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Economics of Conservation Agriculture

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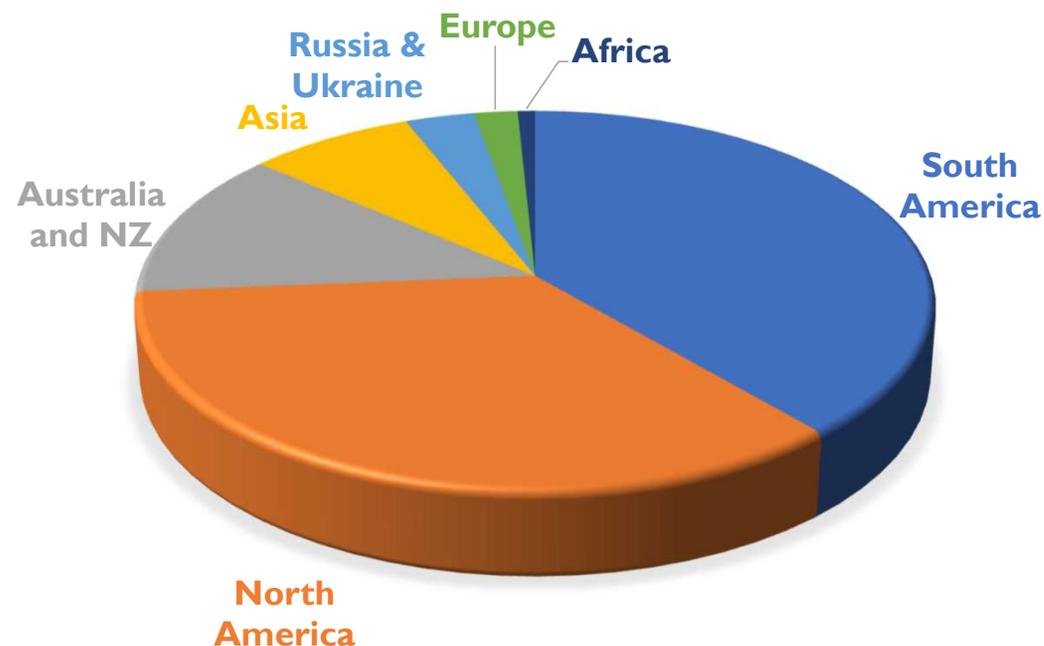
CIMMYT India

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Introduction

- Importance of economics in technology dissemination.
- Conventional idea – profitability affect adoption
- Several studies have shown that CA increases profitability.
- The environmental impacts are also well documented.
- CA is a technology with potential to benefit both farmers and society.
- But its adoption is still low in Asia. Why?

Cropland area under CA by region in 2015/16



Source: Kassam et al. (2018)

Technology characteristics

“Non-divisible”

“Information intensive”

“Adoption by components”

“Discontinuous adoption”

“Externalities”

“Complementary inputs”

“Spillover effects”

“Heterogenous impacts”

Let us Start with Economics of Residue Management.

One of the 3 pillars of CA is residue retention: Mulching.

“To mulch or not to mulch?”

Examining mulching as a technology from an economic perspective

		Private Goods (Farmer Benefits)	
		High	Low
Public Good (Positive Externalities)	High		
	Low		

There is a lot of evidence on the positive public and private benefits of mulching.

What is the need for putting more efforts on technology dissemination?

Types of Benefits and Adoption

Actual benefits vs. Perceived benefits for Farmers

- The difference determines farmer acceptance and adoption
- Due to several reasons (technology attributes, farmer characteristics, social norms etc.)
- Subjective evaluation is equally important.

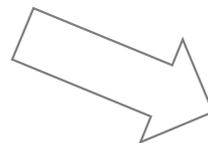
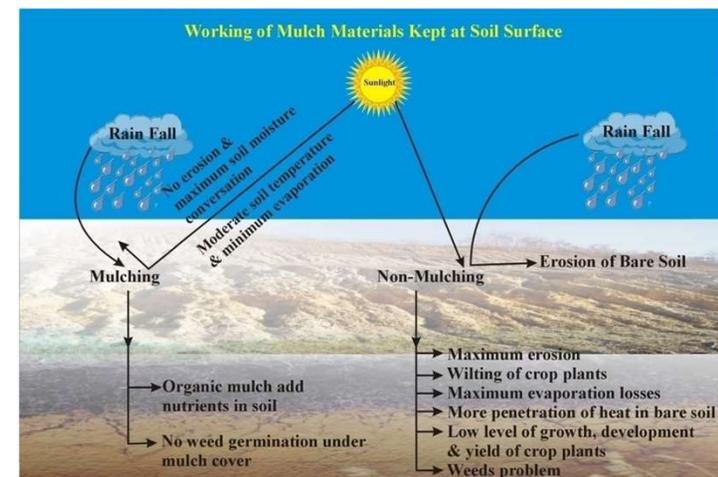
Actual benefits vs. Perceived benefits for the Government

- The difference determines governmental support
- Investment in information campaigns, subsidies, etc.
- Less studies conducted on this aspect.

Private (Farmer) Benefits of Mulching

- Soil moisture conservation
- Minimizing soil compaction and erosion
- Regulation of soil temperature
- Soil fertility improvement
- Mitigation of salt stress
- Diminution of diseases
- Better weed management

Iqbal et al (2020).

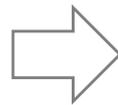


- Higher crop yield
- Low production risk
- Lower variable cost
- Better profits

Private Costs of Mulching

However, soil mulching is one of the uses of crop residues.

- livestock feed
- bedding material for animals
- bio-gas generation
- thatching for rural homes
- mushroom cultivation
- biomass energy production
- fuel for domestic and industrial use
- Others?



Opportunity cost of crop residues.
[Cost of not selecting the “best next alternative”].

Costs of using crop residues as mulch?

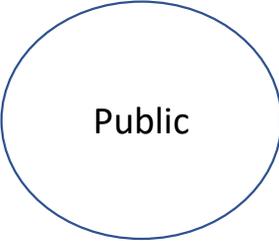
- Increased pest infestation?
- Loss of aesthetic value?
- Transaction costs of getting the tillage technology [expenses incurred when buying or selling a good or service]

Positive Externalities of Mulching

Mainly through avoiding residue burning.

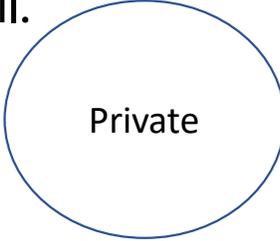
- Health hazard

[burning of one metric tonne of straw releases 3 kg of particulate matter]



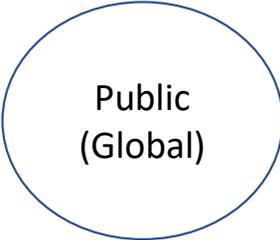
Public

- Nutritional loss and physical health deterioration to the soil.
[including mortality of active beneficial soil bacteria].



Private

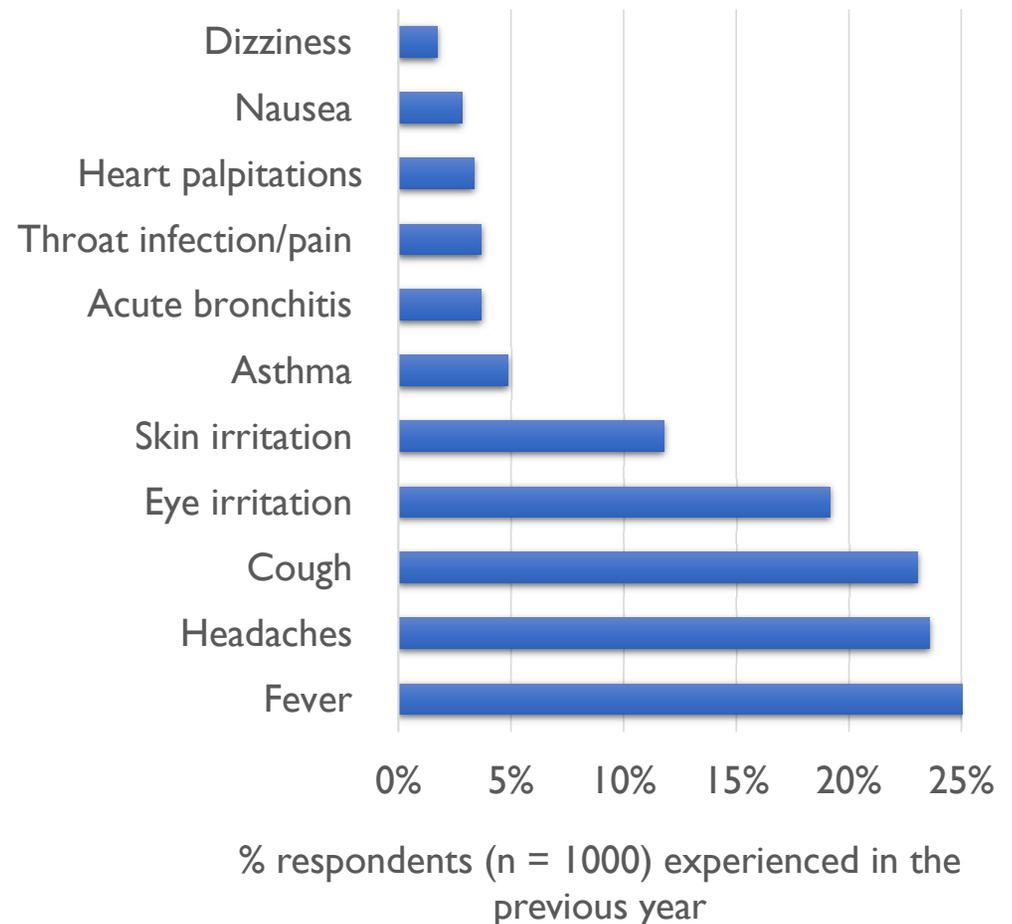
- Emission of greenhouse gases



Public
(Global)

Health externalities of Residue Burning

- Health externalities of residue burning.
- Reported by 1000 wheat farmers in a 2021 survey by CIMMYT.
- The question was “Do you or your family members feel any of the following health problems due to smoke in the air during October-January time?”
- Hence the reported effects are subjective and short-term.



Crop Residue Burning (FAO; 2019 figures)

Biomass burned (dry matter, million MT)

	Rice
India	24.1
China	16.5
Bangladesh	6.3
Indonesia	5.9
Thailand	5.3

	Maize
China	41.3
United States of America	33.0
Brazil	17.5
India	9.0
Argentina	7.2

	Wheat
India	11.7
Russian Federation	11.0
China	9.5
United States of America	6.0
Kazakhstan	4.6

	Sugarcane
Brazil	6.6
India	3.3
Thailand	1.2
China	0.9
Pakistan	0.7

But is this data reliable?

The fraction of dry matter residues burned in the field is taken as 0.25 the developing countries.

Key Concepts to Consider for Assessing the Economics of CA [1]

Social vs. Private Costs/Benefits

Private costs/ Benefits – Realized by the firm and must be included in production decisions.

Social costs / Benefits – include both the private costs/benefits and any other external costs/benefits to society arising from the production process.

- Does the CA adoption benefit farmers?
 - Increase in profitability (direct, private benefit)
 - Non-monetary values (e.g., satisfaction)
 - Low opportunity cost of following CA
 - Transaction costs of getting direct seeder (difficulty).
- Are social values of CA included in farmer decision-making process?
 - Are they appreciated for practicing low-C agriculture?
 - Government support (e.g., machinery subsidy)?

Key Concepts to Consider for Assessing the Economics of CA [2]

Objective vs. Subjective Valuation

- The subjective theory of value
 - the value of a technology is not determined by any inherent property of the technology nor by its yield or profitability potential, but instead by the importance a farmer places on the technology.
- Important for determining adoption.
- The subjective value of a technology can be changed
 - Information dissemination
 - Awareness creation
- A 2016-study showed that only 19% rice-wheat farmers are aware of the CA practices (81% in Punjab, 4% in Bihar).

Awareness and Adoption

	ZT adoption (%HH)	% HH informed about ZT	ZT adoption (%) among the informed
Punjab	45	96	47
Bihar	33	52	63

Source: Krishna et al (unpublished).

Survey was conducted in 2018 (n = 1017 households). In Bihar, the survey was conducted in 2014 (n = 959).

- Awareness creation is a precondition for adoption of a technology.
- The approaches of awareness creation could vary in efficacy.
 - Mass media campaigns
 - Demonstrations
 - Working through lead farmers, cooperatives, service providers
- Awareness does not ensure positive evaluation of the technology

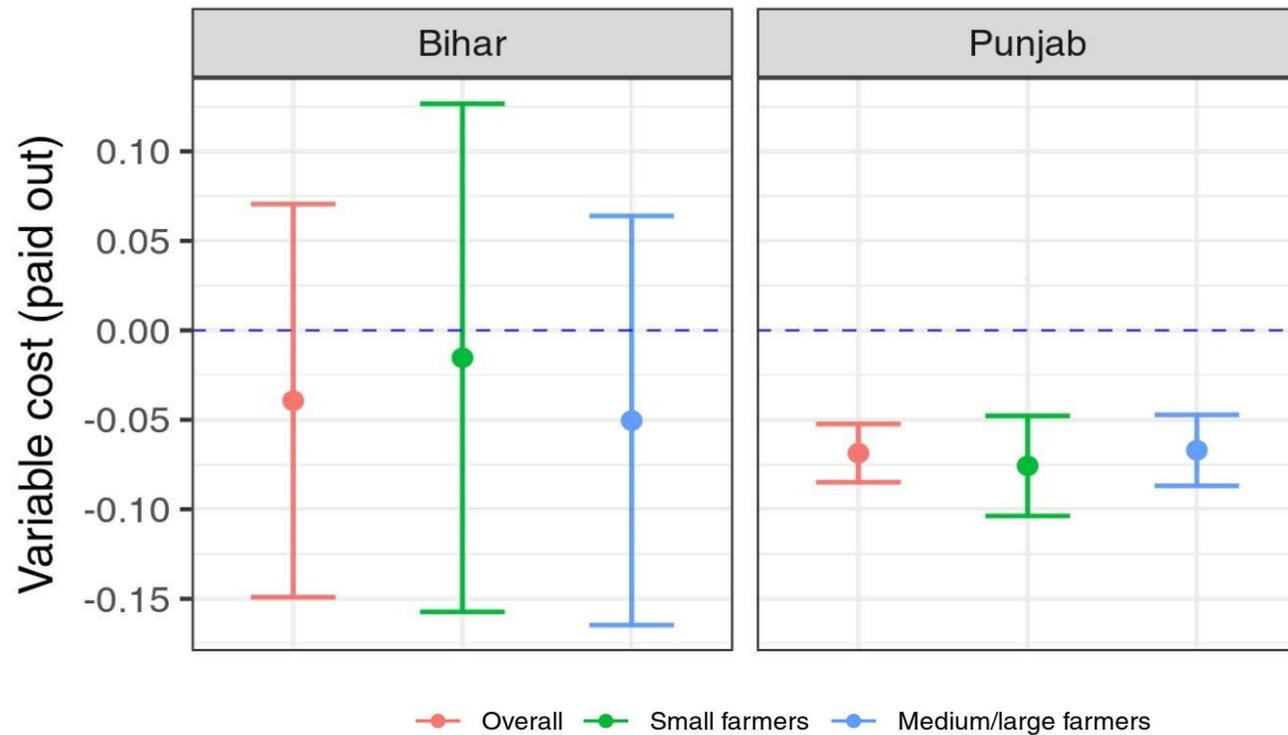
On Farm Impacts of CA

- Yield increase
 - A 5% increase (Krishna and Veetil, 2014)
 - Yield gain of 295 kg ha⁻¹ (Keil et al 2021).
- Variable cost reduction
 - A 14% reduction (Krishna and Veetil , 2014)
- Slight increase in production efficiency
 - 1% increase (Krishna and Veetil, 2014)
- Time saving
 - About 200 min ha⁻¹ (Keil et al 2021).

Krishna and Veetil (2014) study was conducted in Haryana.

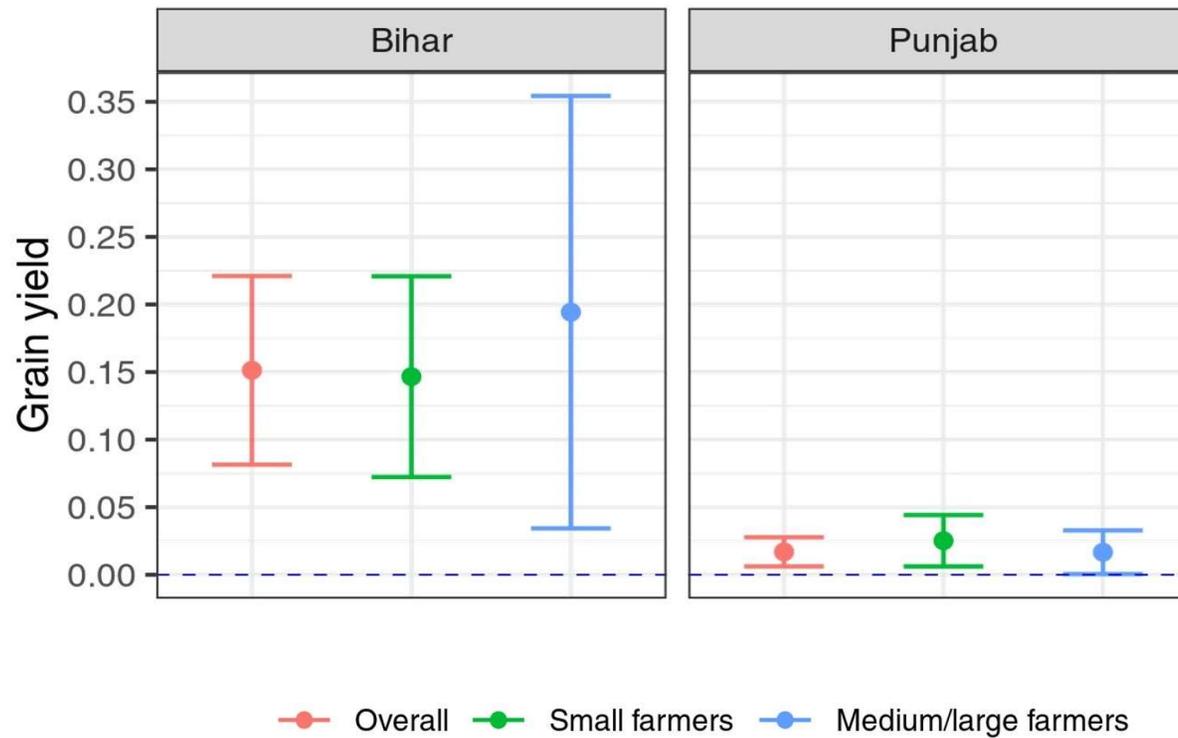
Keil et al (2021) study was conducted in Punjab.

Effect on Variable Cost (%)



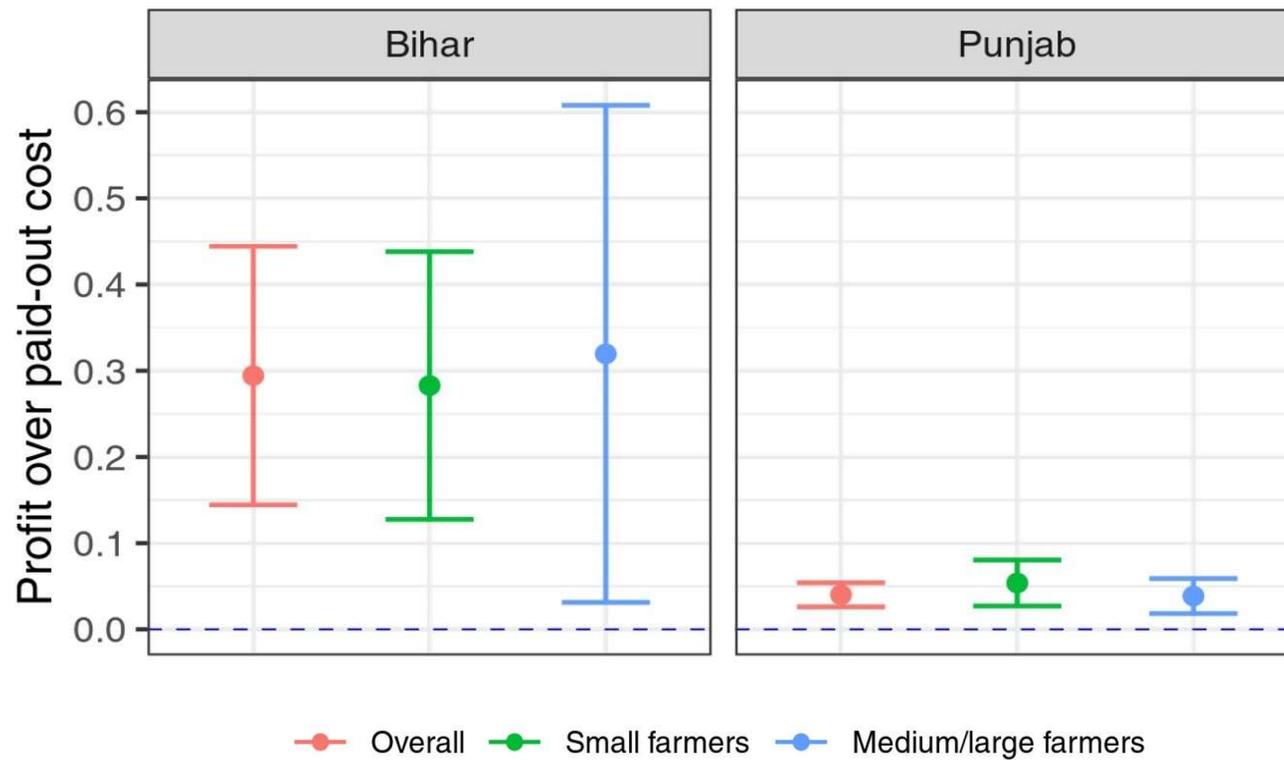
Source: Krishna et al (unpublished).

Effect on Grain Yield (%)



Source: Krishna et al (unpublished).

Effect on Profitability (%)



Source: Krishna et al (unpublished).

How to popularize CA based on its economics?

- The adoption of CA almost always reduces the cost of production.
 - However, the magnitude depends on several factors
 - E.g., cost of fuel, number of passes of tractor in the conventional land preparation methods
- Presence of the yield effect depends on several factors.
 - Particularly, the time of sowing in the absence of the technology.
 - Availability of herbicides.
- The social benefits of the technology must be considered while promoting the technology
 - Payment for ecosystem services.

Conclusions

- CA is a technology with high potential in the facet of climate change.
- Highly relevant in IGP (depleting natural resource base).
- However, the adoption is sub-optimal.
- Understanding the economics of CA technology is essential for its dissemination.
- Avoid asking “what is the problem with the farmers not to adopt CA?”
- Awareness creation, knowledge-base building are inevitable.
- The public good attribute of the technology needs to be recognized.

Questions?