential games in Ethiopia [before and after the intervention]

Question: What do you think should be done to improve groundwater availability? --following the game more interest in growing water saving crops, developing rules for groundwater use, etc.



	Increase the depth of wells	Afforestation	Better pumping technology	Proper well management	Crop rotation	SWC	Collective action	Keep wells far apart	Limit resource users
Women	42	2	6	6	1	4	2	3	1
Men	22	22	10	3		24	0	1	2



	Increase the depth of wells	Afforestation	Better pumping technology	Cleaning the wells from mud	Crop rotation / growing water saving crops	SWC	Collective action	Keep wells far apart	Implementing rules	Collecting rain water	Teracing
Women	25	3	6	15	12	6	8	3	4	0	3
Men	11	21	6	0	19	26	6	1	9	3	4

Conclusions

- The water crisis is rapidly worsening, and Mexico is one of the most affected countries
- There are MANY options to address different water challenges [groundwater depletion, transboundary water cooperation, improved irrigation management for large-scale and small-scale systems. A small selection for irrigation and groundwater management was presented. To move any of these into action, the following steps need to be considered:
  - ✓ Identify all actors that need to be consulted/are affected; all of them need to be engaged to co-identify solutions
  - ✓ Ensure that these actors have the right knowledge, motivation and agency to implement potential solutions
  - ✓ Be intentional of what the goal/objective of addressing the water crisis is [i.e. is it water savings or producing more food?]
  - ✓ Instead of implementing a large-scale “solution”, first implement pilots at smaller scale with connected learning to assess impacts on equity, sustainability and (other) unintended consequences

IFPRI