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30 Years A Thousand Stories and Counting!

The Role of Digital Financial Literacy in Facilitating Climate-Smart Agriculture (CSA) Adoption and Enhancing Food Security:

Evidence from a Repeat Cross-Sectional Household Survey in Cambodia

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Themes will be covered!

Stylize Facts

Smallholder climate vulnerability, digital financial deficits, and food insecurity parameters.

Research Gap/ Literature

Evidence disconnects and the limitation of typical simple binary digital ownership proxies.

Research Questions

Mapping drivers of digital financial capability, agricultural adaptation, and direct mediation paths.

Methodology

Pooled cross-sectional data (N=816) across Cambodia provinces with nearest-neighbor imputation.

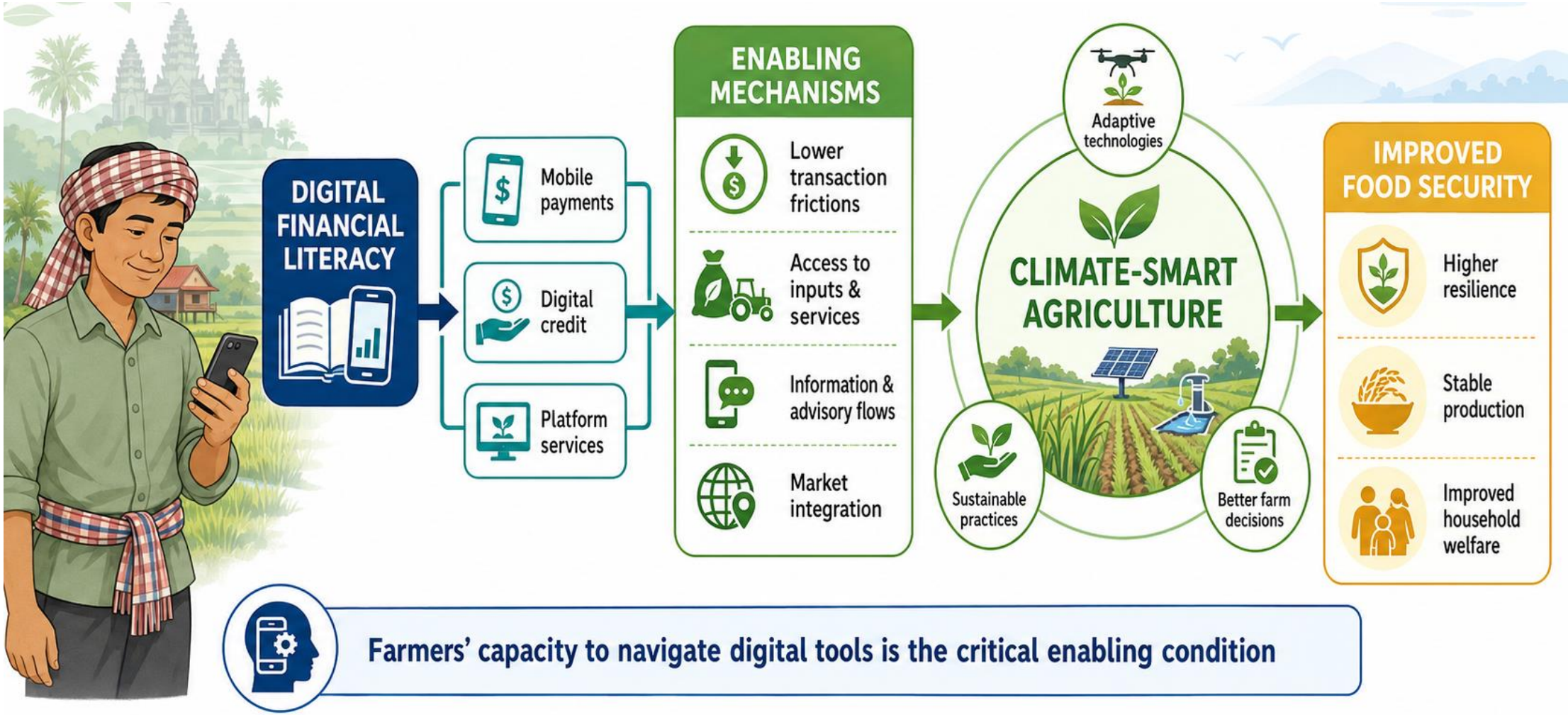
Key Findings

Regressions of DFL inequalities, climate-smart drivers, and final structural equation models (Tables 4, 5, 6).

Policy & Conclusion

Targeted ministerial actions, addressing gender gaps, and structural social protection systems.

Why This Matters!!!



Sources: Yang et al. (2024); Mushi et al. (2022); Liu & Ren (2023); Asante et al. (2025); Hussain et al. (2025); Liu & Li (2025); Mao et al. (2024); Balyan et al. (2024); USAID (2021).

Stylize Facts !!!

HIGH CLIMATE VULNERABILITY

Droughts, floods, rising temperatures, and erratic rainfall threaten smallholder production and rural livelihoods.

LOW DIGITAL FINANCIAL LITERACY

Many rural farmers lack the skills and confidence to use digital financial services for adaptive investment.

LOW CSA ADOPTION & FOOD INSECURITY

Limited CSA adoption and persistent food insecurity leave farming households more vulnerable to climate change.

CORE RESEARCH PROBLEM

It remains unclear whether and how digital financial literacy facilitates CSA adoption and subsequently strengthens household food security in rural Cambodia.

GAPS IN THE LITERATURE

FRAGMENTED EVIDENCE

Digital finance, CSA adoption, and food security are commonly examined separately.

MEDIATION PATHWAY NOT TESTED

The pathway from digital financial literacy to food security through CSA adoption is often inferred rather than directly tested.

LIMITED CAMBODIA-SPECIFIC EVIDENCE

Little is known about how rural farmers convert digital financial capability into climate adaptation and food-security gains.

Contribution of the Study

CAMBODIA'S NATIONAL PRIORITIES

Pentagonal Strategy–Phase I (2023–2028)
Growth, equity, efficiency, sustainability, and digital transformation

Cambodia Climate Change Strategic Plan 2024–2033
Climate resilience and adaptation

Circular Strategy on Environment 2023–2028
Clean, green, and sustainable development

National Green Growth Strategic Plan 2013–2030
Inclusive green growth and resilient livelihoods

Digital economy, financial inclusion, and consumer protection agenda
Safe, inclusive use of digital financial services

SUSTAINABLE DEVELOPMENT GOALS

SDG 1
No Poverty

SDG 2
Zero Hunger

SDG 12
Responsible Consumption and Production

SDG 13
Climate Action

Cross-cutting contribution: resilient livelihoods, sustainable farming, and improved food access

AUSTRALIA'S DEVELOPMENT PARTNERSHIP

Australia's International Development Policy (2023)
Climate action, resilience, gender equality, and genuine partnership

Australia–Cambodia Development Partnership Plan 2025–2029
Climate-resilient agriculture, water management, inclusive growth, and institutional capability

Relevant platform:
Cambodia Australia Partnership for Resilient Economic Development (CAPRED)

RESEARCH EVIDENCE → POLICY DESIGN → INTEGRATED PROGRAMMING → MONITORING, LEARNING & SCALE-UP

POLICY VALUE: The study helps translate broad climate, digital, and inclusion commitments into practical interventions for Cambodia's smallholder farmers.

Literature Review

A CONSISTENT POSITIVE LINK ACROSS SETTINGS

Cambodia

Digital tools integrated into farm decisions are associated with greater CSA intensity and improved food security.

Mwalupaso et al. (2025)

Ghana

Digitally capable households show stronger adoption of ecological and climate-smart technologies, with gains in dietary quality.

Asante et al. (2025)

Pakistan

Digital finance and financial literacy are positively associated with CSA adoption and food-security gains.

Hussain et al. (2025)

China

Digitally literate households demonstrate stronger CSA uptake and improved welfare outcomes.

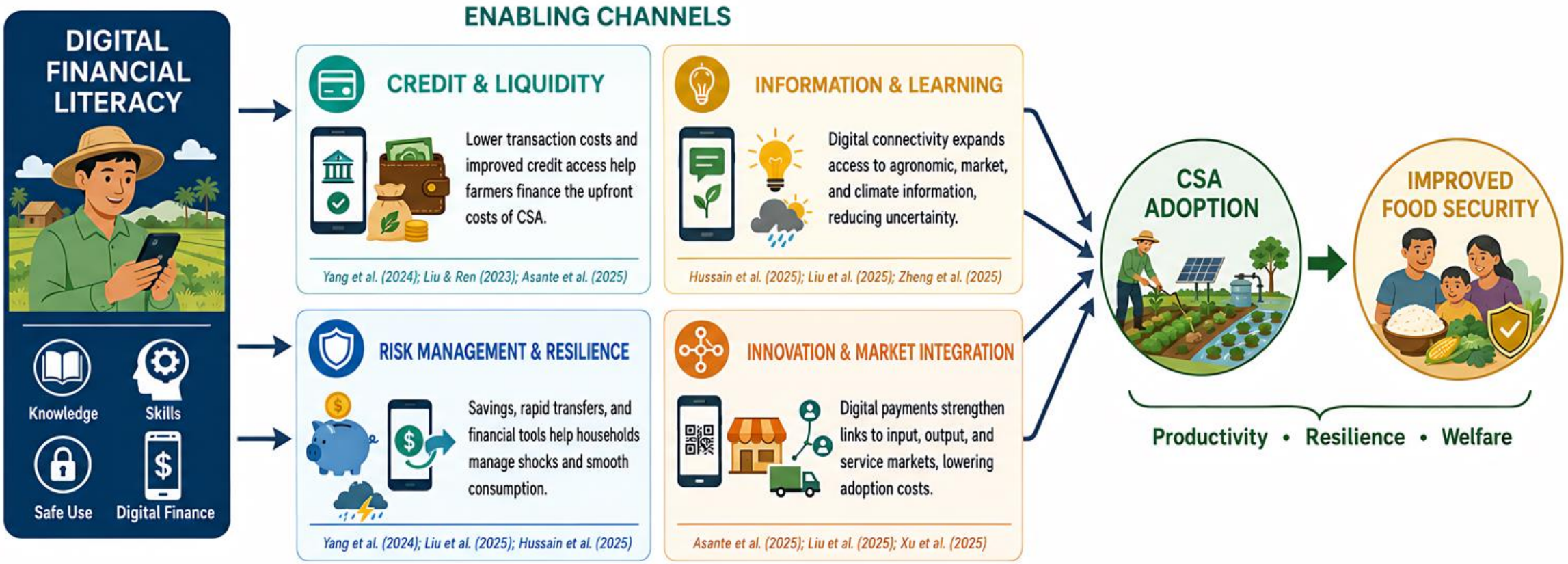
Liu & Li (2025)

COMMON FINDING: Digital financial capability can support adaptive farm investment, CSA uptake, and household resilience.

Literature Review

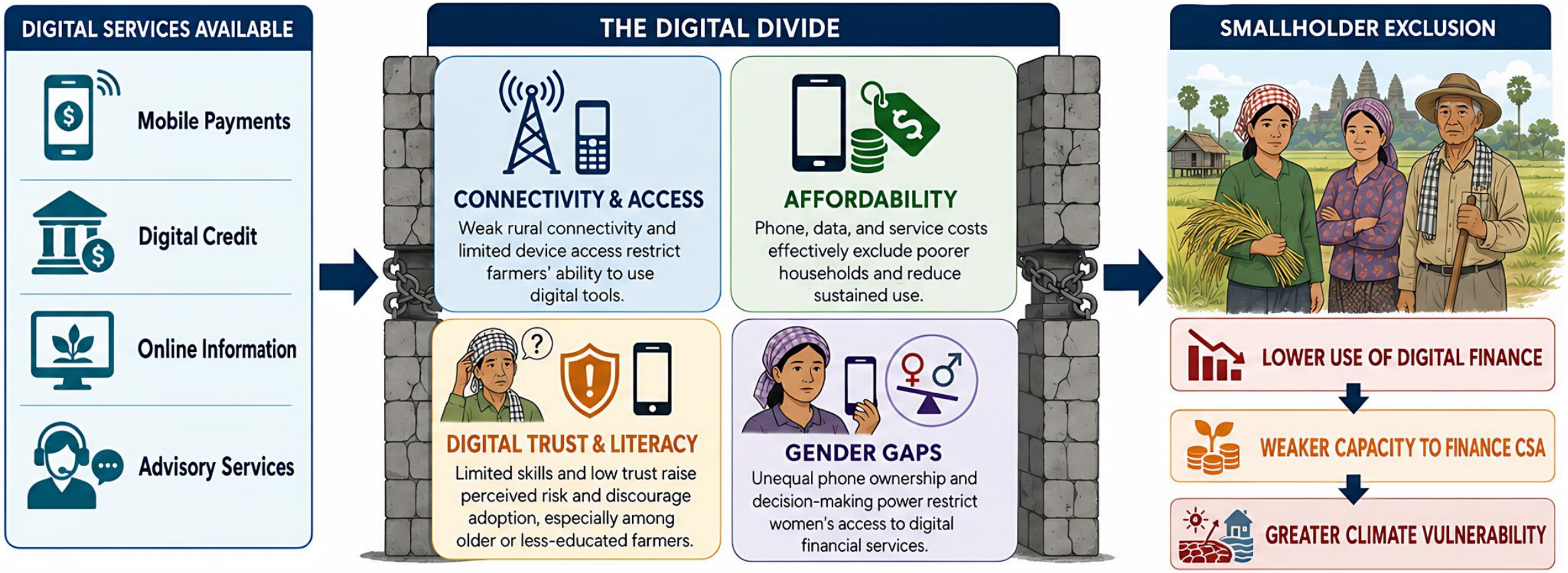
Mechanisms Linking DFL to CSA Adoption

Four interrelated channels connect digital financial literacy to climate-smart agriculture and food security.



Literature Review

Structural barriers can exclude smallholders even when digital services nominally exist.



Research Questions and Empirical Strategies

Questions mapped to outcomes and analytical methods

RQ1 | DIGITAL CAPABILITY

What determines digital financial literacy?

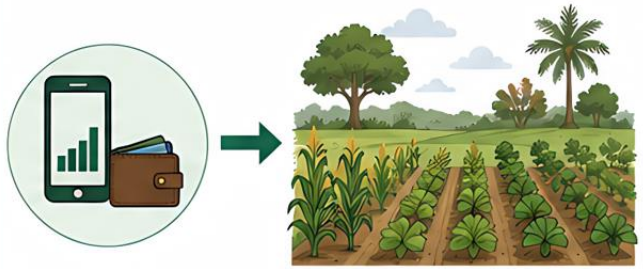
Which socioeconomic, educational, demographic, and spatial factors are associated with DFL among rural smallholders?

OUTCOME: DFL INDEX • METHOD: OLS REGRESSION

RQ2 | ADOPTION DECISION

Does DFL support CSA adoption?

How is household digital financial literacy associated with the adoption of CSA practices, including intercropping?

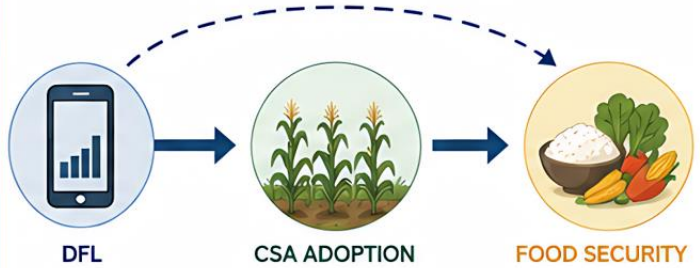


OUTCOME: CSA ADOPTION • METHODS: LOGIT & MULTIVARIATE PROBIT

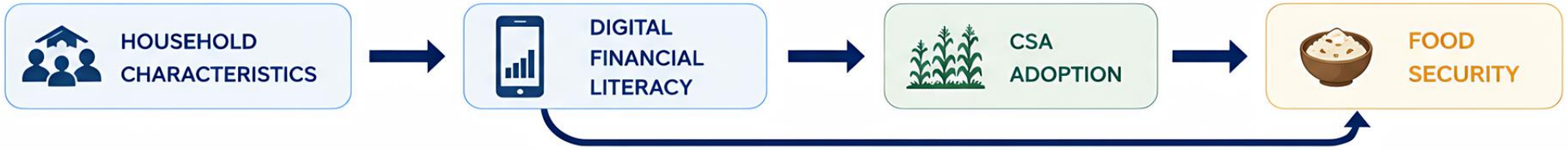
RQ3 | FOOD-SECURITY PATHWAYS

Are the relationships direct or mediated?

What are the direct and CSA-mediated relationships linking digital financial literacy to household food security?



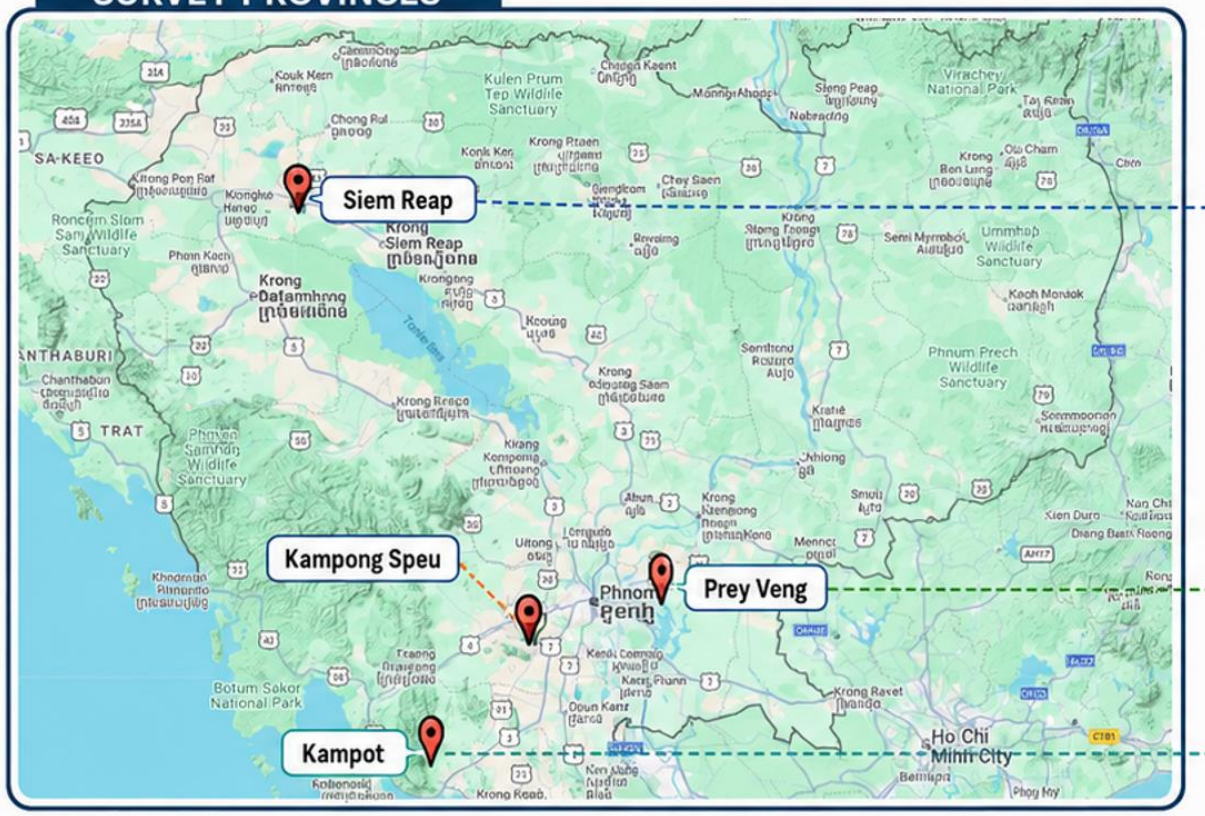
OUTCOME: HFIAS FOOD SECURITY • METHOD: GSEM



The empirical design progresses from determinants, to adoption, to direct and mediated food-security relationships.

Study Locations & Scope

SURVEY PROVINCES



SIEM REAP
TONLE SAP BASIN

Agricultural systems exposed to seasonal flood pulses.

PREY VENG
MEKONG FLOODPLAIN

Intensive lowland rice production across fertile floodplain ecosystems.

KAMPONG SPEU
DROUGHT-PRONE UPLANDS

Upland farming systems with low-moisture-retention soils.

KAMPOT
SOUTHERN COASTAL ZONE

Coastal agriculture exposed to salinity and seawater intrusion.

Study sites span distinct hydrological, climatic, and agricultural conditions.

FOUR PROVINCES | **816 FARMING HOUSEHOLDS** | **REPEAT CROSS-SECTIONS: 2023 & 2025**

Sample distribution 2023 & 2025

Repeat Cross-Sectional Household Surveys

FIRST SURVEY
2023

391 HOUSEHOLDS
Mono-cropping: 282
Intercropping: 109

SECOND SURVEY
2025

425 HOUSEHOLDS
Mono-cropping: 380
Intercropping: 45

POOLED ANALYTIC SAMPLE

816 HOUSEHOLDS
Mono-cropping: 662
Intercropping: 154

The same four provinces were surveyed in both rounds, but the same households were not necessarily re-interviewed.

PROVINCE-LEVEL SAMPLE COMPOSITION

Values shown as Total | Mono-cropping | Intercropping

KAMPONG SPEU

2023:	88	80	8
2025:	94	82	12

POOLED TOTAL: 182

KAMPOT

2023:	76	63	13
2025:	86	63	23

POOLED TOTAL: 162

PREY VENG

2023:	141	73	68
2025:	130	127	3

POOLED TOTAL: 271

SIEM REAP

2023:	86	66	20
2025:	115	108	7

POOLED TOTAL: 201

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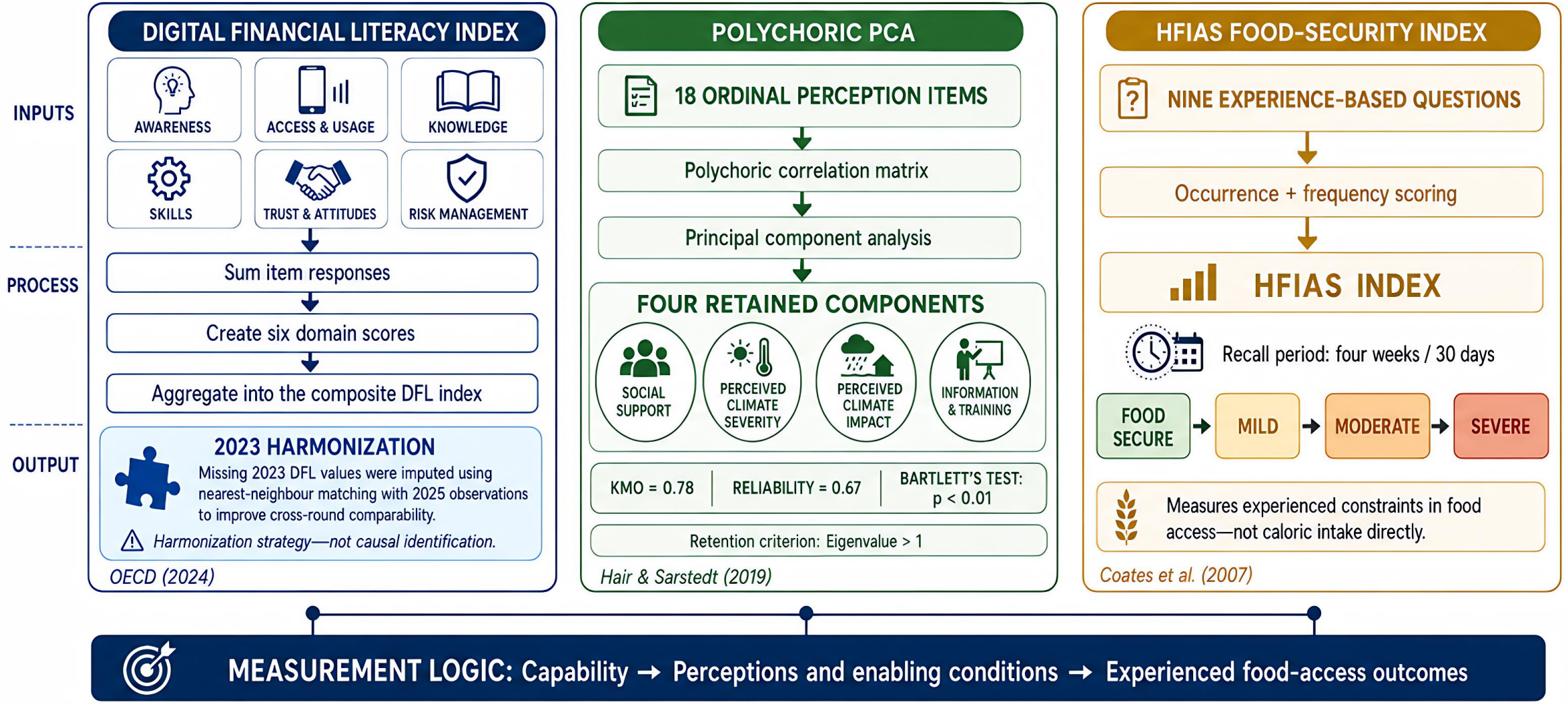
Measuring DFL, Climate change, and Food Security



Empirical Approaches

STAGE 1

DFL Determinants

Continuous DFL index

OLS REGRESSION

DFL ← Household, economic & farm characteristics + fixed effects

Province FE | Year FE | Robust SE

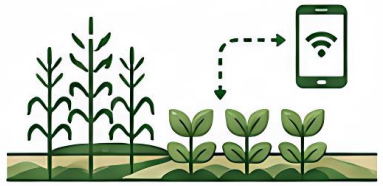
STAGE 2

CSA Adoption

Intercropping = 1

LOGISTIC REGRESSION

CSA ← DFL + distance to market + controls + fixed effects



Stepwise models | Perception indices | VIF checks

STAGE 3

Food Security Pathways

HFIAS categories

GSEM + ORDERED LOGIT

Direct: DFL → Food Security

Mediated: DFL → CSA Adoption → Food Security

Complementary binary-category logits

COMMON COVARIATES

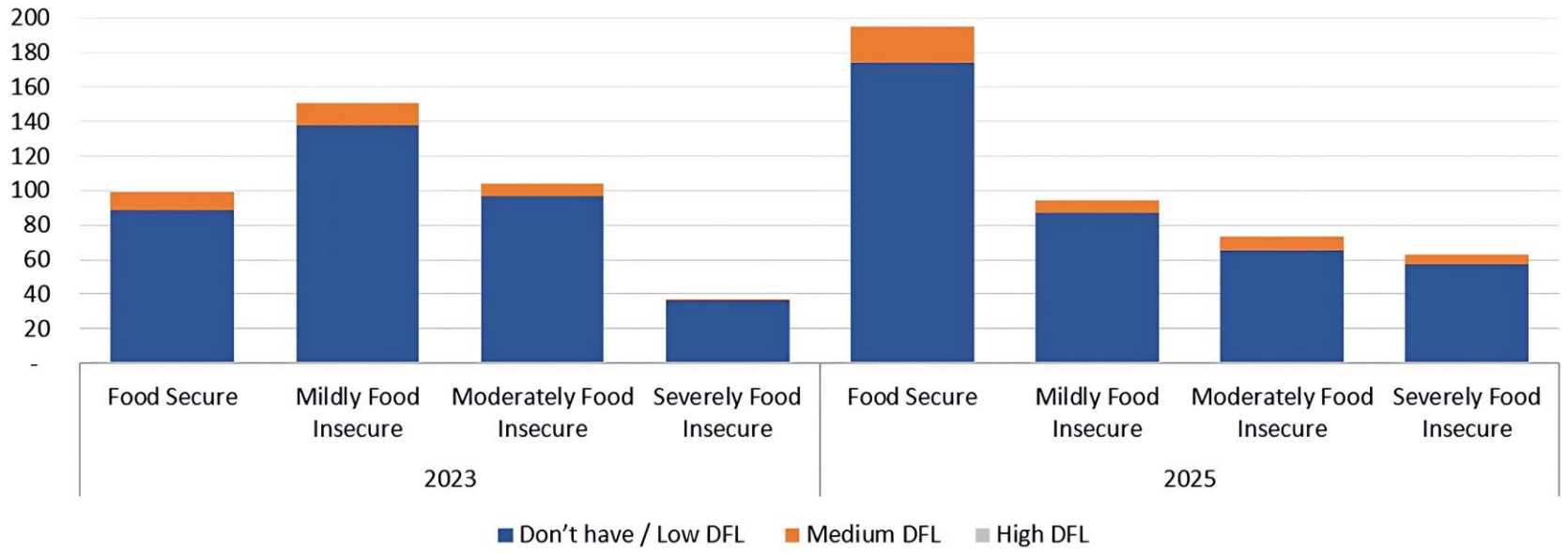
Age & gender | Household size & education | Log expenditure | Farm size & land plots | Association membership | Province and survey-year fixed effects

INTERPRETATION: Associations—not strictly causal effects—because unobserved selection may remain.

Rich controls, fixed effects, and explicit pathway modelling strengthen internal validity. Repeat cross-sections capture population-level change between 2023 and 2025.

DFL and Food Security

FIGURE 1. Digital Financial Literacy by Household Food Security Status, 2023–2025



KEY TAKEAWAY (DESCRIPTIVE)

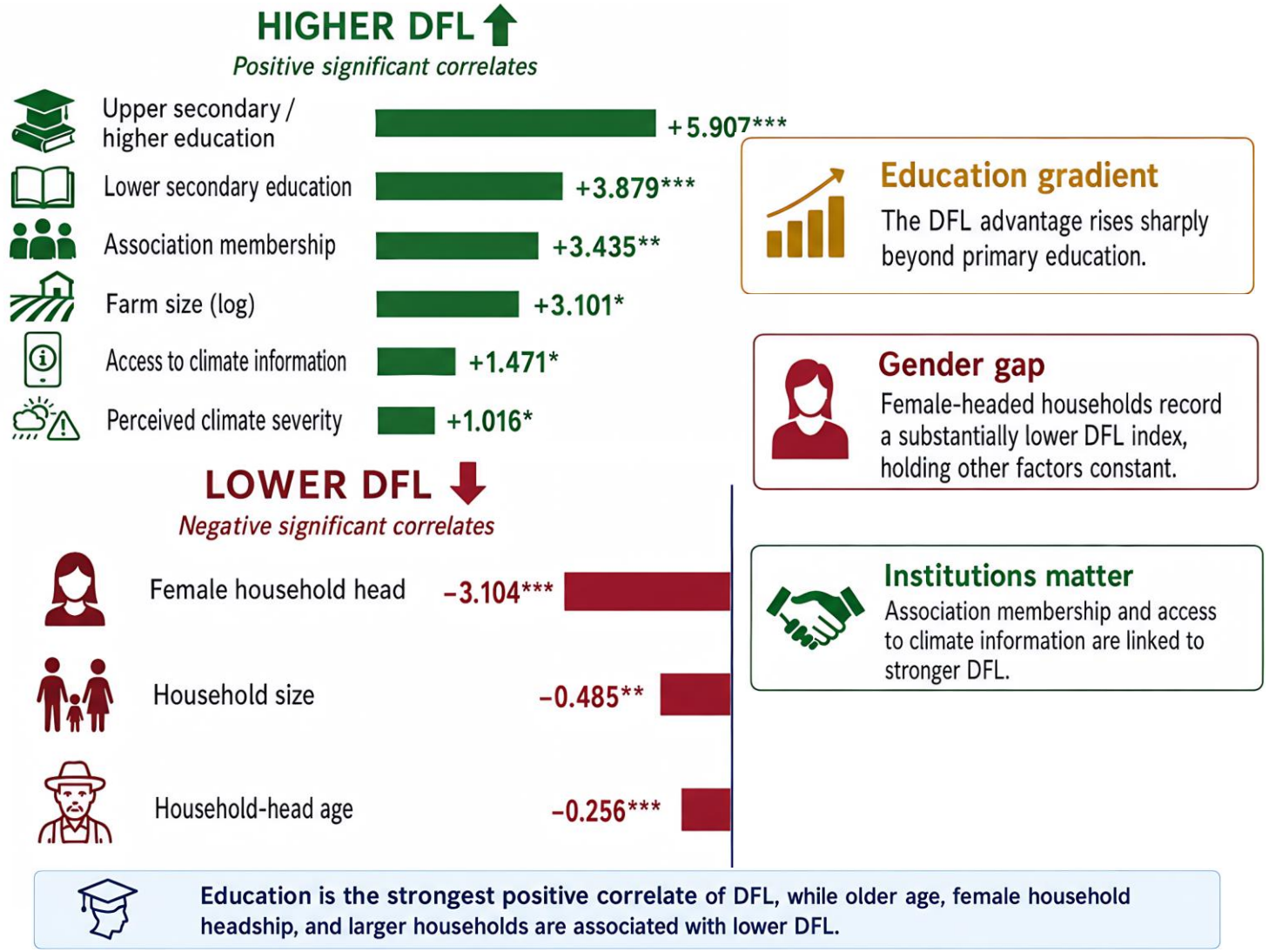
Digital financial literacy remains generally low among smallholder farmers across all food-security categories in both 2023 and 2025.

Households that are food secure show relatively higher levels of medium DFL, especially in 2025.

Findings- Determinants of Digital Financial Literacy

VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)
HH age	-0.255***			**-0.256*** **
	(0.036)			**(0.037)**
HH gender (1=Female)	-3.246***			**-3.104*** **
	(0.974)			**(0.992)**
HH size	-0.536***			**-0.485** **
	(0.202)			**(0.227)**
HH primary educ	1.162			**1.126**
	(1.035)			**(1.024)**
HH lower secondary educ	4.110***			**3.879*** **
	(1.347)			**(1.339)**
HH upper secondary /	6.480***			**5.907*** **
Higher educ	(1.851)			**(1.840)**
Economic dependency ratio		1.491*		0.471
		(0.793)		(0.745)
Expenditure (log)		-0.334		-0.409
		(0.835)		(0.891)
Farm size (log)		3.859**		**3.101***
		(1.848)		**(1.867)**
Member of association		3.745**		**3.435** **
		(1.651)		**(1.555)**
Number of land plots		-0.488		-0.462
		(0.309)		(0.333)
Perceive climate impact			-1.163**	-0.687
			(0.523)	(0.493)
Perceive inform			1.678*	**1.471***
			(0.902)	**(0.881)**
Perceive support			-0.029	0.111
			(0.441)	(0.426)
Perceive climate severity			0.772	1.016*
			(0.632)	(0.593)
Constant	35.467***	21.201***	17.229***	32.399***
	(2.702)	(4.876)	(3.124)	(5.930)
Observations	816	816	816	816
R-squared	0.199	0.115	0.108	0.217
Province FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Mean VIF	*1.68*	*1.71*	*1.60*	*1.84*

*Note: OLS regression is used for the estimation. Dependent variable: Digital Financial Literacy Index (DFL). | Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*



Findings- Determinants of CSA (Intercropping)

VARIABLES	Model (1)	Model (2)	Model (3)	Full Model (4)
DFL Index	0.013	0.012	**0.013***	**0.017****
	(0.008)	(0.008)	**(0.008)**	**(0.009)**
HH distance to market	-0.035	-0.040	-0.034	-0.032
	(0.026)	(0.026)	(0.026)	(0.026)
HH age	**0.026*****			**0.017***
	(0.009)			**(0.010)**
HH gender (1=Female)	-0.268			-0.307
	(0.233)			(0.232)
HH marital status	-0.195			-0.115
	(0.346)			(0.353)
HH size	-0.047			0.008
	(0.053)			(0.060)
HH primary educ	-0.328			**-0.530***
	(0.315)			**(0.321)**
HH lower secondary educ	0.062			-0.129
	(0.370)			(0.374)
HH upper secondary /	0.336			0.137
Higher educ	(0.411)			(0.429)
Economic dependency ratio		**-0.343****		-0.226
		(0.171)		(0.182)
Expenditure (log)		**-0.326***		**-0.370***
		(0.191)		**(0.216)**
Farm size (log)		-0.394		-0.470
		(0.392)		(0.413)
Number of land plots		**0.181*****		**0.193*****
		(0.067)		**(0.073)**
Access to pipe water		0.031		0.043
		(0.230)		(0.245)
Member of association		0.016		-0.222
		(0.305)		(0.333)
Perceive climate impact			**0.419*****	**0.455*****
			(0.110)	**(0.116)**
Perceive inform			**0.461****	**0.468****
			(0.182)	**(0.190)**
Perceive support			0.110	0.096
			(0.100)	(0.100)
Perceive climate severity			-0.234	-0.222
			(0.147)	(0.155)
Constant	-2.351***	-0.188	-1.760**	-0.520
	(0.782)	(1.104)	(0.771)	(1.603)
Observations	816	816	816	816
Province FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Mean VIF	*1.75*	*1.83*	*1.72*	*1.88*
Log Pseudolikelihood	-354.397	-354.968	-351.447	-337.428

*Note: Logistic regression is used for the estimation. Dependent variable: Inter-Cropping. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

Higher DFL is positively associated with intercropping adoption

DFL Index: +0.017**

Logit coefficient; holding observed characteristics and fixed effects constant

POSITIVE SIGNIFICANT CORRELATES

Climate information	+0.468**	*Weak significance: p < 0.10*
Perceived climate impact	+0.455***	*Weak significance: p < 0.10*
Number of land plots	+0.193***	*Weak significance: p < 0.10*
Household-head age	+0.017*	*Weak significance: p < 0.10*

Digital capability matters
The positive DFL coefficient supports the proposed DFL → CSA pathway.

Climate awareness matters
Information access and perceived climate impacts are linked to intercropping uptake.

Farm structure matters
Households operating more land plots are more likely to diversify through intercropping.

N = 816 | Province FE: Yes | Year FE: Yes | Robust SE | Mean VIF = 1.88 | Log pseudolikelihood = −337.428

Findings- Effects of DFL and CSA Adoption on Food Security using GSEM

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Intercropping is associated with a lower likelihood of mild food insecurity—but not with the other food-security categories.

INTERCROPPING

Food secure	Mildly food insecure	Moderately food insecure	Severely food insecure
+0.210	−0.448**	+0.142	+0.051
Not significant	Statistically significant	Not significant	Not significant
	Lower likelihood		

MEDIATION EVIDENCE: PARTIAL — CSA adoption is linked to reduced mild food insecurity, but the pathway is not statistically supported for food security or more severe deprivation.

Education

Primary education is negatively associated with moderate (−0.519**) and severe insecurity (−0.771**); higher education is also negative for moderate and severe categories.

Farm structure

More land plots are associated with food security (+0.197***) and lower moderate insecurity (−0.312***), while larger farm size is positively associated with moderate insecurity (+0.880***).

Climate perceptions

Perceived climate impact and severity are positively associated with food security but negatively associated with mild insecurity.

N = 816 per equation | Province FE: Yes | Year FE: Yes | Robust SE | Separate binary logits

Coefficients are log-odds associations, not marginal effects or causal estimates.
Each HFIAS category is estimated separately; results do not constitute a single ordered-outcome comparison.

*** $p<0.01$ ** $p<0.05$ * $p<0.10$

Policy Implications

Move from stand-alone training to an integrated, farmer-centred delivery model.

1 Make DFL Practical

Design training around receiving payments, purchasing inputs, saving for lean seasons, managing risk, and preventing fraud.

Use cases + safe use

2 Integrate DFL with CSA Services

Deliver digital financial literacy alongside CSA training, extension advice, demonstration farms, and peer learning.

One coordinated service package

3 Close the Gender Gap

Provide women farmers and female-headed households with tailored training, phone-based support, and access to farmer groups.

Gender-responsive delivery

4 Strengthen Learning Systems

Expand agricultural extension, practical demonstrations, farmer training, and peer-to-peer learning to support CSA adoption.

Learn by seeing and doing

5 Turn Climate Awareness into Action

Use community-based support to convert climate information and risk awareness into feasible CSA practices.

Information → local action

DESIGN WITH FARMERS → **DELIVER THROUGH TRUSTED LOCAL CHANNELS** → **TRACK ADOPTION AND FOOD-SECURITY OUTCOMES**

EVIDENCE LINK: Recommendations respond to the observed DFL gender gap, the positive DFL–CSA relationship, and the importance of climate information, farm structure, and community support.

Questions & Answers

Dr. OUM Chan Mono

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