

Economic and Environmental Well-Being for Smallholder Famers:

Can We Avoid Worse-Before-Better Dynamics In Transitioning To Organic Farming?

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APPENDIX I– COMPARATIVES OF CONVENTIONAL VS. ORGANIC FARMING

The table below shows the Comparative Costs of Cultivation for Conventional (i.e., inorganic) vs. Organic Farming's, as distilled from Tej Pratap (2006).

CROP	Percentage Point Difference in Inorganic (Chemical) over Organic	
	Total Cost of Cultivation (Rs/Ha)	Net Profit (Rs./Ha.)
Pepper	-30.98	17.11
Coffee	-13.85	37.18
Pulses	-6.77	20.21
Tea	-6.53	74.11
Arecanut	-2.95	4.70
Jhingora	-0.44	-0.79
Psyllium	-0.22	-25.41
Ragi	0.66	15.82
Barley	1.38	2.14
Yellow and Black Mustard	4.90	-18.58
Potato (Tamil Nadu)	7.05	24.07
Sugarcane	7.37	-18.26
Wheat	7.81	14.4
Caster Oil	9.38	-31.28
Soybean	9.56	-103.98
Paddy	10.56	-4.18
Cumiin	10.65	-37.38
Brown Mustard	12.59	-11.91
Cabbage	13.65	-10.42
Coconut	14.55	-34.87
Potato (Karnataka)	14.94	-16.03
Medicinal and Aromatic	20.79	-0.58
Pearl Millet	32.99	-59.05
Apples	68	31
Banana	68	31
Cotton	69.47	-150

APPENDIX II- GUIDANCE FOR REPRODUCING MODEL RUNS

NOTE: Error! Reference source not found. provides the model initialization. The guidance offered below for reproducing model runs lists only those parameters that change from the specifications in Table 1.

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Use parameterization from Error! Reference source not found.

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Parameter	Value
Switch to Test Overfertilization Ramp	1
Exogenous Switch for Organic Adoption	0

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Parameter	Value
Switch to Test Overfertilization Ramp	0
Exogenous Switch for Organic Adoption	1
Exogenous Percentage of Required Fertilizer Actually Applied Per Acre	1.8

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Parameter	Value
Switch to Test Overfertilization Ramp	0
Exogenous Switch for Organic Adoption	1
Exogenous Percentage of Required Fertilizer Actually Applied Per Acre	1.8, 1.85, 1.9, 1.95, 2.0

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Parameter	Value
Switch to Test Overfertilization Ramp	0
Exogenous Switch for Organic Adoption	1
Exogenous Percentage of Required Fertilizer Actually Applied Per Acre	1.8

Applied Per Acre	
Exogenous Cost Per Acre Organic	12000, 13500, 15000, 16500, 18000

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Parameter	Value
Switch to Test Overfertilization Ramp	0
Exogenous Switch for Organic Adoption	1
Exogenous Percentage of Required Fertilizer Actually Applied Per Acre	1.8
Time for Organic Soil to Develop	1, 2, 3, 4, 5

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Parameter	Value
Switch to Test Overfertilization Ramp	0
Exogenous Switch for Organic Adoption	1
Exogenous Percentage of Required Fertilizer Actually Applied Per Acre	1.8
Adjustment Time	.5, 1, 1.5, 2, 2.5

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Parameter	Value
Switch to Test Overfertilization Ramp	0
Exogenous Switch for Organic Adoption	1
Exogenous Percentage of Required Fertilizer Actually Applied Per Acre	1
Exogenous Switch for Health Hazard	1
Exogenous Health Hazard	0.95, 0.96, 0.97, 0.98, 0.99, 1.0

APPENDIX III- MODEL DOCUMENTATION

"% Profit Retained"=

$100 * (\text{Total Profit} / \text{Max Profit Possible})$

Units: Dmnl

Acres Under Conventional= INTEG (

$-\text{Organic Adop Rate},$
 $2)$

Units: acres [0,2]

Number of acres currently under conventional practices

Acres Under Organic= INTEG (

$\text{Organic Adop Rate},$
 $0)$

Units: acres [0,2]

Number of acres currently under organic practices

Adjustment Time=

1

Units: years

Time it takes to adopt organic farming

Attractiveness of conventional=

$(\text{Conventional Profit} / \text{Reference Profit}) * \text{Weight of profit on attractiveness}$

Units: Dmnl

Attractiveness of conventional farming based on profits

(including capacity and cost of inputs, as well as yield)

Attractiveness of organic=

$\text{Motivation to Adopt Organic} * \text{Weight of motivation on attractiveness} + (\text{Organic Profit} / \text{Reference Profit}) * \text{Weight of profit on attractiveness}$

Units: Dmnl

Attractiveness of organic farming based on profits (including capacity and cost of inputs, as well as yield) and motivation (i.e, social factors)

Conventional Cost=

$((\text{Percent of Costs Spent on Fertilizer} * \text{Exogenous Cost Per Acre Conventional} * \text{Percent of Required Fertilizer Actually Applied Per Acre}) +$

$((1 - \text{Percent of Costs Spent on Fertilizer}) * \text{Exogenous Cost Per Acre Conventional})) * \text{Acres Under Conventional}$

Units: Rs

Cost of farming conventionally, as determined by cost per acre and # acres under conventional, as well as the % of costs that are spent on fertilizer and the amount of fertilizer applied relative to the ideal amount (i.e., over fertilization will raise costs, while under fertilization will save money). If fertilization is applied effectively, costs will equal Exogenous Cost per Acre Conventional

Conventional Profit=

$\text{Conventional Revenue} - \text{Conventional Cost}$

Units: Rs

total profit from conventional farming

Conventional Revenue=

Conventional Yield*Crop Price Per Q

Units: Rs [0,?]

Revenue from conventional farming, as determined by number of Q
produced and price/Q

Conventional Yield=

Conventional Yield Per Acre*Acres Under Conventional

Units: Q

total yield of conventional crops

Conventional Yield Per Acre=

Effect of Soil Health on Yield(Soil Health Conventional)*Max Con-
ventional Yield Per Acre

Units: Q/acre [0,?]

Yield of conventional farming in Q/acre based on Soil Health

Crop Price Per Q=

600

Units: Rs/Q [600,900]

Exogenous price (Rs) for a Q of crops

Desired Organic Acres= ACTIVE INITIAL (

Rel Attractiveness of Organic*Total Acres,
Acres Under Organic)

Units: acres

Number of acres a farmer wants to put under organic farming,
based on the conventional and organic economics plus
motivational factors

Effect of Soil Health on Yield(

[(0,0),(1,1)],(0,0),(0.0488798,0.247619),(0.14053,0.5),(0.334012,
0.752381),(0.568228,0.928571),(0.753564,0.985714),(1,1))

Units: Dmnl

Relationship between soil health and yield of crops. As SH
increases, yield increases

Exogenous Cost Per Acre Conventional=

15000

Units: Rs/acre [0,15000]

Cost per acre of farming conventionally. This includes labor,
seeds, water, and any capital costs (amortized overtime and
per acre). This does NOT include fertilizer.

Exogenous Cost Per Acre Organic=

15000

Units: Rs/acre [0,15000]

Cost per acre of farming conventionally. This includes labor,
seeds, water, and any capital costs (amortized overtime and
per acre). This does NOT include fertilizer.

Exogenous Health Hazard=

0.95

Units: Dmnl

Maximum Health Hazard, as perceived due to exogenous factors

Exogenous Percentange of Required Fertilizer Actually Applied Per Acre=

1.8

Units: Dmnl [0,2]

Initialized to 1 = adequate fertilization.

Exogenous Switch for Organic Adoption=

1

Units: Dmnl [0,1]

Control mechanism to enable/disable acres from converting to
organic farming 1 = organic farmig enabled 0 = cannot adopt
organic

Max Conventional Yield Per Acre=

40

Units: Q/acre [40,50]

average yield in organic farming per acre

Max Cost Possible=

Total Acres * MAX(Exogenous Cost Per Acre Conventional, Exogenous
Cost Per Acre Organic
)

Units: Rs

Maximum Cost Possible

Max Organic Yield Per Acre=

40

Units: Q/acre [20,50]

average yield in organic farming per acre

Max Profit Possible=

Max Revenue Possible - Max Cost Possible

Units: Rs

Maximum Profit Possible

Max Revenue Possible=

Total Acres * MAX(Max Conventional Yield Per Acre, Max Organic
Yield Per Acre) * Crop Price Per Q

Units: Rs

Maximum Profit Possible

Motivation to Adopt Organic=

Effect of Health Hazard on Motivation to Adopt Organic(Health
Hazard)

Units: Dmnl

Motivation to adopt organic farming based on social factors
(rather than economic), such as health hazard from chemical
farming practices and current state of chemical farming
yields

Organic Adop Rate=

(Exogenous Switch for Organic Adoption * STEP(1 , Time for
Switching to Organic) + (1 - Exogenous Switch for Organic Adop-
tion)) * (MIN(Acres Under Conventional,(MAX(0,Desired Organic
Acres-Acres Under Organic)))/Adjustment Time)

Units: acres/year

Rate at which acres are converted from conventional farming to
organic farming acres cannot be moved back to conventional

Organic Cost=

Exogenous Cost Per Acre Organic*Acres Under Organic

Units: Rs

Cost of farming organically, as determined by cost per acre and
acres under organic

Organic Profit=

Organic Revenue–Organic Cost

Units: Rs

total profit from organic farming

Organic Revenue=

Organic Yield*Crop Price Per Q

Units: Rs [0,?]

Revenue from organic farming, as determined by number of Q
produced and price/Q

Organic Yield=

Organic Yield Per Acre*Acres Under Organic

Units: Q

yield, in Q, of land under organic farming

Organic Yield Per Acre=

Effect of Soil Health on Yield(Soil Health Organic)*Max Organic
Yield Per Acre

Units: Q/acre

Per acre yield of organic farming based on max possible yield
and current practices and soil health

Overfertilization Ramp=

RAMP(0.1 , 10 , 30)

Units: Dmnl

Percent of Costs Spent on Fertilizer=

0.3

Units: Dmnl [0,1,0.05]

% of total cost of farming conventionally that is spent on
fertilizer. Set to 30% based on estimates from Tej
Pratap(2006). The fraction of costs allocated to fertiliz-
ers range
from 25-50% in 27 different crops with a mean of 30%.

Percent of Required Fertilizer Actually Applied Per Acre=

Switch to Test Overfertilization Ramp * Overfertilization Ramp +
(1 - Switch to Test Overfertilization Ramp
) * Exogenous Percentange of Required Fertilizer Actually Applied Per
Acre

Units: Dmnl [0,2]

Ratio of fertilizer actually applied to fertilizer requiried for
maximum soil health 0 means none applied 1 means fertilizer
was applied optimally (100%) 2 means 200% of required fer-
tilizer was applied (excessive)

Reference Profit=

1000

Units: Rs

Profit above which the farmer begins to consider a farming

system.

Rel Attractiveness of Organic=

$$\frac{\text{EXP(Attractiveness of organic)}}{(\text{EXP(Attractiveness of organic)} + \text{EXP(Attractiveness of conventional)})}$$

Units: Dmnl

Relative attractiveness of farming organically compared to farming conventionally

Soil Health Conventional= INTEG (

Conventional Soil Health Development-Conventional Soil Health Degradation,

IF THEN ELSE(Acres Under Conventional > 0, Indicated Conventional Soil Health, 0))

Units: Dmnl [0,?]

Stock of conventional soil health based on health of soil converted from organic and development of soil under conventional, minus degradataion

Soil Health Organic= INTEG (

Organic Soil Health Development-Organic Soil Health Degradation, IF THEN ELSE(Acres Under Organic > 0, Indicated Organic Soil Health, 0))

Units: Dmnl [?,1]

Stock of organic soil health based on health of soil converted from conventional and development of soil under organic, minus degradataion

Switch to Test Overfertilization Ramp=

0

Units: Dmnl

When set to 1, tests the overfertilization ramp

Time for Switching to Organic=

10

Units: year

Time at which the "switch" for organic farming becomes enabled.
This number does not impact the fundamental dynamics, rather it delays the time at which the dynamics occur, making them easier to visualize

Total Acres=

Acres Under Conventional+Acres Under Organic

Units: acres

Total number of acres a farmer has

Total Cost=

Conventional Cost + Organic Cost

Units: Rs

Total Profit=

Conventional Profit + Organic Profit

Units: Rs

Total profit for a farmer. This is an output variable for visualization/callibration

Weight of motivation on attractiveness=

Max Profit Possible/Reference Profit

Units: Dmnl [0,10,0.5]

PLEASE NOTE: This value is computed to 18 in order to provide equal weightage to motivational factors as to profit from the farming system being used. The number 18 comes from Maximum Profit/Reference Profit (which under current calibration is Rs. 18000/1000 = 18). We don't know any different and hence the same weightage. Factor indicating the influence of motivational factors on attractiveness of organic. Higher numbers indicate more weight.

Weight of profit on attractiveness=

1

Units: Dmnl

Factor indicating the influence of economic factors on attractiveness of organic. Higher numbers indicate more weight.