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North Colombian farmers' willingness to pay for agrivoltaic's attributes in the context of the Just Energy Transition

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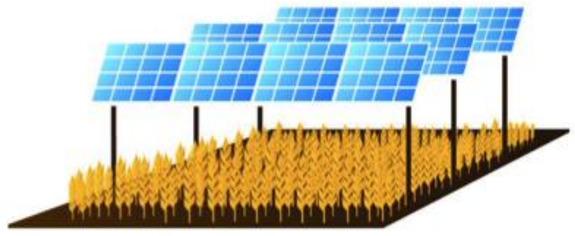
**ALLIANCE OF BIOVERSITY INTERNATIONAL AND CIAT. MULTIFUNCTIONAL LANDSCAPES

I. INTRODUCTION

- Agrivoltaics (AV) involves using land for both agriculture and photovoltaic (PV) energy production, aiming to curb GHG emissions by promoting solar energy deployment while mitigating potential land-use conflicts.

Portrayal of an agrivoltaic system



Source: Burgos-De La Cruz, 2024

- North of Colombia is ideal for AV deployment due to its high annual solar radiation and the national government's promotion of a Just Energy Transition (JET). AV systems could also help address energy insecurity and drought vulnerability issues in the region.
- Understanding farmers' preferences toward AV system attributes is essential, as without their buy-in, there won't be large-scale adoption.

Research question:

Which features of AV systems do smallholder farmers in northern Colombia value most, and how much are they willing to pay for them?

II. METHODOLOGY

1. Discrete Choice Experiment (DCE)

DCE selected as the most appropriate stated preference (SP) method since it:

- Explore individuals' assessment of **not-yet marketable goods** like is the case for AV systems in Colombia
- Evaluate **implicit trade-offs** of goods by focusing on its characteristics

It does so, by modelling the utility (U) of individual i from choosing alternative j as a sum of its k attributes (x) and their marginal contribution to the utility (β):

$$U_{i,j} = \beta_1 X_{1,i,j} + \beta_2 X_{2,i,j} + \cdots + \beta_k X_{k,i,j} + \varepsilon_{i,j}$$

When a $price$ attribute is included, the **willingness to pay (WTP)** for attribute k is:

$$WTP_k = -1\left(\frac{\beta_k}{\beta_{price}}\right)$$

2. Experimental design

Five attributes were selected as the most appropriate based on the literature review as well as results from semi-structured interviews and focus groups with experts, authorities and farmers in Cesar, north of Colombia.

Example of a choice card used in the field experiment

Attribute	Alternative 1	Alternative 2	Opt-out
Permanent **change in the yields** of crops under the AV system	-20%	+10%	0%
Drought-induced crop losses under the AV system area in the next 10 years	1	3	3
Average days of the year with **unexpected power cuts**	0 days/year	12 days/year (1 per month)	24 days/year (2 per month)
Reduction of monthly **energy bill**	70%	35%	0%
Yearly cost of co-investment for the next 10 years	~450 €/year	~225 €/year	0 €/year
Choice	☐	☐	☐

Own elaboration

III. FINDINGS

1. Farmers' most valued attributes of AV systems are protection against droughts and yields' increase

- Farmers' average WTP for one less drought-induced crop loss is **44.9€/year**
- Farmers' average WTP for a permanent 1% increase in agricultural yields is **7.8€/year**

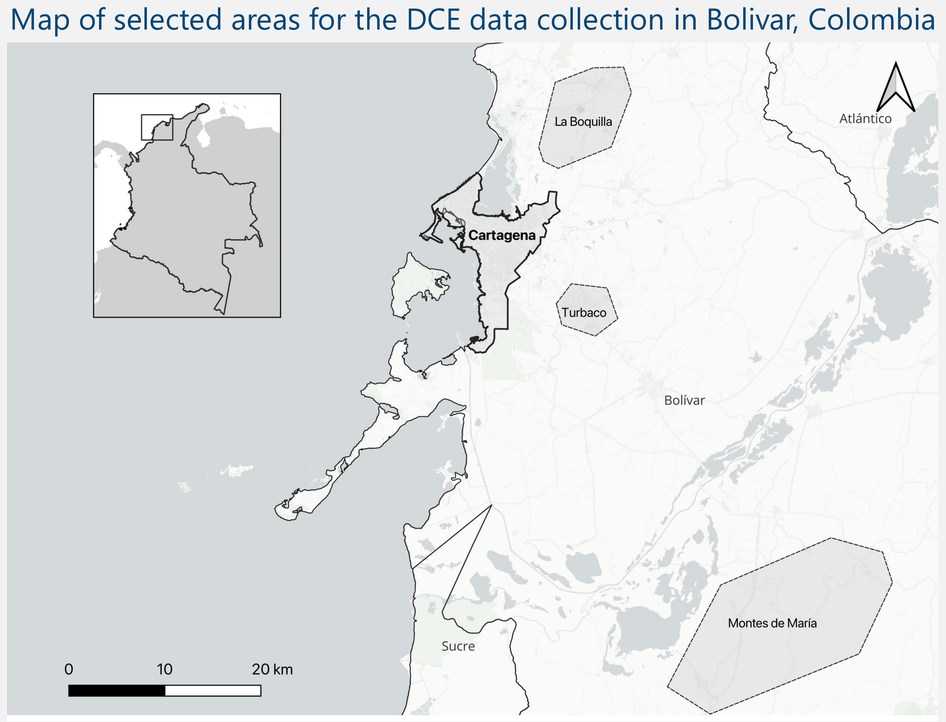
Attribute	Coefficient	WTP (€)
Permanent change in agricultural yields (%)	0.0252*** (0.00789)	7.798*** (0.009)
Drought vulnerability (crop failure from drought in the next 10 years)	-0.145*** (0.0541)	-44.98** (0.080)
Unexpected power cuts (days per year)	-0.0118 (0.00721)	-3.639* (0.0091)
Change in monthly energy bill (%)	-0.00440 (0.00371)	-1.3602 (0.0057)
Co-investment cost (Million COP/year)	-0.718*** (0.188)	
Observations	2,196	2,196

Standard errors in parentheses (p < 0.1, ** p < 0.05, *** p < 0.01)*

2. Preference heterogeneity depending on farmer proximity to a major urban center

- Farmers located ~10 km. (Turbaco) to ~20 km. (La Boquilla) from the major urban center, Cartagena, are significantly **more likely to choose an adoption alternative** compared to those ~70 km. away (Montes de María).

Map of selected areas for the DCE data collection in Bolivar, Colombia



Own elaboration

IV. CONCLUSIONS AND DISCUSSION

- Smallholder **farmers' preferences align** with the agronomical literature, which highlights that major potential benefits from AV systems include **mitigating the impact of extreme heat on soil** and **enhancing the yields** of shade-loving crops.
- AV appears not to be a universal solution: farmers in **land-scarce scenarios**, proxied by proximity to a major urban center, are significantly **more likely to adopt** such dual land-use innovations.

Policy relevance:

To ensure long-term adoption, JET policies should prioritize **shade-tolerant crops in drought-prone areas**, where the **land-use conflicts** are persistent, so AV can deliver benefits for energy and agriculture.

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