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Rice revolutions in Latin America

In 1962, scientists at the International Rice Research Institute (IRRI) debated the cause of low and stagnant rice yields in the tropics: was it variety or crop management? This debate ended with the release of the semidwarf IR8 in 1966, initiating the Green Revolution. The same variety, in the same year, extended this revolution to Latin America, beginning in Colombia and spreading rapidly through the tropics and later to the temperate areas.

The Green Revolution in the Americas was genetic with little contribution from agronomy. Its impact was approximately two additional tons per hectare. On a national basis, this spectacular advance terminated within a few years when essentially all of the irrigated and favored upland ecologies converted to semidwarf varieties. From then on, yields did not increase. On individual farms, the revolution ended after the first harvest. Replanting with IR8, or any other semidwarf, did not result in higher yield. It was a momentous, one-time contribution followed by a persistent yield barrier lasting some 30 years.

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During this period of stagnancy, national yield averages in a few Latin American countries increased modestly, reflecting a shift from favored upland to irrigated cultivation. Neither higher yielding varieties nor improved crop management played a role. In tropical Asia, national averages slowly and steadily moved upward after the Green Revolution. I suspect this reflects better water management and conversion from rainfed and other less productive ecologies to irrigated rice.

An inability to further increase yields engendered another round of debate. The majority view, contending that more productive varieties were needed, led to massive investment during the past 25 years in biotechnology and genetics and under-investment in crop management. The implicit thought is that greater yield capacity is required for higher farm productivity. At the Latin American Fund for Irrigated Rice (FLAR), we hold the minority view that the constraint today is agronomic, not genetic. Our contention is based on two observations.

First, the release of nearly 400 semidwarf varieties over three decades did not increase farm yield. Further, we contend that none of the newer semidwarfs surpasses IR8, Jaya, or Bg-90, the first modern varieties, in yield capacity. Second, every year, a few farms scattered around the hemisphere yield 9-11 tons per hectare or more—roughly double national averages and an indication that existing varieties have considerable unexploited yield capacity. Thus, the problem is not yielding ability.

To narrow this yield gap, FLAR, with support from the Common Fund for Commodities, initiated a crop management program in 2003 under the leadership of agronomist Edward Pulver. This began the identification of six regional agronomic deficiencies: inappropriate seeding dates missing peaks of solar radiation after panicle initiation; extremely heavy seeding densities causing lodging, disease, and pest attacks; repeated aerial spraying rather than seed treatment to control insects; deficient weed control; poor fertilization practices including the application of urea into water; and late establishment of permanent irrigation.

Solutions for each deficiency were packaged together for on-farm demonstrations. After three years, results from several hundred thousand hectares in several counties confirm that an Agronomic Revolution is now in progress. This second revolution, devoid of any genetic contribution, has so far had an impact equal to that of the Green Revolution, increasing farm yield by roughly two tons on average.

Well-managed farms, now yielding 8-11 tons per hectare, confirm that the yield constraint since the introduction of modern varieties in the 1960s has been poor crop management. The key to Dr. Pulver's approach lies in the simultaneous reduction of multiple farm constraints as contrasted with typical agronomy directed toward individual problems.

FLAR believes that once the Agronomic Revolution is widely adopted, productivity will again become stagnant. We contend that the new productivity constraint will revert to varietal yield capacity, as it was pre-Green Revolution. Thus, the present problem of poor crop management, now being resolved, will be succeeded by the need for more productive varieties. FLAR has combined two underappreciated traits—delayed leaf senescence (ageing), or "stay-green," and huge panicles—while maintaining heavy tillering capacity. We expect the enhanced yield capacity of this new plant type will catalyze a second genetic Green Revolution.

Thus, we observe alternating yield constraints: firstly genetic (pre-Green Revolution), then agronomic (post-Green Revolution) followed by the need for a second genetic Green Revolution. Many years separate these quantum leaps in productivity and each advance is achieved with little contribution from the other discipline. In part, this results from the failure of breeders and agronomists to develop strategy jointly. Further, the decades of little progress following the adoption of semidwarfs indicate a misidentification of the yield constraint as institutions directed resources inappropriately. Researchers, like generals, often fight new battles with strategies and tactics of previous wars.

Dr. Jennings, a principal scientist with FLAR, founded the breeding program at IRRI (1961-67), where he discovered the semidwarf gene and led the breeding of IR8.