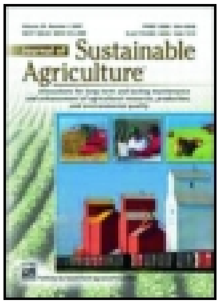

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Biointensive Sustainable Mini-Farming: III. System Performance–Initial Trials

John C. Jeavons

ABSTRACT. The purpose of this paper is to: briefly describe the system performance of the "Grow Biointensive" method of agriculture in the initial trials at Palo Alto, California in a C-horizon molisol material including water use; first year yields; and a second year comparative experiment with broccoli. The data collected at this site, Ecology Action's newer site in northern California near Willits and at the related projects in India and Russia described in this series of articles have not been developed and analyzed on a statistical basis. The results in the different soils, climates and geographic regions involved appear to be significant enough over an almost three decade period to merit statistical evaluation by academic institutions. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-342-9678. E-mail address: <getinfo@haworthpressinc.com> Website: <http://www.HaworthPress.com> 2001 by The Haworth Press, Inc. All rights reserved.]*

KEYWORDS. Biointensive, small-scale, high-yielding, resource-conserving, organic

SYSTEM PERFORMANCE–RESULTS AND DISCUSSION

The Biointensive sustainable mini-farm data collected by Ecology Action and individuals, projects and programs associated with it have not to

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date been statistically developed or analyzed. It has been the goal to demonstrate the potential of the Biointensive system and to leave to others at universities and institutes with larger budgets the complete development of this potential with full academic vigor and statistical analysis including the proper controls. Our results have been uneven over the years as we have been redeveloping the understanding of biologically intensive food raising; changing research sites, soils, climates and water sources; working with an ever-changing group of staff, volunteers, interns and apprentices of different national and educational backgrounds, talents and abilities; and proceeding with limited and uneven funding. *The results of our tests* have varied from crop failures to very significant yields and, all things considered, *have been promising overall*. Some highlights are described below.

Early Work in Palo Alto

In 1972 Ecology Action's non-profit Biointensive self-help food-raising program began in the Stanford University Industrial Park on Syntex Corporation land in Palo Alto, California. Essentially all the topsoil and subsoil had been removed from the mini-farm site during an earlier construction process. The material farmed was a *molisol C-horizon material with a gravelly, sandy clay loam with more soil fertility potential than the soil at the later Willits, California, location*. In addition, the climate was more favorable and the water better. Ecology Action's experience at the Palo Alto site demonstrated the Biointensive method's capacity to build soil, not just to rebuild and maintain soil fertility. Increased productivity with reduced resource consumption per kilogram (pound) of food produced occurred. The level of these increases and reductions is significant and is touched upon by the results noted below.

Water

At Ecology Action's first mini-farming site in Palo Alto, water usage tests were performed. In Santa Clara County as a whole, the *year-round (including both hot and cold growing periods)* water consumption average per day per 9.3 square meters (100 square feet) was about 75.7 litres (20 gallons). At the beginning, Biointensive water consumption was similar at the *hottest time of the year*. As the soil's quality was improved by Biointensive techniques, water consumption at the hottest time of the year dropped five years later, in 1977, to 37.8 liters (10 gallons) per day per 9.3 square meters (100 square feet). This test, using a water meter which measured to the tenth of a gallon, was run on 20 of the 110 test beds. These beds represented a wide spectrum of the crops being grown at all stages of growth. The water consumption per 9.3 square meters (100 square feet) ranged from 30.2 to 113.5 liters (8 to 30 gallons) per day with only one bed each consuming 30.2 and 113.5 liters (8 and 30 gallons). One year later, the average water consumption dropped to approximately 30.2 liters (8 gallons). See Table 1.

The potential exists for Biointensive yields of two to four times the U.S. average per unit of area combined with a 50 to 60 percent reduction in water use per day per unit of area (37.8 to 30.2 litres per 9.3 square meters [10 to 8 gallons of water use per day per 100 square feet]). *This could allow the consumption of water per pound of food produced to be reduced to as low as one-quarter to one-eighth of the amount used by conventional practices depending on the soil and climate involved.* The potential could

TABLE 1. Water Use in the Palo Alto, California, Area (Temperate) per 100 Square Feet (Average, Unless Otherwise Noted)

SPECIFIC DATA	Time Frame	Water Use per 4-Month Crop	Water Use per Day
Commercial agriculture average (1972), Santa Clara County, CA[1]	Year-round average	2,400 gallons [9,085 litres]	20 gallons [76 litres]
Biointensive Unimproved soil (1972)[2]	Hottest time of year	2,400 gallons [9,085 litres]	20 gallons [76 litres]
Biointensive 5-year soil improvement (1977)[2]	Hottest time of year	1,200 gallons [4,542 litres]	10 gallons (5-30 gallons) [38 litres (19-114 litres)]
Biointensive 6-year soil improvement (1978)[2]	Hottest time of year	960 gallons [3,634 litres]	8 gallons [30 litres]
GENERALIZATIONS for temperate areas			
Biointensive	Year-round		4-15 gallons [15-57 litres]
Biointensive	Hottest time of year		8-30 gallons [30-114 litres]

[1] Also considered to be a standard water consumption amount in a large number of temperate and some tropical regions.
[2] Based on tests in Palo Alto, Santa Clara County, CA.

mean that, if similar water-conserving practices had been used on a state-wide level, California might not have experienced a drought during the 1990 through 1996 period, as "one year's worth" of normal agricultural water use could have been sufficient for more than one year.

After much evaluation it appears that the factors which make Biointensive food-raising water-efficient include the following:

- Research by others has shown that soil which has organic matter as 2 percent of its volume in the upper 11 inches of soil can *reduce* the rainfall or irrigation required for poor soils by *as much as 75 percent* (Poor soils contain about 1/2 of 1 percent organic matter in their upper soil area. Biointensive practices encourage maintaining an even higher amount of organic matter than this 2 percent amount) (Wilson, 1968).
- Even under arid conditions, soil which is shaded may *reduce evaporation up to 62 percent,* depending on soil type. The *mini-climate* from closely spaced plants provides good shading (Widtsoe, 1919, pp. 150-151).
- *Transpiration* of water by the plant can be *reduced as much as 75 percent* in soils which contain good quantities of nutrients in the soil water. The Biointensive method prepares the soil in a manner which provides for a high level of fertility (Widtsoe, 1919, pp. 174-192; Tisdale, 1993).

One of the most important themes in the future is going to be how to increase yields with a reduction in resource consumption. If resources are utilized wisely, people can live well with fewer resources. "Grow Biointensive" practices are based upon a natural efficiency of resource use, utilizing the same elements as other forms of agriculture–soil, water, nutrients, seeds, and the energy from the sun–combined in a synergistic manner, with the result being that there can be sufficient resources for the world's population for years to come. The need for good programs of family planning in the future cannot be overemphasized, however. In many situations *Biointensive practices can transform a situation of relative scarcity into one of comparative abundance.* For agricultural water consumption (due to the combined effectiveness of the three principles noted above), this means that, once soil fertility has been established, as little as 151 kilograms (333 pounds) of water may be needed to grow 0.4 kilogram (1 pound) of grain with Biointensive practices in a bioregion where 453.6 kilograms (1000 pounds) of water is required to grow 0.4 kilogram (1 pound) of grain with conventional practices.

Yields–1972 Preliminary Research Report (Ecology Action, 1973)

Grow Biointensive Sustainable Mini-Farming is not a panacea. Like any tool, these practices can be used well or poorly. When used properly, Grow Biointensive techniques can build the soil up to 60 times faster than in nature (Ecology Action, 1996, Worldwide). If not used properly, these techniques can deplete the soil base where they are used as much as 2 to 6 times more rapidly than other techniques, because of their high level of productivity. The difference is in *how* Grow Biointensive practices are used. When used properly with all its techniques, this approach can, over time, create a fertile, lush soil and micro-climate capable of fostering and building a healthy agricultural system with genetic diversity.

The previously uncultivated C-horizon molisol material at our site in Santa Clara County, California, produced some of the following results with vegetables during the first year. The test areas were 1.8 meters by 5.8 meters or 10.6 square meters (6 feet by 19 feet or 114 square feet). Simple hand tools, such as D-handled spades and spading forks, bow rakes, watering hoses with watering fans, wheelbarrows and 5-gallon buckets, were used. Some of these yields are shown in Table 2 (Note: the "U.S. Good Farmer Average" is two times the "U.S. Average").

For example, in 1972 the yield for bush green beans per unit of area was: 2.4 times the U.S. good farmer yield average; 3.9 times the U.S. average; 1.5 times the California average; and 1.6 times the Santa Clara county, California average–the county the project was in.

Sampling and experimentation with other crops in 1972 indicated that the following yields might occur on a sustained basis after more research was performed. See Table 3.

TABLE 2. 1972 Biointensive Tests Produced Yields Times Greater Than:

	U.S. Good Avg.	U.S. Avg.	Calif. Avg.	Santa Clara County Avg.
Zucchini	3.1	---	---	5.5
Bush Green Beans	2.4	3.9	1.5	1.6
Romaine Lettuce	---	---	1.4	---
Bibb Lettuce	---	---	---	2.3

TABLE 3. 1972 Biointensive Tests Producted Yields Times Greater Than:

	U.S. Good Avg.	U.S. Avg.	Calif. Avg.	Santa Clara County Avg.
Celery	2.5	4.7	4.0	5.0
Cauliflower	1.6	3.6	3.4	4.9
Head Lettuce	1.6	2.0	1.7	2.5
Cabbage	2.3	2.5	2.6	3.4
Beets	2.7	4.2	---	---
Carrots	2.1	2.5	1.8	---
Onions	6.3	7.4	6.5	5.7

For example, the yield for celery per unit of area was: 2.5 times the U.S. good farmer average; 4.7 times the U.S. average; 4.0 times the California average; and 5.0 times the Santa Clara county average.

In 1973, the first test on Utah *hard red spring wheat* produced a low yield of 0.75 times the U.S. average for this crop. In 1979, after seven years of selecting better crop spacings and improving skills and the soil, the test on 12.5-centimeter (5-inch) centers produced a yield *4.5 times* the U.S. average for the grain at the rate of 10,266 kilograms per hectare (9,147 pounds per acre) and *9 times* the U.S. average for the straw and refuse at the rate of 30,801 kilograms per hectare (27,442 pounds per acre) (see also: Revelle, 1976). The latter yield was especially important, because the production of sufficient carbon on a "closed-system" basis is necessary so that enough humus-containing compost can be made to ensure truly sustainable soil fertility. The wheat seedlings for this test were transplanted. Millennia ago the Chinese discovered that transplanted grains produce higher yields, and this Ecology Action grain test produced 25% to 35% more grain than parallel tests which mimicked the broadcasting of seed.

In several different plant spacing/seed depth tests, *potato yields* by 1979 had also reached *four times* the U.S. average or 113.4 kilograms (250 pounds) per 9.3 square meters (100 square feet) in multiple simultaneous tests.

1973 Comparative Experiment with Broccoli

The following broccoli head average yields were obtained in tests performed in 1973 in previously uncultivated, predominantly C-horizon soil material using comparative chemical, organic and Biointensive agricul-

TABLE 4. Comparative Tests with Broccoli

	Approx. Avg. Yield/Head	Approx. Lbs. Yield per 100 Sq. Ft.	Approx. Total Yield Times U.S. Avg.
Chemical	0.08 ounce each	0.4	0.02×
Organic	4.0 ounces each	21.2	0.83×
Biointensive	10.0 ounces each (with 3 times the plants per unit of area due to intensive spacing)	53.1	6.25× (7.5 times greater than organic)

ture approaches. The test with duplicate test areas for each of the three approaches was performed by a volunteer, Wayne Miller, who was a professional researcher employed by Zoecon. Miller possessed a Master's degree in Biochemistry and training in statistical analysis. Note the 7.5 times greater yield between the organic and Biointensive approaches (Ecology Action, 1996, Broccoli). See Table 4.

The Question

The question is: How will the Grow Biointensive agricultural system perform under a more difficult environmental situation?

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