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Fertility Assessment and Mapping of Rice Areas under the Magat River Integrated Irrigation System in Isabela, Philippines

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Abstract Soil is important in crop production. It holds water, microorganisms and essential nutrients needed by plants. In the rice areas irrigated by Magat River Integrated Irrigation System (MRIIS) where 2-3 croppings a year is possible, depletion of the native nutrients in the soil becomes a problem. The addition of nutrients, particularly NPK, in the form of inorganic fertilizer becomes a necessity. The immediate effect of inorganic fertilizer lure farmers to apply fertilizers indiscriminately. Hence commercial fertilizers account for approximately 26% of the total cost of rice production. Farmers would borrow against their projected earnings just to buy commercial fertilizers. The result in terms of yield, however, is not always satisfactory. There are times when the potential yield of rice is not attained despite heavy fertilizer application.

In view of this, soil and fertilizer management are given much attention. The fertility status of the soil must be known first through soil analysis in order to achieve precision in fertilizer application. This prevents wastage of resources and environmental pollution since excess fertilizer applied will only find their way eventually to bodies of water. In 2003 to 2005, massive soil sampling and analysis was done in the MRIIS area covering some 84,901.832 hectares. Results of analysis showed that of the total area covered, 74.8 % is low (0 to 2.0 %); 22.5 % is medium (2.1 to 3.0%); 2.7 % is high (3.1% above) in OM. For phosphorus and potassium, 13.6% and 24.4% is sufficient in P (above 20 ppm P) and K (above 60 ppm K) respectively. For the micronutrient zinc, 70.3 % is deficient (below 1.15 ppm Zn).

Using the soil analysis data, fertility maps for each municipality under the MRIIS area were generated. This will serve as ready reference for farmers to base their fertilizer application even if they did not subject their rice fields individually for soil testing. These maps also serve as guide for the DA management in decision making for the allocation of site specific interventions like biofertilizers, zinc sulfate and other soil enriching materials.

Every three years, these fertility maps are updated since the validity of soil analysis results is 3 years or 6 cropping seasons.

Keywords: Soil fertility, potential yield, fertility map

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Introduction

The Magat River Integrated Irrigation System is the biggest irrigation facility in the Philippines. With its inauguration in 1984, two croppings a year for rice is now possible within its service area. Yet despite the abundance of water, good seeds and technology for rice production, the average yield of rice in the region is low at 4.7 MT/ha for hybrid and 3.56 MT/ha for inbred, both of which are way down below their potential yields.

Generally, if plants do not perform according to expectations, one of the things to suspect is nutrient deficiency. Plants require at least 16 elements for optimal growth (Alejar and Sese, 1999). Majority of these elements come from the soil. Hence fertility assessment through soil analysis is an important tool in crop production. Soil analysis is a chemical method of estimating the nutrient-supplying power of a soil (Tisdale *et al.*, 1985). Knowing the available nutrient content of the soil enable farmers to apply the right kind and amount of fertilizer. Rational fertilizer use is one of the key factors in improving and increasing productivity of agricultural lands, particularly in the tropical region where nutrient deficiency is a limiting factor. It also prevent wastage of fertilizer material and subsequent environmental pollution. Cognizant of this, precision farming through proper fertilization became one of the advocacy of the Rice Program of Region 2 in the Philippines.

There are two soils laboratory in Region 2 – one in Cagayan and one in Isabela. The Soils Laboratory-Isabela covers Isabela and Quirino provinces. Unfortunately, with a total rice area of 160,229 hectares in Isabela and Quirino and approximately 74,000 farmers being, not all rice farmers can avail of soil analysis services. Nevertheless, the generation of fertility maps, even for the MARIIS service area only, will enable more rice farmers to enjoy the benefit of soil analysis. This project was undertaken to have a readily available and accessible reference material, guide and basis for rice fertilization. Other objectives include:

1. Development of farmers' awareness on the importance of soil sampling and analysis;
2. Assessment of the fertility status of rice areas under the MRIIS in the region;
3. Establishing a basis for DA management in allocating site specific yield-boosting interventions;
4. Increasing yield of rice; and.
5. Providing basis for fertilizer dealers in positioning fertilizer materials in the region.

The validity of soil test results is three years or 6 cropping seasons. Hence every after 3 years, updating of fertility maps is being done.

Materials and methods

Collection of mapping information

Base maps per municipality within the MRIIS service area in Isabela were secured from the National Irrigation Administration (NIA). These base maps show the location of irrigation Turn-Outs and Irrigators' Associations (IA).

Conduct of briefing and hands-on demo on proper soil sampling

Massive briefing on soil sampling was conducted from February to March 2003. Participants include farmers, Turn-Out Chairmen, Municipal Agriculturists and Agricultural Technicians.

Soil sample collection

Soil sampling was done by the trained farmers after harvest. The intent of this is for farmers to appreciate and value the importance of proper soil sampling and analysis. Included only in this project are municipalities covered by MRIIS in Isabela. The activity started in 2003. The second round was conducted in 2007 and the third round in 2011. Another round is slated for 2015, and so on. One composite soil sample was collected per Turn-Out (the smallest unit within the irrigation system) which could represent 2 - 50 hectares.

Soil analysis

Standard operational procedures for soil analyses were adopted from the Bureau of Soils and Water Management, the central soils laboratory in the Philippines. Organic matter, phosphorus. potasium, and zinc contents were analyzed using Walkley Black Method, Olsen's Method, Cold Sulfuric Extraction Method and DTPA method, respectively. Soil pH was also analyzed using pH meter.

Release and distribution of soil analysis results

Each farmer within the Turn-Out was given a copy of soil analysis result. Included therein are the recommended nutrient rate, the computed fertilizer material and the schedule of fertilizer application – all of which are easily understood by the farmers. They will use this as guide in fertilizer application pending the release of fertility maps.

Consolidation of data

Result of soil analyses were categorized into deficient, moderately deficient, slightly deficient and sufficient levels. Each level has its corresponding fertilizer recommendation in kilograms per hectare.

Fertility map preparation

Fertilizer recommendations per Turn-Out within the IA was plotted on a scale of 1:20,000.

Briefing on fertility map utilization

Municipal agriculturists, agricultural technicians and members of the IA were briefed on how to use and interpret fertility maps.

Fertility map distribution

All municipalities covered by the project was given a copy of their respective fertility maps for display at their Agriculture Office (located usually at the Municipal Hall). NIA was also given a copy of the NIA District Fertility Map. Other interested stakeholders are given upon request.

Results and discussion

As of 2003 the MRIIS has a total service area of 84,901.2 hectares found in municipalities of Isabela and Quirino (78,433 of which are in Isabela). Improvement of the facility in 2007 increased its coverage area in Isabela to 94,717 hectares. Farmers in the MRIIS area are organized into Irrigator's Associations (351 IA's). Each IA is subdivided into Turn-Outs (3693 T.O'S) according to Table 1.

Soil Sampling and Analysis

The precision of soil analysis results depend mainly on the collection of soil sample. Since approximately 1 kilogram of soil is collected to represent the whole sampling area which could be as large as 50 hectares, proper procedures should be strictly followed to obtain soil test results that precisely reflect the true fertility status of the soil. Hence proper soil sampling was emphasized during the briefings conducted.

Soil samples received at the laboratory were immediately recorded, labeled, air-dried and pulverized to pass at least 40 mesh before they are subjected for analysis. The three major elements N, P, and K were tested. For minor elements, only zinc was analyzed since it is considered by rice experts in the region to be the most crucial trace element to rice production.

After laboratory analysis, nutrient recommendations are given using the Table of Fertilizer Recommendations developed by the Bureau of Soils and Water Management. This table is a product of a nationwide calibration study conducted by the bureau in the 70's. Modification for recommendations for hybrid rice and corn has been made in the 90's. Fertilizer material requirements corresponding to each recommendation are then computed. Soil test results including all the pertinent data are then printed and reproduced to be given to all farmer members within the Turn-Out. This serves as basis for fertilizer application while the fertility maps are not yet available. Table 2 is an example of soil test result being released by the soils laboratories in the region.

Table 1. Magat River Integrated Irrigation System service area (in hectares).

MUNICIPALITY	NO. OF IA'S	NO. OF T.O.'S	NO. OF FARMERS	SERVICE AREA, HA. (2003)	SERVICE AREA, HA. (2007-present)
District II					
Aurora	7	58	1587	1,959.68	2,184.00
Burgos	14	123	2140	3,698.26	2,768.00
Gamu	6	46	579	835.98	3,040.00
Roxas	18	176	3712	4,829.91	5,503.40
San Manuel	17	135	3575	5,331.16	7,178.30
District III					
Alicia	46	496	8636	10,499.75	10,144.50
Angadanan	14	159	2247	2,208.88	2,959.50
Cabatuan	21	222	4948	5,198.88	5,085.00
Cauayan	37	426	7706	7,740.63	8,853.80
Luna	11	100	3032	2,425.44	2,389.60
Reina Mercedes	5	45	1397	1,103.12	1,210.50

San Mateo	43	556	9314	9,401.60	10,440.70
District IV					
Cordon	15	131	3227	3,968.53	4,257.00
Echague	16	185	2705	1,269.77	2,925.80
Ramon	33	306	5839	7,996.10	8,991.50
San Idisro	13	176	2248	2,793.55	3,905.60
Santiago	35	353	7349	7,170.94	7,880.40
Total	351	3693	70,241	78,433.18	90,717.60

Table 3. Percentage of different levels of organic matter per municipality.

Municipality	Nitrogen, ranges in %								
	2003			2007			2011		
	0-2 %	2.1-3.5 %	3.6 % above	0-2 %	2.1-3.5 %	3.6 % above	0-2 %	2.1-3.5 %	3.6 % above
District II									
Aurora	62.22	33.27	4.51	45.11	45.26	9.62	89.19	10.81	
Burgos	67.92	24.11	7.96	94.69	5.31		95.72	4.28	
Gamu	87.14	12.57	0.29	97.11	2.89		98.90	1.10	
Roxas	60.85	34.11	5.05	53.16	45.17	1.68	73.18	26.83	
Sn Manuel	65.83	30.24	3.93	100.00			71.39	28.61	
District III									
Alicia	79.98	19.18	0.84	99.21	0.79		80.09	19.91	
Angadanan	94.80	5.20	0.00	91.70	8.30		97.93	2.07	
Cabatuan	60.31	33.70	5.99	100.00			70.20	29.80	
Cauayan	84.06	14.97	0.97	98.41	1.59		97.17	2.83	
Luna	72.00	26.83	1.17	96.09	3.91		92.42	7.58	
R. Mercedes	96.61	3.39		85.63	14.37		96.65	3.36	
San Mateo	57.62	36.89	5.50	87.17	12.83		77.84	21.74	0.43
District IV									
Cordon	85.16	14.84		87.04	12.97		90.63	9.40	
Echague	90.86	9.14		91.64	8.36		91.61	8.38	
Ramon	89.17	10.14	0.69	90.22	9.78		94.12	5.87	
San Isidro	89.87	9.31	0.82	94.18	5.82		94.44	5.56	
Santiago	87.27	12.23	0.50	63.51	35.05	1.44	95.35	4.65	
Total	***76.12***	***21.37***	***2.52***	***89.31***	***10.30***	***0.40***	***86.62***	***13.33***	***0.43***
Rice variety	NUTRIENT REQUIREMENT, Kg N/Ha								
Hybrid	120	100	80	120	100	80	120	100	80
Inbred	100	80	60	100	80	60	100	80	60

The preceding table (Table 3) show the fertility status of the MRIIS area considered in this project in terms of organic matter. Of the total area, 76.12% is very low in organic matter in 2003, 89.31% in 2007 and 86.62% in 2011. At this level of soil OM, 120 kg N per hectare is recommended. This means that

10 years ago, larger rice area within the MRIIS has high nitrogen content compared to succeeding years.

For phosphorus, data presented in Table 4 show a larger area (69.06% or 62,595 hectares) sufficient with this element in 2007. These areas need only 7 kg P/ha as maintenance dose or none at all. In 2003, 33.08% (30,009 hectares) is sufficient while in 2011, the area sufficient in P dropped to 19.02 % (17,254 hectares) . Areas low in phosphorus (66.92% in 2007, 30.93% in 2007 and 80.98% in 2011) need either 60, 40 or 20 kg/ha P fertilizer depending on the level of deficiency.

Table 4. Percentage of different levels of phosphorus per municipality.

Municipality	Phosphorus, ranges in ppm														
	2003					2007					2011				
	0-5	6-10	11-20	21-50	51 & above	0-5	6-10	11-20	21-50	51 & above	0-2	3-10	11-30	31-50	51 & up
District II															
Aurora	0.81	21.00	44.94	22.08	11.17			12.43	27.35	52.93		6.04	45.04	31.55	17.37
Burgos	12.67	17.79	39.77	22.36	7.40			35.67	48.18	16.15	3.84	22.29	55.24	11.55	7.08
Gamu	8.24	22.49	42.31	3.77	23.19	20.76	22.81	8.25	28.80	19.38	0.00	57.90	34.60	6.74	0.76
Roxas	5.93	12.69	35.17	23.49	22.72	4.18	4.92	5.81	35.54	49.55	0.62	16.96	36.33	43.91	2.19
Sn Manuel	4.99	13.85	33.96	18.16	29.04		20.48	9.34	27.75	42.42		11.12	48.61	34.25	6.02
District III															
Alicia	5.29	19.65	55.25	14.34	5.48	0.02	4.16	8.28	49.54	38.00	2.59	26.53	53.61	5.64	11.62
Angadanan	7.65	19.45	30.90	37.18	4.82	1.85	7.25	15.87	21.70	53.33	4.95	36.63	57.98	0.48	0.00
Cabatuan	1.40	10.02	23.43	32.53	32.62	0.61	1.44	0.43	43.73	53.79	5.23	22.38	43.56	25.81	3.03
Cauayan	2.26	20.12	61.32	12.77	3.53	2.89	26.28	24.27	32.60	13.96	10.39	50.34	32.43	6.18	0.65
Luna	0.00	14.22	39.23	21.99	24.56		3.41	3.20	24.29	69.10	11.70	34.29	39.13	9.82	5.06
R. Mercedes	0.00	44.18	39.45	6.58	9.79	3.81	14.96	38.06	26.59	16.58	5.76	40.42	48.72	4.88	0.20
San Mateo	1.01	5.17	45.87	34.66	13.28	11.72		27.93	34.95	25.40	3.46	31.77	54.33	9.11	1.33
District IV															
Cordon	3.47	9.42	37.64	18.86	30.61	1.91	8.58	7.02	31.72	50.76	0.29	19.57	45.85	25.05	9.25
Echague	1.87	9.71	64.72	14.38	9.32	17.05	29.61	23.95	15.85	13.52	5.00	21.04	47.97	8.58	17.41
Ramon	14.94	32.45	39.81	4.87	7.93	5.02	11.32	21.59	38.61	23.47	3.31	35.00	48.03	9.21	4.44
San Isidro	2.86	17.40	48.55	20.86	10.34	4.87	11.75	9.17	34.75	39.46	5.32	37.33	50.50	5.83	1.01
Santiago	12.37	19.26	46.22	11.10	11.05	2.60	16.67	23.11	37.35	20.27	2.46	32.71	51.95	7.99	4.90
Total	5.73	17.16	44.03	19.08	14.00	4.40	10.71	15.82	35.33	33.73	3.81	30.07	47.10	14.12	4.90
Rice variety	NUTRIENT REQUIREMENT, Kg P/Ha														
Hybrid & inbred	60	40	20	7	0	60	40	20	7	0	60	40	20	7	0

In the case of potassium, the same trend was observed (Table 5). The largest area with sufficient levels of K was obtained in 2007, followed by 2003 and the least in 2011. Compared with phosphorus, potassium deficiency in the MRIIS area is more severe. For 2011, 85.89% of the total area or 77,917.35 hectares are very low in potassium requiring 60, 45 or 30 kilogram of K fertilizer.

Table 5. Percentage of different levels of potassium per municipality.

Municipality	Potassium, ranges in ppm													
	2003				2007					2011				
	0-35	36-55	55-75	76 above	0-35	36-55	55-75	76 -100	above 100	0-35	36-55	55-75	76 -100	above 100
District II														
Aurora	0.05	5.82	32.68	61.44		0.05	5.82	32.68	61.44	9.79	12.93	55.28	9.46	12.54
Burgos	28.31	24.67	27.35	19.67	8.08	20.23	24.67	27.35	19.67	44.70	11.83	31.73	2.64	9.10
Gamu	46.66	12.27	20.29	20.78	8.79	37.75	12.27	20.29	20.78	84.63	5.54	3.93	2.77	3.31
Roxas	25.24	14.36	18.07	42.32	10.11	15.14	14.36	18.07	42.32	22.56	26.09	14.90	5.41	31.03
Sn Manuel	10.56	15.71	18.92	54.81	3.01	7.55	15.71	18.92	54.81	5.61	12.60	38.69	14.45	28.64
District III														
Alicia	66.73	22.64	6.08	4.55	24.14	42.59	22.64	6.08	4.55	69.55	7.81	7.11	2.77	12.76
Angadanan	66.75	21.21	2.85	9.18	44.38	22.38	21.22	2.85	9.18	69.44	22.06	5.08	2.10	1.38
Cabatuan	16.20	12.52	17.98	53.31	2.85	13.35	12.52	17.98	53.33	36.55	15.91	23.77	8.92	14.85
Cauayan	70.26	19.46	6.85	3.43	33.76	36.49	19.46	6.85	3.43	85.43	10.41	4.16	0.00	0.00
Luna	47.86	9.79	12.53	29.82	10.48	37.38	9.79	12.53	29.82	65.58	18.16	7.89	1.93	6.44
R. Mercedes	36.64	23.28	16.49	23.60	18.74	17.89	23.28	16.49	23.60	48.34	15.82	19.29	2.67	13.88
San Mateo	20.03	17.48	25.37	37.13	9.54	10.48	17.48	25.37	37.13	38.14	20.47	28.19	5.88	7.33
District IV														
Cordon	13.35	14.61	32.39	39.65	1.35	12.00	14.61	32.39	39.65	45.17	23.37	22.01	1.50	7.96
Echague	61.43	20.21	8.50	9.87	27.36	34.07	20.21	8.50	9.87	57.63	10.11	17.11	3.00	12.16
Ramon	76.72	13.04	3.76	6.48	34.96	41.76	13.04	3.76	6.48	70.41	10.53	12.58	0.83	5.65
San Isidro	86.01	10.68	1.86	1.45	42.26	43.75	10.68	1.86	1.45	67.59	12.37	15.42	1.60	3.03
Santiago	57.71	18.35	13.84	10.10	28.57	29.14	18.35	13.84	10.10	87.08	9.30	0.00	0.34	3.27
Total	45.15	16.95	14.64	23.26	19.23	25.92	16.95	14.64	23.26	54.51	14.06	17.33	3.94	10.17
Rice variety	NUTRIENT REQUIREMENT, Kg K/Ha													
Hybrid & inbred	60	45	30	0	60	45	30	7	0	60	45	30	7	0

Zinc is the only trace element included during the first and second round of fertility assessment since we still do not have established or calibrated recommendation for the other trace elements. Table 6 present the percentage

of area showing different levels of zinc relative to the total area. In 2003, 72.19% or 56,621 hectares are Zn deficient.

Table 6. Percentage of different levels of zinc per municipality.

Municipality	Zinc, ranges in ppm											
	2003				2007				2011			
	0-0.4	0.5-0.8	0.81-1.15	1.16 up	0-0.4	0.5-0.8	0.81-1.15	1.16 up	0-0.4	0.5-0.8	0.81-1.15	1.16 up
District II												
Aurora	12.35	48.93	0.00	38.72	12.35	48.93	0.00	38.72	6.01	25.65	12.10	56.75
Burgos	17.48	53.02	2.36	27.15	17.48	53.02	2.36	27.15	6.40	18.30	23.38	54.93
Gamu	20.56	51.44	4.56	23.45	20.56	51.44	4.56	23.45	19.89	10.08	29.00	17.65
Roxas	19.45	47.40	0.00	33.14	19.45	47.41	0.00	33.14	9.42	34.74	31.27	27.16
Sn Manuel	14.97	32.19	0.95	50.93	14.97	33.15	0.95	50.93	14.66	32.63	14.42	48.67
District III												
Alicia	21.88	36.86	19.57	21.69	21.88	36.86	19.57	21.69	16.13	20.36	23.93	33.90
Angadanan	9.65	23.94	18.85	47.56	9.65	23.94	18.85	47.56	9.25	20.35	14.36	42.82
Cabatuan	12.89	37.59	25.41	24.11	12.89	37.59	25.41	24.11	18.53	46.57	21.68	20.26
Cauayan	11.30	30.41	27.70	30.59	11.30	30.41	27.70	30.59	31.88	10.86	12.66	30.98
Luna	24.81	56.56	0.16	18.46	24.81	56.56	0.16	18.46	61.38	23.47	9.41	4.85
R. Mercedes	9.80	27.63	22.66	39.91	9.80	27.63	22.66	39.91	12.27	29.73	25.17	28.59
San Mateo	19.38	41.16	20.09	19.37	19.38	41.16	20.09	19.37	16.85	35.28	18.45	30.07
District IV												
Cordon	23.76	43.66	0.48	31.72	23.76	43.66	0.48	32.10	13.51	24.50	13.88	46.12
Echague	10.30	52.42	0.00	37.28	10.30	52.42	0.00	37.28	0.00	5.68	13.21	82.70
Ramon	23.39	41.99	21.36	13.26	23.39	41.99	21.36	13.26	0.14	12.64	21.59	64.21
San Isidro	24.87	17.76	16.46	40.91	24.87	17.76	16.46	40.91	13.36	25.37	26.53	34.35
Santiago	19.38	33.21	20.28	27.13	19.38	33.21	20.28	27.13	25.52	24.38	16.20	32.28
Total	18.38	38.56	15.17	27.81	18.44	38.05	14.32	29.19	15.69	23.93	19.79	38.62
Rice variety	NUTRIENT REQUIREMENT, Kg Zn/Ha											
Hybrid & inbred	20	15	10	0	20	15	10	0	20	15	10	0

In an attempt to correct this deficiency, the management of the Department of Agriculture in Region 2 decided to procure zinc sulfate (17-21%) to be distributed in Zn deficient areas. The total distribution was 384,954 kilograms covering a total of 29,615 hectares (Table 7). Apparently, not all deficient areas were applied with zinc sulfate. Nevertheless, during the 2nd and 3rd round of fertility assessment, a continuous drop in Zn deficiency was observed - 70.81% in 2007 and 61.38% in 2011.

In 2011, other trace elements including copper, manganese and iron were also analyzed to define further the fertility status of the project area. Looking at Table 8, a very large area of the MRIIS (95.31% or 86,463 hectares) is now very low in copper. For manganese, 42.8% (38,827 hectares) is below ideal range which is 40 – 120 ppm Mn. Iron deficiency is not yet a problem in the MRIIS rice area. These results prompted the Soils Laboratory staff in the region to conduct calibration study for copper and manganese in 2012 to develop recommendation for these two elements. It is still an ongoing project.

Soil Fertility mapping

Results of soil analysis per Turn-out are consolidated and given the corresponding N, P and K fertilizer recommendation. These fertilizer recommendations are the ones plotted on a map. Figures 1 and 2 are an examples of fertility map being generated out of the soil analysis data. Each color on the map represents combination of NPK fertilizer recommendation.

Table 7. Zinc sulfate distribution in 2005 – 2006.

Municipality	Zn deficient areas, Ha	Zinc Distribution, Kg	Area Served, Ha
District II			
Aurora	1,201	15,750	1,584
Burgos	2,694	17,850	1,266
Gamu	640	5,790	470
Roxas	3,229	31,650	3,165
Sn Manuel	2,565	21,744	1,354
District III			
Alicia	8,222	42,670	3,052
Angadanan	1,158	9,200	793
Cabatuan	3,946	19,785	1,552
Cauayan	5,373	43,590	2,906
Luna	1,978	5,725	438
R. Mercedes	663	6,650	476
San Mateo	7,581	25,000	1,983
District IV			
Cordon	2,695	24,800	1,731
Echague	796	21,130	1,679
Ramon	6,936	59,550	4,632
San Isidro	1,651	12,571	877
Santiago	5,226	21,500	1,658
Total	**56,553**	**384,954**	**29,615**

Table 8. Percentage of different levels of Cu, Mn and Fe per municipality (2011).

Municipality	Copper, ranges in ppm			Manganese, ranges in ppm				Iron, ranges in ppm			
	0-17	18-50	above 51	0-39	40-120	121-200	above 200	0-25	26-50	51-300	above 300
District II											
Aurora	92.04	7.96		38.87	51.48	9.15	0.50	14.62	14.39	71.22	
Burgos	99.65	0.35		31.01	44.92	21.63	2.45	9.99	22.04	67.42	0.63
Gamu	100.00	0.00		17.81	62.78	19.41		8.54	14.52	75.84	1.10
Roxas	77.70	22.30		26.22	57.45	16.32		3.22	27.16	69.62	
Sn Manuel	84.87	15.13		42.00	55.76	2.23		10.04	30.07	59.89	
District III											
Alicia	99.95	0.05		41.87	47.53	10.59		8.58	12.10	79.32	
Angadanan	99.41	0.59		22.22	67.80	9.98		9.81	40.88	49.55	
Cabatuan	99.27	0.73		49.78	41.27	8.95		4.73	14.87	80.51	
Cauayan	98.86	1.11		60.40	31.88	7.71		23.64	25.03	51.62	
Luna	100.00			75.98	22.10	1.93		25.86	27.08	47.06	
R. Mercedes	100.00			17.99	76.84	5.16		13.06	4.64	82.30	
San Mateo	98.52	1.48		51.69	37.16	10.01	1.13	4.15	14.22	81.62	0.21
District IV											
Cordon	80.88	19.12		17.72	54.83	27.46		4.19	12.85	83.42	
Echague	100.00			35.04	51.51	13.47		4.21	10.81	84.99	
Ramon	99.86	0.13		59.46	30.54	8.67	0.14	14.18	21.62	64.22	
San Isidro	93.24	6.75		31.00	43.45	25.08	0.47	12.05	23.69	64.83	
Santiago	98.05	1.95		51.89	38.18	9.92		10.29	17.21	72.85	
Total	95.31	4.68		42.80	44.62	12.16		10.46	20.26	69.66	

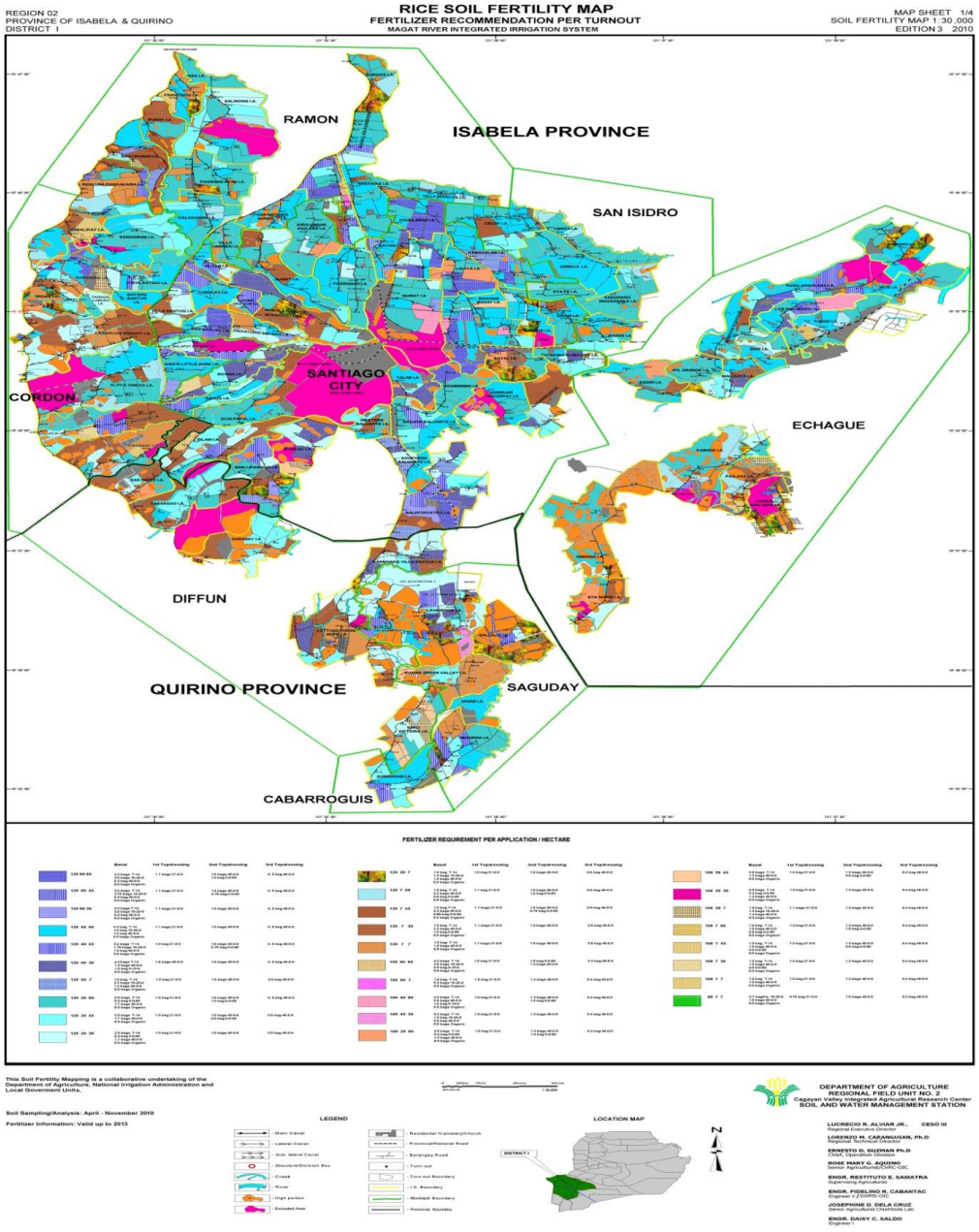

Figure 1. Fertility map of District IV, version 2011.

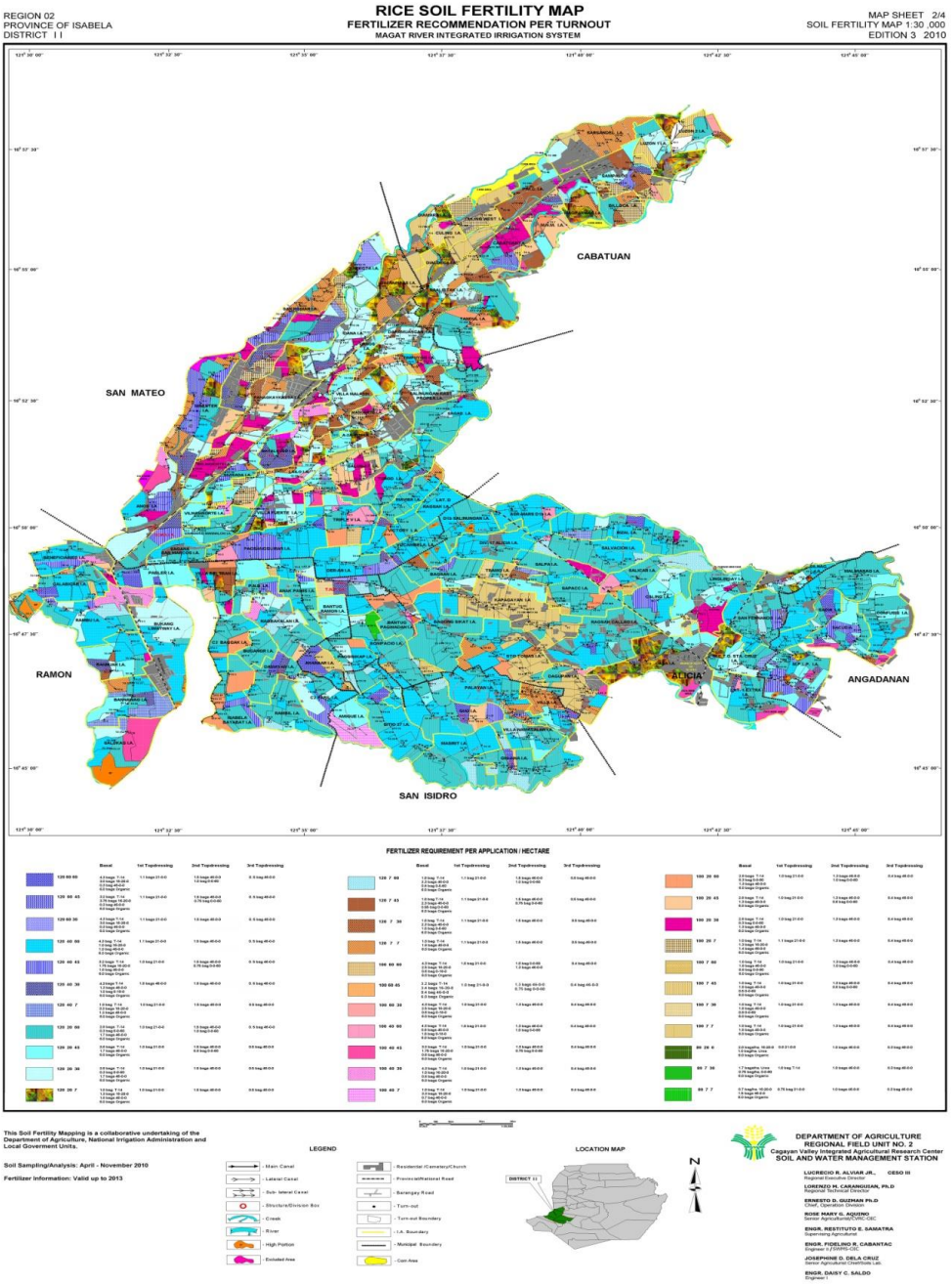

Figure 2. Sol fertility map of District II, version 2011.

Summary and conclusion

Rice areas covered by MRIIS is generally low in nitrogen measured as organic matter. With 120, 100 and 80 kg N/ha recommendation, approximately 9,000MT of N fertilizer is being applied in these rice areas every cropping season - granting that all farmers follow the fertilizer recommendation given by the Soils Laboratory. With 40 – 50% efficiency of N assimilation by rice cop, then some 4,500 MT nitrogen are either released in the atmosphere or leached underground causing environmental pollution.

Only phosphorus in 2007 yielded a minimal deficient area which is 30.93% of the total area. For the same year, the least potassium deficient area was also obtained, although the figure was still high at 62.1%. While the Department of Agriculture is advocating the use of soil analysis as a tool to increase rice production as it nurture the soil and the environment, it is the farmers who determine the success of this endeavor. Hence their participation in this kind of project is very crucial and very much appreciated.

Recommendations

Close monitoring of changes in soil fertility status within the MRIIS area should be done and this calls for the continuation of this regular activity of the two soils laboratories in Region 2. Massive information campaign on the result of this activity should also be done to include not only farmers but other stakeholders like agricultural researchers, agricultural technicians, fertilizer dealers and the Local Government Units.

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