Horticultural Development and Its Welfare Implications on Agricultural Household Education Investment in Indonesia

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Abstract:

Promoting horticultural crop adoption is a widespread development strategy in developing countries to augment agricultural households' income. Other than the income effects demonstrated in previous research, horticultural farming's indirect welfare effects such as child education are less well understood. Educational investment is vital for rural development and long-term agricultural productivity. This study analyzes how horticultural farming affects agricultural household education investment, using cross-sectional data of Indonesian Family Life Survey covering seven provinces in Eastern Indonesia (IFLS East). The multiple outcome variables include education spending, number of hours spent in school, and grade repetition. The possible endogeneity of horticultural farming is carefully addressed through instrumental variables estimation. The overall result indicates a positive impact of horticultural farming on child education spending for primary school children in both genders. We also found negative effects of staple crop farming on education spending and number of hours spent in school. This research contributes to existing empirical research in horticultural development, demonstrating horticultural crop adoption would not only increase household income but also household education investment.

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Abstract

Promoting horticultural crop adoption is a widespread development strategy in developing countries to augment agricultural households' income. Other than the income effects demonstrated in previous research, its indirect welfare effects on child education are less well understood. Educational investment is vital for rural development and long-term agricultural productivity. This study analyzes how horticultural farming affects agricultural household education investment, using a cross-sectional data from Indonesian Family Life Survey East by SurveyMETER and RAND Corporation. The multiple outcome variables include education spending, number of hours spent in school, and grade repetition. The possible endogeneity of horticultural farming is carefully addressed through instrumental variables estimation. The overall result indicates a positive impact of horticultural farming on child education spending for primary school children in both genders. We also found negative effects of staple crop farming on education spending and number of hours spent in school. This research contributes to existing empirical research in horticultural development, demonstrating horticultural crop adoption would not only increase household income but also household education investment.

Introduction

Insufficient human capital investment particularly education has direct welfare implications for households, as it affects other human capital dimensions such as health and nutrition outcomes. Education is one of the mechanisms to alleviate poverty and increase household's overall welfare. Promoting horticultural farming among agricultural households is a widespread development strategy in developing countries to increase agricultural households' income. The empirical literature demonstrates income effects related to the adoption of horticultural crops (Barrón and Rello, 2000, pp. 289-297, Ali and Abedullah, 2002, pp. 145-176, Minot and Roy, 2007, Weinberger and Lumpkin, 2007, pp. 1464-1480, Hichaambwa, et al., 2015). However, the effects on household education investment are less well understood. Understanding this linkage will support agricultural policy development to benefit agricultural households in terms of human capital enrichment and long-term agricultural productivity.

This study seeks to clarify the impact of horticultural farming on household education investment considering three competing hypotheses. The null hypothesis is that horticultural farming has no effect on child education outcomes. The first alternative hypothesis is that horticultural farming has positive effects on child education, as horticultural farming leads to more disposable income for households to spend on child education, thus inducing a positive effect on education investment. The second alternative hypothesis is that horticultural farming has negative effects on child education; as horticultural farming increases household income and is more labour-intensive (Joshi, et al., 2006, pp. 219-236, Minot and Roy, 2007, Birthal, et al., 2013, pp. 61-91), it might induce parents to reallocate child time and financial resource toward horticulture farming instead.

Previous research indicates horticultural farming leverages income for farmers, generates employment and better utilisation of farm resources; it also produces a higher

demand for labour than staple crops, such as input application, weeding, and harvesting (Ali and Abedullah, 2002, pp. 145-176). Crop diversification toward horticulture crops such as fruits, vegetables, spices, and flowers generates higher net returns per unit of land than staple crops such as rice or maize (Weinberger and Lumpkin, 2007, pp. 1464-1480). Economies of scale are a less vital factor for generating profits compared to staple crop farming. Thus, small farmers with less land can generate higher profit from growing high-value horticultural crops in their lands compared to growing staple crops. The biggest impact of horticultural farming on poverty was found among small-scale farmers with land no more than two hectares (Birthal, et al., 2015, pp. 70-92).

Considerable research has studied what determines child education in many developing countries to understand household decision making regarding child education investment (Al-Samarrai and Reilly, 2000, pp. 430-474, Glick and Sahn, 2000, pp. 63-87, Dancer and Rammohan, 2007, pp. 171-195, Kabubo-mariara and Mwabu, 2007, pp. 572-593). One of the most important determinants of child schooling is household wealth and income (Gibson and Sear, 2010, pp. 693-701). As horticultural farming generally contributes to higher amount of household income, it may have an impact on education investment. However, horticultural farming offers higher net return per unit of land compared to other agricultural crops and it is labour-intensive (Weinberger & Lumpkin 2007). It might affect the opportunity cost of children time and may induce children to spend more time doing farm work other than in school.

Recent research on the impact of farming on child education outcome has been done in the other types of agricultural technology such as system of rice intensification (Takahashi and Barrett, 2013, pp. 269-289). The result of the research indicates no significant effect of SRI on child school enrolment in both genders. In terms of cash crop, another recent research

studies impact of cotton farming on child education in Burkina Faso (Kazianga and Makamu, 2016, pp. 34-54). The results show that cotton farming induces an increase in school enrolment for girls, however no significant effects for boys. In terms of horticultural farming, research found a positive impact on primary school enrolment through female wage employment in the horticultural industry (Maertens and Verhofstadt, 2013, pp. 118-131).

As the results from previous studies regarding crop choice and educational outcome are varied, it is still inconclusive in what direction horticultural farming affects households' educational outcomes, and mostly limited to child enrolment. Our study offers another dimension of understanding education outcomes, we analyze the impact of horticultural farming on education spending, amount of time a spent in school, and grade repetition, in comparison with staple crop farming in the context of Indonesia.

Data

The data used in our study is the Indonesian Family Life Survey Eastern Indonesia (IFLS East 2012). The data was the cooperation between SurveyMETER, RAND Corporation and AusAid. The IFLS East 2012 is the first wave of the household longitudinal surveys conducted particularly in Eastern Indonesia, as there is no comparable data available in this region (Sikoki Bondan, 2013). The survey includes seven provinces in Eastern Indonesia: East Nusa Tengara, Southeast Sulawesi, East Kalimantan, Maluku, North Maluku, Papua, and West Papua. The sampling methods of the IFLS EAST survey was conducted in several stages. The sampling was stratified by provinces. After seven provinces were selected, 14 villages or Kelurahan were randomly drawn without replacement and equal probability. However, the team later decided to drop some villages in Papua due to safety issues and draw replacement villages. There was one village refusing to participate in community survey, so another village was drawn in Papua. The total number of villages was 99 villages.

Subsequently the enumerators visited the 99 villages and developed the smallest local area unit (satuan lingkungan setempat or SLS) to obtain representative samples of households from each village. Finally, simple random sampling method was used to select 20 to 30 households out of 100 to 150 households in each SLS. 2,547 households out of 3,159 selected households provided at least a partial interview. The response rate was 80.6%. Most of the provinces has higher than 80% response rates except for East Kalimantan and Papua, which have 74% and 76% respectively.

In this study, the sample consisted of 1,277 children who fulfilled the following criteria: (1) their households own farm business, (2) they are enrolled in primary school or junior high school. (3) age under 15

To measure the impact of horticultural farming on household welfare, horticultural households in this study is defined as households who grow vegetable/fruit/spice as their most valuable crop or second most valuable crop. Staple households in this study is defined as households who grow staple crop as their most valuable crop and do not have horticultural crop as their second most valuable crop.

Empirical analysis

In order to understand the impact of horticultural farming on child education, we focus on three outcome variables; (1) Child's education expenditure in the past academic year, (2) Number of hours spent in school during the previous week, (3) Whether the child has ever repeated a grade.

OLS and 2SLS regression are employed for models with continuous outcome variables (education expenditure and school hours). Logistic regression and linear probability model are employed for models with binary outcome variables (grade repetition).

The empirical model is as below:

$$y_{ij} = x_i\beta_1 + HH_j\beta_2 + HORT_j\beta_3 + \epsilon_{ij} \qquad (1)$$

$$y_{ij} = x_i\beta_1 + HH_j\beta_2 + HORT_j\beta_3 + \epsilon_{ij} \qquad (2)$$

$$HORT_j = x_i\gamma_1 + HH_j\gamma_2 + Z_j\gamma_3 + U_{ij}$$

y_{ij} denotes the outcome, x_i is a vector of child characteristics, HH_j is a vector of household characteristics, HORT is a dummy variable which takes a value of 1 if the household grows fruit/vegetable/spice as their most or second most valuable crop, and 0 otherwise, Z_j is an instrumental variable: whether the village has horticultural crop as their main crop or not.

Further we would like to understand the child education outcome of households growing staple crop as their most valuable crop and do not have horticultural crop as their second most valuable crop. The empirical model is as below:

$$y_{ij} = x_i\beta_1 + HH_j\beta_2 + STAPLE\beta_3 + \epsilon_{ij} \qquad (3)$$

$$y_{ij} = x_i\beta_1 + HH_j\beta_2 + STAPLE\beta_3 + \epsilon_{ij} \qquad (4)$$

$$STAPLE_j = x_i\gamma_1 + HH_j\gamma_2 + Z_j\gamma_3 + U_{ij}$$

y_{ij} denotes the outcome, x_i is a vector of child characteristics, HH_j is a vector of household characteristics, STAPLE is a dummy variable which takes a value of 1 if the household grows staple crop as their most valuable crop and does not have horticultural crop as their second most valuable crop, and 0 otherwise. Z_j is an instrumental variable: whether the village has horticultural crop as their main types of crop.

As the OLS and logistic regression estimates potentially carry some bias from unobserved heterogeneity or factors. Instrumental variable technique of 2SLS regression has been used to mitigate the bias of the models with continuous outcome variables. Linear probability model has been selected for models with binary outcome variable, as it

accommodates causal inference in limited dependent variable models with binary endogenous regressors (Angrist, 2001, pp. 2-28). The instrumental variable employed in this study is a dummy variable which takes a value of 1 if the village has horticultural crop as their main production, 0 otherwise. This instrument is correlated with the endogenous explanatory variable, but does not have a causal effect on the child education outcome variables.

First-stage regression summary statistics is below:

Endogenous variables	**R-sq.**	**Adjusted R-sq.**	**Partial R-sq.**	**F(1,1243)**	**Prob> F**
HORT	0.1768	0.1549	0.0141	17.7429	0.0000
STAPLE	0.3369	0.3193	0.0272	34.8149	0.0000

Additionally, province fixed effects were included in the model estimation to control for the average difference in any observable and unobservable predictors across the seven provinces.

Results and discussion

Table 2.1 Summary of the impact of crop choice on child education outcomes with province fixed effects

The impact of crop choice on child education outcomes with province fixed effects (OBS = 1,277)

OLS for (1),(2) Logistic regression for (3)			**2SLS**	
	HORT	**STAPLE**	**HORT**	**STAPLE**
(1) Education spending	70.415 (46.906)	-146.984*** (52.742)	1363.409*** (495.179)	-1104.231*** (354.565)
R-squared	0.2116	0.2151	-	0.0071
(2) Hours spent in school in a week	.750* (.440)	-.054 (.497)	3.127 (3.706)	-2.533 (3.000)
R- squared	0.1684	0.1665	0.1489	0.1498
(3) Grade repetition	1.178 (.190)	.867 (.156)	-.041 (.215)	.033 (.174)
R-squared	0.1378	0.1375	0.1383	0.1409

Notes: Asterisks denote the following:

*indicates significance at 10%; **indicates significance at 5%; *** indicates significance at 1%. Standard errors are in parentheses

With province fixed effects, we found a statistically significant impacts of household crop choice on education spending for the whole sample (Table 2.1). Growing horticultural crop as the most/second most valuable crop demonstrates a positive relationship with more education spending within households, whereas staple crop cultivation without horticultural crop has a significant negative impact on education spending. However, we found no significant effect of crop choice on hours spent in school and grade repetition.

Table 2.2 Summary of the impact of crop choice on child education outcomes on sub-samples with province fixed effects

The impact of crop choice on child education outcomes on sub-samples with province fixed effects

BOYS (obs = 640)				
OLS for (1),(2) Logistic regression for (3)			**2SLS**	
	HORT	**STAPLE**	**HORT**	**STAPLE**
(1) Education spending (,000 IDR)	39.721 (83.154)	-168.357 (91.254)	2224.797** (1054.589)	-1592.002*** (609.339)
(2) Hours spent in school in a week	-.057 (.620)	.887 (.681)	3.569 (5.532)	-2.554 (3.926)
(3) Grade repetition	1.082 (.242)	.788 (.191)	.132 (.337)	-.094 (.239)
GIRLS (obs = 637)				
OLS for (1),(2) Logistic regression for (3)			**2SLS**	
	HORT	**STAPLE**	**HORT**	**STAPLE**
(1) Education spending (,000 IDR)	92.236** (46.171)	-109.401** (52.674)	566.883* (327.384)	-589.312* (334.767)
(2) Hours spent in school in a week	1.583*** (.651)	-1.228 (.745)	3.143 (4.280)	-3.267 (4.467)
(3) Grade repetition	1.275 (.325)	1.151 (.338)	.325 (.233)	.033 (.241)
PRIMARY SCHOOL CHILDREN (obs = 1,041)				
OLS for (1),(2) Logistic regression for (3)			**2SLS**	
	HORT	**STAPLE**	**HORT**	**STAPLE**
(1) Education spending (,000 IDR)	49.831 (32.364)	-77.625** (37.124)	655.022** (289.839)	-610.458** (255.177)
(2) Hours spent in school in a week	.486 (.482)	.356 (.553)	.581 (3.721)	-.542 (3.473)
(3) Grade repetition	1.181 (.209)	.915 (.185)	-.132 (.229)	.123 (.211)

JUNIOR HIGH SCHOOL CHILDREN (obs = 236)				
OLS for (1),(2) Logistic regression for (3)			2SLS	
	HORT	**STAPLE**	**HORT**	**STAPLE**
(1) Education spending (,000 IDR)	-172.006 (237.822)	-213.903 (242.400)	7649.144 (8351.089)	-2585.988* (1360.741)
(2) Hours spent in school in a week	2.859** (1.206)	-2.600** (1.233)	41.596 (41.519)	-14.062** (6.814)
(3) Grade repetition	1.095 (.536)	.557 (.276)	-.204 (.311)	.604 (1.072)

Notes: Asterisks denote the following:

*indicates significance at 10%; **indicates significance at 5%; *** indicates significance at 1%. Standard errors are in parentheses

In terms of sub-samples, we found a significant positive effect from horticultural farming on education spending for boys and girl using 2SLS (Table 2.2), however the effect was larger among boys. Moreover, the results show a significant negative impact from staple crop farming on education spending for boys and girls, however the coefficient of boy sub-sample is higher. We also found a positive significant impact from horticultural farming on hours spent in school for girls but not for boys.

The positive significant effect of horticultural farming on education spending was found only among primary school children from 2SLS, whereas the negative significant effect of staple farming without horticulture was found in both primary and junior high school children. We found a positive effect of horticultural farming on hours spent in school among junior high school children, whereas we found a negative effect from staple crop farming on this outcome variable.

The overall result indicates a positive impact of horticultural farming on child education spending. The results are in alignment with the first alternative hypothesis that horticultural crop farming has a positive impact on child education outcomes in agricultural households.

However, it is not yet clear through which mechanism horticultural farming has an impact on education spending. It might be due to increased household income and unobserved factors. One possible explanation might be that farmers who adopt horticultural crops are more educated than other farmers, as more educated farmers are more likely to adopt new agricultural technologies (Knowler and Bradshaw, 2007, pp. 25-48). As parental education is positively correlated with child education investment, farmers who adopt horticultural crops are more likely to spend more on child education potentially due to increased income and their own awareness of educational benefits. Moreover, another plausible explanation for positive effects on education spending may be due to female empowerment from horticultural activities. Past research indicates horticultural industry leads to more female engagement in labour force, in production and marketing activities (Dolan and Sutherland, 2002, Maertens, et al., 2012, pp. 473-497). As female empowerment is associated with positive child schooling outcomes particularly in primary school enrolment (Maertens and Verhofstadt, 2013, pp. 118-131), it is possible that increased education spending from horticultural households is due to increased female empowerment and female participation in horticultural activities.

Horticultural crops require more knowledge and capital to maintain than staple crops and it is more labour-intensive (Joshi, et al., 2006, pp. 219-236, Birthal, et al., 2013, pp. 61-91). However, it does not have any significant negative effect on hours spent in school or grade repetition. According to our second alternative hypothesis, the increased labour demand associated with horticultural crop might decrease hours spent in school of a child and increase farm work hours, potentially leading to delayed educational progress from grade repetition. However, the results from this study indicate that the labour-intensive nature of horticultural farming does not demonstrate such effects. The possible explanation might be

that it is more efficient to hire farm labourers to help maintain the horticultural crops, which involves weeding, spraying, fertilising and other physical demanding activities.

In terms of staple crop farming without horticulture, the overall results indicate a negative impact on education spending compared with other types of households. The plausible explanation from the descriptive statistics (Table 1) may be that staple crop households generate less income, and able to obtain less amount of borrowing which is vital for financing child education (Jacoby, 1994, pp. 151-160).

In terms of education level, the positive impact of education spending is significant only among primary school children, however we found a positive impact in terms of school hours for junior high school children. Junior high school children seem to spend more time in school if they are from horticultural households, however, they seem to spend less time in school if they are from staple households. The possible explanation may be that staple crop farming households potentially have to rely on income from children work to maintain the livelihood of their households. Especially once children reach an age of junior high school students, the opportunity cost of their time also increases. Their time could be used toward gaining wage income from working as a farm labourer or other off-farm work to assist with household income.

Conclusion

Understanding the impact of crop choice on household education investment could provide policy recommendation to favour horticultural crop adoption in Indonesia. The advantages of horticultural crop adoption are not only household income but also household education investment, contributing to a long-term impact on poverty reduction and rural development. Further attention and policy implementation should be directed particularly toward staple farming households, as the results show consistent negative effects on child education outcomes.

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Table 1 Descriptive statistics of dependent and independent variables

Variables	Children of all farm HH	Children of HORT HH	Children of Non-HORT HH	Children of STAPLE w/o HORT HH	Children of all farm households except STAPLE w/o HORT HH
Number of obs	1,277	460	817	426	851
	Mean (SD)	***Mean (SD)***	***Mean (SD)***	***Mean (SD)***	***Mean (SD)***
Education spending (thousand)	615.75 (817.34)	669.57 (683.22)	585.45 (882.90)	485.3 (563.85)	681.05 (911.64)
School hours (time spent in school last week)	24 (7.47)	24.52 (7.46)	23.70 (7.47)	23.6 (6.90)	24.19 (7.74)
Child academic performance: ever fail & need to repeat a grade (0=No 1=Yes)	0.246 (.431)	0.226 (.418)	0.258 (.437)	0.286 (.452)	0.226 (.419)
Child working while in school	0.178 (.383)	0.176 (.381)	0.179 (.384)	0.185 (.389)	.175 (.380)
Child age	10.36 (2.24)	10.1 (2.25)	10.52 (2.23)	10.55 (2.22)	10.27(2.25)
Gender (0 = Female, 1 = Male)	0.501(.50)	0.486 (.50)	0.509 (.50)	0.50 (.50)	0.501(.50)
Edulevel (0 = Primary, 1 = Junior High)	0.184 (.388)	0.18 (.384)	0.187 (.390)	0.187 (.391)	.183 (.387)
Religious school (0 = No, 1 =Yes)	0.054 (.226)	0.086 (.282)	0.035 (.185)	.011 (.107)	0.075 (.263)
Book received (0 = No, 1 =Yes)	0.619 (.485)	0.608 (.488)	0.625 (.484)	0.631 (.4829)	0.613 (.487)
Aid received (0 = No, 1 =Yes)	0.88 (.323)	0.93 (.254)	0.853 (.354)	0.847 (.360)	0.897 (.303)
Child health (0 = unhealthy, 1 = somewhat unhealthy, 2 = somewhat healthy, 3 = very healthy	2.276 (.462)	2.297 (.485)	2.264 (.449)	2.234 (.424)	2.297 (.479)
First born (0 = No, 1 =Yes)	0.335 (.472)	0.321 (.467)	0.342 (.474)	.370 (.483)	0.317 (.465)
Last born (0 = No, 1 =Yes)	0.146 (.353)	0.16 (.367)	0.138 (.345)	0.138 (.345)	0.15 (.357)

Only child (0 = No, 1 =Yes)	0.072 (.258)	0.067 (.250)	0.074 (.263)	0.082 (.274)	0.066 (.250)
HH head age (years)	44.46 (10.58)	44.32 (10.63)	44.54 (10.56)	44.3 (10.41)	44.54 (10.67)
HH head education (years)	6.98 (3.94)	7.13 (4.03)	6.9 (3.88)	6.5 (3.66)	7.22 (4.05)
Female HH head (0 = No, 1 =Yes)	0.111 (.315)	0.104 (.306)	0.116 (.320)	0.159 (.366)	0.088 (.283)
HH head - separated/divorced/ widowed (0= No, Yes=1)	0.072 (.259)	0.071 (.258)	0.073 (.261)	0.075 (.263)	0.071 (.258)
HH income (million)	20.08 (32.67)	23.29 (42.74)	18.28 (25.16)	14.98 (22.22)	22.64 (36.55)
HH assets (million)	127.0 (184.5)	141.3 (180.2)	118.9 (186.4)	103.3 (157.6)	138.8 (195.5)
Borrowing (million)	1.648 (18.139)	1.996(23.909)	1.452 (13.888)	0.571 (3.776)	2.187 (22.044)
Number of HH member aged 0 -5	0.762 (.834)	0.747 (.851)	0.771 (.825)	0.767 (.823)	0.76 (.840)
Number of HH member aged 6-12	1.813 (.986)	1.797 (.981)	1.822 (.989)	1.772 (.988)	1.834 (.985)
Number of HH member aged 13-17	0.758 (.847)	0.721 (.912)	0.778 (.808)	0.723 (.750)	0.775 (.891)
Number of HH member aged 18- 65	2.407 (1.043)	2.406 (.980)	2.408 (1.078)	2.368 (1.034)	2.427 (1.048)
Number of HHmember aged 66 and over	0.134 (.384)	0.119 (.362)	0.143 (.396)	0.150 (.401)	0.126 (.376)
Number of primary schools in the village	1.722 (1.346)	1.719 (1.203)	1.723 (1.420)	1.924 (1.592)	1.62 (1.192)
Number of junior high schools in the village	1.711 (.950)	1.882 (1.100)	1.615 (.839)	1.471 (.689)	1.831 (1.036)
Horticultural crops as the village's main crops (0 =No, 1 = Yes)	0.512 (.500)	0.697 (.459)	0.407 (.491)	0.274 (.446)	0.631 (.482)

Table 2.1 Summary of the impact of crop choice on child education outcomes

The impact of crop choice on child education outcomes (OBS = 1,277)

	OLS for (1),(2) Logistic regression for (3)		2SLS	
	HORT	**STAPLE**	**HORT**	**STAPLE**
(1) Education spending	81.559* (44.608)	-175.272*** (46.597)	513.494*** (176.407)	-490.013*** (164.587)
R-squared	0.1946	0.2014	0.1341	0.1723
(2) Hours spent in school in a week	1.030** (.422)	-.310 (.444)	2.781* (1.622)	-2.654* (1.558)
R- squared	0.1362	0.1324	0.1243	0.1131
(3) Grade repetition	1.083 (.163)	1.023 (.158)	-.047 (.093)	.044 (.089)
R-squared	0.1187	0.1185	0.1207	0.1238

Notes: Asterisks denote the following:

*indicates significance at 10%; **indicates significance at 5%; *** indicates significance at 1%. Standard errors are in parentheses

Table 2.2 Summary of the impact of crop choice on child education outcomes with province fixed effects

The impact of crop choice on child education outcomes with province fixed effects (OBS = 1,277)

	OLS for (1),(2) Logistic regression for (3)		2SLS	
	HORT	**STAPLE**	**HORT**	**STAPLE**
(1) Education spending	70.415 (46.906)	-146.984*** (52.742)	1363.409*** (495.179)	-1104.231*** (354.565)
R-squared	0.2116	0.2151	-	0.0071
(2) Hours spent in school in a week	.750* (.440)	-.054 (.497)	3.127 (3.706)	-2.533 (3.000)
R- squared	0.1684	0.1665	0.1489	0.1498
(3) Grade repetition	1.178 (.190)	.867 (.156)	-.041 (.215)	.033 (.174)
R-squared	0.1378	0.1375	0.1383	0.1409

Notes: Asterisks denote the following:

*indicates significance at 10%; **indicates significance at 5%; *** indicates significance at 1%. Standard errors are in parentheses

Table 2.1 Summary of the impact of crop choice on child education outcomes on sub-samples

The impact of crop choice on child education outcomes on sub-samples

	BOYS (obs = 640)			
	OLS for (1),(2) Logistic regression for (3)		2SLS	
	HORT	**STAPLE**	**HORT**	**STAPLE**
(1) Education spending (,000 IDR)	38.767 (78.840)	-162.116* (82.948)	711.378** (324.852)	-713.061** (317.816)

(2) Hours spent in school in a week	.613 (.602)	.282 (.635)	1.693 (2.352)	-1.697 (2.371)
(3) Grade repetition	.950 (.198)	.989 (.212)	-.018 (.142)	.018 (.142)
		GIRLS (obs = 637)		
	OLS for (1),(2) Logistic regression for (3)		**2SLS**	
	HORT	**STAPLE**	**HORT**	**STAPLE**
(1) Education spending (,000 IDR)	131.489*** (43.360)	-183.863*** (44.606)	371.368** (157.735)	-342.947** (142.720)
(2) Hours spent in school in a week	1.458** (.608)	-1.027 (.631)	-3.387* (2.021)	3.668* (2.182)
(3) Grade repetition	1.226 (.284)	1.164 (.271)	-.028 (.118)	.026 (.109)
		PRIMARY SCHOOL CHILDREN (obs = 1,041)		
	OLS for (1), (2) Logistic regression for (3)		**2SLS**	
	HORT	**STAPLE**	**HORT**	**STAPLE**
(1) Education spending (,000 IDR)	83.370*** (30.749)	-144.743*** (32.307)	394.093*** (118.152)	-391.617*** (114.377)
(2) Hours spent in school in a week	.694 (.461)	.202 (.488)	1.535 (1.693)	-1.526 (1.691)
(3) Grade repetition	1.103 (.182)	1.064 (.180)	-.034 (.100)	.033 (.099)
		JUNIOR HIGH SCHOOL CHILDREN (obs = 236)		
	OLS for (1), (2) Logistic regression for (3)		**2SLS**	
	HORT	**STAPLE**	**HORT**	**STAPLE**
(1) Education spending (,000 IDR)	-178.017 (222.331)	-150.193 (222.144)	1338.526 (1039.974)	-1004.153 (730.425)
(2) Hours spent in school in a week	3.228*** (1.125)	-3.466*** (1.121)	14.937** (5.867)	-11.206*** (3.947)
(3) Grade repetition	.859 (.386)	.759 (.330)	-.110 (.265)	.083 (.200)

Notes: Asterisks denote the following:

*indicates significance at 10%; **indicates significance at 5%; *** indicates significance at 1%. Standard errors are in parentheses

Table 3.1 Summary of the impact of crop choice on child education outcomes on sub-samples with province fixed effects

The impact of crop choice on child education outcomes on sub-samples with province fixed effects

		BOYS (obs = 640)		
	OLS for (1),(2) Logistic regression for (3)		**2SLS**	
	HORT	**STAPLE**	**HORT**	**STAPLE**
(1) Education spending (,000 IDR)	39.721 (83.154)	-168.357 (91.254)	2224.797** (1054.589)	-1592.002*** (609.339)
(2) Hours spent in school in a week	-.057 (.620)	.887 (.681)	3.569 (5.532)	-2.554 (3.926)
(3) Grade repetition	1.082	.788	.132	-.094

	(.242)	(.191)	(.337)	(.239)
GIRLS (obs = 637)				
OLS for (1),(2) Logistic regression for (3)			**2SLS**	
	HORT	**STAPLE**	**HORT**	**STAPLE**
(1) Education spending (,000 IDR)	92.236** (46.171)	-109.401** (52.674)	566.883* (327.384)	-589.312* (334.767)
(2) Hours spent in school in a week	1.583*** (.651)	-1.228 (.745)	3.143 (4.280)	-3.267 (4.467)
(3) Grade repetition	1.275 (.325)	1.151 (.338)	.325 (.233)	.033 (.241)
PRIMARY SCHOOL CHILDREN (obs = 1,041)				
OLS for (1),(2) Logistic regression for (3)			**2SLS**	
	HORT	**STAPLE**	**HORT**	**STAPLE**
(1) Education spending (,000 IDR)	49.831 (32.364)	-77.625** (37.124)	655.022** (289.839)	-610.458** (255.177)
(2) Hours spent in school in a week	.486 (.482)	.356 (.553)	.581 (3.721)	-.542 (3.473)
(3) Grade repetition	1.181 (.209)	.915 (.185)	-.132 (.229)	.123 (.211)
JUNIOR HIGH SCHOOL CHILDREN (obs = 236)				
OLS for (1),(2) Logistic regression for (3)			**2SLS**	
	HORT	**STAPLE**	**HORT**	**STAPLE**
(1) Education spending (,000 IDR)	-172.006 (237.822)	-213.903 (242.400)	7649.144 (8351.089)	-2585.988* (1360.741)
(2) Hours spent in school in a week	2.859** (1.206)	-2.600** (1.233)	41.596 (41.519)	-14.062** (6.814)
(3) Grade repetition	1.095 (.536)	.557 (.276)	-.204 (.311)	.604 (1.072)

Notes: Asterisks denote the following:

*indicates significance at 10%; **indicates significance at 5%; *** indicates significance at 1%. Standard errors are in parentheses

Table 3.2 The impact of crop choice on education spending with province fixed effects

The impact of crop choice on education spending, OBS: 1,277

	OLS		**2SLS**	
	HORT	**STAPLE**	**HORT**	**STAPLE**
Treatment effect	70.415 (46.906)	-146.984*** (52.742)	1363.409 (495.179)	-1104.231*** (354.565)
Education level (primary/junior high)	378.503*** (70.114)	387.1613*** (69.975)	332.765 (89.514)	427.322*** (79.022)
Gender	98.161** (42.047)	96.430 ** (41.935)	133.20 (54.318)	97.587** (46.535)
Age	14.266 (12.990)	13.656 (12.925)	42.611 (19.515)	19.736 (14.514)
Ever fail	-87.757* (51.598)	-87.900* (51.459)	-141.472 (67.770)	-107.882* (57.566)
Child work	-157.391***	-162.861***	-177.166	-205.499***

	(57.581)	(57.497)	(72.503)	(65.676)
Child health	-4.824	-8.252	-47.980	-45.883
	(45.192)	(45.113)	(58.928)	(51.913)
Firstborn	33.238	36.531	47.985	63.206
	(58.145)	(58.033)	(73.034)	(65.130)
Lastborn	-19.759	-14.292	-13.971	23.363
	(66.363)	(66.249)	(83.139)	(74.789)
Only child	-81.356	-77.792	11.505	-21.646
	(96.267)	(96.046)	(125.626)	(108.534)
Aid received	-83.576	-80.776	-199.158	-103.537
	(65.982)	(65.715)	(93.595)	(73.394)
Book received	2.468	1.872	84.179	26.974
	(44.691)	(44.515)	(64.015)	(50.241)
Religious school	-95.736	-92.750	-218.555	-116.868
	(99.857)	(99.546)	(133.493)	(110.813)
HH head education	17.006***	16.216***	18.398	11.568*
	(5.848)	(5.841)	(7.343)	(6.700)
HH head age	-4.083*	-4.136*	-2.625	-3.963
	(2.351)	(2.345)	(2.996)	(2.603)
HH head (divorce/separate/widow)	136.305	103.261	118.979	-118.090
	(102.504)	(103.000)	(128.540)	(140.008)
Female HH head	2.351	-62.269	-110.247	148.721
	(86.427)	(87.014)	(108.383)	(123.548)
No. of HH member aged 66 and over	189.444***	187.296***	233.923	189.077***
	(58.064)	(57.913)	(74.658)	(64.267)
No. of HH member aged 18-65	2.442	4.801	24.813	28.097
	(22.967)	(22.938)	(29.995)	(26.839)
No. of HH member aged 13-17	31.285	27.269	57.816	10.527
	(29.389)	(29.323)	(38.164)	(33.109)
No. of HH member aged 6-12	-68.463***	-66.749***	-21.575	-38.959
	(24.266)	(24.202)	(35.235)	(28.711)
No. of HH member aged 0-5	-59.021**	-58.194**	-21.350	-39.443
	(28.372)	(28.295)	(38.311)	(32.136)
HH income (million_IDR)	4.396***	4.449 ***	3.785	4.578***
	(.903)	(.901)	(1.155)	(1.001)
HH assets (million_IDR)	-.348***	-.376 ***	-.681	-.672***
	(.1357)	(.135)	(.211)	(.185)
HH borrowing (million_IDR)	8.172***	8.184 ***	9.689	8.801***
	(1.495)	(1.491)	(1.959)	(1.670)
No. of primary schools in the village	18.045	-19.720	6.366	34.030*
	(17.606)	(26.672)	(22.492)	(20.102)
No. of junior high school in the village	-7.750	20.724	-41.805	-109.758**
	(26.293)	(17.578)	(35.384)	(44.248)
Province fixed effects	yes	yes	yes	yes
(constant)	589.160**	672.502***	-184.341	940.936***
	(227.680)	(225.930)	(409.658)	(269.201)
F (33, 1243)	10.11	10.32		
Wald chi2(33)			218.85	279.99
R-squared	0.2116	0.2151	-	0.0071

Notes: Asterisks denote the following: *indicates significance at 10%; **indicates significance at 5%; *** indicates significance at 1%. Standard errors are in parentheses

Table 4 The impact of crop choice on hours spent in school with province fixed effects

The impact of crop choice on hours spent in school, OBS: 1,277

	OLS		2SLS	
	HORT	**STAPLE**	**HORT**	**STAPLE**
Treatment effect	.750* (.440)	-.054 (.497)	3.127 (3.706)	-2.533 (3.000)
Education level (primary = 0 junior high =1)	.718 (.658)	.747 (.659)	.634 (.670)	.851 (.668)
Gender (male =1)	.254 (.394)	.234 (.395)	.318 (.406)	.237 (.393)
Age	.961*** (.122)	.945*** (.121)	1.013*** (.146)	.961*** (.122)
Ever fail	-.716 (.484)	-.686 (.485)	-.815 (.507)	-.738 (.487)
Child work	-.272 (.540)	-.263 (.541)	-.308 (.542)	-.373 (.555)
Child health	.603 (.424)	.626 (.425)	.524 (.441)	.528 (.439)
Firstborn	.212 (.546)	.205 (.546)	.239 (.546)	.274 (.551)
lastborn	-1.691*** (.623)	-1.693*** (.624)	-1.681*** (.622)	-1.595*** (.632)
Only child	-1.641* (.904)	-1.691* (.905)	-1.470 (.940)	-1.546* (.918)
Aid received	1.016 (.619)	1.082* (.619)	.804 (.700)	1.023* (.621)
Book received	.315 (.419)	.269 (.419)	.465 (.479)	.334 (.425)
Religious school	-1.372 (.937)	-1.302 (.938)	-1.598 (.999)	-1.365 (.937)
HH head education	.111** (.054)	.110** (.055)	.113** (.054)	.098* (.056)
HH head age	.025 (.022)	.024 (.022)	.028 (.022)	.025 (.022)
Female HH head	-.937 (.811)	-.916 (.820)	-.964 (.811)	-.370 (1.045)
HH head (divorce/separate/widow)	.519 (.962)	.517 (.970)	.488 (.962)	-.055 (1.184)
No. of HH member aged 66 and over	.550 (.545)	.524 (.545)	.632 (.558)	.529 (.543)
No. of HH member aged 18-65	-.043 (.215)	-.055 (.216)	-.002 (.224)	.005 (.227)
No. of HH member aged 13-17	-.418 (.276)	-.434 (.276)	-.369 (.285)	-.477* (.280)
No. of HH member aged 6-12	.476** (.227)	.450** (.228)	.562** (.263)	.522** (.242)
No. of HH member aged 0-5	-.348 (.266)	-.369 (.266)	-.279 (.286)	-.321 (.271)
HH income (million_IDR)	.003 (.008)	.004 (.008)	.002 (.008)	.004 (.008)
HH assets (million_IDR)	-.000 (.001)	-.000 (.001)	-.001 (.001)	-.001 (.001)
HH borrowing (million_IDR)	.003 (.014)	.002 (.014)	.006 (.014)	.004 (.014)
No. of primary schools in the village	-.289* (.165)	.281* (.165)	-.310* (.168)	-.247 (.170)

No. of junior high school in the village	.364 (.246)	.379 (.251)	.302 (.264)	.146 (.374)
Province fixed effects	yes	yes	yes	yes
(constant)	7.753*** (2.138)	8.218*** (2.129)	6.331** (3.066)	8.913*** (2.278)
F (33, 1243)	7.63	7.52		
Wald chi2(33)			250.47	250.72
R-squared	0.1684	0.1665	0.1489	0.1498

Notes: Asterisks denote the following:

*indicates significance at 10%; **indicates significance at 5%; *** indicates significance at 1%. Standard errors are in parentheses

Table 5 The impact of crop choice on grade repetition with province fixed effect

The impact of crop choice on grade repetition, OBS: 1,277				
	Logistic regression		**2SLS**	
	HORT	**STAPLE**	**HORT**	**STAPLE**
Treatment effect	1.178 (.190)	.867 (.156)	-.041 (.215)	.033 (.174)
Education level (primary/junior high)	.304*** (.071)	.307*** (.071)	-.210*** (.038)	-.213*** (.038)
Gender (male = 1)	1.936*** (.282)	1.932*** (.281)	.107*** (.023)	.108*** (.022)
Age	1.399*** (.064)	1.396*** (.064)	.053*** (.008)	.053*** (.006)
Child work	1.179 (.217)	1.173 (.216)	.031 (.031)	.032 (.032)
Child health	1.009 (.155)	1.013 (.156)	.005 (.025)	.005 (.025)
Firstborn	.833 (.166)	.836 (.167)	-.029 (.031)	-.029 (.031)
Lastborn	1.054 (.251)	1.063 (.253)	.006 (.036)	.004 (.036)
Only child	1.507 (.509)	1.498 (.505)	.061 (.054)	.062 (.053)
Aid received	.872 (.189)	.883 (.191)	-.026 (.040)	-.029 (.035)
Book received	1.053 (.164)	1.044 (.162)	.008 (.027)	.010 (.024)
Religious school	.885 (.377)	.893 (.382)	.004 (.058)	.001 (.054)
HH head education	.980 (.020)	.979 (.019)	-.003 (.003)	-.003 (.003)
HH head age	1.001 (.008)	1.001 (.008)	-.000 (.001)	6.47e-06 (.001)
Female HH head	1.176 (.341)	1.212 (.354)	.031 (.047)	.023 (.060)
HH head (divorce/separate/widow)	.743 (.266)	.720 (.259)	-.048 (.055)	-.041 (.068)
No. of HH member aged 66 and over	1.653*** (.307)	1.646*** (.305)	.085*** (.032)	.086*** (.031)

No. of HH member aged 18-65	.991 (.078)	.992 (.078)	-.005 (.013)	-.005 (.013)
No. of HH member aged 13-17	1.068 (.106)	1.061 (.106)	.012 (.016)	.014 (.016)
No. of HH member aged 6-12	1.225*** (.099)	1.224*** (.099)	.026* (.015)	.026* (.014)
No. of HH member aged 0-5	1.193* (.111)	1.191* (.111)	.027 (.016)	.027* (.015)
HH income (million_IDR)	.994 (.004)	.994 (.004)	-.000 (.000)	-.000 (.000)
HH assets (million_IDR)	.999 (.000)	.999 (.000)	-8.80e-06 (.000)	-9.06e-06 (.000)
HH borrowing (million_IDR)	.978 (.019)	.977 (.019)	-.000 (.000)	-.000 (.000)
No. of primary schools in the village	1.155** (.066)	1.160** (.067)	.021** (.009)	.020** (.009)
No. of junior high school in the village	.750*** (.074)	.741*** (.075)	-.039*** (.015)	-.037* (.021)
Province fixed effects	yes	yes	yes	yes
(constant)	.006*** (.005)	.007*** (.006)	-.292* (.175)	-.325** (.132)
Pseudo R-squared	0.1378	0.1375		
LR chi2(32)	196.63	196.23		
Wald chi2 (32)			211.90	212.54
R-squared			0.1383	0.1409

Notes: Asterisks denote the following:

*indicates significance at 10%; **indicates significance at 5%; *** indicates significance at 1%. Standard errors are in parentheses