Rice Nutrition Management in Latin America

By José Espinosa

Rice production in Latin America has both social and economic relevance. It generates significant employment and contributes greatly to the gross national product of countries in the region. High yields are important as rice is a staple food in the Dominican Republic, Guyana, Panama, Peru, and Suriname. It is an important and common food in Brazil, Colombia, Haiti, Cuba, Ecuador, Venezuela, Nicaragua, and other countries in the region.

Total rice production is affected by planted area and yield per hectare. Changes in planted area are mainly the result of governmental policies. Total harvested area in Latin America decreased between 1980 and the mid 1990s, largely due to less upland rice production in Brazil. However, a significant increase is apparent in several countries, including Argentina, Uruguay, Peru, and Ecuador (**Table 1**). Latin America still has appreciable land and water resources available to expand rice production, especially in Brazil, Colombia, and Venezuela. To date, area expansion has not been necessary because of the increasing production per hectare resulting from the adoption of high yielding varieties and improved crop management practices.

Rice growing areas of Latin America, both upland (47 percent) and irrigated (53 percent), are located on alluvial land, river estuaries, deep valleys, and flat land. Rice is cultivated under several climatic conditions that range from dry to very wet. Soil conditions also vary with climate and parent material. Mollisols, Vertisols, and Inceptisols in the drier areas have high pH and good fertility, whereas Inceptisols, Ultisols and Oxisols in the wetter areas have low pH and medium to low fertility. The latter are savanna soils located in Brazil, Colombia, and Venezuela, the area considered most important for future expansion in rice production.

Rice Fertilization and Soil Management

Commercial quality, high yields are possible using semi-dwarf varieties with high tillering potential. These varieties have a high nutrient demand, particularly for nitrogen (N). The nutrient demand for high yielding rice is partially met by the soil, but supplemental fertilizer is required during rapid growth stages when nutrients are in greatest demand. Nutrient management, along with pest, disease, and weed

Table 1. Total land area under rice and average production in Latin American countries.

Country	Area, '000 ha 1990	Area, '000 ha 1995	Area, '000 ha 2000		Yield, t/ha 1990	Yield, t/ha 1995	Yield, t/ha 2000
Argentina	117.0	184.0	190.0		3.67	5.03	5.01
Bolivia	109.0	130.0	170.0		1.93	2.03	2.05
Brazil	3,950.0	4,380.0	3,630.0		1.88	2.57	3.01
Chile	32.6	33.9	27.0		4.17	4.30	4.19
Colombia	521.0	407.0	440.0		4.06	4.28	4.77
Costa Rica	61.0	48.3	80.0		3.44	3.69	3.28
Cuba	155.0	87.0	123.0		3.06	2.56	2.28
Ecuador	269.0	396.0	366.0		3.12	3.26	3.59
El Salvador	14.3	9.6	14.0		4.33	5.33	4.31
Guatemala	14.3	11.0	15.0		3.11	2.79	2.57
Guyana	51.4	127.0	145.0		3.03	3.97	4.14
Honduras	17.6	13.2	5.7		2.50	2.61	1.27
Mexico	105.0	78.4	97.9		3.74	4.68	4.60
Nicaragua	45.9	62.7	80.2		2.63	3.71	3.56
Panama	98.4	99.0	150.0		2.26	1.78	2.37
Paraguay	34.0	48.0	25.0		2.52	2.84	3.72
Peru	185.0	203.0	300.0		5.23	5.62	5.55
Dominican Rep.	89.4	102.0	120.0		4.79	4.77	4.43
Suriname	52.0	60.0	50.0		3.77	4.03	3.61
Uruguay	78.1	146.0	205.0		4.45	5.50	5.73
Venezuela	115.0	177.0	150.0		4.31	4.27	4.91
Total	**6,100**	**6,800**	**6,380**	**Average**	**3.43**	**3.79**	**3.76**

control, is a common management practice that increases nutrient use-efficiency and allows production of economic yields.

Nutrient removal varies with crop variety. Knowledge of the amount and dynamics of nutrient removal is necessary to design fertilizer recommendations and timing of application. An example of nutrient removal data for cv. *CR-1821*, a variety from Costa Rica that produces high yields and has a high nutrient demand, is presented in **Figure 1**. Tested under semi-commercial conditions and irrigation, it produced a total dry matter yield of 20.3 t/ha: 9.3 t/ha of grain and 11.0 t/ha of straw. Crop uptake was 200 kg N/ha, 94 kg P_2O_5/ha, and 320 kg K_2O/ha. It is worth noting the high N and potassium (K) uptake. This variety also extracted 71 kg calcium (Ca)/ha, 46 kg magnesium (Mg)/ha, and a large amount of sulfur (S), 22 kg/ha. Sulfur is not generally applied as fertilizer in Costa Rica.

Most rice varieties respond to N application, although the response is a function of variety, cropping system, and the N demand at specific growth stages. For example, maximum yield was obtained with 180 kg N/ha with cv. *CR-1821* under irrigated conditions, but with only 150 kg N/ha for cv. *CICA-4* under upland cultivation.

Regional N losses are high due to the elevated temperature and high rainfall conditions. Research determined that split N applications based on crop growth stage and nutrient need could reduce N losses to leaching or denitrification. Summarizing research results from different Latin American countries, best yields are obtained by applying 20 percent of the total N at planting time, 20 percent at tillering, and the remaining 60 percent at flower initiation. Field research has also demonstrated that equal or higher yields are possible with four split N applications, but the additional cost of application increases total production expenses.

Studies on the use of slow release N fertilizers found slightly higher

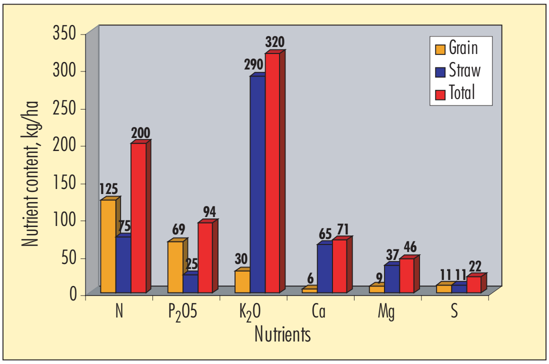

Figure 1. Nutrient removal by the CR-1821 rice variety in Costa Rica with a total dry matter yield of 20.3 t/ha.

rice yields compared to those obtained with straight urea. This advantage was associated with an apparent higher N recovery. The study also demonstrated that application of the entire N requirement at seeding resulted in a poor (18 percent) fertilizer use-efficiency. Nitrogen recovery was higher under irrigated conditions (40 percent) than upland conditions (35 percent).

Phosphorus (P) requirements for rice are relatively low; hence rates of application are also low, particularly in high pH soils. However, P is important in acid, low fertility soils. Under high yielding conditions, P is needed to balance the high requirement of N and K, even if the P content in the soil is relatively high. Phosphorus recommendations for rice grown under different soil conditions in the region are presented in **Tables 2**, **3** and **4**.

Potassium fertilizer requirements are related to soil K availability, the variety's K demand, and yield goal. Substantial amounts of K accumulate in rice straw (**Figure 1**) and are lost when straw is removed from the field. Incorporating crop residues recycles an appreciable amount of K, making it available for use by following crops, avoids K depletion, and maintains soil fertility. Despite the smaller quantity of K removed by harvested grain, farmers should account for this portion of K removed from the soil.

Correlation and calibration studies conducted in the region have established K rates needed in rice production. The critical K level is set at 0.1 $cmol_c$/l. Therefore, if soil tests are equal to or lower than this value, applications of 60 to 120 kg K_2O/ha are recommended depending on the soil type and K uptake requirement of the rice variety.

The critical K level in high pH soils is a useful tool for farmers, but it should be considered in combination with the Ca+Mg/K ratio. This parameter is important in Vertisols and in associations of Vertisols and Mollisols with high Ca and Mg contents. In these cases, an imbalance with K can develop resulting in responses to K application at soil K contents as high as 0.2 $cmol_c$/l. This is particularly true when the Ca+Mg/K ratio is greater than 204. This situation has been confirmed in Costa Rica

Table 2. Fertilizer recommendations for irrigated rice growing in Vertisols and Mollisols in Costa Rica.

	Potassium level, $cmol_c$/l								
	Low, <0.1			Medium, 0.11-0.20			High, >0.20		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
	kg/ha								
Phosphorus, mg/L: Low, < 5	180	60	60	180	60	30	180	60	0
Phosphorus, mg/L: Medium, 6-10	180	30	60	180	30	30	180	30	0
Phosphorus, mg/L: High, >10	180	0	60	180	0	30	180	0	0

P and K extracted with modified Olsen solution; N applied in three split applications.

where rice responses to applications of 80 kg K_2O/ha were evident in a Vertisol with a K content of 0.15 $cmol_c$/l and a Ca+Mg/K ratio of 273. Potassium recommendations for rice in different soil conditions in the region are presented in **Tables 2, 3** and **4**.

Use of urea in upland rice and urea and ammonium nitrate in paddy rice has led to S deficiencies in many of the rice production areas of the region. In some cases, S becomes the yield-limiting factor. Correction of S deficiency is achieved with an application of 30 kg S/ha.

Zinc (Zn) deficiency is common in rice soils in Latin America and is related to low Zn availability, particularly in soils of high pH. The critical Zn level for rice in the region is around 3 mg/l (modified Olsen extraction).

Table 3. Fertilizer recommendations for irrigated rice growing in Ultisols and Oxisols in Costa Rica and Colombia.

	Potassium level, $cmol_c$/l								
	Low, <0.1			Medium, 0.11-0.20			High, >0.20		
Phosphorus, mg/l	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
	---------- kg/ha ----------								
Low, < 5	150	120	120	150	120	90	150	120	60
Medium, 6-10	150	80	120	150	80	90	150	80	60
High, >10	150	40	120	150	40	90	150	40	60

P extracted with Bray 2 solution; K extracted with ammonium acetate; N applied in three split applications.

Table 4. Fertilizer recommendations for upland rice growing in Ultisols and Oxisols in Costa Rica and Colombia.

	Potassium level, $cmol_c$/l								
	Low, <0.1			Medium, 0.11-0.20			High, >0.20		
Phosphorus, mg/l	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
	---------- kg/ha ----------								
Low, <5	120	100	90	120	100	60	120	100	30
Medium, 6-10	120	50	90	120	50	60	120	50	30
High, >10	120	25	90	120	25	60	120	25	30

P extracted with Bray 2 solution; K extracted with ammonium acetate; N applied in three split applications.

Farmers in Latin America can only achieve maximum economic yield and maintain high soil fertility by practicing balanced and timely fertilization. **Table 2** shows nutrient recommendation for rice varieties grown under flooded conditions and high soil pH levels in Costa Rica with a yield goal of 6.5 t/ha. **Tables 3** and **4** show site-specific fertilizer recommendations for rice under irrigation and upland conditions in low pH soils of the eastern savannas of Colombia and are representative of soils throughout northern Latin America. **BCI**

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