Sustainable Agriculture as an E³ Approach to Reducing Rural/Urban Poverty

Max Maquito, Ph.D.
(UP SOLAIR, SGRA)

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Conventional VS Sustainable Agriculture (Stylized Facts)

- High-Yield Seeds
- High dependence on external inputs
  - Irrigation
  - Agro-chemicals (e.g., herbicides, pesticides, inorganic fertilizers)
  - Tends to use more mechanization and fossil fuels
- Tends toward mono-culture
- Example: The Green Revolution

- Traditional/Indigenous or non-genetically modified seeds
- Low to zero dependence on external inputs
  - Harnessing instead of dominating nature
  - Tends to be labor-intensive
- Tends toward multi-culture
- Example: Organic Farming

What is organic agriculture?

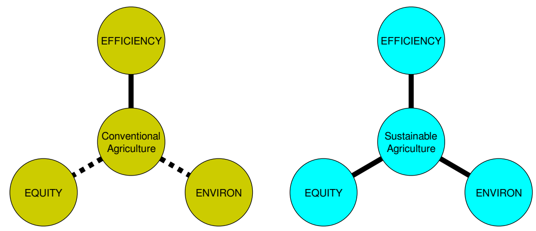
An ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain, or enhance ecological harmony. The primary goal of organic agriculture is to optimize the health and productivity of interdependent communities of soil life, plants, animals and people.

— The U.S. Department of Agriculture National Organic Standards Board

In general, crop produce or products that qualify as organic must be:

1. free from genetic modification;
2. grown without synthetic chemicals; and
3. processed without food additives or ionizing radiation.

Conventional VS Sustainable



Comparison: Efficiency Pretty, et. al. (2006)

TABLE 2. Summary of Adoption and Impact of Agricultural Sustainability Technologies and Practices on 286 Projects in 57 Countries[a]

FAO farm system category	number of farmers adopting	number of hectares under sustainable agriculture	average % increase in crop yields
1. smallholder irrigated	177,287	357,940	129.8 (±21.5)
2. wetland rice	8,711,236	7,007,564	22.3 (±2.8)
3. smallholder rainfed humid	1,704,958	1,081,071	102.2 (±9.0)
4. smallholder rainfed highland	401,699	725,535	107.3 (±14.7)
5. smallholder rainfed dry/cold	604,804	737,896	99.2 (±12.5)
6. dualistic mixed	537,311	26,846,750	76.5 (±12.6)
7. coastal artisanal	220,000	160,000	62.0 (±20.0)
8. urban-based and kitchen garden	207,479	36,147	146.0 (±32.9)
all projects	12,564,774	36,952,903	79.2 (±4.5)

[a] Yield data from 360 crop project combinations; reported as % increase (thus a 100% increase is a doubling of yields). Standard errors are given in brackets.

Comparison: Efficiency Rodale Institute (2011)

RODALE INSTITUTE

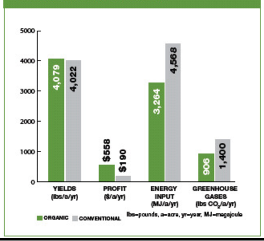
Founded in 1947 by organic pioneer J.I. Rodale to study the link between healthy soil, healthy food and healthy people. He moved from NYC to rural Pennsylvania in the late 1930's where he was able to realize his keen personal interest in farming.

Comparison: Efficiency Rodale Institute (2011)

FST FACTS

- Organic yields match conventional yields.
- Organic outperforms conventional in years of drought.
- Organic farming systems build rather than deplete soil organic matter, making it a more sustainable system.
- Organic farming uses 45% less energy and is more efficient.
- Conventional systems produce 40% more greenhouse gases.
- Organic farming systems are more profitable than conventional.

COMPARISON OF FST ORGANIC AND CONVENTIONAL SYSTEMS

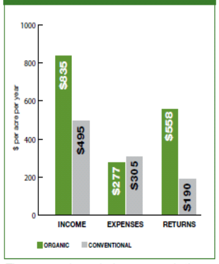


Comparison: Efficiency Rodale Institute (2011)

FROM FST, we have found that:

- **The organic systems were nearly three times more profitable than the conventional systems.** The average net return for the organic systems was $558/acre/year versus just $190/acre/year for the conventional systems.
- **Even without a price premium, the organic systems are competitive with the conventional systems.** Marginally lower input costs make the organic systems economically competitive with the conventional system, even at conventional pricing.
- The most profitable grain crop was the organically grown wheat netting $835/acre/year.
- No-till conventional corn was the least profitable crop netting just $27/acre/year.

INCOME, EXPENSES & RETURNS IN FST ORGANIC AND CONVENTIONAL SYSTEMS

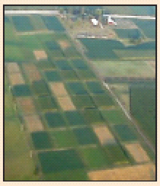


The economic analysis covers only the time period 2008-2010 to reflect data collected for the most recent cropping system comparisons.

Comparison: Efficiency Iowa State U. (2011)

What is LTAR?

LTAR is a randomized, replicated comparison of organic and conventional agriculture near Greenfield, Iowa—one of the longest running replicated comparisons in the country. The project began in 1998 with support from the Leopold Center for Sustainable Agriculture, as part of the Organic Agriculture Program at Iowa State University.



The project compares the following crop rotations using identical crop varaities, each repeated four times in 44 plots:

- Conventional corn-soybean (2 year)
- Organic corn-soybean-oat/alfalfa (3 year)
- Organic corn-soybean-oat/alfalfa-alfalfa (4 year)
- Organic soybean-wheat/red clover (2 year)

Comparison: Efficiency Iowa State U. (2011)

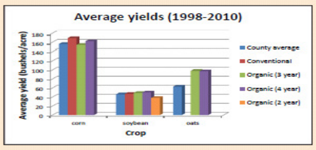
Farming practices

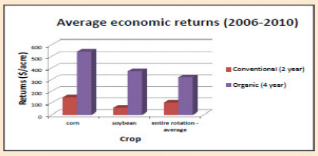
- The conventional rotation receives synthetic nitrogen amendments, herbicides and pesticides according to Iowa State University recommended rates.
- The organic plots receive local compost made from a mixture of corn stover and manure.
- Organic corn and soybean plots receive an average of two rotary-hoeings and two row cultivations per season for weed management.
- A 30-foot buffer separates the organic and conventional plots.
- The U.S. Department of Agriculture's National Organic Program certifies the organic plots annually.
- Crops are mechanically harvested with combines and hay rakers/balers.

Comparison: Efficiency Iowa State U. (2011)

Similar yields produced

- Averages from 13 years of the LTAR experiment show that yields of organic corn, soybean and oats have been equivalent to or greater than conventional counterparts.
- A 12-year average for alfalfa and 8-year average for winter wheat also show no significant difference between organic yields and the county averages.





Above: Organic rotations offer similar yields and much higher returns to management (after deducting labor, land and production costs) than conventional crops.

Comparison: Efficiency Iowa State U. (2011)

Organic offers greater profit

- On average, returns to management (after deducting labor, land and production costs) for organic systems are **roughly $200 per acre greater** than conventional returns, according to actual LTAR data and modeling.
- Organic systems have lower production costs because they eliminate the need for expensive herbicides and synthetic fertilizers.
- Organic crops have higher value on the market.

Comparison: Equity

- What is the effect of conventional agriculture on poverty reduction (→ ↑ equity) ?
- Let's use the Green Revolution to represent conventional agriculture adopted to developing countries
- Green revolution is claimed to be scale-neutral
  - It could be adopted by farmers irrespective of their farm size
  - The adoption of High-Yield Variety (HYVs) occurred quickly.
    - By 1970, about 20 percent of the wheat area and 30 percent of the rice area in developing countries were planted to HYVs
    - by 1990, the share had increased to about 70 percent for both crops.

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Comparison: Equity

- Studies have shown mixed results
  - Early studies indicated that the GR was bad for small (poor) farmers
  - Recent studies cites some counter-examples
- International Food Policy Research Institute (IFPRI): GR also worked for small (poor) farmers, depending on their access to
  - Land, with secure ownership or tenancy rights
  - Efficient input, credit, and product markets
  - Policies that do not discriminate against small farms and landless laborers (e.g., no subsidies on mechanization, no scale biases in agricultural research and extension)

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Comparison: Equity (Comment)

- However, conditions cited by IFPRI do not tend to be scale-neutral but scale-biased (in favor of large farms), especially in (but not limited to) the case of developing countries
  - Large farms tend to have more secure ownership
  - Large farms tend to have easier access to credit, inputs, and product markets
  - Large farms tend to have more political clout

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Comparison: Equity (Comment)

- Deninger and Squire (1998): LDCs 1960s to 1990s → land distribution is not optimal (WB)
  - There is a strong negative relationship between initial inequality in the asset distribution and long-term growth
  - Asset (land) distribution inequality reduces income growth for the poor, but not for the rich
  - There is little support for inequality to improve as a country develops

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Comparison: Equity (Comment)

- Gupta, et. al. (1998): LDCs 1980s-1997 → corruption (ability of powerful people to influence government policies) is not good for improving income inequality and poverty (IMF)
  - Reduction in
    - economic growth
    - progressivity of the tax system
  - Perpetuates
    - an unequal distribution of asset ownership
    - an unequal access to education

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Comparison: Environment Pretty, et. al. (2006)

TABLE 3. Summary of Changes in Water Productivity by Major Crop Type Arising from Adoption of Sustainable Agricultural Technologies and Practices in 144 Projects[a]

crop	water productivity before intervention (kg food m^{-3} water ETa)	water productivity after intervention (kg food m^{-3} water ETa)	water productivity gain (kg food m^{-3} water ETa)	% increase in WP
irrigated				
rice (n = 18)	1.03 (±0.22)	1.19 (±0.12)	0.16 (±0.04)	15.5%
cotton (n = 8)	0.17 (±0.04)	0.22 (±0.05)	0.05 (±0.02)	29.4%
rainfed				
cereals (n = 80)	0.47 (±0.06)	0.80 (±0.09)	0.33 (±0.05)	70.2%
legumes (n=19)	0.43 (±0.07)	0.87 (±0.16)	0.44 (±0.11)	102.3%
roots and tubers (n=14)	2.79 (±0.73)	5.79 (±1.08)	3.00 (±0.65)	107.5%
urban and kitchen gardens				
vegetables and fruits (n=5)	0.83 (±0.29)	2.96 (±0.97)	2.13 (±0.71)	256.6%

[a] Standard errors in brackets.

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Comparison: Environment
Pretty, et. al. (2006)

TABLE 4. Summary of Potential Carbon Sequestered in Soils and Above-Ground Biomass in the 286 Projects[a]

FAO farm system category	carbon sequestered per hectare ($t\ C\ ha^{-1}\ y^{-1}$)	total carbon sequestered ($Mt\ C\ y^{-1}$)	carbon sequestered per household ($t\ C\ y^{-1}$)
1. smallholder irrigated	0.15 (±0.012)	0.011	0.06
2. wetland rice	0.34 (±0.035)	2.53	0.29
3. smallholder rainfed humid	0.46 (±0.034)	0.34	0.20
4. smallholder rainfed highland	0.36 (±0.022)	0.23	0.56
5. smallholder rainfed dry/cold	0.26 (±0.035)	0.20	0.32
6. dualistic mixed	0.32 (±0.023)	8.03	14.95
7. coastal artisanal	0.20 (±0.001)	0.032	0.15
8. urban-based and kitchen garden	0.24 (±0.061)	0.015	0.07
total	0.35 (±0.016)	11.38	0.91

[a] Standard errors in brackets.

Comparison: Environment
Pretty, et. al. (2006)

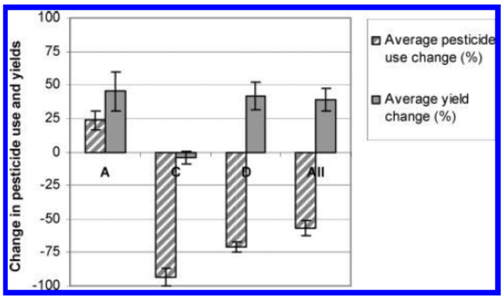


FIGURE 5. Changes in pesticide use and yields in 62 projects (A, $n = 10$; C, $n = 5$; D, $n = 47$).

Comparison: Environment
Rodale Institute (2011)

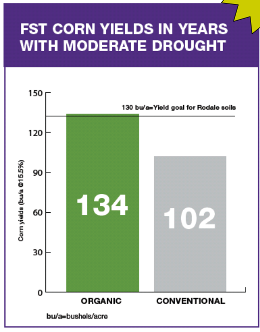
- **Soil health in the organic systems has increased over time while the conventional systems remain essentially unchanged.** One measure of soil health is the amount of carbon contained in the soil. Carbon performs many crucial functions such as acting as a reservoir of plant nutrients, binding soil particles together, maintaining soil temperature, providing a food source for microbes, binding heavy metals and pesticides, influencing water holding capacity and aeration, and more. More carbon is better!

Soils in the organic and conventional plots are very different in appearance due to the increase in soil organic matter in the organically managed soils. The organically managed soil is darker and aggregates are more visible compared to the conventionally managed soil.

Comparison: Environment
Rodale Institute (2011)

BONUS

- **Organic corn yields were 31% higher than conventional in years of drought.** These drought yields are remarkable when compared to genetically engineered "drought tolerant" varieties which saw increases of only 6.7% to 13.3% over conventional (non-drought resistant) varieties.
- **Corn and soybean crops in the organic systems tolerated much higher levels of weed competition than their conventional counterparts, while producing equivalent yields.** This is especially significant given the rise of herbicide-resistant weeds in conventional systems, and speaks to the increased health and productivity of the organic soil (supporting both weeds and crop yields).



Comparison: Environment
Rodale Institute (2011)

BONUS

GENETICALLY MODIFIED CROPS

According to the Department of Agriculture, 94% of all soybeans and 72% of all corn currently grown in the United States are genetically modified to be herbicide-tolerant or express pesticides within the crop. So, in 2008, genetically modified (GM) corn and soybeans were introduced to FST to better represent agriculture in America. GM varieties were incorporated into all the conventional plots.

We incorporated the GM crops to reflect current American agriculture, rather than to specifically study their performance. Our data only encompasses three years, but the research being done in the community at large highlights some of the clear weaknesses of GM crops:

Comparison: Environment
Rodale Institute (2011)

BONUS

- **Farmers who cultivated GM varieties earned less money** over a 14-year period than those who continued to grow non-GM crops according to a study from the University of Minnesota.
- **Traditional plant breeding and farming methods have increased yields of major grain crops three to four times more than GM varieties** despite huge investments of public and private dollars in biotech research.
- **There are 197 species of herbicide-resistant weeds, many of which can be linked directly back to GM crops,** and the list keeps growing.

Pesticides commonly used in agriculture have been found in drinking water, sometimes at levels above regulatory thresholds.

- **GM crops have led to an explosion in herbicide-use** as resistant crops continue to emerge. In particular, the EPA approved a 20-fold increase in how much glyphosate (Roundup®) residue is allowed in our food in response to escalating concentrations.

Comparison: Environment
Iowa State U. (2011)

Soil quality improved

- Total nitrogen increased by 33 percent in the organic system.
- Researchers measured higher concentrations of carbon, potassium, phosphorous, magnesium and calcium in the organic soils.
- Organic soils have lower acidity.
- The results suggest that organic farming can create greater efficiency in nutrient use and higher carbon sequestration potential.

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Comparison: Environment
IFPRI (2002)

These problems are slowly being rectified without yield loss, and sometimes with yield increases, thanks to policy reforms and improved technologies and management practices, such as pest-resistant varieties, biological pest control, precision farming, and crop diversification

- The Green Revolution has also been widely criticized for causing environmental damage.
  - Excessive and inappropriate use of fertilizers and pesticides has polluted waterways, poisoned agricultural workers, and killed beneficial insects and other wildlife.
  - Irrigation practices have led to salt build-up and eventual abandonment of some of the best farming lands.
  - Groundwater levels are retreating in areas where more water is being pumped for irrigation than can be replenished by the rains.
  - heavy dependence on a few major cereal varieties has led to loss of biodiversity on farms.

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The Green Revolution (緑の革命)

- **Green Revolution** refers to a series of research, development, and technology transfer initiatives, occurring between the 1940s and the late 1970s, that increased agriculture production around the world, beginning most markedly in the late 1960s
- The term "Green Revolution" was first used in 1968 by former United States Agency for International Development (USAID) director William Gaud, who noted the spread of the new technologies and said,
  - "These and other developments in the field of agriculture contain the makings of a new revolution. It is not a violent Red Revolution like that of the Soviets, nor is it a White Revolution like that of the Shah of Iran. I call it the Green Revolution."

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The Green Revolution (緑の革命)

- The initiatives, led by Norman Borlaug, the "Father of the Green Revolution" credited with saving over a billion people from starvation, involved the development of high-yielding varieties of cereal grains, expansion of irrigation infrastructure, modernization of management techniques, distribution of hybridized seeds, synthetic fertilizers, and pesticides to farmers.
- The agricultural development that began in Mexico by Norman Borlaug in 1943 had been judged as a success and the Rockefeller Foundation sought to spread it to other nations.
- The Office of Special Studies in Mexico became an informal international research institution in 1959, and in 1963 it formally became CIMMYT, The International Maize and Wheat Improvement Center
- In 1961 India was on the brink of mass famine. Borlaug was invited to India by the adviser to the Indian minister of agriculture M. S. Swaminathan. Despite bureaucratic hurdles imposed by India's grain monopolies, the Ford Foundation and Indian government collaborated to import wheat seed from CIMMYT

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The Green Revolution (緑の革命)

- India soon adopted IR8 – a semi-dwarf rice variety developed by the International Rice Research Institute (IRRI) that could produce more grains of rice per plant when grown with certain fertilizers and irrigation
  - In 1960, the Government of the Republic of the Philippines with Ford and Rockefeller Foundations established IRRI (International Rice Research Institute). A rice crossing between Dee-Geo-woo-gen (China) and Peta (Indonesia) was done at IRRI in 1962

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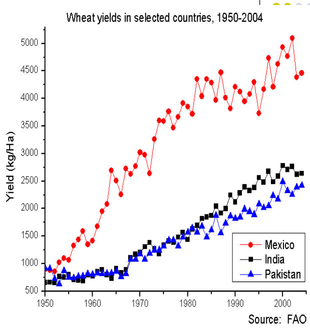
The Green Revolution (緑の革命)


Borlaug speaking at the Ministerial Methodist Conference and Expo on Agricultural Science and Technology in June 2003
Nobel Peace Prize in 1970



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The Green Revolution (緑の革命): Comment

- No intention to question the humanitarian motives of Dr. Borlaug and the GR
- The GR was an available response to the food crisis that was hitting Asia then
- However, the following could be noted
  - Large scale social experiments have to be avoided as much as possible,
    - since any error will correspondingly have great repercussions
  - GR was not the only response available then
    - For example: the traditional farming techniques of peasants in Latin America

The Green Revolution (緑の革命): Comment--Altieri (1999)

TABLE I. Estimated arable land and population on steep slopes of selected latin american countries and their contribution to total agricultural output[a]

Country	% land farmed on slopes	Agricultural population (%)	Percent contribution to agricultural output (including coffee)	Contribution to country's total agricultural production	
				Corn (%)	Potato (%)
Ecuador	25	40	33	50	70
Colombia	25	50	26	50	70
Peru	25	50	21	20	50
Guatemala	75	65	25	50	75
El Salvador	75	50	18	50	—
Honduras	80	20	19	40	100
Haiti	80	65	30	70	70
Dominican Republic	80	30	31	40	50

[a]Modified after Posner and McPherson (1982).

The Green Revolution (緑の革命): Comment--Altieri (1999)

TABLE II. Maize yields from chinampa plots during the 1950s

Location	Plot Size (ha)	Yield (kg/ha)
Tlahuac	0.32	5500
	0.10	3750–4500
	0.16	4650–5500
	0.10	3750–4500
	0.16	4650
	0.16	6300
San Gregorio	0.20	3750–4500
	0.21	3600–4350
	0.10	3750–4500
	0.12	4950

Source: Sanders (1957).

The Green Revolution (緑の革命): Comment--Altieri (1999)

TABLE III. Yields and total biomass of maize, beans, and squash (kg ha^{-1}) in polyculture as compared with several densities (plants ha^{-1}) of each crop in monoculture

Crop	Monoculture				Polyculture
Maize					
Density	33 000	40 000	66 600	100 000	50 000
Yield	990	1150	1230	1170	1720
Biomass	2823	3119	4487	4871	5927
Beans					
Density	56 800	64 000	100 000	133 200	40 000
Yield	425	740	610	695	110
Biomass	853	895	843	1390	253
Squash					
Density	1200	1875	7500	30 000	3330
Yield	15	215	430	225	80
Biomass	241	841	1254	802	478
Total polyculture yield					1910
Total polyculture biomass					6659

Source: Gliessman (1998).

The Green Revolution (緑の革命): Comment--Altieri (1999)

- traditional farmers have developed and/or inherited complex farming systems, adapted to the local conditions,
- that have helped them to sustainably manage harsh environments and to meet their subsistence needs,
- without depending on mechanization, chemical fertilizers, pesticides or other technologies of modern agricultural science

The Green Revolution (緑の革命): Comment--Altieri (1999)

- Many scientists wrongly believe that traditional systems do not produce more because hand tools and draft animals put a ceiling on productivity.
- Productivity may be low but the causes appear to be more social, not technical. When the subsistence farmer succeeds in providing food, there is no pressure to innovate or to enhance yields.
- Nevertheless, agro-ecological field projects show that traditional crop and animal combinations can often be adapted to increase productivity when the biological structuring of the farm is improved and labor and local resources are efficiently used

The Green Revolution (緑の革命): Comment--Altieri (1999)

TABLE IX. Extent and impacts of agroecological technologies and practices implemented by NGOs in peasant farming throughout Latin America

Country	Organization involved	Agroecological intervention	No. of farmers or farming units affected	No. of hectares affected	Dominant crops	Yield inc
Brazil	EPAGRI AS-PTA	Green manures cover crops	38 000 families	1 330 000	Maize, wheat	198–246%
Guatemala	Altertec and others	Soil conservation, green manures, organic farming	17 000 units	17 000	Maize	250%
Honduras	CIDDICO COSECHA	Soil conservation, green manures	27 000 units	42 000	Maize	250%
EL Salvador	COAGRES	Rotations, green manures, compost, botanical pesticides	> 200 farmers	nd	Cereals	40–60%
Mexico	Oaxacan Cooperatives	Compost, terracing, contour planting	3000 families	23 500	Coffee	140%
Peru	PRAVTIR CIED	Rehabilitation of ancient terraces	> 1250 families	> 1000	Andean Crops	141–165%
	PIWA-CIED	Raised fields	nd	250	Andean crops	333%
	CIED	Watershed agricultural rehabilitation	> 100 families	N/A	Andean Crops	30–50%
	IDEAS	Intercropping, agroforestry, composting	12 families	25	Several Crops	20%
Dominican Republic	Plan Sierra Swedforest-Fudeco	Soil conservation, dry forest management silvopastoral systems	> 2500 families	> 1000	Several Crops	50–70%
Chile	CET	Integrated farms, organic farming	> 1000 families	> 2250	Several Crops	> 50%
Cuba	ACAO	Integrated farms	4 cooperatives	250	Several Crops	50–70%

nd = no data.
Source: Browder (1989), Altieri (1995), Pretty (1997).

Let us work together towards sustainable shared growth for the Philippines!

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