

Testing Productivity and Farm Size Relationship in India: Evidence from India's SAT

Rahul Kumar Singh, PhD Candidate, IIT Bombay

Sarthak Gaurav, Associate Professor, IIT Bombay

Srijit Mishra, Professor, IGIDR Mumbai

ASSA Annual Meeting 2024

San Antonio, TX

January 06, 2024

Outline

- Background
- Motivation
- Empirical strategy
- Data
- Results
- Conclusion

Farm Size-Productivity Puzzle


Inverse Relationship (IR) debate

- Small farms more productive than large farms (Chayanov, 1926)
- Intense debate on IR in 1960s and 1970s (Sen 1962, Bardhan 1973, Rudra 1968, Saini 1971)
 - Holds at aggregate level but vanishes at disaggregated
 - Holds for traditional/developing but not in advanced/developed settings (sheng & chancellor 2019)
 - Holds for some period but not in other (Assunção & Braido 2007, Foster & Rosenzweig 2022)
- IR in other countries: Brazil, Pakistan, Malaysia (Berry & Cline 1979)

Theoretical Sketch

- One-factor production function (Uncontrolled)
 - *Farm Productivity* $= \frac{Q}{A} = q = \varphi_u(A)$
 - Ideal Condition: $\frac{\partial \varphi_u}{\partial A} = 0$
 - Empirical evidence: $\frac{\partial \varphi_u}{\partial A} \neq 0$
- Agriculture: Complex system (Controlled)
 - *Farm Productivity* $\varphi_u(A) = f(l(A), k(A), \varphi_c(A))$
- Heterogeneity Controls
 - Time Invariant: Fixed effect at household and plot level
 - Time Variant: Controls for plots and household characteristics

Why Plot level analysis



Everything is fine in my field

Soil Characteristics


Irrigation Source

Cropping Pattern

Supervision

Labour Intensity

Capital Intensity



I am worried about operations in Plot 2

Hope animals will not harm Plot 3's crops

PLOT 2

PLOT 3

PLOT 1

Plot 1 operations seems to be going well

Explanations for IR

- Market Imperfection
 - Labour and land (Sen 1962, Carter 1984, Carter & Wiebe 1990)
 - Credit market (Eswaran & Kotwal 1986, Feder 1985)
- Mode of production: Intensive use of family labour (Sen 1962, Carter 1984)
- Heterogeneity
 - Farmer's skills (Assuncao & Ghatak 2003)
 - Plots and land (Lamb 2003, Benjamin 1995)
 - Risk aversion (Srinivasan 1972, Barrett 1996)
- Measurement error
 - Plot size (Carletto *et al.* 2013, Lamb 2003)
 - Output (Desiere & Jolliffe 2018)

Emerging literature

- U-shaped relationship
 - China (Sheng *et al.* 2019), Nigeria (Omitilewa *et al.* 2021), India (Foster & Rosenzweig 2022)
- Measurement issues
 - Partial productivity vs TFP (Aragon *et al.* 2022)
 - Production and plot size in Ethiopia (Ayalew *et al.* 2023)
 - Edge effect (Bevis & Barret 2020)
- Weakened Inverse Relationship: Tanzania (Wineman & Jayne 2021), India (Deininger *et al.* 2018)

Motivation

- Structural Transformation (Binswanger-Mkhize 2013)
- Technology Change
 - HYV, Irrigation etc.
 - Intensive input use, farm mechanisation
- Marginalization of holdings and food security (Helfand & Taylor 2021, Foster & Rosenzweig 2020, Yamauchi 2021)
- Land reforms policy and livelihood security
- Dynamics of relationship

Key Research Questions

- Does the IR relationship hold good as economy progresses?
- Do technological and labor market shifts impact the farm size-productivity relationship in India's semi-arid tropics from 1975 to 2014?
- Are smallholders' livelihoods viable in contemporary agricultural contexts?

Empirical Strategy: Household Level

$$\ln y_{i,t} = \alpha_1 + \beta_1 \ln A_{i,t} + \theta_1 \ln l_{i,t} + \gamma_1 \ln k_{i,t} + \delta X_{i,t} + \eta T + \varepsilon_{i,t} \quad (1)$$

$y_{i,t} = \frac{Y_{i,t}}{C_{i,t}}$, Y is agricultural output value and profit of household i in year t

$l_{i,t} = \frac{L_{i,t}}{C_{i,t}}$, L is labour hours by household i in year t

$k_{i,t} = \frac{K_{i,t}}{C_{i,t}}$, K is non-labour input expenditure by household i in year t

Hypothesis:

$$H_0: \beta_1 = 0$$

$$H_1: \beta_1 \neq 0$$

Empirical Strategy: Plot Level

$$\ln y_{i,j,t,s} = \alpha_2 + \beta_2 \ln P_{i,j,t,s} + \theta_2 \ln l_{i,j,t,s} + \gamma_2 \ln k_{i,j,t,s} + \delta X_{i,t} + \lambda W_{i,j,t} + \eta T + \varepsilon_{i,j,t,s} \quad (2)$$

$y_{i,j,t,s} = \frac{Y_{i,j,t,s}}{C_{i,j,t,s}}$, Y is agricultural output value and profit of household i in plot j in season s of year t

$l_{i,j,t,s} = \frac{L_{i,j,t,s}}{C_{i,j,t,s}}$, L is labour hours by household i in plot j in season s of year t

$k_{i,j,t,s} = \frac{K_{i,t}}{C_{i,j,t,s}}$, K is non-labour input expenditure by household i in plot j in season s of year t

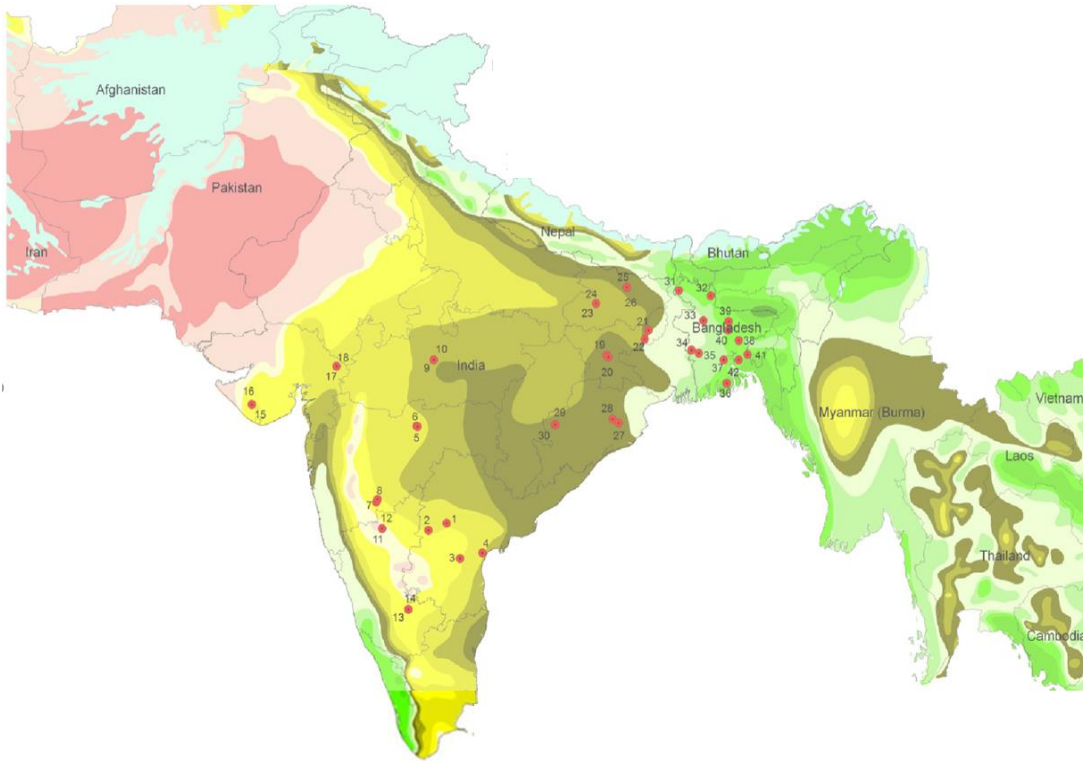
Hypothesis:

$$H_0: \beta_2 = 0$$

$$H_1: \beta_2 \neq 0$$

Characteristics of SAT Study Region

Map 1: Location of ICRISAT's villages



- Rainfed agriculture
- Degraded soil
- Mean annual rainfall 400 – 1200 mm
- Length of Growing Period (75-180 days)
- More than 18 °C mean monthly temperature
- 37.2 % India's geographical area
- Low agricultural productivity and high risk (Ryan and Spencer, 2001)

Source: <https://vdsa.icrisat.org/vdsa-map/vdsa-location-map.html>

Data: For Household Level Analysis

- ICRISAT VDSA panel data 1975-2014 (6 villages, MH/AP)
 - Wave I (1975-84)
 - Wave II (2001-08)
 - Wave III (2009-14)
- Data
 - Cultivation: Input and Output
 - Household characteristics
 - Landholding details
- One of the most well-known and productive datasets in the world (Over 145 PhDs, 1000 papers) (<https://oar.icrisat.org/view/type/thesis.date.html>)

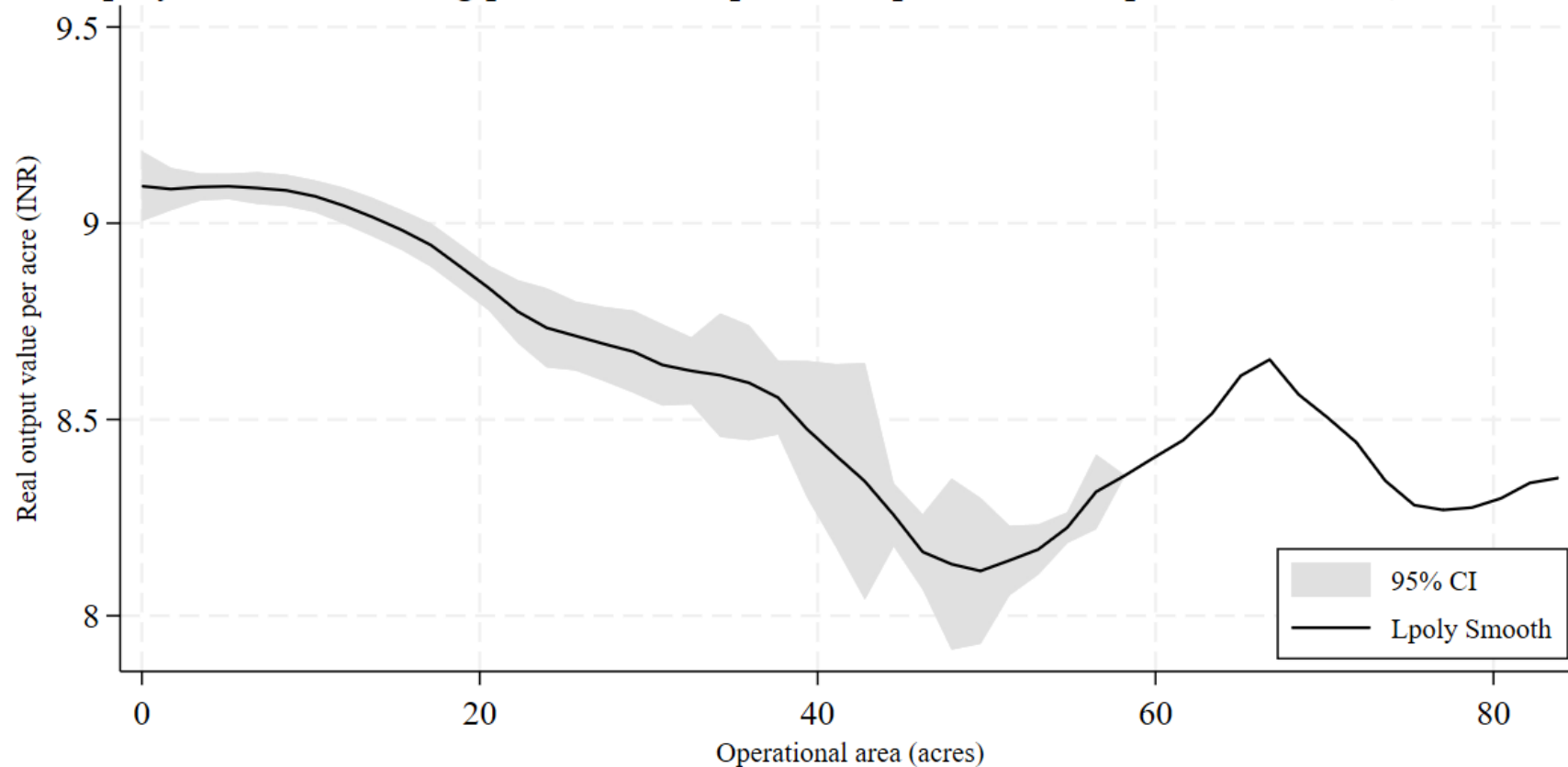


Data: For Plot Level Analysis

- Identification issue of plots in Wave-II (Missing plot codes)
- Period
 - Wave-I (1975-1984)
 - Wave-III (2009-2014)
- Data
 - Seasonal at plot level
 - Input and output
 - Annual
 - Plot details
 - Household characteristics

Unconditional relationship between real output value per acre and farm size (acres) (1975-2014)

Local polynomial smoothing plot of real output value per acre and operational area (1975-2014)



Note: X and Y axis are plotted in level and log scale respectively.

There are only 1.0% observations in data having operational land more than 45 acres.

Farm size and productivity relationship (1975-2014)

Table 1: Farm size and productivity relationship (1975-2014)

Dependent Variable (in logs)	Output Value Model				Profit Model			
	Un- conditional	Conditional	With household controls	With household + temporal controls	Un- conditional	Conditional	With household controls	With household + temporal controls
Log Operational area (acre)	-0.315*** (0.022)	-0.067*** (0.017)	-0.035* (0.018)	0.003 (0.016)	-0.338*** (0.035)	-0.115*** (0.033)	-0.092*** (0.035)	-0.039 (0.034)
Log Labour (hours/acre)		0.509*** (0.018)	0.581*** (0.019)	0.720*** (0.018)		0.412*** (0.036)	0.498*** (0.037)	0.669*** (0.039)
Log Input cost (Rs. /acre)		0.365*** (0.01)	0.263*** (0.011)	0.108*** (0.012)		0.346*** (0.019)	0.219*** (0.021)	0.02 (0.025)
Household controls			Yes	Yes			Yes	Yes
Year				Yes				Yes
Constant	9.583*** (0.041)	3.690*** (0.106)	3.008*** (0.153)	3.406*** (0.145)	8.840*** (0.065)	3.642*** (0.205)	3.192*** (0.302)	3.611*** (0.303)
N	5647	5646	5632	5632	4705	4704	4696	4696
R-sq	0.49	0.71	0.73	0.79	0.38	0.49	0.51	0.56

Cultivation changes: Labour vs Technology

Table 2: Changing Factor Intensity and Farm Size: 1975-2014

Dependent Variable (in logs)	Labour (hours/acre)			Input cost (Rs. /acre)		
	Wave-I (1975-1984)	Wave-II (2001-2008)	Wave-III (2009-2014)	Wave-I (1975-1984)	Wave-II (2001-2008)	Wave-III (2009-2014)
Log Operational area (acre)	-0.244*** (0.02)	-0.147*** (0.03)	-0.135*** (0.03)	0.035 (0.05)	0.028 (0.04)	0.096** (0.04)
Log Labour (hours/acre)				0.956*** (0.06)	0.871*** (0.03)	0.743*** (0.03)
Log Input cost (Rs. /acre)	0.217*** (0.01)	0.339*** (0.01)	0.440*** (0.02)			
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Constant	3.205*** (0.55)	3.342*** (0.26)	1.855*** (0.35)	1.309 (1.16)	2.843*** (0.43)	4.391*** (0.44)
N	1351	2691	1669	1351	2691	1669
R-sq	0.84	0.78	0.78	0.78	0.78	0.77

Note: Dependent variables are in logarithmic scale and all costs are at constant price (Base year: 2012)

Standard errors in parentheses and significance level as follows * p<0.1, ** p<0.05, *** p<0.01

Declining Crop Diversity: Household level

Table 3: Household level crop diversity over time

Dependent Variable:	Log Crop diversity		
	Wave-I	Wave-II	Wave-III
Year	-0.021*** (0.01)	-0.011** (0.01)	-0.038*** (0.01)
Log Operational area (acre)	-0.534*** (0.03)	-0.348*** (0.03)	-0.482*** (0.03)
Log Labour (hours/acre)	0.129*** (0.03)	0.246*** (0.02)	0.314*** (0.03)
Log Input cost (Rs. /acre)	0.055*** (0.02)	0.017 (0.01)	-0.028 (0.02)
Household controls	Yes	Yes	Yes
Year	Yes	Yes	Yes
Constant	-0.198 (0.62)	-1.465*** (0.27)	0.15 (0.37)
N	1351	2691	1669
R-sq	0.83	0.70	0.77

Note: Dependent variables are in logarithmic scale and all costs are at constant price (Base year: 2012)
Standard errors in parentheses and significance level as follows * p<0.1, ** p<0.05, *** p<0.01

Fixed effects Model

Table 4: Dynamic Farm Size Productivity Relation at household level

Dependent Variable (in logs)	Wave-I (1975-1984)				Wave-II (2001-2008)				Wave-III (2009-2014)			
	Output Value Model		Profit Model		Output Value Model		Profit Model		Output Value Model		Profit Model	
	Without inputs	With Inputs	Without inputs	With Inputs	Without inputs	With Inputs	Without inputs	With Inputs	Without inputs	With Inputs	Without inputs	With Inputs
Log Operational area (acre)	-0.313*** (0.03)	-0.085*** (0.03)	-0.321*** (0.06)	-0.159** (0.06)	-0.123*** (0.04)	0.035 (0.03)	-0.139** (0.07)	-0.016 (0.07)	-0.067 (0.06)	0.032 (0.05)	-0.035 (0.11)	0.086 (0.11)
Log Labour (hours/acre)		0.671*** (0.04)		0.617*** (0.09)		0.726*** (0.03)		0.625*** (0.06)		0.765*** (0.04)		0.803*** (0.10)
Log Input cost (Rs. /acre)		0.075*** (0.02)		-0.106** (0.04)		0.164*** (0.02)		0.127*** (0.04)		-0.080*** (0.03)		-0.217*** (0.07)
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	7.697*** (0.85)	3.867*** (0.75)	4.642*** (1.01)	1.892* (1.10)	10.010*** (0.41)	4.272*** (0.36)	9.672*** (0.66)	4.830*** (0.70)	9.802*** (0.52)	6.116*** (0.50)	10.845*** (0.95)	7.842*** (1.08)
N	1344	1344	1196	1196	2642	2641	2163	2162	1647	1647	1338	1338
R-sq	0.73	0.8	0.52	0.54	0.62	0.76	0.52	0.58	0.6	0.71	0.51	0.54

Note: Dependent variables are in logarithmic scale and all costs are at constant price (Base year: 2012)

Standard errors in parentheses and significance level as follows * p<0.1, ** p<0.05, *** p<0.01

Fixed Effects Model: Plot level analysis

Table 5: Dynamic Farm Size Productivity Relation (For Balanced Panel) at plot level

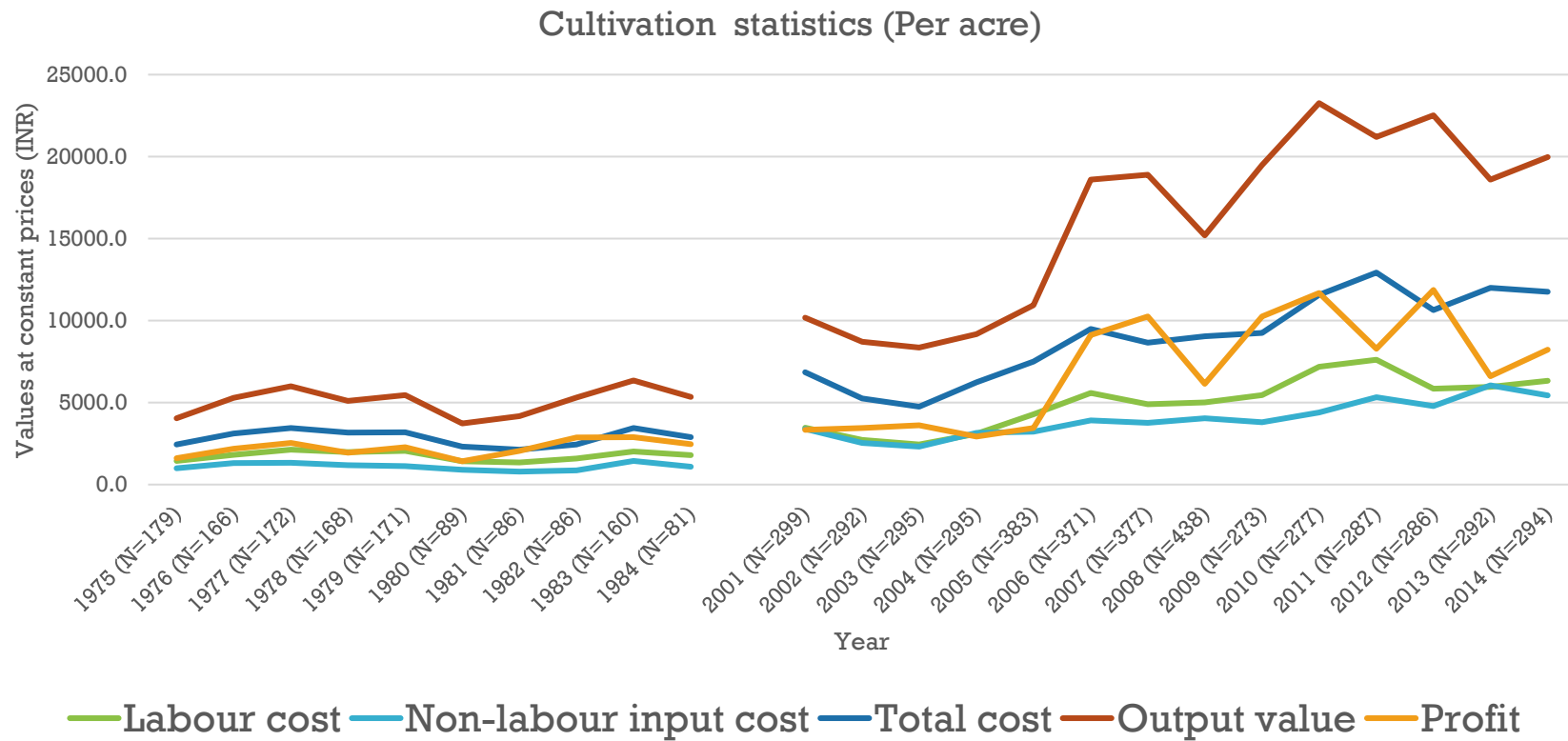
Dependent Variable (in logs)	Wave-I				Wave-III			
	Output Value Model		Profit Model		Output Value Model		Profit Model	
	Without inputs	With Inputs	Without inputs	With Inputs	Without inputs	With Inputs	Without inputs	With Inputs
Log Plot Area (acre)	-0.171*** (0.05)	0.029 (0.04)	-0.259*** (0.08)	-0.091 (0.08)	-0.103 (0.17)	-0.13 (0.13)	0.305 (0.30)	0.244 (0.29)
Log Operational area (acre)	0.014 (0.02)	0.059*** (0.01)	-0.003 (0.03)	0.021 (0.03)	-0.118*** (0.02)	0.01 (0.02)	-0.104** (0.04)	-0.005 (0.04)
Log Labour (hours/acre)		0.827*** (0.02)		0.756*** (0.04)		0.559*** (0.02)		0.376*** (0.05)
Log Input cost (Rs./acre)		0.061*** (0.01)		-0.026 (0.02)		0.287*** (0.02)		0.280*** (0.04)
Season	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plot Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	7.692*** (1.07)	2.617*** (0.88)	6.373*** (0.99)	1.964** (0.97)	10.034*** (0.51)	4.708*** (0.41)	9.254*** (0.85)	4.849*** (0.85)
N	5581	5577	4484	4480	3913	3911	2987	2985
R-sq	0.71	0.81	0.6	0.64	0.55	0.73	0.5	0.55

Note: Dependent variables are in logarithmic scale and all costs are at constant price (Base year: 2012)

Standard errors in parentheses and significance level as follows * p<0.1, ** p<0.05, *** p<0.01

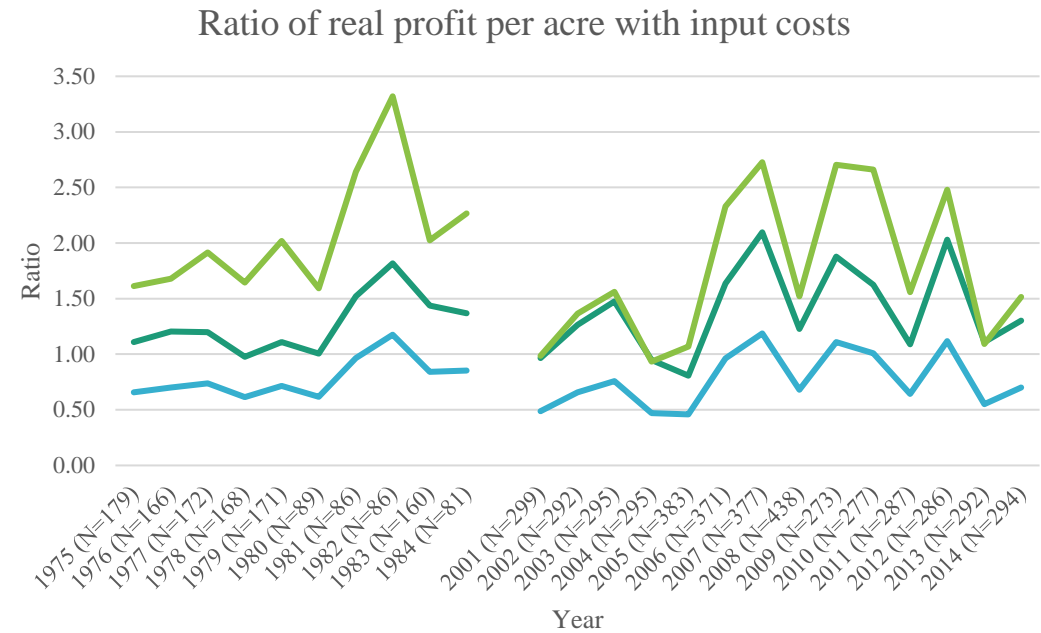
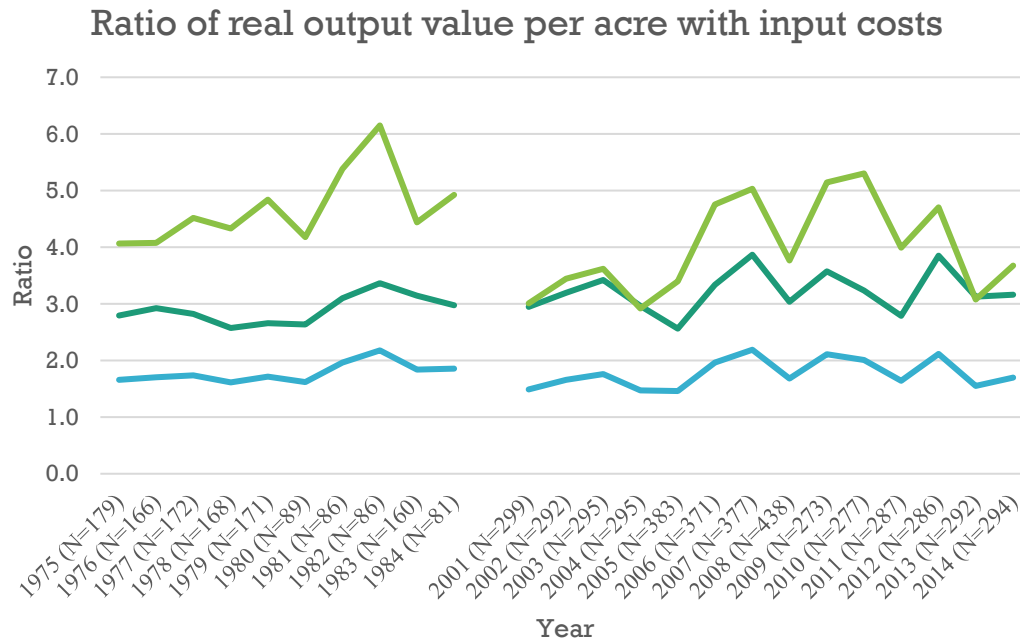
Cultivation Statistics: Household-level

Figure 1: Cultivation cost and output trends (Value at constant price, Base year: 2012)



More Cultivation Statistics: Household-level

Figure 2: Ratio of agricultural output and cultivation over time



- Output/Labour cost
- Output/Non-labour cost
- Output/Total cost

- Profit/Labour cost
- Profit/Non-Labour cost
- Profit/Total cost

Smallholders Sustainability

Table 6: Annual cultivation income for household

Farm group	Wave-I (1975-84)	Wave-II (2001-2008)	Wave-III (2009-2014)
Labour	11293.9	20894.2	18298.1
Small	11737.1	21879.7	37813.7
Medium	20633.7	47271.0	84476.9
Large	62364.3	80416.2	127942.8

Note: All incomes are at constant prices (Base year: 2012)

Table 7: Farm group classification based on operational landholdings (ha) in villages

Farm Group	Aurepalle	Dokur	Shirapur	Kalman	Kanzara	Kinkheda
Labour	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Small	0.2-1.2	0.2-0.9	0.2-2.0	0.2-3.6	0.2-1.8	0.2-2.0
Medium	1.2-3.2	0.9-2.1	2.0-5.3	3.7-8.5	1.8-5.3	2.0-4.5
Large	>3.2	>2.1	>5.3	>8.5	>5.3	>4.5

Conclusion

- Using ICRISAT's VLS data for 1975-2014
- Differences in relationship at household and plot level on controlling for labour and non-labour inputs
- Weakening IR over time: Small holders losing edge to large holders
- Modernization of agriculture led to a statistically flat IR by the end of the period.
- Results are robust to both measures of productivity (Output value and Profit)
- Sustainability issues: Production increased over time but returns to the total cost not increased in same proportion

Thank You
rahul.singh@iitb.ac.in

Supplementary Material

Variables Description

A1: List of variables and description

Variable	Description
Dependent Variable: Productivity	Measured in terms of output value per acre and profit per acre in INR (at constant prices)
Log Operational area	Operational landholding by household (acres)
Log Plot area	Area of the agricultural plot in acres (plots with codes A, B, C, D, etc)
Log Labour (hours/acre)	Total labour hours per acre by household (hired and family labour)
Log Labour cost (Rs./acre)	Total labour cost per acre by household (hired labour cost and imputed value of family labour)
Log Non-labour input cost (Rs. /acre)	Total input cost (machinery and input) per acre by household
Season	Cropping season(Rabi and Kharif)
Irrigation Status	Irrigation status if the plot (Fully irrigated, More than 50% irrigated, Less than 50% irrigated and Rainfed)
Soil Type	Type of soil for plot
Log Crop Diversity	Number of crops per acre grown by household in one survey year
Head's gender	Gender of household head (Male, Female)
Age of head (Years)	Age of household head (years)
Years of head education	Household head's education (years)
Number of members in household whose primary work in farming	Number of members in household who are primarily engaged in farming
Number of members in household whose primary work in livestock	Number of members in household who are primarily engaged in livestock work
Family size	Number of family members in household
Head's main occupation	Main occupation of household head
Year	Agricultural survey year (July-June)

Descriptive Statistics: Household-level analysis

A2: Summary Statistics

Year	Head's Age (Years)	Head's education (Years)	Family Size	Operational Land (Acres)	Cropped area (Acres)	Number of crops per acre	number of plots	Labour hours (Per Acre)
1975 (N=179)	44.2	2.8	6.7	11.9	13.1	0.9	3.4	294.3
1976 (N=166)	44.8	2.7	6.9	14.0	15.4	0.7	3.9	314.6
1977 (N=172)	45.3	2.9	6.8	14.4	15.9	0.8	4.1	316.9
1978 (N=168)	45.9	2.9	6.8	13.3	14.2	0.7	3.7	271.4
1979 (N=171)	47.6	2.7	6.9	12.6	13.2	0.7	3.7	280.7
1980 (N=89)	49.1	2.4	6.8	12.2	12.9	0.9	3.2	227.3
1981 (N=86)	50.2	2.3	6.8	12.1	13.3	0.9	3.1	208.0
1982 (N=86)	51.1	2.3	7.0	12.0	12.7	0.9	3.2	216.7
1983 (N=160)	50.4	2.6	6.9	13.1	14.2	0.8	3.5	284.8
1984 (N=81)	51.3	2.6	6.5	12.1	12.8	0.9	3.2	247.5
2001 (N=299)	47.0	4.4	5.3	6.6	6.6	0.7	1.5	294.0
2002 (N=292)	47.9	4.4	5.3	6.9	6.9	0.7	1.6	222.7
2003 (N=295)	48.6	4.4	5.5	7.1	6.6	0.7	1.7	207.4
2004 (N=295)	48.9	4.5	5.5	7.0	6.8	0.7	1.7	278.9
2005 (N=383)	49.1	4.3	5.4	7.5	8.0	0.8	2.2	297.3
2006 (N=371)	48.6	4.5	5.2	7.6	7.6	0.7	2.3	346.9
2007 (N=377)	49.5	4.4	5.2	7.4	8.4	0.6	2.3	333.5
2008 (N=438)	48.9	4.8	5.1	7.4	6.7	0.6	2.2	278.2
2009 (N=273)	49.3	4.8	5.2	7.3	6.7	0.7	2.3	288.8
2010 (N=277)	49.1	5.2	5.0	7.0	7.0	0.7	2.3	317.5
2011 (N=287)	48.9	5.1	5.1	7.0	6.7	0.7	2.3	297.4
2012 (N=286)	49.3	5.2	5.0	7.1	7.3	0.6	2.4	245.7
2013 (N=292)	49.9	5.3	5.0	7.2	8.3	0.5	2.4	237.1
2014 (N=294)	49.8	5.4	4.9	6.7	6.5	0.6	2.3	241.6

Note: Statistics only for households operating on agricultural land (Labour households without operational land excluded).

Fixed effect Model: Generational change

A3: Dynamic Farm Size Productivity Relation at household level

Dependent Variable (in logs)	Generation-I (1975-1979)				Generation-II (2009-2014)			
	Output Value Model		Profit Model		Output Value Model		Profit Model	
	Without inputs	With Inputs	Without inputs	With Inputs	Without inputs	With Inputs	Without inputs	With Inputs
Log Operational area (acre)	-0.332*** (0.05)	-0.101** (0.05)	-0.325*** (0.10)	-0.229** (0.10)	-0.067 (0.06)	0.032 (0.05)	-0.035 (0.11)	0.086 (0.11)
Log Labour (hours/acre)		0.597*** (0.06)		0.428*** (0.13)		0.765*** (0.04)		0.803*** (0.10)
Log Input cost (Rs. /acre)		0.100*** (0.03)		-0.111* (0.06)		-0.080*** (0.03)		-0.217*** (0.07)
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	8.162*** (1.02)	4.056*** (0.93)	2.766* (1.61)	1.307 (1.77)	9.802*** (0.52)	6.116*** (0.50)	10.845*** (0.95)	7.842*** (1.08)
N	844	844	737	737	1647	1647	1338	1338
R-sq	0.77	0.83	0.57	0.58	0.6	0.71	0.51	0.54

Note: Dependent variables are in logarithmic scale and all costs are at constant price (Base year: 2012)

Standard errors in parentheses and significance level as follows * p<0.1, ** p<0.05, *** p<0.01

Fixed effect Model: Controlling for Supervision and Crop Intensity

A4: Dynamic Farm Size Productivity Relation at household level

Dependent Variable (in logs)	Wave-I (1975-1984)				Wave-II (2001-2008)				Wave-III (2009-2014)			
	Output Value Model		Profit Model		Output Value Model		Profit Model		Output Value Model		Profit Model	
	Without inputs	With Inputs	Without inputs	With Inputs	Without inputs	With Inputs	Without inputs	With Inputs	Without inputs	With Inputs	Without inputs	With Inputs
Log Operational area (acre)	-0.289*** (0.05)	-0.096** (0.04)	-0.287*** (0.09)	-0.158* (0.09)	-0.144*** (0.05)	-0.05 (0.04)	-0.280*** (0.09)	-0.205** (0.08)	-0.02 (0.08)	-0.03 (0.07)	0.08 (0.16)	0.11 (0.16)
Log Labour (hours/acre)		0.674*** (0.04)		0.636*** (0.09)		0.741*** (0.03)		0.647*** (0.07)		0.813*** (0.04)		0.829*** (0.10)
Log Input cost (Rs. /acre)		0.077*** (0.02)		-0.106** (0.04)		0.166*** (0.02)		0.130*** (0.04)		-0.089*** (0.03)		-0.225*** (0.07)
Number of crops (per acre)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of plots operated	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	7.505*** (0.85)	3.948*** (0.76)	4.855*** (1.03)	2.145* (1.10)	9.797*** (0.41)	4.254*** (0.36)	9.583*** (0.66)	4.833*** (0.70)	9.608*** (0.53)	6.165*** (0.50)	10.548*** (0.96)	7.841*** (1.08)
N	1344	1344	1196	1196	2642	2641	2163	2162	1647	1647	1338	1338
R-sq	0.74	0.80	0.52	0.55	0.63	0.76	0.52	0.58	0.60	0.71	0.51	0.54

Note: Dependent variables are in logarithmic scale and all costs are at constant price (Base year: 2012)

Standard errors in parentheses and significance level as follows * p<0.1, ** p<0.05, *** p<0.01

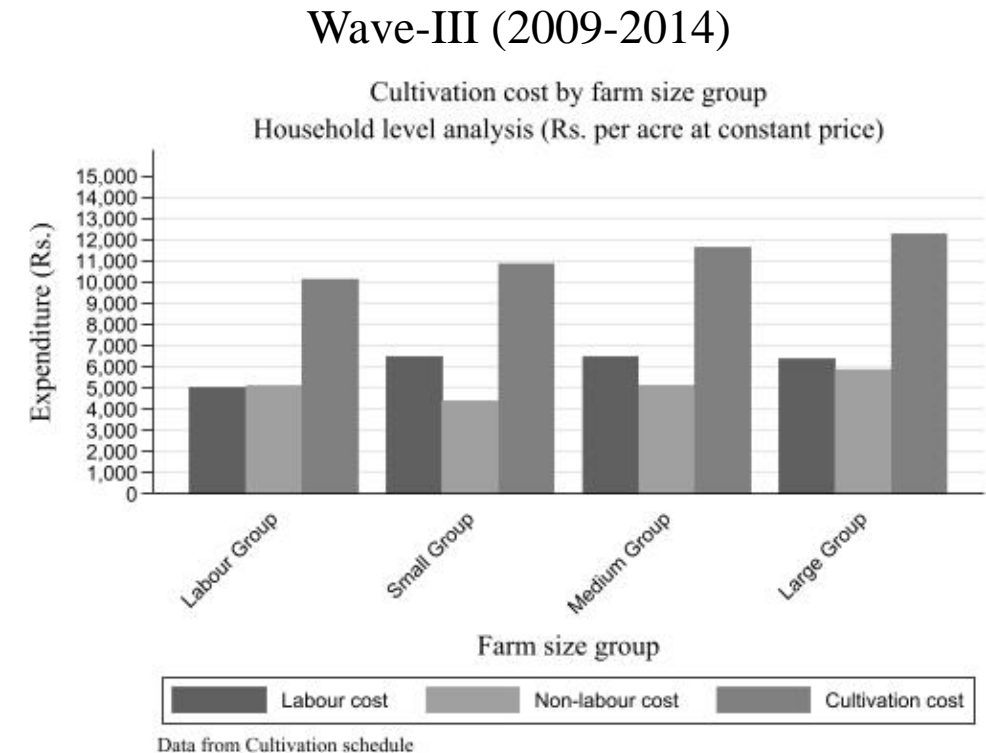
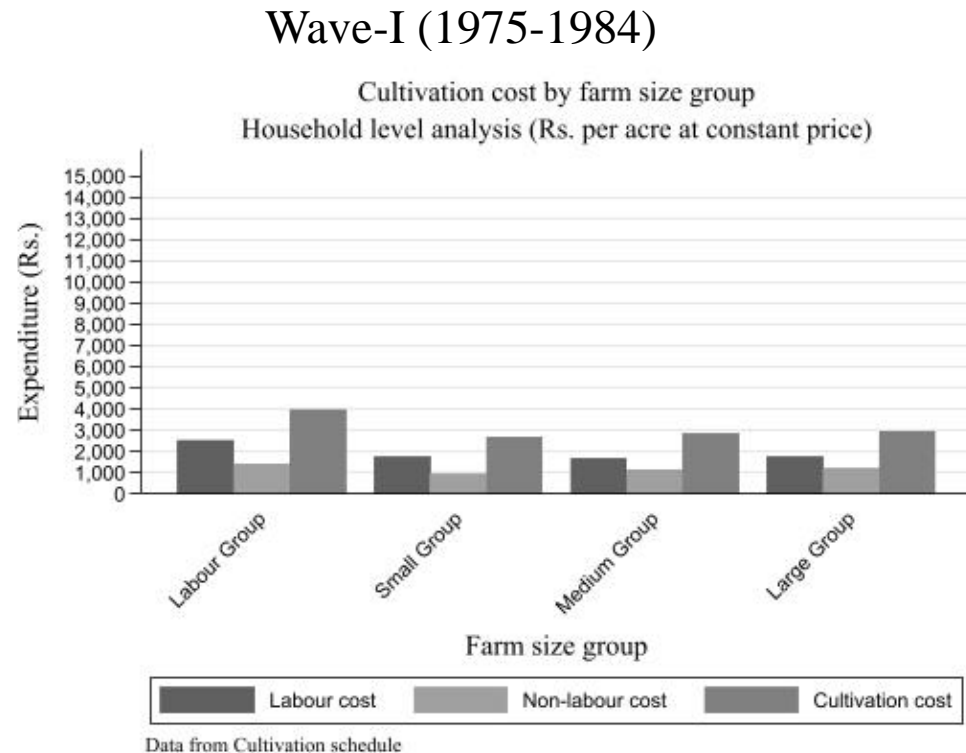
Labour and input intensity at plot level

A5: Labour and input intensity at plot level

Dependent Variable (in logs)	Labour(hours/acre)		Input(INR/acre)	
	Wave-I	Wave-III	Wave-I	Wave-III
Log Plot Area (acre)	-0.209*** (0.04)	-0.054 (0.14)	-0.180*** (0.07)	0.184 (0.17)
Log Operational area (acre)	-0.032*** (0.01)	-0.075*** (0.02)	-0.194*** (0.02)	-0.081*** (0.02)
Household controls	Yes	Yes	Yes	Yes
Plot controls	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Constant	4.148*** (0.80)	5.117*** (0.43)	5.027*** (1.39)	6.993*** (0.52)
N	5872	4056	5865	4053
R-sq	0.74	0.61	0.74	0.69

Cultivation Cost by Farm Size Groups

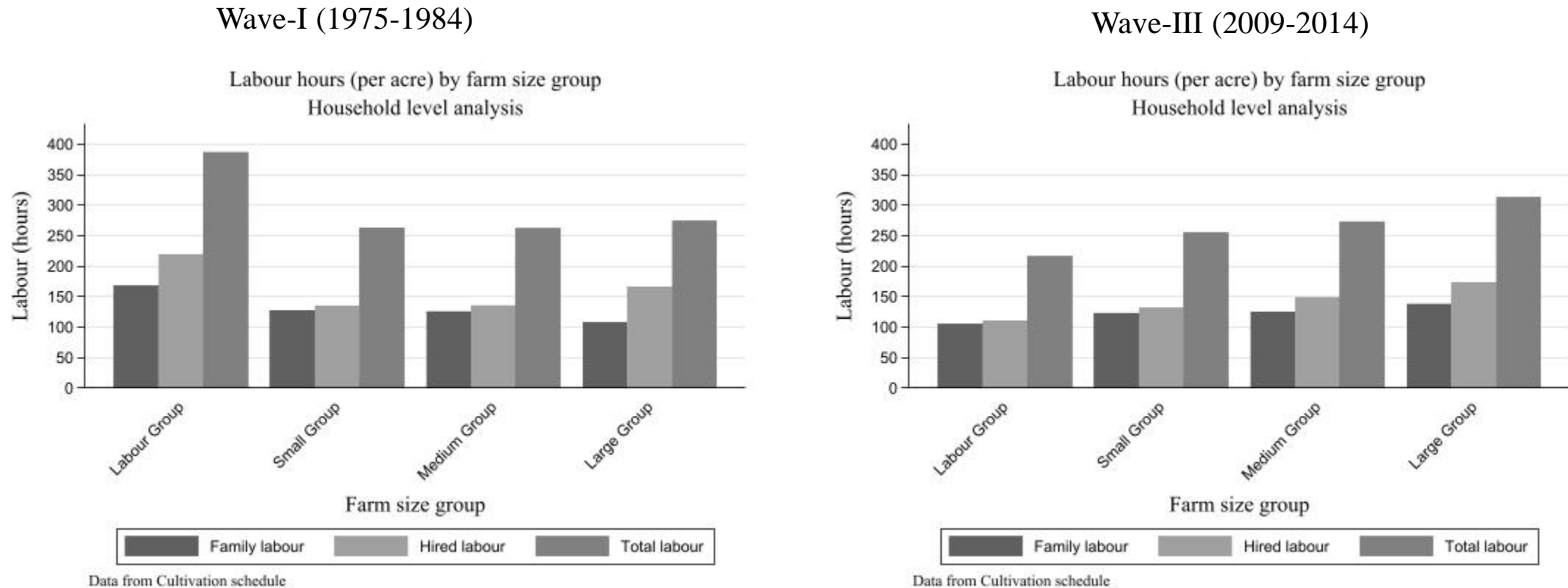
Figure 3: Cultivation cost by farm size groups



Note: Farm size group classification according to ICRISAT's sampling criteria

Family Vs Hired Labour

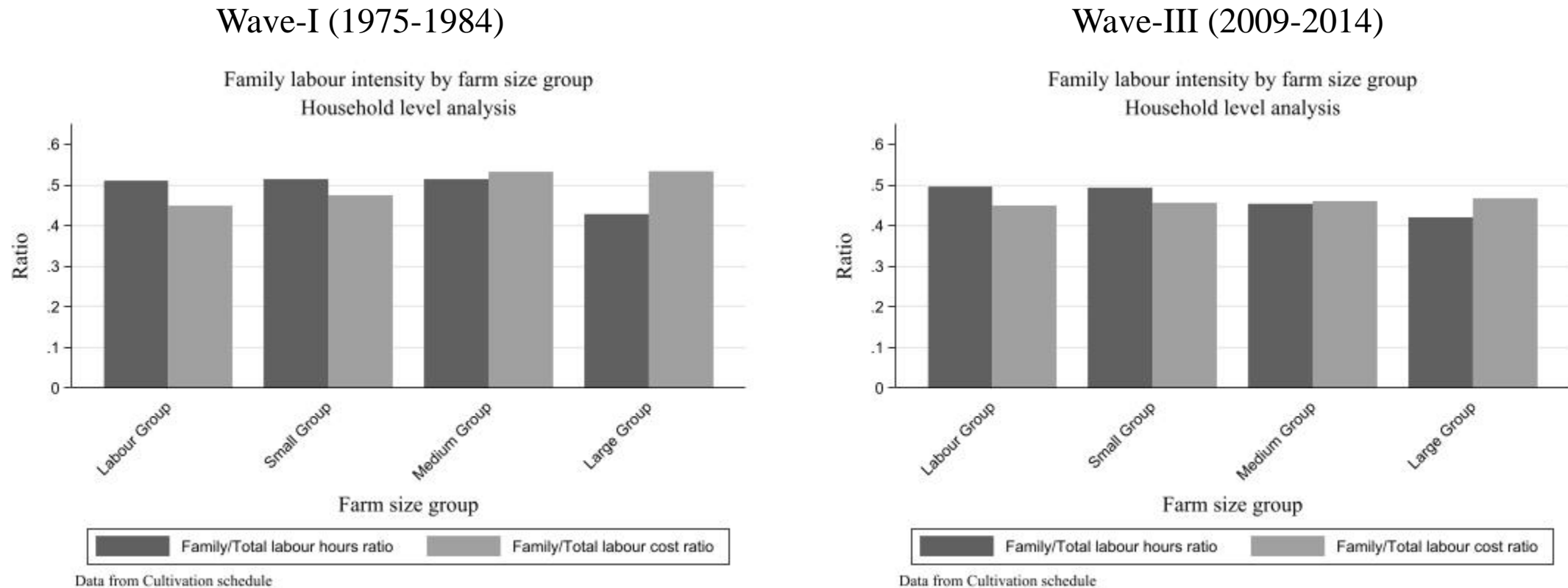
Figure 4: Comparison of hired and family labour utilization by farm size groups



Note: Farm size group classification according to ICRISAT's sampling criteria

Family Labour Intensity

Figure 5: Comparison of family labour intensity by farm size groups



Note: Farm size group classification according to ICRISAT's sampling criteria