RICE CROP MANAGER

HARNESSING DIGITAL AGRICULTURE: LESSONS FROM THE PHILIPPINES

International Rice Research Institute *in collaboration with*
Philippine Department of Agriculture
Philippine Rice Research Institute (PhilRice)

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ACRONYMS

AEW	Agricultural Extension Worker
ATI	Agricultural Training Institute
BAR	Bureau of Agricultural Research
BSWM	Bureau of Soils and Water Management
DA	Department of Agriculture, Philippines
DICT	Department of Information and Communications Technology
FAO	Food and Agriculture Organization of the United Nations
FITS	Farmers' Information and Technology Services
FOS	Field Operations Service
FPOPD	Field Programs Operational Planning Division
GPS	Global Positioning System
GPX	GPS Exchange Format
ha	Hectare
HYTA	High Yield Technology Adoption
ICTS	Information and Communications Technology Service
IRRC	Irrigated Rice Research Consortium
IRRI	International Rice Research Institute
IT	Information Technology
IVR	Interactive Voice Response
kg	Kilogram
KPI	Key Performance Indicator
MEL	Monitoring, Evaluation and Learning
MOET	Minus-One Element Technique

NGO	Non-governmental Organization
NMR	Nutrient Manager for Rice
NRP	National Rice Program
NUPW	National Updating and Planning Workshop
PhilRice	Philippine Rice Research Institute
PMS	Planning and Monitoring Service
PMT	Project Management Team
PRIME	Pest and Disease Risk Identification and Management
PRISM	Philippine Rice Information System
RCM	Rice Crop Manager
RCMAS	Rice Crop Manager Advisory Service
RFOs	Regional Field Offices
RMT	Regional Management Team
RSBSA	Registry System for Basic Sectors in Agriculture
RTC	Regional Training Center
RUPW	Regional Updating and Planning Workshop
SMS	Short Message Service
SO	Special Order
SSNM	Site-Specific Nutrient Management
SUCs	State Universities and Colleges
TOT	Training of Trainers
UN	United Nations
UPLB	University of the Philippines Los Baños
UX	User experience
WeRise	Weather-rice-nutrient integrated decision support system

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EXECUTIVE SUMMARY

As the global population continues to rise, food insecurity for almost 10 billion people will be one of the starkest challenges of our time. Improving the productivity of staple foods, such as rice, will be critical to feed the world's most vulnerable populations. Digital agriculture platforms and digitally-enabled services can help increase farmers' yields and incomes through agro-advisory services, providing improved information about crop management practices.

One such platform is Rice Crop Manager (RCM), a blended digital agriculture platform that is grounded in robust scientific research to generate the most appropriate nutrient and crop management recommendation specific to an individual farmer's field. Evidence indicates that if followed, these recommendations will bring about increases in both yields and farmers' incomes.

RCM was co-developed by the International Rice Research Institute and the Philippine Rice Research Institute with funding from the Department of Agriculture, in partnership with various government, private sector, research and academic institutions. Over the years, the project has undergone numerous iterations, adjusting not only to technological and research innovations and learnings, but also to partner needs and increased scale. It has transformed from a booklet to a CD-ROM to ultimately becoming a web-based application, and now an Android application. To date, approximately 1.4 million farmers in the Philippines have been reached and over 2 million recommendations have been distributed. Monitoring, evaluation and learning results indicate that RCM has increased yields by an average of 392 kg/ha/cropping season and provided an average additional net income of US$122/ha/cropping season.

This case study details the design, development, implementation, and scale of RCM as a digital agriculture platform that has nationwide reach and is fully integrated into a national agriculture program. Each component of the RCM program – from its applications and databases, governance and leadership, research, and dissemination – is examined. A number of lessons learned and recommendations are outlined at the end of the document. The goal of this case study is to share these lessons with other organizations and government agencies that are implementing digital agriculture programs to scale and be sustainable in the long term.

OVERVIEW

The global population is forecasted to reach 9.6 billion by 2050, requiring food production to rise significantly to prevent food insecurity and global hunger.[1] In the Philippines, the population is projected to increase by 15 million people from 2015 to 2025.[2] Rice is a staple food for a majority of Filipinos, increasing the imperative for local supplies of the grain to meet the demand.[3] In order for production to increase to meet this growing population pressure as well as respond to other challenges such as climate change and environmental sustainability, certain efficiency and productivity gains are critical for rice production systems. One way to accomplish these required gains is through the promotion and adoption of the best scientifically-grounded crop management practices.

Globally, digital technologies have been harnessed to help smallholder farmers increase yields and incomes.[4] From shared services for machinery to prevent postharvest losses to Internet of Things (IoT) sensors to monitor and inform irrigation decisions, digital and precision agriculture can lead to increased efficiency, productivity, and yields. Through mobile phones, farmers can access information that is otherwise unavailable or difficult to identify, including market prices, weather forecasts, and best crop production techniques. Drones and remote sensing can provide yield estimations, soil condition and water availability information, and early warnings for pest and disease outbreaks. The potential of these technologies to improve outcomes is remarkable. It is thus critical to understand their design, implementation, adoption, and sustainability methodologies to ensure that they indeed have impact.

In the Philippines, Rice Crop Manager (RCM) has blended digital technology and robust scientific research to generate a nutrient and crop management recommendation specific to a farmer's field that, if followed, will boost yields and incomes. It was co-developed by the International Rice Research Institute (IRRI) and the Philippine Rice Research Institute (PhilRice) with funding from the Philippines Department of Agriculture (DA). RCM Advisory Service (RCMAS) is a bundle of tools and services that collects data on rice farmers and their fields and provides precise, field-specific recommendations.

This case study examines the design, development, and deployment of RCM as one of the few examples of nationwide digital agriculture scale in the world. Investments in leadership, governance, scientific research, content, partnerships, and capacity building make RCM a truly unique use case. Specifically, this case study aims to (1) provide a detailed examination of RCM history and implementation in the Philippines and (2) outline key lessons learned, challenges, and recommendations for RCM partners and other organizations designing and implementing digital agriculture platforms.

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1 Nikola M. Trendov, Samuel Varas and Meng Zeng, *Digital Technologies in Agriculture and Rural Areas Briefing Paper*, Food and Agriculture Organization of the United Nations, Rome, 2019, http://www.fao.org/3/ca4887en/ca4887en.pdf

2 Philippine Statistics Authority, *Updated Population Projections Based on the Results of 2015 POPCEN*, 4 October 2019, https://psa.gov.ph/content/updated-population-projections-based-results-2015-popcen

3 The Philippines abandoned a self-sufficiency goal and liberalized rice imports. But after the COVID-19 pandemic showed the necessity of ensuring local supply, the DA set a 94% self-sufficiency target for 2020. See DA-Communications Group, *Rice farmers to receive free seeds, fertilizers for May 2020 main season*, https://www.da.gov.ph/rice-farmers-to-receive-free-seeds-fertilizers-for-may-2020-main-season/

4 Nikola M. Trendov, et al., *Digital Technologies in Agriculture and Rural Areas Briefing Paper*

BACKGROUND

BACKGROUND

Rice Production and Government Policies

The goal of RCM was to bring actionable and timely crop management recommendations to farmers and agricultural extension workers (AEWS) to increase yields and incomes. Currently, RCM's vision is to establish "RCM Philippines as the Department of Agriculture ICT platform to make Filipino rice farmers competitive through science-based crop management recommendations for increased yields and incomes." To that end, RCM has been incorporated into the Philippine Rice Industry Roadmap 2030 for targeted campaigns intended to improve rice production in the country.

The development of RCM is linked to the declining state of the country's rice sector competitiveness. From 2012 to 2016, rice production increased by an average of only 0.5% annually.[5] A survey in 2013 among rice farmers documented their average production at 3,513 kilograms (kg) per hectare (ha) for a net income of approximately US$347/ha.[6] It was found that one of the major reasons for the stagnation of rice production during this time was poor management practices. These practices account for the difference in yield gap, or the difference between the potential yield and actual farmers' yield. Ineffective fertilizer use was a major contributor to this yield gap. Most farmers do not apply the right fertilizer sources at optimal levels and times during crop growth. Farmers are also constrained by the cost of fertilizer, which accounts for 15% to 20% of the total rice production cost.[7] Farmers may adhere to or revert to old practices, applying fertilizer at suboptimal times and amounts, thereby incurring unnecessary costs.

5 Philippine Statistics Authority, *Crops Statistics of the Philippines*. https://psa.gov.ph/content/crops-statistics-philippines-national-and-regional

6 Philippine Statistics Authority, 2013 Costs & Returns of Palay Production, https://psa.gov.ph/content/costs-and-returns-palay-production-0

7 Philippine Statistics Authority, *Updates on Fertilizer Prices*. https://psa.gov.ph/content/updates-fertilizer-prices-0

Site-Specific Nutrient Management: Development and Initial Dissemination

Recognizing the need to address productivity gaps as well as information asymmetries, scientists at IRRI developed the scientific principles of site-specific nutrient management (SSNM) which could help farmers immediately boost yields and profits by adjusting fertilizer use. SSNM provided an approach for determining optimal amounts of nitrogen (N), phosphorus (P), and potassium (K) required from fertilizer to attain a target yield for a specific field.[8]

SSNM responds to a rice crop's nutritional needs, sets a target yield for a certain field that can be realistically attained, and accounts for available nutrients from the soil, crop residues, manure, and irrigation water. It then provides guidance on what amounts of N, P, and K should be applied at specific growth stages. Because the recommendation is exact and timely, excessive or inadequate fertilizer use is avoided and farmers benefit through increased yields and high returns from their investment in fertilizers.

However, the challenge rested on how to simplify the SSNM information and make it accessible for AEWs to widely disseminate it and make farmers understand it as well. In 2006, one-page guides on fertilizer management were developed, with the initial version providing information at the national level (Figure 1). Customized guides were developed for all major rice-growing provinces. However, the guides were considered unwieldy and generic and required farmers to manually compute the amounts of fertilizer to be applied to their field.[9] Monitoring and evaluation was also challenging as the number of users and adoption rates were difficult to track.

8 Roland J. Buresh, former Principal Scientist, IRRI, notes on SSNM, 25 June 2020; Rowena Castillo, Manager for Project Development and Deployment, IRRI, online interview, 13 April 2020

9 Roland J. Buresh, former NMR and RCM Project Leader, IRRI, online interview, 1 May 2020; Philip Joshua Sinohin, Specialist - Information Systems (Software Design), IRRI, online interview, 7 April 2020

Implementing site-specific nutrient management (SSNM) for irrigated rice in the Philippines

Apply fertilizer based on critical growth stage and yield targets as indicated below.

Fertilizer	Early growth Within 14 days after transplanting (DAT) or 21 days after sowing (DAS)	Active tillering	Panicle initiation	Maturity
Nitrogen (N)	Moderate amount	LCC-based (see part 2)	LCC-based (see part 2)	-
Phosphorus (P_2O_5), Zinc (Zn), and Sulfur (S)	100%	-	-	-
Potassium (K_2O)	50–100%	-	As needed (see part 3)	-

Part 1. Apply fertilizer during early growth within 14 DAT or 21 DAS.

Step 1. Select a yield target from the options of 4.5–5.5, 6–7, and ≥7.5 t ha^{-1} (with yield expressed at 14% water content).
Step 2. Select a fertilizer N rate from the table based on yield target.
Step 3. Select a fertilizer P_2O_5 rate from the table based on historical use of P_2O_5 and MOET results, if available.
Step 4. Select a fertilizer K_2O rate from the table based on straw management and MOET results, if available.
Step 5. For rice-growing areas where fertilizer Zn is recommended, apply 25 kg zinc sulfate ha^{-1}.
Step 6. Where S is recommended, apply S based on yield target.

Fertilizer	Yield target (t ha^{-1}) → / Target location ↓	4.5–5.5	6–7	≥7.5
		Fertilizer rate (kg ha^{-1})		
N	All fields	20	30	40–50
	Threshold P_2O_5 rate	20	25	35
P_2O_5	≥P_2O_5 threshold applied per season in past 2 years or moderate P response with MOET	20	25–30	35–40
P_2O_5	<P_2O_5 threshold applied per season in past 2 years or high P response with MOET	25–30	30–40	40–50
P_2O_5	No P response with MOET	0	0	20
K_2O	Straw removed and low stubble retained (<10 cm) or high K response with MOET	30	30–40	40–50
K_2O	Straw removed and stubble retained (≥30 cm) or moderate K response with MOET	20	25–30	35–40
K_2O	Straw returned and stubble retained	0	20	30–40
K_2O	No K response with MOET	0	0	20
Zinc sulfate	Zn deficiency symptoms in previous crops or Zn response with MOET	25	25	25
S	S deficiency symptoms in previous crops or S response with MOET	10-15	15-20	20-25

Step 1. Identify fields requiring additional fertilizer K_2O based on the presence of one or more of the following:
- Previous history of severe K deficiency, such as high K response with MOET.
- Yield response to fertilizer K_2O of ≥1 t ha^{-1} with nutrient omission plot technique.
- Alkaline (pH>8) irrigation water.

Part 2. Topdress N as needed by the crop, based on leaf color.

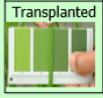
Option 1. Take LCC readings at active tillering and panicle initiation, and apply urea as indicated below.

- Panicle initiation (PI) is about 60 days before harvest.
- Active tillering is midway between 14 DAT or 21 DAS and PI.

Yield target (t ha^{-1}) →		4.5–5.5	6–7	≥7.5 [a]
LCC reading (immediately before N application)		Application of urea (kg ha^{-1})		
	LCC ≤ 3	75	100	125
	LCC = 3.5	50	75	100
	LCC ≥ 4	0	0	50

[a] For hybrid rice, apply 50 kg urea ha^{-1} at early heading if LCC ≤ 3.

Option 2. Take LCC readings every 7–10 days from tillering to booting. Apply urea when the LCC reading falls below the critical value, as indicated below.

LCC critical value (apply N when leaf color reaches critical value) ↓		Application of urea (kg ha^{-1})					
		Tillering to PI			PI to booting		
Yield target (t ha^{-1}) →		4.5–5.5	6–7	≥7.5	4.5–5.5	6–7	≥7.5 [a]
Wet-seeded 	LCC < 3	50	75	100	0 [b]	50	50 [c]
Transplanted 	LCC < 3.5						

[a] For hybrid rice, apply 50 kg urea ha^{-1} at early heading if LCC reading reaches the critical value.
[b] Apply 50 kg urea ha^{-1} in seasons with climate favorable for high yield.
[c] Increase to 75 kg urea ha^{-1} for hybrid rice.

Step 2. For identified fields, select a fertilizer K_2O rate from the table below based on yield target.
Step 3. Encourage farmers to apply the recommended fertilizer K_2O rate to a portion of their field and compare yields with and without the added K_2O.

Yield target (t ha^{-1})	4.5–5.5	6–7	≥7.5
Fertilizer rate (kg K_2O ha^{-1})	10–20	20–30	30–40

Figure 1. *SSNM* implementation guide for the Philippines (2007).

DEVELOPMENT OF THE RICE CROP MANAGER ADVISORY SERVICE (RCMAS)

DEVELOPMENT OF THE RICE CROP MANAGER ADVISORY SERVICE (RCMAS)

By 2007, IRRI scientists recognized that a field-specific recommendation for fertilizer rates could be calculated using farmers' answers to 10-12 questions about their farming practices. Farmer information on their field size, variety, and crop establishment practices enhanced the recommendation on the amounts of fertilizer and when to apply it. The calculations were also automated, kicking off a period of experimentation and iteration to identify a tool that was easy to use and convenient for AEWs.

Nutrient Manager for Rice

Nutrient Manager for Rice (NMR) was the first tool developed using SSNM principles to provide a field-specific nutrient management recommendation. It was designed and deployed from 2008 to 2013 with AEWs as intended users. A recommendation was generated for a field following a 20-question interview about the farmer's field and farming practices. IRRI partnered with the University of the Philippines Los Baños to develop the first version of the NMR through MS Access and distributed in CDs. Then, it became web-based, where the responses from the interview were sent to a cloud-based calculator utilizing SSNM-based algorithms and databases on rice varieties and rice-growing environments. Generated recommendations provided guidelines on fertilizer sources, rates, and timing.

The evolution of the NMR from 2008 to 2012 was based on a series of iterations and insights about the technology platform's viability, reach, and ease of use (Table 1). The conceptualization and development of each platform were also based on internet access and assumptions about future roll out and infrastructure across the country. After consultation with IT experts, IRRI believed that projected widespread access and use of the internet justified having an online platform as the primary channel for information dissemination; hence the web application was transitioned to HTML5 in 2012.[10]

10 Roland J. Buresh, former NMR and RCM Project Leader, IRRI, online interview, 1 May 2020.

Table 1. Evolution of Nutrient Manager for Rice.

VERSION	Nutriet Manager for Rice (NMR)	NMRiceWeb	NMRiceMobile	NMRiceApp
TIMEFRAME	2008 - 2009	2009 - 2013	2011 - 2013	2012 - 2013
PLATFORM	CD-ROM	Internet	Basic mobile phones	Android smartphones
DESCRIPTION	• First tool developed using SSNM, originally programmed in MS • Access and distributed in CDs • Farmer was interviewed by AEW and a recommendation was generated	• Farmer-AEW interview results sent to cloud-based server to calculate recommendation (internet connection required) • 2012 HTML5 updated version allow offline/SMS interviews and access • SMS/printed recommendation	• IVR technology-enabled. • Toll-free hotline; voice-prompted interviews • Fertilizer guidelines for farmers generated via SMS	• Farmer receives SMS recommendation from AEW • Interview data sent to cloud-based server
REASON FOR DEVELOPMENT	CD-ROMs as means of mass distribution	Monitoring of encoded data made possible	Accessible for farmers without internet connectivity	• Enabled offline/remote interviews • Internet connection still required for generation of recommendations
REACH & SCALE	3,000+ CD-ROMs distributed to stakeholders	• 26,565 recommendations generated (2012-2013) • No baseline web usage data (2019-2011)	10,664 calls Jan 2011-2012 with only 12% completion rate	No data collected due to unavailability of data-pull functionality
CHALLENGES	• Challenges in the use of older to newer CD-ROM versions caused confusion • CD-ROMs use discontinued to ensure availability of updated information for users	AEW and farmers' access to technology devices / equipment was limited	• Low farmer mobile usage confidence for interviews • Discontinued in 2013 due to limited funding	• Updates difficult to define due to separate upgrade-related programming • Lack of internet and mobile connectivity

RICE CROP MANAGER AND ADVISORY SERVICE (RCMAS)

In 2013, IRRI transitioned to Rice Crop Manager (RCM), which incorporated crop management advice to further boost rice yields. IRRI then partnered with PhilRice with funding from the DA to tailor RCM for use in the Philippines, officially launching it with PhilRice in November 2013. The DA supported research to evaluate and refine RCM recommendations through the Bureau of Agricultural Research (BAR) as well as activities associated with deployment and the enhanced use of RCM through the Agricultural Training Institute (ATI).

RCM is currently a web-based tool and Android application whose target users are AEWs, crop advisors, input providers, and farmer leaders who interview farmers. As with NMRiceWeb, it is accessed via laptop, smartphone, or tablet. The process for producing a recommendation is that an AEW interviews the farmer before the cropping season, inputs the data in the RCM, generates and prints a recommendation, and then hands this recommendation to the farmer with a supporting explanation. An offline capability was also added so that farmers' answers could be temporarily stored on the device and sent to the web once online. Table 2 shows the full timeline for the development of NMR, RCM, and associated tools while Table 3 presents the suite of tools associated with RCM which was launched as RCMAS in December 2016.

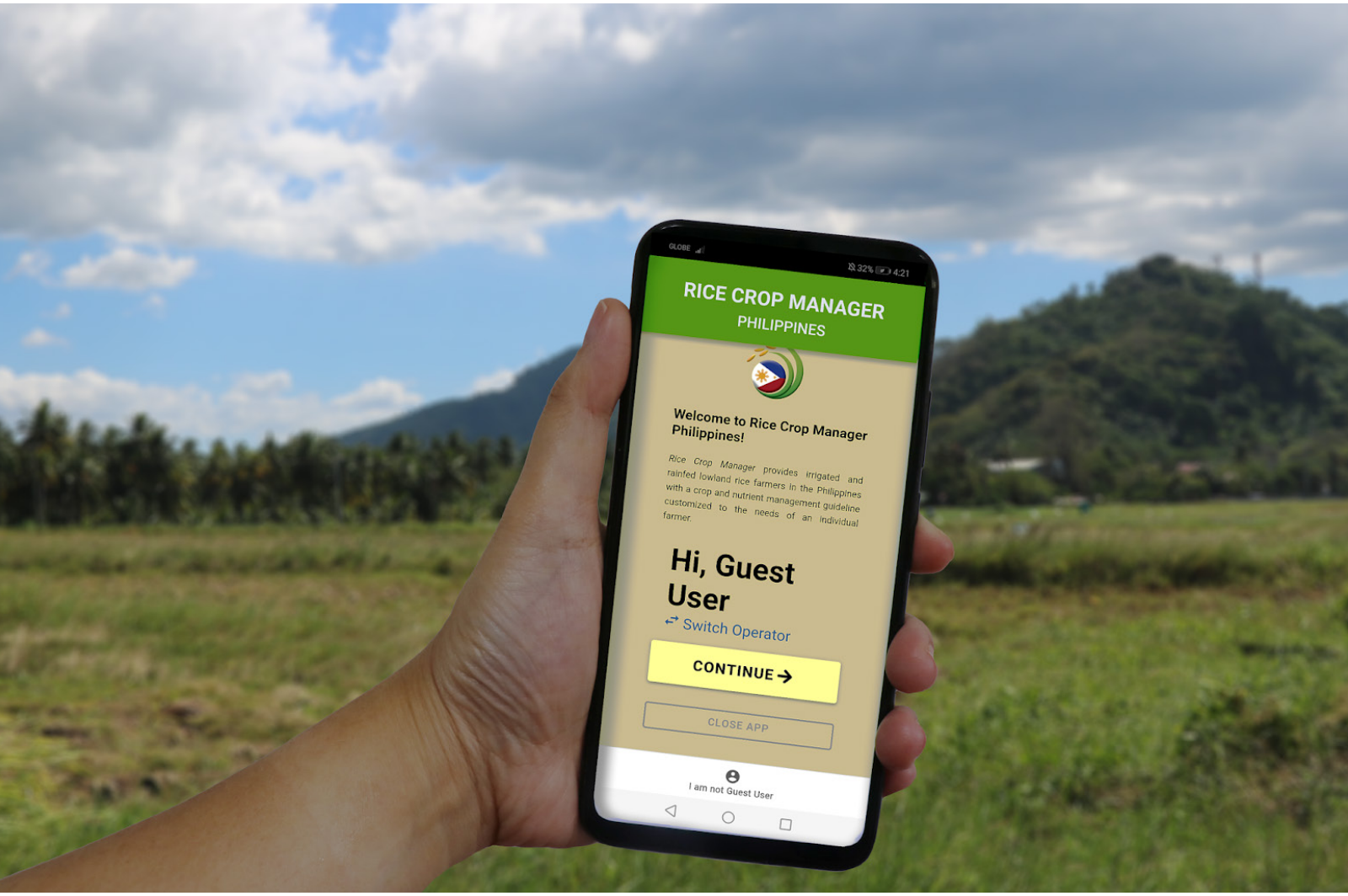


Table 2. Timeline of *NMR* to *RCMAS*.[11]

2008	NMR is launched and programmed in MS Access and distributed through CD-ROM.
2009	NMRiceWeb is introduced. The 2008 CD version of NMR is discontinued.
2011	NMRiceMobile, using IVR, is rolled out for users of non-smartphones.
2012	NMRiceApp is launched for Android phones. It is the offline version of NMRiceWeb.
2012	NMRiceWeb, programmed in HTML5, is released.
November 2013	RCM Philippines is launched.
June 2015	RCM Messenger, an SMS-based service for farmers, is rolled out.
August 2015	Farming Monitor is launched to track farmers' uptake of the RCM recommendation.
October 2015	Beta versions of Farmer and Field Registration and ID Maker are developed.
December 2016	RCMAS is launched. It includes RCM, Messenger, Farming Monitor, Farm and Farm Lot Registration, and Farmer ID Maker.
December 2017	User Registration is launched.
March 2020	Android app with data sync capability is launched.

11 Roland J. Buresh, former NMR and RCM Project Leader, IRRI, notes on NMR, 25 June 2020; IRRI, Terminal Reports for DA-BAR for project Rice Crop Manager implemented 1 April 2013 to 31 December 2016; IRRI, Rice Crop Manager now available as an Android application, http://news.irri.org/2020/03/rice-crop-manager-now-available-as.html

RICE CROP MANAGER ADVISORY SERVICE (RCMAS)
SUITE OF TOOLS

	DESCRIPTION	REASON FOR DEVELOPMENT	TARGET AUDIENCE	STATUS AND CHALLENGES	SCALE AND REACH AS OF APRIL 2021
Rice Crop Manager (2013 – present)	• Web-based farmer-AEW interviews for site-specific pre-season crop recommendations • SMS/printout recommendations provided to farmers	Updated to include recommendations for water management, seed rate, and crop protection	AEWs, researchers, input providers	• RCM recorded a 27% and 58% "farmer uptake" versus uptake of farmer • Poor internet connectivity led to printing and distribution issues [12] • Some responses unaccounted for due to manual/offline documentation	• More than **2.5 million** recommendations generated for interviewed farmers; • **1.1 million** farmers reached
Farmer and Farm Lot Registration (2015 - present)	• Global Positioning System (GPS)-enabled farm-lot size identification; data fed into RCM for fertilizer input calculation • Farmer and farm lot data logged into RCM database for unique ID assignment	Farmer over/underestimating farm lot size led to imprecise fertilizer input calculation and recommendation	AEWs	• DA adopted farmer registration and geo-referencing protocol • DA updates RSBA database with collected farmer and farm lot data • Lack of handheld GPS device for some municipalities	• **160,866** farmers and **257,194** farm lots registered • **110,992** georeferenced farms, equivalent to **74,952** hectares
ID Maker (2015 - present)	Generates ID cards with RCM ID number and farm lots associated with FFR-registered farmers	RCM ID card with exact farm and field area data are given to registered farmers Used to automatically obtain relevant farmer and farm lot information in RCM interviews	AEWs, Farmers	• RCM ID card system received positively by farmers • Farmer preference for similar ID to be used for other transactions beyond RCM • Cost for ID printers and accessories i.e. printer ribbon, PVC cards, etc. a deterrent	• **6,199** farmer ID cards generated

[12] Ester Ruth Torreverde, Agriculturist II and RCM Focal Person, DA RFO 6, online interview, 15 May 2020

RICE CROP MANAGER ADVISORY SERVICE (RCMAS)
SUITE OF TOOLS

	DESCRIPTION	REASON FOR DEVELOPMENT	TARGET AUDIENCE	STATUS AND CHALLENGES	SCALE AND REACH AS OF APRIL 2021
Messenger (2015 - present)	• Follow up farmer phone interviews to check consistent use of crop establishment date and rice variety initially reported by farmer • Updated SMS-generated RCM recommendations despite crop establishment date and/or variety changes	• Follow-up farmer calls conducted to confirm any crop establishment changes • Recommendations on dates and rates for top-dressed fertilizer application adjusted depending on determined changes	Staff members of ATI's Regional Training Centers (RTCs) who also operate ATI's Farmer Contact Center that links farmers to agricultural information.	Discontinued in Q2 2021 due to: • Low call turnouts • Unconfirmed interview information generate generic SMS recommendations on fertilizer timing application • Often, farmers do not have access to mobile phones and when they do, their numbers are not always reachable when called. They may have changed their number or they were occupied when the RTC called. The calls are usually made during office hours, which oftentimes do not coincide with the time that farmers are available [13].	**59,669** calls were made with only **4,821** successful
Farming Monitor (FM) (2015 - 2018)	Post-harvest practices and results monitoring	Track farmers' uptake of the RCM recommendation and changes in farming practices at cropping season end	RFO staff members	• Transformed into a MEL tool to capture farmer adoption of RCM recommendations • Used by DA to conduct internal MEL	**21,638** post-cropping interviews were done through RCM FM and data were used for reporting by DA-RFOs
User Registration (2017 - present)	• RCM user registration allowed users access to RCMAS applications and data • Users monitored are reported to the DA	Enables user access to RCM suite of tools and resources	AEWs, farmers, and RFO and RTC staff and researchers	• Platform users are categorized into "national" or "public" • Training materials are accessible to users through this portal	**6,956** RCM users registered

[13] Antonieta J. Arceo, Chief, Information Services Division, DA-ATI, online interview, 24 And 27 April 2020; IRRI report to DA-ATI, *Rice Crop Manager Phase II: Part B. Maintenance and use of a climate-informed rice agro-advisory and information service for the Philippines*, May 2017 and March 2018

RICE CROP MANAGER ADVISORY SERVICE (RCMAS)
SUITE OF TOOLS

	DESCRIPTION	REASON FOR DEVELOPMENT	TARGET AUDIENCE	STATUS AND CHALLENGES	SCALE AND REACH AS OF APRIL 2021
Companion Application (2017 - 2018)	• SMS-generated recommendations produced without internet connection • Interview information and recommendations are transmitted between the RCM server and mobile device	Addressed recommendation-delivery issues related to internet connectivity	AEWs	Erratic network/signal and SMS congestion caused delays in recommendation generation	**33** recommendations generated with **165** SMS received from registered farmers
Farming Monitor for Monitoring, Evaluation & Learning (MEL) (2018 - 2019)	• Accurate understanding of impact and outcomes • End-of-cropping season uptake data capture	• DA expressed interest in the RCM program impact • Strong data collection platform required for RCM impact and reach insighting	RFO staff members	Including FM for MEL made the interview longer by around 100 questions depending on the farmer's response	• **3,627** complete datasets extracted from the application were used for RCM evaluation. • Results showed that **27%** of **1,876** RCM farmers adopted the recommendation during the dry season 2017-2018
Android Application (2020 - present)	• Data sync features allow efficient capture and generation of farmer interviews and recommendations • Allows downloads of RCM recommendations in PDF for printing • The first version was launched in March 2020	Provides offline RCM questionnaire	Extension workers	Immediate information collection and recommendation generation are dependent on RCM database sync which requires device to be online	**11,533** generated recommendations for farmers interviewed offline

Rice Crop Manager

Reference Number: 2215834

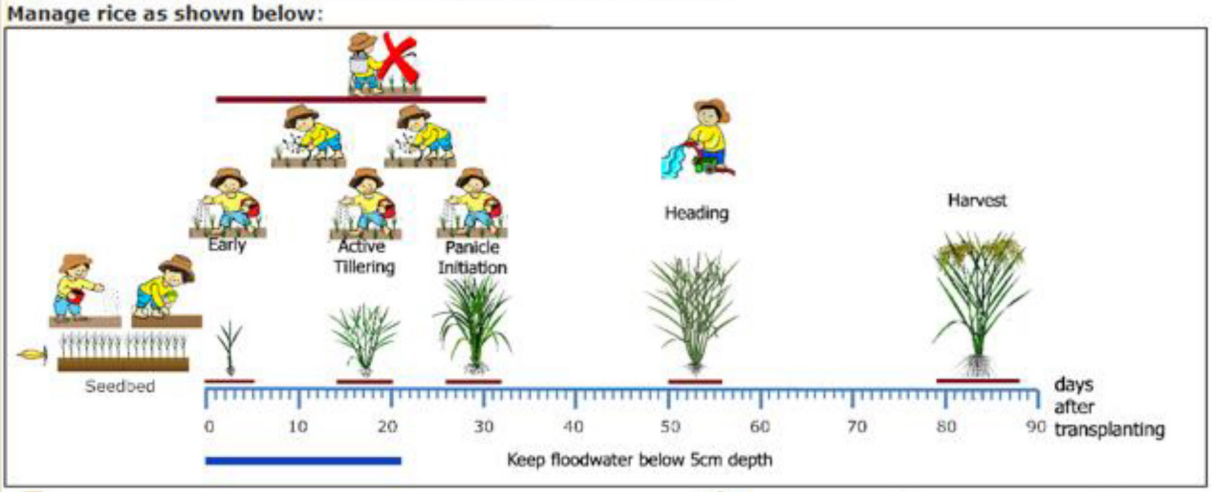
Name of farmer: Juan Dela Cruz
Farm Lot name: Field 2
Location: Pagdugue, Dumangas, Iloilo, Region VI

Date generated: November 19, 2019

Water regime: rainfed
Crop establishment: manual transplanting
Variety: NSIC Rc192(Sahod Ulan 1)
Sowing date: November 17, 2019

Note: Use this recommendation for sowing in November 2019 only.

Manage rice as shown below:



Apply Zinc to seedbed. Broadcast 1kg of zinc sulfate per 40 kg of seed within 10 days after sowing

Use certified or good quality seeds for 1 hectare farm lot.

Do not spray insecticide within 30 Days After Transplanting. Plants compensate for early damage caused by defoliators; no spray also conserves beneficial organisms.

Use 21 days old seedlings with good snail control
Younger seedling can increase plant vigor and yield

Ensure weed is controlled before fertilizer application.

Irrigate your farm lot at flowering when there is no standing water on farm lot

Keep floodwater. When there is risk of rice submergence during early growth stage, keep flood water below 5 cm depth.

Apply fertilizer as indicated below:

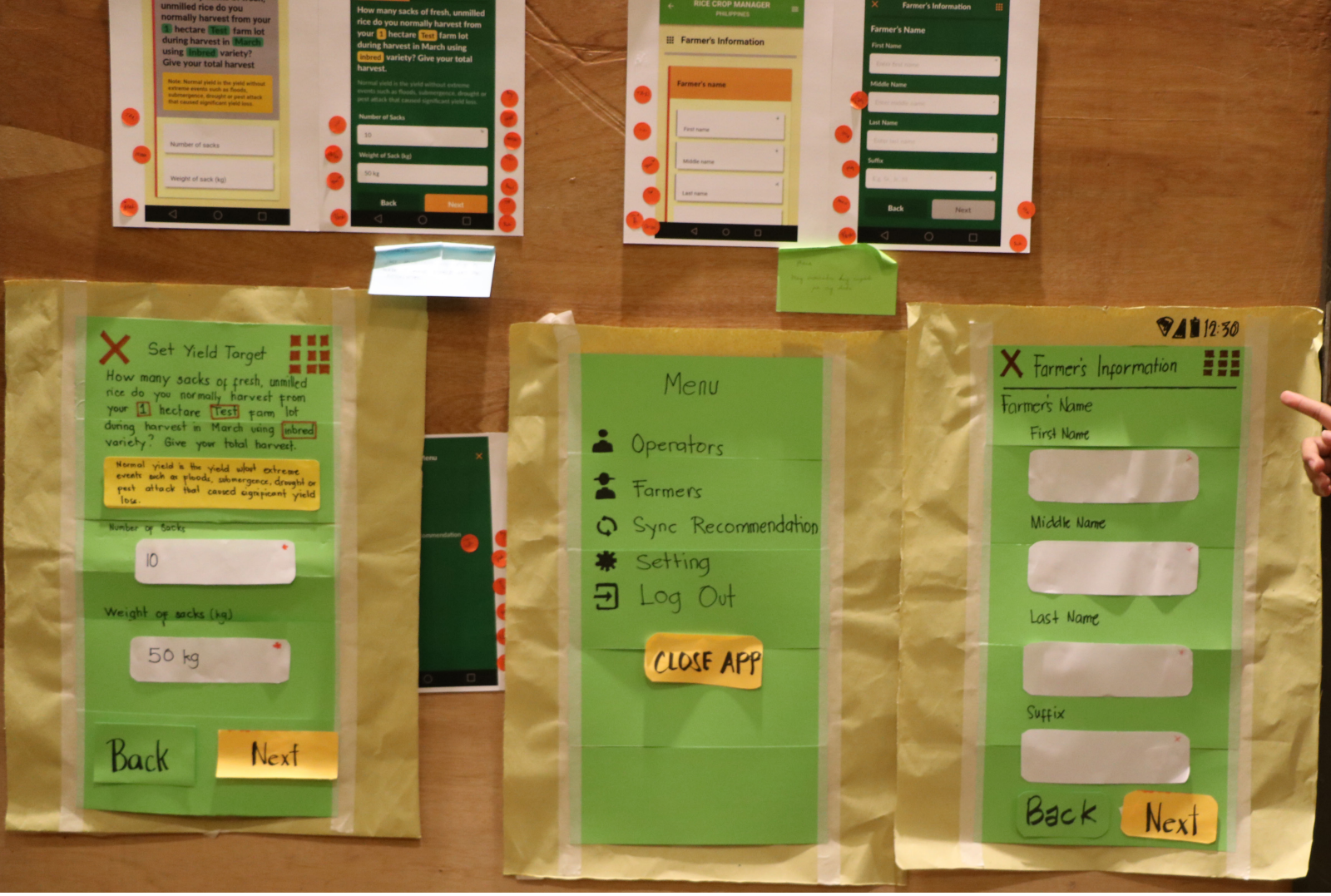
Target yield (fresh): 98 sacks at 50 kg/sack

Growth Stages	Days After Transplanting (15-22 days seedling)	Days After Transplanting (23 days or more seedling)	Fertilizer amount for 1 ha		
			14-14-14 with sulfur	urea	MOP or 0-0-60
Early	Basal to 10	Basal to 5	3 bags and 33 kg	---	---
Active tillering	17-23	14-20	---	21 kg	---
Panicle initiation	28-34	26-32	---	1 bag	33 kg

When farm lot has overflow of water or drought at active tillering:
If overflow of water or drought ends by 24 Days After Transplanting, apply fertilizer for active tillering after the overflow of water or drought. Apply the fertilizer for panicle initiation within 29 to 35 Days After Transplanting.
If overflow of water or drought extends beyond 24 Days After Transplanting, eliminate application for active tillering. Only apply fertilizer for panicle initiation.

Figure 2. Sample of the *Rice Crop Manager* Recommendation Page.

RICE CROP MANAGER DESIGN



RICE CROP MANAGER DESIGN

The success of RCM in the Philippines has hinged on the complex interplay of robust science, relationship building, and results across the main components of the project: research, dissemination, applications and databases, and governance and leadership. The next section will examine how these design elements were integral to RCM's development while also posing challenges for its scale and sustainability.

Partnership Building

The longevity and integration of RCM into the DA's programmatic work are grounded on strategic and meaningful partnerships with various DA agencies which are critical for its success. IRRI's team provided thought leadership and partnership brokering since the beginning of NMR and RCM. In partnership with the DA National Rice Program (NRP) within its Field Operations Division (FOS), IRRI identified key DA agencies to be involved in RCM to provide added value for Filipino farmers and rice production.

The three primary RCM partners include:

1. **International Rice Research Institute (IRRI):** From 2013 to 2021, IRRI has been responsible for the overall program management for research, dissemination, applications and databases, and governance. As an international research-for-development organization, IRRI's main objective has been to ensure that the complex science of SSNM improved outcomes for farmers.[14] In addition to scientific expertise, IRRI also specializes in capacity building. It acts as a neutral convener that can leverage lessons learned from other geographies and across research disciplines such as soil science, water management, weed management, seed systems, and environmental sustainability, among other areas.

14 Roland J. Buresh, former NMR and RCM Project Leader, IRRI, online interview, 1 May 2020

Figure 3. Department of Agriculture Organizational Chart.

2. **Philippine Rice Research Institute (PhilRice)**: PhilRice is the key research partner for RCM and will be responsible for all RCM components following the transition in December 2021. PhilRice's mandate, as the national rice research organization, is to harness scientific research to improve the local rice sector. Its interest in the use of digital technology to advance this objective has been growing steadily over the years.

3. **Philippines Department of Agriculture (DA)**: The agencies involved in RCM include those that operate at the central office level for governance, thought leadership, and strategic planning, and at the regional level through operational units that are responsible for extension and working directly with farmers and AEWs.
   a. **Bureau of Agricultural Research (BAR)**: DA-BAR is a direct funder of RCM with a focus on the research and development of RCM applications and database structures. DA-BAR coordinates funds for research and development projects in agriculture and fisheries.
   b. **Agricultural Training Institute (ATI)**: DA-ATI is also a direct funder for RCM for training, dissemination, and operational maintenance of the applications and databases. ATI serves as the extension arm of the DA, reaching local areas through its Regional Training Centers (RTCs).
   c. **Field Operations Service (FOS) and Field Programs Operational Planning Division (FPOPD)**: FOS implements DA programs at the local level through the Regional Field Offices (RFOs) and coordinates the planning and budgeting of the RCM-related activities of the RFOs.
   d. **RFOs Operations and RTCs**: These agencies provide training to AEWs and oversee the dissemination of the RCM recommendations from AEWs to farmers.
   e. **RFOs Research and Development**: They were the initial partners in the deployment of the RCM in the regions but later took on research activities on RCM evaluation and nutrient-omission plot technique (NOPT) trials within areas and rice-production conditions not covered by the research activities of PhilRice.
   f. **Information and Communications Technology Service (ICTS)**: ICTS provides the main host server for RCM applications and databases. After the transition, it will also provide guidance in integrating RCM with other DA tools, sharing information, and databases of farmers.
   g. **Planning and Monitoring Service (PMS)**: PMS provides guidance in the Monitoring, Evaluation and Learning (MEL) processes in the uptake of RCM by AEWs and farmers.

Research

RCM began as a research project that tested the validity of the site-specific nutrient management (SSNM) principles. IRRI and PhilRice collaborated on research to further improve RCM's capability. This has led to periodic releases of the upgraded version of RCM from 2014 to 2021. Most of the upgrades were on the features and operation of the application. Databases on potential yield and variety lists used with RCM were done on a yearly basis.

SSNM improvements, crop management research, and NOPT trials

The IRRI-PhilRice joint research obtained data from various regions of the Philippines to ensure that RCM recommendations covered diverse rice farming production environments. A total of 1,191 on-farm trials, which included farmers' and experimental plots, were conducted in irrigated and rainfed areas in 13 regions from 2014 to 2020 to determine the benefits of RCM over farmers' practice. NOPT trials were conducted to gather data on indigenous nutrient supply in these environments to determine needed adjustments in the calculation of pre-season fertilizer rates.

Key Insights for RCM Algorithm Upgrades

Upgrades in RCM algorithms to calculate N, P, and K rates will come from the results of the RCM evaluation and NOPT trials conducted from 2014 to 2020. The upgrades will focus on:

(1) Target yield setting - examination of uncertainties associated with farmer's estimation of field area and moisture content of palay at harvest; estimation of exploitable gaps in yield from yield potential generated using a crop model and historical climate data.

(2) Adjustment of N calculations - examination whether field characteristics observed before and during the cropping season can be used to adjust fertilizer N management.
(3) Adjustment of P and K calculations - examination whether field characteristics of locations can be used to adjust P and K management.

Dissemination & Training

As the RCM program evolved, the emphasis shifted on getting the recommendations into the hands of farmers. The operational model for dissemination has the following six components:

Inter-agency collaboration and partnership: The dissemination of RCM and RCMAS required extensive inter-agency partnerships to maximize the reach and scale of the program. Nationwide dissemination required the collaboration of both the RFOs and RTCs. RFOs report to the DA Central Office and the RTCs report to DA-ATI. The dissemination of the RCM recommendations was handled by the RFOs from 2014 to 2015 and was extended to the RTCs in 2016.

Training of Trainers (TOT): The RCM team adopted a TOT model for more wide-scale training to reach more extension workers. The TOT was conducted for RCM focal persons of the RFOs and RTCs, focusing on operating the RCM tool, generating a recommendation, and training RCM coordinators designated from among extension workers in the provinces, municipalities, and cities.

Target setting: Initially, the Key Performance Indicator (KPI) for AEWs with respect to RCM was the number of recommendations generated. Targets were set by RFOs in consultation with the NRP which is managed by the FOS. These targets varied depending on the rice-producing area, geography, and the number of farmers in each region. The targets dictated the budget for RCM allocated for each region. However, in 2018, these targets changed. Targets are now set by RFO and RTC RCM focal persons with some local government partners during the Regional Updating and Planning Workshops.

AEW Interview and Recommendation Provision: After AEWs are trained, they are able to conduct the RCM interview. AEWs have innovated on the process depending on their specific needs, conditions, and users. Extension workers usually introduce RCM during farmers' meetings held at local agriculture offices where large groups attend. Often, these meetings coincide with input distribution. AEWs also do farm and home visits for farmers located in far-flung barangays or upland barangays. However, sometimes these areas are not reached because of transportation constraints as well as the absence of financial allowance from local governments to travel to these areas. Extension workers have also conducted interviews using pre-printed recommendations, inputting data on the web-based application but manually inputting the recommendation because of a lack of printers or other supplies.

Support for AEWs: RFOs have been supporting AEWs by providing allowance for mobile load credit and devices such as tablets and pocket WiFi, printers, and other office supplies. Some also provided a monthly incentive (approximately US$70 as of 2020) so that the AEWs can deliver results on RCM and perform other assignments.

Integration with existing DA programs and policies: As the DA investment in RCM continued, additional efforts were made to integrate it with ongoing and new digital agriculture and other extension programs to maximize its reach and potential.

a. ATI manages a series of Farmers' Information and Technology Services (FITS) Centers, which are a one-stop information and activity hub for farmers. These are usually maintained and housed in the local agriculture office. RTCs have equipped some FITS centers with internet connection, computers, and printers to also become RCM hubs where recommendations can be generated and printed. By July 2021, there were 439 "RCM-enhanced" FITS centers out of 900 total.
b. RCM recommendations are a requisite for farmers who participate in the High Yield Technology Adoption (HYTA) program and the rice model farm program that distribute inbred and hybrid seeds and fertilizers.

c. DA-ATI has included RCM modules in a number of initiatives, including the Agricultural Development Officers of the Community (AgRiDOC) program for extension workers in rice-producing areas that ran from 2014 to 2019 and the ongoing Digital Farmers Program that targets youth and farmers.

The dissemination and training component is critical in ensuring that RCM recommendations get into the hands of farmers. Working across various agencies that all have different governance structures, timeframes, and strategies have required a significant investment to make sure the appropriate stakeholders are included in the partnership.

Applications and Databases

From the beginning of RCM, all the digital platforms and associated applications and databases were developed in-house at IRRI. It was deemed important to have that knowledge and development within IRRI to be able to quickly adjust the apps based on the scientific inquiries and updates. Since 2013, the DA has funded the development, maintenance, upgrading, and continuous operations of RCMAS and RCM Statistics.

Core Apps & Databases Team (AppsLab): At its largest, the AppsLab team of agronomists/soil scientists, software developers and database managers, and communication specialists at IRRI included 15 people. The AppsLab team works closely with the science team to develop, iterate, and upgrade the applications and databases while the communications specialists handle the development of training materials for each application.

Development of additional applications in RCMAS: Since its deployment in 2013, RCM has evolved and integrated tools and services collectively known as the RCMAS (Figure 3). In March 2020, it was decided to consolidate the applications within RCMAS into one application, which is now RCMAS 4.0.

User-testing and user-experience (UX): IRRI ensures that during the user testing and experience workshops (UX), representatives from RFOs, RTCs, and the DA Central Office were present. LGUs and farmers were also interviewed to get their feedback. Beginning with the RCM Companion App development in 2017, a testing protocol was developed for the RFOs to follow and distribute to the field implementers. This feedback led to the termination of the companion app. Recognizing the utility of this methodology, the team conducted a UX workshop in 2018 which led to the development of the Android app. To date, around 20 sprint demos have already been conducted.

Partnership with ICTS: In July 2019, the Apps and Database team planned and discussed how DA-ICTS and PhilRice would be involved in the three-year transition strategy and process. Major considerations such as clarity of accountability, roles, and responsibilities, technical capacity, and human resources were identified to be vital for a smooth transition to the DA. By July 2019, the director of DA-ICTS relayed the agency's full support to the RCM transition initiative and introduced the ICTS support staff. Following several workshops, DA-ICTS was identified as the primary host to provide the infrastructure needed for RCMAS, with PhilRice as the back-up host/server starting in 2022. All the needed changes to be done by PhilRice must be in consultation with ICTS and vice versa to promote transparency and awareness between both agencies.

Data privacy and security: In February 2017, the RCM Management Team approved getting the consent of farmers for the RCMAS tools. This was in line with the Data Privacy Act or Republic Act No. 10173. RCM also started to use the https protocol to secure all data transfers between the user's browser and the servers. This enabled encryption and prevented eavesdropping. More importantly, users and other institutes trust and are more likely to use sites that are https enabled.

AWS and cloud server: The move to use a cloud server using the Amazon Web Services (AWS) to host the applications and databases started in March 2009. Over the years, RCM tools proliferated and a single server was insufficient to hold the backend services for the source codes, calculations, and database for static data. An expandable server was then introduced to address the bigger usage volume. With the transition of

RCMAS to the DA by 2021, the applications and databases will be shifted from a cloud server to on-premise servers at DA-ICTS since the acquisition of cloud services is still in its planning stage while the on-premise facility is already available. There is a plan for DA-ICTS and PhilRice to further explore a hybrid model with both cloud and on-premise servers following the transition.

Governance and Leadership

Given the complexity, scale, and multiplicity of partners involved in RCM, functional governance and leadership were crucial for a smooth implementation and clear lines of decision-making. Ensuring that RCM was embedded into the research, dissemination, and technology agencies at the DA will hopefully bode well for the future scale and sustainability of the program. Clear governance and leadership roles and responsibilities allow for clarity of decision-making, discussion, and processes. In addition to more formally coordinated groups such as the Project Management Team (PMT), RCM also benefits from informal, interpersonal relationships, and communities that have been nurtured since program inception. The core components of RCM's governance and leadership include (1) focal persons, (2) special orders and formalization of RCM activities, (3) national meetings and workshops, (4) strong interpersonal relationships, (5) series of technical working groups and scopes of work (SOWs), and (6) a national leadership body.

Focal persons: Beginning in 2014, a group of focal persons were identified at all levels of the concerned DA agencies. First, a DA-funded IRRI team member was embedded within the DA. This person was able to not only coordinate and track governance activities internally at the DA, but also to provide key information and guidance on DA activities, strategic levers for action, and an insider understanding of DA activities in general. At the regional level, focal persons at RFOs and RTCs were designated to oversee planning, budgeting, research, training, and dissemination of RCM activities. The identification of these focal persons directly linked RCM to focal person KPIs, creating accountability, buy-in, and wider reach.

Special Orders (SOs): As in other government agencies, the DA relies on Special Orders signed by the Secretary of Agriculture to formalize key decisions, partnerships, and specify roles and responsibilities. These SOs signal a professionalization and formalization of processes, outputs, working groups, and activities that spur the central and regional office counterparts to act.

National and Regional Meetings: Twice a year, the RCM core team hosts the National Updating and Planning Workshop (NUPW). Depending on the agenda, the invitees vary, although this meeting is typically intended for those responsible for or involved in dissemination and training as well as IRRI, PhilRice, regional focal persons, representatives from DA organizations and the Central Office, and associated agencies. NUPWs provide a venue, usually two full days of meetings, for partners to report on progress and updates, work through challenges, and plan for the upcoming seasons. Regional Updating and Planning Workshops (RUPWs), which are only held in select regions, involved regional focal persons and local government partners.

Strong interpersonal relationships: Since 2013, a number of stakeholders have been involved in the RCM and have developed strong interpersonal relationships. Group chats, emails, SMS, and phone calls allow partners to immediately raise, discuss, resolve issues and make announcements. This intangible component has further strengthened the investment of all people involved in the project who take pride in the work that they are doing for Filipino rice farmers.

Project Management Team (PMT): The PMT was created in 2016 through an SO which indicates that the PMT is needed for the "smooth implementation" of the RCM project as the number of partners had expanded and there was a need to delineate work tasks and deliverables. The goal was to create a body to oversee the planning, implementation, and monitoring of RCM. PMT membership has changed over the years as RCM has evolved and will continue to govern RCM after its full transfer to the DA.[15] Regional Management Teams (RMTs) were also formed in 2018 and are headed by the RFO Regional Executive Director. The RMTs include

15 Lorna Belinda I. Calda, Supervising Agriculturist and Officer-in-Charge - Chief, Field Programs Operational Planning Division, DA-FOs, online interview, 17 July 2020; Roy M. Abaya, Director, DA-FOS, answers to questionnaire

regional rice and RCM focal persons as well as other staff members and officials of RFOs, RTCs, and PhilRice.

Technical Working Groups (TWGs): While the PMT served as the overarching management body and the SOs provided professionalization and formalization of activities, TWGs were formed to address discrete components of RCM implementation like MEL and for specific components of the RCM transition, such as apps and databases, research, training, and dissemination.

RESULTS AND IMPACT

RESULTS AND IMPACT

Some research within the RCM project supported by DA-BAR examined whether the field-specific recommendations provided by RCM increased farmers' income and yield. By the end of 2020, on-farm trials indicated that RCM did increase yields by an average of 392 kg/ha/cropping season and provided an average additional net income of US$122/ha/cropping season. At the same time, the DA focused on the number of recommendations generated and set high regional targets with funding for training and dissemination. From 2014 to 2020, over 2.5 million recommendations were generated by RFOs and RTCs in collaboration with their respective LGUs.

M&E activities were conducted by RFOs using the Farming Monitor app, but this was not mainstreamed across the country because the duration of the interview presented too much of a burden to AEWs. In 2018 and 2019, respectively, internal and external MEL studies were commissioned. The external study was a more comprehensive evaluation of the effectiveness and sustainability of the RCM dissemination process and was conducted by the Asian Centre for Enterprise Development, Inc. (ASCEND). The key findings from the internal MEL study can be found in Figure 4.

Overall, results in experimental fields and MEL studies have shown that if RCM recommendations are followed, increases in yield and income will be achieved. The emphasis, therefore, must shift to how behavior change, adoption, demand creation, and awareness of the benefits of RCM can be shared through both traditional and nontraditional means.

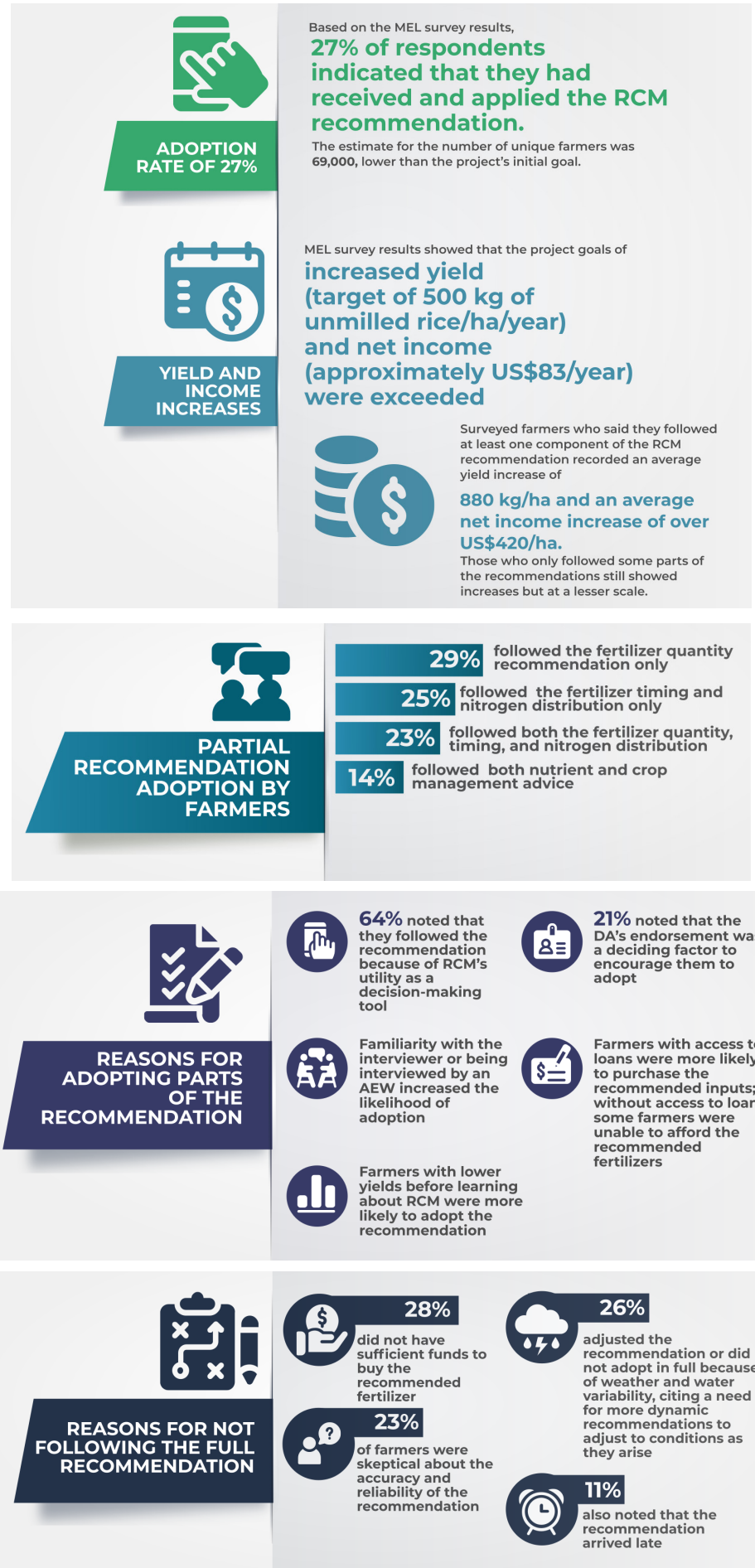


Figure 4. Key findings from the internal monitoring, evaluation, and learning study.

TRANSITION TO THE PHILIPPINES DEPARTMENT OF AGRICULTURE

TRANSITION TO THE PHILIPPINES DEPARTMENT OF AGRICULTURE

With its processes set in place, the entire RCM program will be transferred to the DA and be fully transitioned by the end of 2021. IRRI and PhilRice have worked to capacitate and share leadership responsibilities for RCM over the years in anticipation of this moment. This transition is a significant development and a unique example of country leadership for digital agriculture. Figure 5 shows the operational structure for the RCMAS within the DA following the full transition.

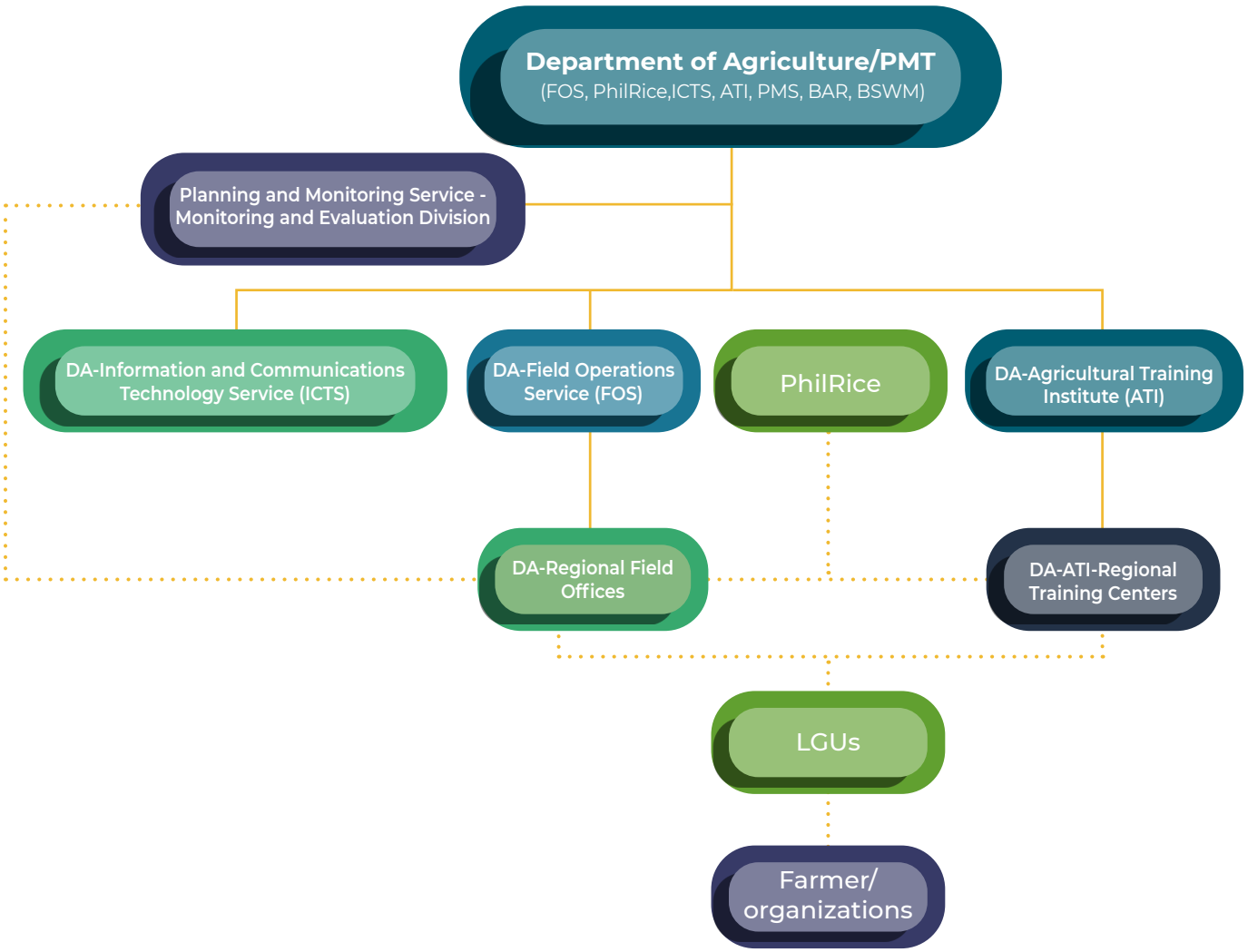


Figure 5. Organizational and functional structures at various levels of operation.

Research: During the transition year of 2021, the project team focused on capacity building activities on data collection and analysis, SSNM principles, and forward thinking thought leadership on what upgrades and research questions could potentially take place in the future. IRRI is also developing a comprehensive research operations manual intended to be a reference document post-transition. PhilRice will lead the research aspect of RCM and DA-BAR has said it will provide funds if needed for the research.

Dissemination and Training: During RCM implementation, IRRI was responsible for preparing training manuals and serving as a resource person at the trainers' training of focal persons and coordinators. The FOS/RFOs and ATI/RTCs are expected to continue these training and dissemination activities.

Applications and Databases: Prior to the full transition to the DA, it was critical to ensure that the source code for RCM was clean and up-to-date. As such, the RCM AppsLab spent two years not only updating the source code in a series of design sprints, but also training their counterparts in the DA-ICTS and PhilRice's information technology (IT) team on the new code. A TWG for apps and databases (T3) oversees and provides guidance for these activities.

Internal and External Communications: IRRI has also been responsible for communications activities, providing announcements about app upgrades, solutions to technical issues, and meeting notices, and managing the project's Facebook page.

Governance and Leadership: The PMT as the core management structure will be retained. The PMT will continue to set the strategic direction and to convene the offices, bureaus, agencies, and corporations that will be involved in work planning and M&E. The PMT is led by FOS, thereby ensuring that RCM will continue to be used in regional rice programs and projects.

Budgeting and National Policy: One of the clearest tests of government buy-in is the allocation of funding for continued operation. PhilRice and associated DA bureaus and offices must ensure that budget requests are made with ample time, and that their staff resources are sufficient post-transition. The procurement and hiring of staff with the required skillsets could be a potential issue in the future.

Monitoring, evaluation, and learning: Results from the internal and external MEL studies will guide areas of emphasis for the DA post-transition. Adoption, demand creation, innovative partnerships, and training are areas of potential focus. PMS is planning to institute a results-based M&E system for RCM that will focus on outcomes rather than outputs.

Increasing adoption of RCM Recommendations: In 2019, IRRI committed to increase the adoption rate of RCM from 27% to 58% to ensure that the benefits of RCM are truly realized. Strategies outlined by IRRI and DA officials to achieve this include:

- Incorporate RCM into more DA rice-related initiatives, such as the rice model farm program.
- Expand RCM dissemination pathways. A research project called ScaleRCM has been funded by DA-BAR to explore the effectiveness of different dissemination pathways, which include fertilizer dealers, credit providers, and SUCs as dissemination actors. The COVID-19 pandemic paused project activities, and results will only be finalized in 2022 and then integrated into the program. ScaleRCM is a partnership between IRRI and UPLB.
- Expand the extension service. The DA aims to add more local farmer technicians who will help disseminate the RCM recommendation and to designate officers of farmers' organizations and technology-savvy youth as RCM champions.
- Enhance more FITS Centers as RCM hubs. DA-ATI is also setting up additional FITS Centers in barangays.
- Accredit more rice-producing learning sites that use RCM like fields that serve as demonstration and training farms for other farmers.
- Harness traditional and social media and training programs such as School on the Air and the Digital Farmers Program to promote RCM.

Finally, the RCM team, PhilRice, and DA counterparts are finalizing a comprehensive Sustainability Plan that will outline the specific activities, budget, and roles and responsibilities for RCM post-transition with a focus on its long-term sustainability.

The three-year time horizon for RCM's complete transition has provided ample time for IRRI to be thoughtful about how it builds skills, alliances, and ownership of the platform for long-term viability, scale, and sustainability.

CHALLENGES AND LESSONS LEARNED

CHALLENGES AND LESSONS LEARNED

Since the implementation of RCM, there have been a number of challenges and lessons learned across management, design, research, partnership, and coordination components. The RCM team has already integrated some of these lessons into the program design, pivoting when necessary and being responsive to partner and ecosystem changes. These challenges and the team's approaches can provide interesting and useful insights for similar digital agriculture projects.

User-centered Design

Designing with the user helps ensure that digital solutions are designed, tested, and implemented with the user at the center of the process. It is one of the nine core Principles for Digital Development[16] that have been identified by the global donor and implementer communities. Co-creation and user-centered design ensure that the digital agriculture tool is designed *with* and not *for* users' needs and feedback.

Unfortunately, when RCMAS was designed and scaled, there was not a concerted effort to systematically co-create, prototype, and test the tool with AEWs and farmers. Instead, platforms were designed and developed based on what the RCM team believed would be the most informative and useful tools. These decisions had implications on the deployment, adoption, and understanding of the tools. First, it meant that the added tools and applications to RCMAS gave more rigor and scientific accuracy to the recommendation, but made the tool more complex and burdensome to AEWs.

It would have been helpful to consider the overall burden of work for AEWs in conceptualizing the dissemination strategy for RCM during the design phase. Instead of sometimes being considered an added burden or task, RCM's initial design could have shown the value in making AEWs' day-to-day tasks easier and contribute to their overall effectiveness and KPIs. In the Philippines, AEWs perform tasks related to the delivery of all agricultural and fishery activities to farmers. One AEW can serve between 200 to 300 farmers but often lacks adequate support for supplemental, yet integral, parts of their work such as transportation and communications. Given these specific constraints, and considering that RCM is a digital agriculture tool, the DA did respond by providing technology tools, devices, pocket WiFi, mobile data credits, and cash incentives. However, the benefits were not distributed equally across AEWs and regions due to limited budgets.

16 www.digitalprinciples.org

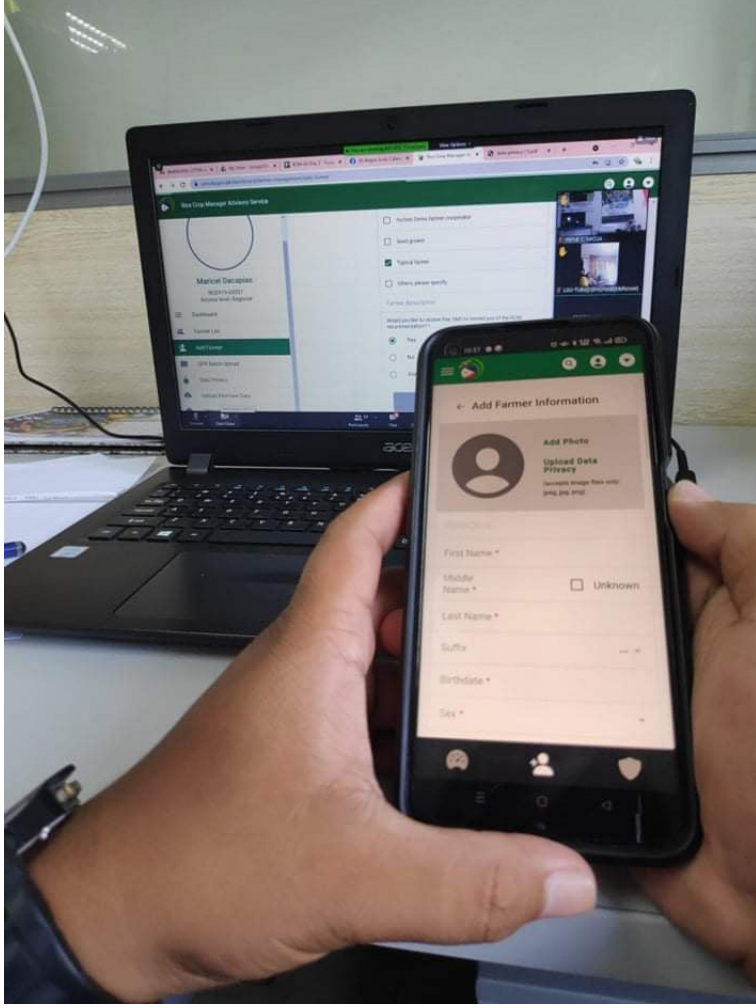
Another key constraint that would have been identified if the RCM was designed with the user is internet connectivity. AEWs sometimes used their own money to buy mobile data credits where mobile internet was available.

The end user of the RCM is the farmer who is the recipient of the recommendation. However, no strategy was done in the RCM to determine if the farmer understood the format of the recommendation, if the text or images were intuitive, or if additional explanation is required over the course of the season. Often, farmers practice the same techniques and crop management methods and are hesitant to adopt RCM recommendations in full. Understanding not only how farmers currently learn and consume information, where they get it, and who they trust would have provided more insight into how to change farmer behavior and create demand for RCM.

Once these initial design challenges and missteps were identified, the RCM team worked to adapt RCMAS accordingly. For example, there had been numerous requests for an Android application, but based on the above lack of user-centered insights, the team was hesitant to launch an app without doing due diligence on the need for such a platform. The team initially conducted stakeholder interviews and surveys to ascertain the demand. After it was decided that the Android app was truly needed, the team conducted multiple user experience (UX) and user interface (UI) workshops with AEWs and tailored their design accordingly. The Android app was completed in March 2020 and the team continues to elicit feedback for future improvements.

Enabling Environment and Internet Connectivity

Understanding the existing ecosystem and enabling environment is the second of the Principles for Digital Development, which includes understanding and integrating the users' context. The users' cultural norms, economic situation, political environment, and available technology, among others, determine their ability to effectively use and access a digital tool. One of the key constraints and lessons of the RCM was the lack of internet connectivity in rural areas that hampered the full potential of its implementation and dissemination. AEWs need to connect to the



internet to generate the RCM recommendation after inputting the farmers' responses in the interview. In some cases, generation and printing of the recommendation had to occur at different times, thus increasing the time between the interview and the delivery of the recommendation. The recommendation was thus delivered late and sometimes not at all.

Given the challenge of internet connectivity, the RCM team tested other methods of dissemination to increase adoption. These complementary measures included SMS messages as well as IVR and phone calls to follow up with farmers on the utilization of the recommendations. However, the response rate for these platforms remained at a low 10% success rate and were not scaled nationwide.[17] The Android app was one tool to address the connectivity issue as it can be operated offline and has the capability to sync captured data.

17 As of 2019, based on IRRI report to DA-ATI, *Rice Crop Manager Phase II: Part B. Maintenance and use of a climate-informed rice agro-advisory and information service for the Philippines, Completion Report, March 2018 to February 2019*

One important lesson was the need for hybrid models of dissemination that combined new and old technologies. AEWs were able to innovate and problem solve as issues related to connectivity arose. For example, some AEWs brought the farmers to a central meeting place where they had either confirmed and tested the WiFi or where their WiFi devices worked. There, farmers were briefed, interviewed, and given the recommendation immediately. Sometimes, this meeting coincided with other events such as distribution of inputs (i.e. seeds or fertilizers) or listing for crop insurance. The downside though was an extended waiting time for farmers. It also skewed their incentive to be at the event, where obtaining RCM recommendations then became only secondary.

Software Development

The decision to have all software and database development at IRRI has had important implications for the development of the RCMAS. At one time, the RCM IRRI team employed 12 software developers and database managers; at the time of transition to the DA, IRRI will have a team of five to perform the same functions. As a research institution, the organizational structure meant that software developers sat with scientific teams to develop logic and decision trees for applications. This had two specific implications. First, it meant that they were not benefiting from collaboration across projects to foster their own skill growth. Second, it resulted in limited interoperability among the applications because these were based on research inquiry and not user-centered. A clear cost-benefit analysis of developing these tools in-house versus outsourcing them to technology firms was not conducted, hence, the total cost of ownership was never calculated.

In 2018, the organizational structure of IRRI changed, and all software developers were consolidated into a "cluster." The new supervisor was an enterprise architect and software developer who was able to streamline development processes, ensure programmers were learning from each other and leveraging skill sets across teams, and keep the team updated on software development processes. This resulted in a number of physical and/or online training sessions for the RCM AppsLab team on topics such as Agile methodology, UI/UX workshops, and Angular development. Also, the team attended a number of developer conferences that tackled developments in ICT such as Google DevFest and DevCon.

One of the key lessons learned was the need for an overarching software development framework that all the AppsLab applications could reference. Because the applications were essentially designed as standalone entities, there needed to be a mental shift with the transition for programmers to consider that they were working on a full suite of complementary tools. All the applications were rebuilt in preparation for transition to the DA. The team had to balance rebuild activities with daily maintenance, operations, and upgrading.

The AppsLab team also learned the value of user-centered design for their work later in implementation. In the initial development of RCM, the target users and testers were non-programmers or scientists who oversaw the development of the tools. Later, in 2017 and 2018, the RCM recognized the importance of consulting with target users and having a quality control team to check the tools before they were released. Programmers were also brought to the user training, experience, and interface workshops to see the use of the tools firsthand. Focusing on user-centered design and testing tools with the target audience would have provided additional insights from the beginning.

Finally, it is important to note that the AppsLab team had to develop a number of complementary soft skills during the transition phase. As technologists, their main roles and responsibilities were to code, manage data, and ensure that the platforms remained operational. With the transition, however, the team had to take on the additional responsibilities of rebuilding code, writing an Operations Manual for the applications and databases, training their counterparts in ICTS and PhilRice, and conducting high-level consultations and briefings with the DA. The team has stretched its core competencies to the benefit of the team as a whole.

Multi-stakeholder Partnerships and Collaboration

Partnerships are the cornerstone of RCM's success and longevity. The partnership structure is complex and involves multiple stakeholders to facilitate government ownership, leadership, and long-term sustainability. Like all relationships, partnerships within and across government agencies were not always smooth and were grounded in both interpersonal relationships and professional goals. From the beginning of the project, the former IRRI project leader ensured that the key stakeholders were consulted and their inputs considered in RCM's development and worked to build rapport with and trust in partners. For the RCM project, it was also critical to find champions within the DA with the vision and political and social capital to identify funding for RCM and also integrate it into government policy.

These multi-stakeholder partnerships were fostered at multiple levels to ensure that RCM was embedded into the day-to-day operations of the DA agencies. For example, both the DA Central Office and regional offices were engaged in linking training, dissemination, agricultural research, and rice science. This partnership structure also made possible checks and balances across partners. A key mechanism to concretize the stakeholder roles and responsibilities was the issuance of the SOs and other official documentation that outlined how partners worked together.

At the next level, RCM was embedded and inextricably tied to the daily tasks of extension workers. The role of the RCM focal persons was created; they were responsible for engaging local governments through provincial and municipal agriculturalists. An RCM focal person leads the RCM regional team, creates workplans, manages the budget, procures the necessary technology devices, and reports back to the DA and IRRI. Agriculturalists provide a bridge from the DA to the mayors and governors, who are responsible for approving DA projects, and to extension workers, who implement them.

Dissemination and Training

The nationwide scale of RCM depends on effective, widespread training and dissemination that is tailored for users with a focus on adoption.

A number of lessons learned were captured in the transition from NMR to RCM that impacted the dissemination and uptake of the recommendation:

- **Real-time information**: Digital platforms allow flexibility to provide consistent, accurate, timely nutrient recommendations. The RCM team recognized that farmers needed more dynamic information and considered their real-time information needs. Providing a web-based platform that integrated up-to-date science into the cloud-based algorithm was one way of doing this.
- **Updated infrastructure and hardware**: NMR required yearly updating the information on rice varieties and fertilizer calculations. The use of CD-ROMs to disseminate NMR eventually resulted in multiple versions in use at any one time, causing confusion among the AEWs and farmers.

- **Application vs. website**: NMRiceApp and NMRiceWeb were simultaneously updated and the user's smartphone had to be connected to the internet to download the most recent version. Unreliable connectivity and lack of awareness about this issue made this consistent updating difficult to guarantee.

- **Self-administered vs. face-to-face interviews**: Farmers' hesitance at the use of IVR technology implied that they needed or preferred to be interviewed by the AEWs. Also, a printed recommendation was selected as the most viable format because most farmers did not own mobile phones, even basic ones, at the time.

- **Local language translation and lack of user testing**: The interview questions and recommendations were translated not only into English and Tagalog, but also into local languages such as Iloko, Bicolano, Cebuano, and Hiligaynon. However, there were a lot of vocabulary variations and inadequate language testing with users. English and Tagalog had the widest use among NMR users and were adopted in RCM.

- **Tailored recommendations with images and locally-relevant market information**: To better guide farmers, NMR's fertilizer recommendation contained illustrations of the rice variety's critical growth stages and the range of days for applying a specific fertilizer at specific amounts. The recommended fertilizers were listed according to local market access. The amount of fertilizer was expressed in both number of bags and kilos. These design characteristics were replicated in the RCM recommendation.

Complementing the dissemination lessons, the training modules for RCM also evolved. Training modules exist on various topics for research and dissemination. For extension workers, these include:

- How to operate RCM-related IT equipment
- How to interview a farmer
- How to generate a recommendation
- How to explain the recommendation to the farmer
- How to use and operate RCM Advisory Service suite of tools (began in 2017)
- Overview of SSNM

In the first four years of RCM dissemination (2014 to 2017), the training was heavily focused on technical aspects such as conducting the interview and generating the recommendation. However, AEWs noted that they were unable to answer farmers' questions about the nutrient and crop management guidelines and underlying science for the recommendation. Therefore, in 2018, the training included an explanation of SSNM and a session on how nutrient calculations worked.

As the MEL results indicate, interaction with an AEW was a critical factor in the farmer's decision to adopt the RCM recommendation. As such, AEW training is key. Refresher training sessions and testing of AEWs' knowledge would help ensure that the information remains consistent and understood and provides an opportunity to ask and document additional questions from farmers. The MEL results also reveal how critical the role of the RCM focal points is because they are responsible for training and convincing others to use the recommendation. Unfortunately, extension workers, who are on short-term contracts, are often sent to these trainings; the turnover in the group is high, thus requiring continuous training of the local RCM team.

Research

The backbone of the development of the RCM is the science of SSNM. The scientific discussions and critical thinking among scientists were the most crucial part in the conceptualization and development of the applications. Research remains important to address changes in the rice production ecosystem other than the nutrients.

Field research sought to collect data to improve the RCM's capability to provide better advice to boost farmers' yields and incomes. Trials comparing farmers' fields with RCM fields were conducted in various locations in the Philippines that represented different rice-growing conditions. Specifically, the trials looked into how RCM would perform in irrigated and rainfed areas compared with farmers' practices. Similarly, NOPT trials were conducted to enhance the calibration of the rates of N, P, K, zinc, and sulfur. The breadth,

scope, and length of these field trials, buffeted at times by typhoons, pest infestations, and the lack of certified seeds, presented a big challenge to researchers of both IRRI and PhilRice.

How PhilRice and IRRI managed their partnership, forged since PhilRice began operations in 1987, provides lessons for projects with comparable aims and scale. Their collaboration was shaped by their distinctive strengths and their specific limitations. PhilRice was present in multiple locations of the Philippines and had staff to implement and monitor the field trials while IRRI was headquartered in Los Baños, Laguna. IRRI scientists and researchers also visited the trial sites. IRRI shared its expertise in soil science and agronomy, experimental methods, and data processing and analysis. Turnover of PhilRice staff on contracts did not deter the PhilRice-IRRI collaboration and was addressed through training and retooling workshops. Discussions among researchers were open, whether junior or senior researchers, and all were involved in meetings where research findings were discussed, knowledge gaps were identified, and additional research areas were planned.

Monitoring, Evaluation, and Learning

The MEL framework with clear indicators is a critical component of programmatic design and implementation to systematically measure and assess project performance and impact. When RCM began, there was no MEL framework. The indicators of success were based on outputs instead of outcomes, making it impossible to assess the project's impact.

From 2013 to 2017, the main indicator for measuring the success of RCM was the number of recommendations generated. Increases in yield and income were mainly captured from the on-farm trials. In 2017, the DA recognized that the number of generated recommendations did not correlate with actual adoption. It was unclear if these recommendations were increasing farmers' yields and incomes. Instead of qualitative anecdotes from farmers and extension workers, the DA wanted quantitative evidence that the RCM program did produce improved outcomes.

A key lesson learned was that baseline, midline, and endline data collection and MEL frameworks, indicators, and operationalization would have provided valuable insights throughout the implementation of the RCM project. The MEL framework was not introduced until 2018 with governance structures like the MEL TWG in place; hence, it was difficult to measure the change in farmer behavior and knowledge acquisition. Furthermore, identifying realistic, measurable, and valid indicators at the project outset, in collaboration with all project stakeholders, ensures that there is continuous adaptive learning which allows projects to pivot if needed.

Another related lesson learned was that it would have been valuable for the IRRI RCM team to have included MEL activities and experts at the project onset. Without this information, programmatic design and implementation decisions were being made based on anecdotal evidence, perception, and assumption instead of data-driven evidence of what was working.

RECOMMENDATIONS AND NEXT STEPS

RECOMMENDATIONS AND NEXT STEPS

The COVID-19 pandemic has underscored the relevance and importance of the goals of the DA's Rice Industry Roadmap for food security and productivity. As the disease spread in the early months of 2020, the distribution of seeds and fertilizers to rice farmers was accelerated to boost production. Complementing these policy measures are digital agriculture platforms that enable the transfer of timely, context-specific information on crop management practices. RCM has already proven that it works. The focus now will be on its adoption, scale, impact, and its full transition to the DA by the end of 2021.

This final section outlines specific recommendations to ensure that RCM has long-term sustainability and is also able to innovate, pivot, and adapt to the needs of Filipino rice farmers. These recommendations and next steps build on the RCM learnings, results, and outcomes from 2013 to 2021 and seek to strengthen the RCM. While these recommendations are specific to RCM, we believe that they can be applied in other contexts and for other digital agriculture platforms.

User-centered Design

- In order to increase the adoption of the RCM recommendations, it will be critical to design future dissemination, research, training, and platform development with the target users. Designing with the user will be especially important if the DA and PhilRice intend to extend the RCM user base to farmers or other stakeholders. It will be crucial to understand how users change behavior, their time and financial constraints, and their specific objectives and needs and use these to design a tool that responds to those needs.

- User-centered design also has to remain dynamic, recognizing that the enabling environment and user contexts will continue to evolve over time. What works today may not be relevant in the future. Adaptive and iterative models of RCM design and deployment will be necessary.

- Monitoring, evaluation, and learning frameworks should include user-centered design indicators and adoption metrics for success. MEL studies will track these potential changes; adapting implementation and integrating these learnings in an agile manner will allow the RCM program to remain responsive to user needs.

- Conduct user experience and user testing activities regularly and be an integrated programmatic activity as part of a continuous process of learning and adaptation.

- Given the feedback on farmer responsiveness to "seeing is believing", RFOs can also lead in demonstrating the benefits of RCM to farmers through peer-to-peer learning or technology demonstration farms. Farmers who have experienced a higher yield and income following the RCM recommendation can serve as local champions, encouraging behavior change and adoption.

- Another potential avenue for increased adoption is the use of social networks and other multi-channel platforms for information dissemination. These social networks could be in-person, such as farmers' cooperatives, or online such as Facebook Messenger groups. Multi-channel platforms could be used for

demand creation activities to increase farmers' exposure to information about RCM recommendations to trigger their curiosity and potential utilization.

- Additional studies to understand the digital literacy of farmers by assessing and then conducting basic training on phone use or other digital literacy skills will also guide future development.

- Farmers' practices in individual regions may also be analyzed to develop a comprehensive communications, marketing, and outreach strategy and operational plan that provides simple and clear messages highlighting the benefits of RCM. It will be important to ensure that these messages are streamlined and integrated with other DA recommendations and digital agriculture platforms to not confuse the farmer.

Enabling Environment and Internet Connectivity

- Project implementers should recognize and adapt to low connectivity challenges and opportunities. One such opportunity is working closely with the Department of Information and Communications Technology (DICT) to include local agriculture offices in its "Free WiFi for All Program". This inter-agency collaboration can be a win-win situation as DICT will better understand areas with low connectivity and be able to document the direct impact of the Free WiFi program. This could potentially facilitate RCM interviews and recommendation generation.

- During and after the transition of RCM to the DA, its integration of RCM into DA guidelines for related digital agriculture programs and projects, such as those that distribute fertilizers and seeds to farmers. It is important to complement this integration with positively-reinforcing messaging and training to ensure that the RCM recommendation is understood. Some examples of other decision-support tools and databases that would benefit from integration include:

  - PalayCheck: provides farmers with recommendations on seed quality, land preparation, crop establishment, and the management of nutrients, water, pests, harvest, and postharvest.
  - Minus-One Element Technique (MOET): checks soil nutrient deficiencies and computes fertilizer requirements for rice; has been pilot tested by PhilRice.
  - Soil fertility maps: provide fertilizer guidelines based on soil analysis and are managed by the Bureau of Soils and Water Management (BSWM)
  - Weather-rice-nutrient integrated decision support system (WeRise): a web-based decision support tool that provides quick advice to farmers, researchers, and AEWs on optimum planting time, variety selection, and amount and timing of fertilizer application in rainfed rice areas under current and future climate conditions.
  - Philippine Rice Information System (PRISM): an online national rice monitoring system that uses data from remote sensing, crop modeling, smartphone-based surveys, and web platforms to deliver actionable information on rice crop seasonality, area, yield, and crop losses due to natural calamities. Initially implemented by IRRI and transitioned to PhilRice.
  - Pest and Disease Risk Identification and Management (PRIME): provides data on pests and diseases to better manage and target risk areas and risk factors for pest outbreaks and identify appropriate management strategies and tactics to reduce crop losses and contribute to rice availability and consumption.
  - Digital Farmer Program: ladderized learning program for small scale-farmers on mobile and internet literacy.

Long-term Sustainability and Institutionalization

- Continued updating of RCM for research, dissemination and training, and applications and databases to ensure that it remains as a cutting-edge, reliable, and effective tool to increase yields and incomes. It is important that the RCM remains flexible and adapts

to changes in the landscape of technology, extension, user profiles, environment, and external shocks through experimentation, iteration, and inquiry.

- Activities that foster institutionalization and embed RCM into DA policies and strategies will ensure long-term investment in the platform. For example, specific budget line items should be dedicated to the implementation, dissemination, research, and software development and maintenance for all associated agencies. Local agriculturists can encourage the institutionalization of RCM in local governments by providing annual budgets for its use and technology demonstrations in farmers' fields.
- Identify and nurture RCM champions that should be identified at all levels of government through the DA Central Office at the national level and through the RFOs and RTCs at the local, provincial, municipal, or city level. Relatedly, other key players in the community outside of the traditional RCM structure could also be identified and trained, including local farmer technicians, farmer-led extensionists, Magsasaka Siyentista (farmer scientist), farmers' association leaders, or even be "civilians" such as farmer leaders, youth leaders, educators, among others.
- For extension workers' training on RCM and its dissemination, implementers should consider incentive-based programs and behavior change communication that build ownership and understanding of the RCM tool. By showing them that RCM can facilitate and not burden their workload, the potential for RCM utilization will increase.

Dissemination and Training

- Piggy-backing on existing or complementary programs with a focus on integration and interoperability to double down on DA investments in digital agriculture should be considered. This streamlined approach can also decrease confusion among farmers about DA programs and messaging.
- Conduct pre- and repeated post-test training evaluations to determine the level of knowledge acquisition and retention about the topic and to assess the needs and effectiveness of the training. The recommended intervals would be before the training, immediately at the end of the training, and six months and then 12 months post-training. These indicators can be included as part of the MEL framework and operational plan.
- Future training and dissemination activities should be designed with the user. Training should have an emphasis on retraining and refresher courses to include topics not just on operating RCM and SSNM, but also soft skills-based training sessions on their role as key interlocutors and change agents linked to macro level, national goals.
- Consider innovative methods of dissemination and training using hybrid, non-traditional, digital and non-digital formats depending on what user research indicates will be the most effective platform. Conduct pilots and investigate an approach that considers more than one touch point of information about RCM. A scenario would be receiving information not only from an AEW but also from a jeepney advertisement, a radio broadcast, a farmer Facebook group or chatbot, and a fertilizer package. Who are in the farmers' trust circles should be investigated and targeted?
- As mentioned, the ScaleRCM program will not conclude until 2022 because of the COVID-19 pandemic. Integrate the most salient findings from ScaleRCM, which will hopefully provide valuable insights into innovations in the dissemination strategies, which also may continue to vary by region. Working with nontraditional partners such as SUCs, crowd-funding platforms, and banks could unlock a lot of potential for the uptake of RCM recommendations.

Software Development

- Technology is not static; new software developments and innovations are happening daily. To ensure that RCM remains up-to-date and relevant, it will be important for the PhilRice IT team and ICTS to make strategic choices about when upgrades, rebuilds, or additions are made

for the RCM platform based on the available time, human, and financial resources.

- Linked with the research component, the RCM team has discussed potentially adjusting the RCM algorithm to make either automated recommendations or recommendations at landscape level. For both of these options, it will be critical to work closely with the research, dissemination, and MEL teams to understand the needs of its users.
- The PhilRice IT and ICTS teams should also consider including additional skill sets for the future, including data science and machine learning skills, to augment their teams.
- The IRRI AppsLab team benefited greatly from joining user experience and user interface workshops to better understand how AEWs interact with their platforms. Consider bringing software developers and database managers with the dissemination and training teams or to NUPWs and RUPWs to interact directly with AEWs, observe, and understand their work.

Multi-stakeholder Partnerships and Collaboration

- Partnership and inter-agency collaboration have been the hallmarks of the RCM program to date. Nurturing these relationships will bolster the future of RCM. Furthermore, understanding and scheduling budgeting and project life cycle timeframes will be important for long-term planning.
- Consider and anticipate personnel changes as much as possible for changes such as retirements and elections that will affect the management and partnerships within the project.
- As RCM expands its partnership base, it will be important to consider the KPIs and unique interests of all the partner organizations. These KPIs could range from scientific publications and new research studies to impact and increased incomes and yields, to even revenue generation if working with the private

sector. Understanding these mandates and ensuring partners are satisfied with the project results will create clarity of expectation.

Research

- As additional research questions arise, it would be helpful to link user-centered design with scientific analysis and consider research that is responsive to and targets the needs of end users. Identifying scientific research areas for crop management practices to improve RCM will involve talking to and observing farmers, understanding what type of advice is most pertinent to them and needed, and then determining if it is realistic and feasible to integrate into the RCM.
- Development and implementation of a science- and team-based approach for determining when new components of crop management arising from research are sufficiently tested and verified to be ready for incorporation into RCM.
- Collaboration is encouraged to better understand research gaps that could have regional implications and thus would require region-specific adjustments in RCM calculations and/or decision logic (e.g. pest occurrences that may only be applicable for a certain region/s).
- Recognizing the high touch requirements for AEW to farmer interactions, the RCM team had been discussing if landscape-level recommendations were possible. Data analysis of variability in the recommendations across regions is required to understand how different the recommendations are and if economies of scale can be identified in dissemination.
- A modularized approach to RCM could allow regions and AEWs to layer on information as appropriate and needed by the farmer. IRRI is currently experimenting with layering PRISM data into the algorithm, as well as modules on finances/input affordability and weed management.

Monitoring, Evaluation and Learning

- The periodic internal M&E evaluations of the RCM program provide additional accountability, data-driven insights, and justifications or explanations for how RCM will also continue to evolve. These are critical for future growth and learning.
- In order to truly embed the MEL framework into the day-to-day operations of RCM, RFOs can be trained in MEL with easily accessible and understandable indicators and guidelines for implementation.
- Maintain the functions and oversight of the Monitoring, Evaluation and Learning Technical Working Group to provide accountability, supervision, and guidance of the MEL framework and its operationalization.
- Ensure that MEL activities continue to emphasize targeted, timely data analysis and reporting and not only data collection. Data analysis can produce powerful insights into what is and is not working in project implementation. Identify specific team members responsible for MEL and include MEL KPIs in their performance evaluations.

Governance and Leadership

- The Project Management Team (PMT) has played a crucial role in providing a critical governance and leadership structure for RCM. It is recommended that the PMT remains intact as an action-oriented group that provides guidance on implementation and strategic direction. The membership of the PMT must be carefully selected since its composition has implications for future direction and goal.
- As the DA considers the long-term vision for RCM, it will be important to map who are the integral stakeholders that need to buy-in to the vision for RCM. Whether in the DA Central Office, private sector, RFOs and RTCs or others, a repeated stakeholder mapping exercise will provide targeted guidance.

CONCLUSION

Rice Crop Manager is one of the few digital agriculture platforms that has been developed, piloted, disseminated, scaled, and evaluated at a national level. Significant time, relationship, financial, and scientific investments were made to ensure that the RCM platform provides continuous, uninterrupted service and recommendations to Filipino rice farmers.

The RCM project has benefitted from tremendous thought leadership from all the original project partners – the Philippines Department of Agriculture and its associated agencies, the International Rice Research Institute, and the Philippine Rice Research Institute. Without this vision for how to improve the productivity of rice farmers, the program would not have materialized.

Moving forward, we look forward to seeing how RCM continues to push the bounds of what is possible in solving for information asymmetries and using digital technology in cutting-edge, innovative ways. The Philippines and Filipino rice farmers will continue to change and evolve. We look forward to seeing how RCM does the same.

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