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Rice in the Crop Rotation[1]

T. Schueneman, C. Rainbolt, and R. Gilbert[2]

Introduction

The total value of rice in the south Florida row-crop rotation far exceeds its monetary return in the world marketplace. If a grower were to base the decision to grow rice solely on the market value of rough rice, it is doubtful rice would be grown at all. However, when the overall value of rice and its effects on the environment, the succeeding crop, and the overall profit margin of the rotation are considered, rice production is feasible.

As with most grain crops, the profit margin from a typical rice crop is relatively small. However, the normal sugarcane planting that follows a rice crop benefits in several ways. Pest management costs are reduced, silicon used to boost rice yields has a carryover effect on the sugarcane, and sugarcane yields are significantly increased. Also, since rice is grown in the rainy season and is always flooded, soil and water conservation and increased habitat for wildlife result.

Direct Benefit: Cash from the Rice Crop

When computing costs and returns for rice production in the Everglades Agricultural Area (EAA) of Florida in 1992, Alvarez (1993) estimated rice yields for the main crop to be 45 hundredweight (cwt) of dry rice per acre and 28 cwt per acre for the ratoon (regrowth) crop. He used the then-current price of $7.60 per cwt of rough rice and estimated a net loss of $2.18 per acre for the main crop but a profit of $136.75 per acre when the ratoon crop was included. Alvarez assigned 66% of the calcium silicate soil amendment (silicon fertilizer) costs of $90 per acre to the succeeding sugarcane crop and charged no land cost, since he assumed the land would be vacant if not in rice.

In Spring 2005, the price of rough rice was approximately $8.00 per cwt. It was assumed that production costs have increased by an inflation factor of at least 3% per year since 1992. Everything else being equal—including yields and production practices—net returns would be $118.00 per acre for

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2. Thomas Schueneman, Extension Agent IV, Ph.D., Palm Beach County - District V; C. Rainbolt, assistant professor, Agronomy Department, Everglades Research and Education Center, Belle Glade, FL; R. Gilbert, assistant professor, Agronomy Department, Everglades Research and Education Center, Belle Glade, FL; Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL 32611.

the main crop and about $3.00 per acre for the ratoon crop.

If Alvarez had applied the entire $90 per acre calcium silicate slag charge to the rice crop, as many growers actually do, and charged $150 per acre toward land rent or return on investment for land owned, returns would have decreased further..

A land owner can expect to realize profit growing rice only if he or she owns the property, grows both main and ratoon crops, and does not assume a land cost. If a grower leases land only for rice production it is doubtful a profit can be made.

Crayfish as a Co-crop

Crayfish (*Procambris alleni*), referred to as the "Everglades Crawfish", is abundant in the EAA. Since local species of crayfish are often grown as a companion crop with rice in Louisiana and Arkansas, the suggestion was made that the rice-crayfish combination should be tried in Florida. Schueneman (1991) and Schueneman and Jones (1991) did a thorough review of this possibility and determined that crayfish could indeed be grown with rice in Florida. However, the profitable ratoon rice harvest would have to be forfeited in order to allow the "young of the year" crayfish to emerge from their burrows and grow. More important, the length of growing season required to mature these young crayfish to market size would preclude the planting of sugarcane as the normal crop rotation with rice. Therefore, the authors concluded that crayfish did not fit into the prevailing EAA rice-sugarcane crop rotation.

Indirect Benefits

Indirect economic benefits of a rice crop refer to improvements in profit margin or production efficiency of the next crop that would not have occurred if rice had not preceded it. Soil conservation and improvements in tilth are difficult to put a price on but would be reason enough to incorporate rice into the crop rotation.

Increased Sugarcane Yields

Numerous studies have shown that sugarcane following rice produces more sugarcane and more sugar per acre than the same variety grown after another crop or after fallow. Alvarez and Snyder (1984) compared sugarcane yields from 82 fields where rice had been the preceding crop versus 36 fields where sugarcane followed a fallow period. An average yield increase of 17.7 tonnes of cane per hectare (ha) (7.9 tons per acre) resulted when the sugarcane was preceded by rice. In 1984 dollars this amounted to an additional net return of $376 per ha ($152 per acre). In another on-farm trial, Snyder et al. (1986) increased sugarcane yields by 3.8 tons per acre by growing rice first rather than maintaining a dry-fallow. This resulted in $234 per acre additional net income from the plant-crop sugarcane alone.

The annual EAA high-yield award in the category of sugarcane grown on sandy soil is usually won by a grower producing sugarcane following rice. Yields were much greater than on sand fields where rice had not been grown. These increases are not due to rice alone, but are the combined result of rice culture and silicon applications (refer to section on "Silicon Benefits").

Averaging of Cultural Costs Across Crops

Tillage operations for most crops grown in the EAA are fairly similar and are done before every crop. The exception is land leveling (Alvarez, 1993).

Land leveling is important because as the water table is raised, and the land surface is not close to being perfectly level, some areas of the field will be flooded while others remain above water. This has a direct impact on stand establishment, weed control, nutrient management, and overall water management. In recent years laser plane technology has become the most widely used method of land leveling, but it is fairly expensive. This is usually a custom-hired operation and costs about $70.00 per acre.

The good news is that laser leveling will last for the next two or three crops. Since a sugarcane crop will normally last three years (one harvest per year), and two successive sugarcane crops are usually grown between rice crops, a total of two rice harvests (plant and ratoon) and six sugarcane harvests benefit from the laser leveling. Therefore, each rice harvest should be assessed only $9 per acre for land leveling, not $70.

Improved Fertilizer Efficiency

One of the major environmental issues in the EAA is residual phosphorous (P) remaining in the soil after a vegetable crop has been harvested. By following vegetables with a sugarcane crop, much of this residual P is removed in the sugarcane biomass. This results in low soil test levels for available P. Even then, rice does not normally respond to additions of fertilizer on muck soils (Snyder and Jones, 1989). In a greenhouse trial, on a high pH Histosol testing very low in available P, rice yields did respond to broadcast P applications up to 60 kg/ha (Snyder et al., 1990). However, when these results were applied to actual production fields, no yield response was obtained (personal communication with G. H. Snyder).

Only the grain portion of the rice plant is removed from the field. The rice straw and roots are incorporated into the soil after harvest. As they decay, these plant parts release bound nutrients that become available for uptake by the succeeding crop.

Pest Management Benefits

Wire worms, *Melanotus communis* (Gyll.) and other species, are serious pests of newly planted sugarcane and sweet corn, the most commonly grown crops following rice rotation (Cherry, 1987). A series of experiments by Genung (1970) showed that flooding fallow fields for various lengths of time during the summer gave different levels of wireworm control. While total control was achieved with a continuous flood for six weeks, some re-infestations occurred if, after the flood was removed, weeds were allowed to regrow. It has since been documented (Hall, 1990; Cherry and Raid, 1998) that flooding fields during the summer reduces or eliminates the need to use a preplant insecticide for wireworm control. Cherry et al. (1993) and Cherry and Raid (1998) concluded that rice cultivation provides the necessary flooded conditions for wire worm control and eliminates the need for a preplant insecticide. Thus, rice cultivation provides both a savings of $25 an acre for the insecticide not needed and pays for the cost of flooding, a cost normally borne by the crop following a fallow-flood.

Flooded rice fields also suppress certain weed species such as spiny amaranth (*Amaranthus spinosus*) (Dusky, 1987). Even though herbicides must still be used, they may be more effective after a flooded period. This should reduce weed competition in the succeeding sugarcane crop and give a positive economic return.

Conservation of Soil

Soil subsidence is the loss of surface elevation due to decomposition (mineralization) of the organic soil. Microbial activity is the major cause of mineralization and requires the presence of oxygen. A deep water table allows a large amount of soil to be aerated, which promotes mineralization (Snyder et al.1978). High summer temperatures accelerate the process (Bonner and Galston, 1952).

Rice, or the act of growing rice, effectively stops subsidence of muck soil during the hot summer months, the time of the year when the rate of subsidence is the greatest (Snyder et al., 1978). A grower could add years to the productive life of his EAA farm with frequent rice crops in rotation with sugarcane or vegetables.

Soil Conditioning Benefits of Rice Stubble and Straw

For many years growers have noticed improved yields in the crops that followed rice (Alvarez and Snyder, 1984). This has been referred to as the "rice effect". Possible explanations of this are that the rice straw and stubble improve soil texture and tilth, improve drainage, and store nutrients in an available form for the next crop.

The organic soils of the EAA become powdery with continued cultivation. Seed beds are easily eroded. Roth Farms (personal communication), located in the EAA, grew rice in the 1960s and 1970s, not for grain, but as a cover crop for the soil conditioning benefit of the rice straw. Vegetables are usually grown on raised beds to reduce crop damage from flooding. The bedding process was much more effective after a rice cover crop.

This "rice effect" is not limited to improved soil management. It is expressed in yield improvements, as mentioned earlier. Organic soils that have traditionally produced low sugarcane yields have been "rejuvenated" by growing a rotation of rice before replanting sugarcane (Hundley Farm personal communication).

Silicon Benefits

The big boost in both rice and sugarcane yields has come from applying a soluble form of silicon as a preplant fertilizer application (Anderson et al., 1987; Ulloa and Anderson, 1991). Silicon is not considered an essential plant nutrient; however, there is a considerable body of information linking elevated silicon content in plants to improved disease resistance and yields, especially in grasses (Datnoff et al., 1990).

In the absence of previous silicon applications on soils testing low for silicon, rice yields were increased by 20% with a two ton per acre calcium silicate slag treatment (Snyder and Jones, 1990). Ulloa and Anderson (1991) found that a three ton per acre slag treatment was adequate to produce yield increases of 17-21% per acre for sugarcane.

Snyder and Jones (1990) found that, while there was a significant carry-over benefit to the next year, a significant additional yield increase was obtained with a supplemental silicon treatment. Anderson et al. (1987) obtained a 16% increase in sugar yield when an eight ton per acre calcium silicate slag application was made before the previous rice crop, and 21% sugar yield increase when the slag was applied after the rice but before the sugarcane crop. This also indicates a multiple year effect from a single silicon application.

While a rice-sugarcane rotation results in increased sugarcane yields when compared to a rotation that does not include rice (Alvarez and Snyder, 1984), adding a silicon amendment to the rice also boosts sugarcane yields (Anderson et al., 1987).

Rice straw has been shown to keep silicon in an available form so that, as the straw decays during the following sugarcane crop, the silicon becomes available for uptake by the sugarcane plant.

The silicon effect lasts for several years after application (Snyder and Jones,1990; Anderson et al., 1991; Anderson and Snyder, 1990). Therefore, the $90 cost per acre for calcium silicate slag (Alvarez, 1993) should be spread over the rice and at least the next 3 sugarcane harvests, resulting in an annual cost to rice of only $22.50. If, on the other hand, bookkeeping practices dictate charging the current rice crop the entire $90 silicon charge, a production-costs savings of $22.50 per acre per year would result for the next three sugarcane harvests.

Environmental Benefits

Environmental benefits refer to desired environmental side effects of a rice crop. These are usually difficult to quantify but may be important enough to sway a grower's decision to plant rice.

Water Storage

Water storage in much of south Florida is essentially above ground. The EAA is underlain by the Fort Thompson limestone formation, a series of impervious limestone layers sandwiching-in layers of marl. Therefore, impounded water remains above ground and does not replenish an aquifer.

Temporary Water Storage During Storms

Evaporation from open water surfaces during the summer in south Florida has been measured by the University of Florida and ranges from 6 to 7 inches per month. Water loss from sugarcane and rice through evapotranspiration is less than open water surface evaporation (Schueneman and Snyder, 2000). Monthly rainfall averages 8 to 9 inches for the same period. While this is not significantly more than the normal evapotranspiration rate for crops in the field, it is not uncommon for storms to produce 5 to 10 inches of rain.

Excessive rainfall interferes with farming operations associated with sugarcane and vegetable production and must be quickly pumped off farm land into nearby drainage canals. Drainage water is then pumped into one of the Water Conservation Areas for long term storage or, as often happens, allowed to flow into the ocean.

Removes Soluble Phosphorus in Water Runoff from Other Crops

Rice paddies have been identified as a best management practice (BMP) for the removal of elevated nutrient levels in drainage water from surrounding fields (Izuno, 1991; South Florida Water Management District, 1997). Rather than drain sugarcane and fallow vegetable fields directly into SFWMD canals, this drainage can be pumped into neighboring rice fields and allowed to slowly seep back into the drainage system. During this impoundment time, residual nutrients have a chance to be utilized by the rice plants and algae in the water.

An additional benefit is that this allows for a more orderly flow of water from non-rice fields to the Water Conservation Areas during periods of high rainfall. Also, being able to cycle excess water through a rice field gives growers an alternative to pumping directly to a SFWMD canal. This can save the cost of monitoring for phosphorous loading every time a discharge pump is turned on.

Creates Habitat for Wildlife

Rice fields are flooded for up to 100 consecutive days, are usually 40 acres in size, and are often undisturbed for most of the growing season. Because many prey species thrive under these flooded conditions, wading birds and waterfowl abound. Turnbull (1989) concluded that a new population of fulvous whistling-ducks (*Dendrocygna bicolor*) has become established in south Florida because of rice production, thereby representing an increase in Florida's resident waterfowl resource. A study by Townsend (2000) found 41 species of wading birds and waterfowl in the EAA rice fields.

Summary

Under current world rice-marketing conditions, rice production is barely a break-even proposition. Since most of the production costs are borne by the plant crop, a second harvest (ratoon) is profitable. The major advantages of growing rice are the indirect cultural and environmental benefits.

Following rice, sugarcane has land that has been leveled, does not require a preplant insecticide, has fewer weeds, exhibits improved tilth, and produces up to 20% more yield. Rice crops can add years of productive life to sugarcane fields.

Environmentally, rice fields provide for increased water storage, improved fertilizer efficiency, and expanded habitat for wildlife.

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