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THE ECONOMIC POTENTIAL FOR INCORPORATING RICE IN EVERGLADES VEGETABLE PRODUCTION SYSTEMS[1]

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Abstract. **Vegetables are grown on about 50 thousand acres of organic soils in the Florida Everglades Agricultural Area each winter season. This land is generally idle during the summer. Growers often flood idle land to help control pests, to improve soil tilth and to reduce biological oxidation of the organic soil. Rice (*Oryza sativa*) is sometimes planted as a cover crop, but is not harvested for grain. An economic analysis reveals that rice could be grown for grain at a profit in rotation with vegetable crops, in spite of additional costs incurred with grain production.**

Over 90 million dollars worth of vegetables are produced annually on about 50 thousand acres in the Everglades Agricultural Area. Crops are produced primarily during the winter season when other vegetable growing regions of the eastern United States are not in production. During the summer months the vegetable land in the Everglades is idle.

The Agricultural Area, which extends south from Lake Okeechobee, is composed of organic soils that generally contain less than 15% mineral matter, by weight. Like all drained organic soils, the Everglades soils are being lost (subsiding) by microbial oxidation. Flooding essentially stops oxidation and, along with the use of high water tables during crop production, can conserve organic soils. Many growers flood their land during the summer to aid in nematode, insect, disease and weed control (11, 12). Flooding is also used to improve soil tilth. Some growers plant rice *(Oryza sativa)* in the summer to further suppress weeds and improve soil tilth. The rice is disked into the soil before any grain is produced.

In this paper we will explore the possibilities of increasing farm income by including one or more rice crops in the normal vegetable production cycle.

Fitting Rice Into The Vegetable Production Cycle

The average time from seeding to maturity of 12 rice varieties tested in Florida in 1953-56 ranged from 127 to 153 days (Table 1). Considerable worldwide emphasis has been placed on rice breeding in recent years. Other varieties with lesser or longer time spans probably have been or could be developed. Rice can be planted from April through July and harvests can be continued through December.

Table 1. Average time from seeding to maturity and grain yield of rice grown in the Florida Everglades in 1953-56.[z]

Grain type and variety	Seeding to maturity time	Grain yield
	days	pounds/acre
Short-grain		
Caloro	149	2023
Cody	127	2559
Colusa	128	2862
Medium-grain		
Arkrose	153	3344
Calrose	148	2073
Magnolia	127	2806
Nato	127	3640
Zenith	129	3232
Long-grain		
Bluebonnet 50	145	3365
Century Patna 231	133	3550
Sunbonnet	143	3758
Toro	144	3594

[z]Average seeding date is March 31. Source: Adair, *et al.* (1).

Vegetable growers generally stagger plantings to provide a more continuous harvest period. Vegetable planting in the Everglades begins in mid to late August and harvest ends in mid-May to late June (Table 2). Thus growers could not wait until all vegetable harvesting ceases before planting rice nor could all rice be harvested before any vegetable planting is started. Growers would have to integrate rice and vegetable operations during certain periods of the year. Using beans or sweet corn as an example, fields that are harvested after the end of March would not normally be replanted until fall, probably no sooner than mid-August, approximately 135 days later. Vegetable planting in the fall could be delayed in those fields that had been harvested later in the previous spring to give the same time interval. Thus it should be possible to fit a crop of one of the earlier maturing rice varieties into this time span. It would be more difficult to fit a crop of rice into a radish operation, but it would be easier to grow rice in rotation with certain leafy crops or potatoes. For example, some lettuce fields could be available from mid-February to the end of August, a period of nearly 200 days. Since vegetable growers do not always

Table 2. Approximate planting and harvesting periods for vegetable crops in the Everglades Agricultural Area.

	Planting		Harvest	
	Begins	Ends	Begins	Ends
Beans *(Phaseolus vulgaris)*	Aug. 15	March 31	Oct. 15	June 30
Sweet Corn *(Zea mays)*	Aug. 15	March 31	Oct. 1	June 15
Lettuce *(Lactuca sativa)*, escarole and endive *(Chicorium endivia)*	Sept. 1	Feb. 15	Nov. 1	May 15
Radish *(Raphanus sativus)*	Sept. 1	May 15	Oct. 1	May 31
Celery *(Apium graveolens* var. *dulce)*	Aug. 15	March 31	Nov. 1	June 30
Parsley *(Petroselinum crispum)*	Aug. 15	March 31	Nov. 1	May 31
Potato *(Solanum tuberosum)*	Sept. 15	Oct. 31	Dec. 15	Feb. 15
Cabbage *(Brassica oleracea* var. *capitata)*	Sept. 1	March 15	Nov. 15	April 30
Chinese Cabbage *(Brassica Pekinensis)*	Sept. 1	March 31	Nov. 15	May 31

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plant the same vegetable crop in a particular field that was grown there the previous season, many combinations of successive vegetable crops are possible. A rice crop should fit into many of these combinations.

An Economic Analysis

Preliminary estimated costs associated with a) planting rice as a cover crop only, and b) planting and harvesting rice for grain, have been developed for the Everglades, using information obtained from local growers and from other sources. Since this past summer has been the first time in 20 years that rice has been grown for grain in the Everglades, the cost figures are based on rather limited information. Nevertheless, the data show in a preliminary way the net change in farm income attributable to harvesting rice, as compared to just growing it for a cover crop.

The cost for planting and growing rice as a cover crop is estimated to be $46.67 per acre, with the cost of seed comprising about half of this total (Table 3). Seed costs are somewhat greater when rice is grown for grain since a higher seeding rate will be used. No costs for fertilizer or pesticides are budgeted for rice grown as a cover crop, but a total of $40 per acre is estimated for these items when rice is grown for grain. Eighty-five percent of this total is for pesticides. More experience is needed to determine how much fertilizer is justified when rice production follows a well fertilized vegetable crop. The total cost of production, including harvesting, is estimated to be $152 per acre. The cash return will vary with the yield and market price (Table 4). Yields of 3.5-4 thousand pounds (35-40 cwt) per acre[2] should be possible (Table 1) and were obtained this past summer. Thus net revenue could vary from $58 to $168 per acre. Growing rice as a cover crop yields no cash return other than that obtained in the subsequent crop. So it might be worth harvesting the grain even if only enough return were realized to pay the cost of keeping the land flooded and maintaining a cover crop during the summer. But from the economic analysis presented here, a profit should be realized in spite of the increased costs incurred when the rice is grown for grain.

Table 3. Estimated costs per acre associated with rice planted as a cover crop and rice planted and harvested for grain on 280 acres in the Florida Everglades, 1977.

Item	Cover Crop	Grown for Grain	Increased Costs
Variable Costs		$	
Seed[z]	23.40	35.10	11.70
Fertilizer, pesticides	0	40.25	40.25
Irrigation[y]	3.07	6.15	3.08
Labor[x]	3.00	9.66	6.66
Machinery and equipment[w]	5.06	16.29	11.23
Machinery hired (aircraft)[v]	3.75	12.75	9.00
Marketing[u]	0	5.00	5.00
Miscellaneous	1.00	3.00	2.00
Fixed Costs			
Machinery and equipment[t]	7.39	23.80	16.41
Land[s]	0	0	0
Irrigation systems[s]	0	0	0
Total Costs	46.67	152.00	105.33

[z]90 and 135 lb, respectively, at $0.26/lb, sowed by aircraft.
[y]Estimated and adapted from similar operations.
[x]At $3.00/hr. and including all operations performed.
[w]Including repairs, fuel and oil, based on Kay *et al.* (7).
[v]Estimate obtained from local companies.
[u]Arbitrarily chosen, varies with yield, market location, transportation.
[t]Including depreciation, interest, insurance and property taxes, based on Kay *et al.* (7).
[s]No charge is made to land or the irrigation system since the opportunity cost in this comparison is zero.

[2]For metric conversions see Table near the front of this Volume. One cwt = 100 lb = 45.4 kg. Ed.

Table 4. Estimated annual returns per acre, assuming different yields and prices, from planting and harvesting rice in the Florida Everglades.

Yield/acre	Price	Total Revenue	Total[z] Costs	Net Revenue
cwt	$/cwt	$	$	$
35	6	210	152	58
35	7	245	152	93
35	8	280	152	128
40	6	240	152	88
40	7	280	152	128
40	8	320	152	168
45	6	270	152	118
45	7	315	152	163
45	8	360	152	208

[z]From Table 3.

Other Considerations

Rice has been grown for grain in the Everglades both commercially and experimentally. Considerable information is available on rice production in this area (3, 4, 5, 6, 9). No major problems appear to preclude rice production in this region but measures must be taken to overcome certain disease and nutritional problems. However, Orsenigo (9) has outlined some production problems that need further research. These include the effect of varieties, growth stage, N and season on *Piricularia* disease, the effect of rice upon other crops in a rotation (soil and water management, diseases, rice volunteering as a weed in rotational crops, particularly in celery), and mechanization.

In the past, difficulties associated with marketing have deterred rice production in the Everglades. Grain harvested in the late summer will be high in moisture. Rice is best stored at 11% moisture. If grain moisture is greater than 20%, drying must be started within a matter of hours. The grain cannot be dried too fast, for rapid drying can result in cracked kernels which results in a poor grade at the market place. A rice drying facility has recently been constructed in the Everglades.

The Federal Government has a marketing program, but the grower need not market within this program. The program consists of price supports, loan guarantees and allotments. Most of the acreage is already alloted and is set aside in soil bank. Florida was alloted 1,202 acres in 1973, of which 872 acres were in Palm Beach County. Growers producing rice outside of the Federal program must sell their grain on the open market without price supports. The projected domestic market price for 1977-78 for unmilled rice is $7.50-8.50 per cwt (2). It is unlikely that Florida producers would seriously affect the market price since such a great quantity of rice is already grown. World production is over 5 billion cwt (8). Western hemisphere production is about 400 million cwt (8, 10), and United States production is approximately 117 million cwt (8). Thus, if all 50 thousand acres of Everglades vegetable land were put into rice production during the summer and yielded 40 cwt per acre, the area still would produce less than 2% of the current total U.S. rice production.

Selling rice through the established Louisiana markets has generally proven unsatisfactory in the past. The recent increase in the Latin population of South Florida has created a local market of considerable size, and further increases are likely. Miami should emerge as a major center of Caribbean, Central and South American trade (which may eventually include Cuba) and could offer a local alternative to the distant New Orleans and Houston export centers.

Experience has shown that a rice growing operation should be fully vertically integrated, controlling the means of production, drying, storage and selling the crop. In addition, if rice is marketed locally, some milling facilities will be needed. This offers potential for additional income, since milling more than doubles the price of rice.

In the Everglades it is probably best to let rice germinate in moist soil and then flood (9). Rice is not a full aquatic. Rice fields in this region will be very level and there will be little water flow. The water becomes warm, low in oxygen, and contaminated with algae. This decreases root systems and tillering. After rice is tall enough to shade the water, growth is enhanced by flooding. Thus, rice has a lower water requirement early in its growth. This fits in with the water supply pattern in the Everglades (Table 5). The rainy season begins in late May or June, and average rainfall exceeds pan evaporation from June through September. It may be necessary to pump water into the fields in excess of evapotranspirational usage. One study in the Everglades showed that seepage losses were twice as great as those by evapotranspiration (5).

Rice production, whether for grain or cover crop, may help farmers with their water management problems. Concern is mounting over releasing farm drainage into public waters. It has been suggested that farmers may have to set aside a portion of their land to receive water drained from the remainder. Perhaps rice lands could both produce income and be a reservoir for farm drainage.

Table 5. Average summer rainfall and pan evaporation for the years 1924-76 at the Agricultural Research and Education Center, Belle Glade.[z]

Month	Rainfall	Pan evaporation	Rainfall—pan
		(inches)	
April	2.93	6.41	−3.48
May	4.76	6.94	−2.18
June	9.18	6.09	+3.09
July	8.29	6.23	+2.06
August	8.05	6.01	+2.04
September	8.63	5.13	+3.50

[z]Source: AREC-Belle Glade weather records.

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ENERGY ANALYSIS OF THE USE OF FULL-BED PLASTIC MULCH ON VEGETABLES

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Abstract. **The effects of production practices on energy consumption are growing in importance due to the increasing costs and decreasing availability of energy. The effects of the use of full-bed plastic on the total energy consumed in staked tomato production were investigated. Increases in energy consumption compared with no-mulch production are due to the energy sequestered in the plastic mulch, the soil fumigant, increased fertilization and increased irrigation. Decreases in energy consumption are due to fewer cultivations and elimination of the pre-emergence herbicide. The net effect is a 58% increase per unit area in total energy requirements for production and harvesting using plastic mulch. However, since production is also much greater with plastic mulch, the net effect is that energy productivity, the quantity of product per unit of energy, is slightly increased.**

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There is recent widespread increased awareness of the importance, and, indeed, necessity, of energy as an input to industrialized agricultural systems. The energetics of alterna-