STATUS OF HERBICIDE RESISTANCE IN RICE AND CORN

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BASIS: **Department of Agriculture Administrative Order No. 8 Series 2002:** Importation and Commercialization of Modern Biotechnology – Derived Products

- The Philippines is the first country in Asia to approve the cultivation of genetically modified (GM) crops for food and feeds
- Highly stipulated – NO SIGNIFICANT RISKS TO HUMAN HEALTH AND ENVIRONMENT
- NEED TO CONDUCT RISK ASSESSMENT

STATUS OF HERBICIDE RESISTANCE IN CORN

- Glyphosate is a herbicide that deserves special attention
- Broadspectrum of action, high efficacy, low-cost herbicide
- Used become massive – risk comes from the repetitive use thus, resistance to increase substantially

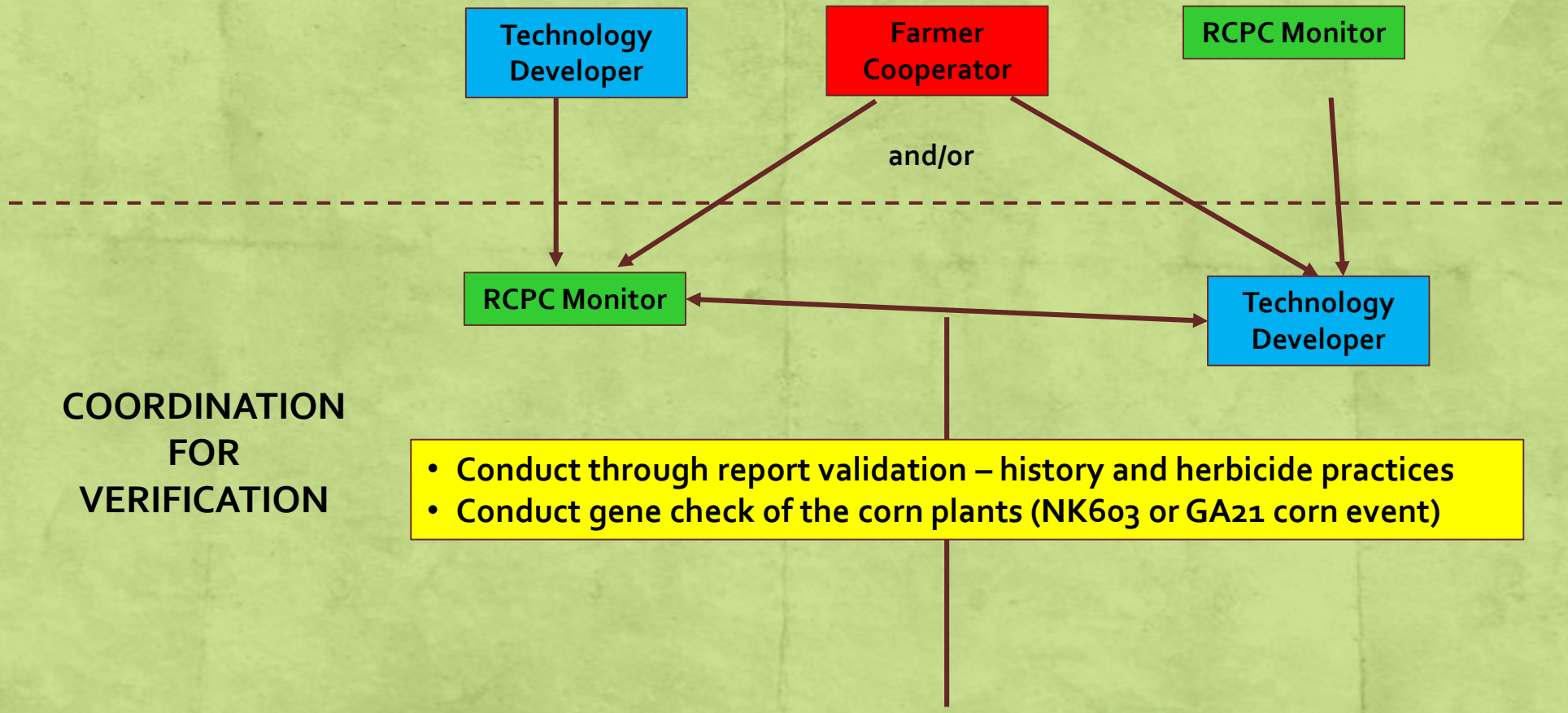
STATUS OF HERBICIDE RESISTANCE IN CORN

- In the Philippines, GT corn was grown since 2005
- As of 2013 – estimated to be 750,000 ha; increased to 812,000 ha in 2016 and decreased to 642,000 ha in 2017 (ISAAA, 2017)
- GM-GT corn according to farmers reduce their production cost and increase their profits compared to conventional/ ordinary corn
- Requires proper stewardship and constant monitoring of weeds to prevent the evolution of Glyphosate resistant weeds in a particular fields

WEED RESISTANCE MONITORING IN GLYPHOSATE READY CORN

MONITORING, DETECTION AND MARKING

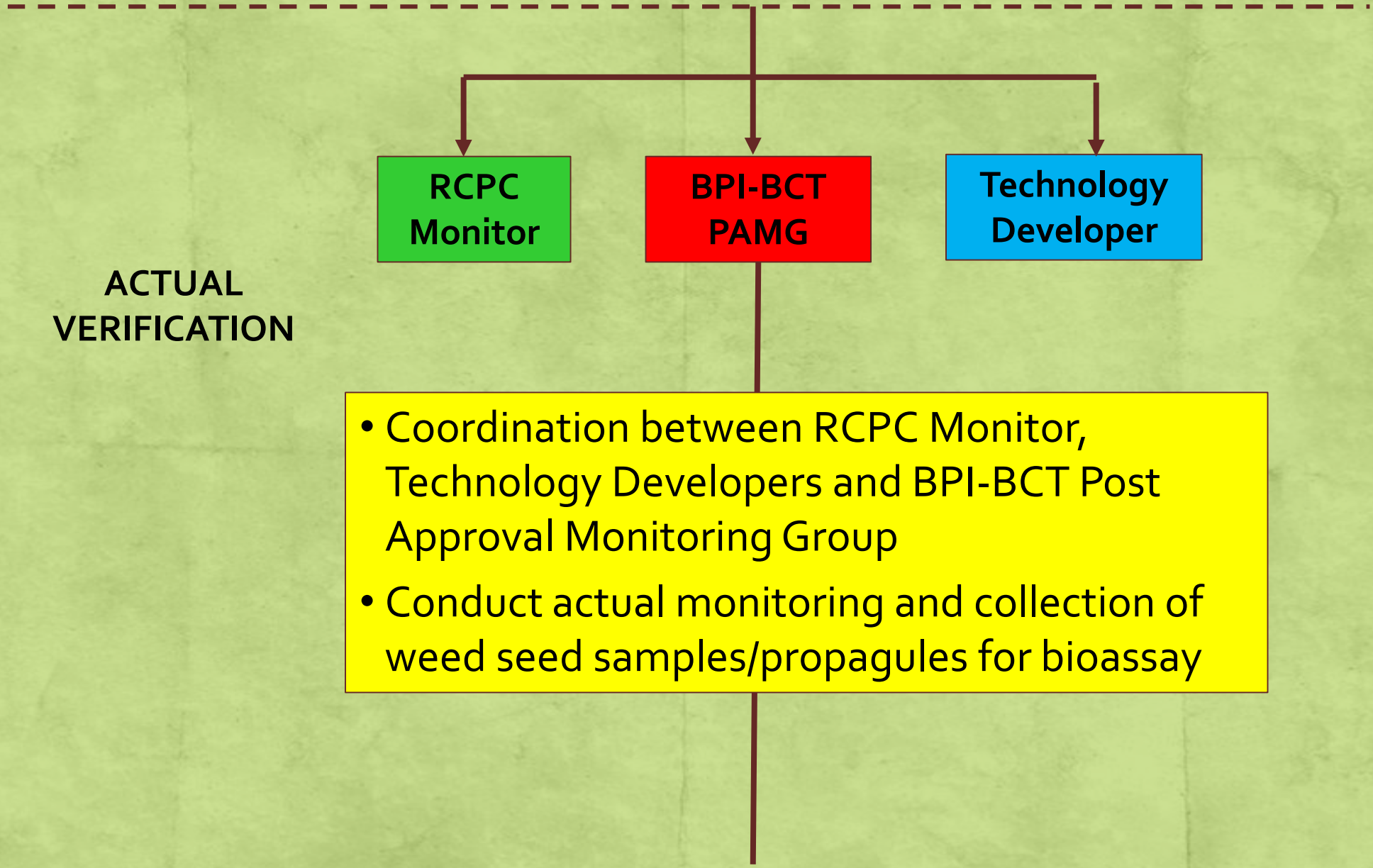
- Regular WRM monitoring is conducted in designated sites
- Indicators of weed shifting & resistance observed in farmers' corn field reported by farmer, farmer cooperator, and technology developer
- Marking of the site



COORDINATION FOR VERIFICATION

- Conduct through report validation – history and herbicide practices
- Conduct gene check of the corn plants (NK603 or GA21 corn event)

Process flow on the verification of weed resistance from the continuous spraying of glyphosate to herbicide-tolerant corn



Process flow on the verification of weed resistance from the continuous spraying of glyphosate to herbicide-tolerant corn (*cont'n....)*

Post-verification & Remedial Actions

BPI-BCT Post Approval Monitoring Group – Focal Person

- Informs BPI Director and WRMAT/Weed Experts and schedules meeting for the course of action

Process flow on the verification of weed resistance from the continuous spraying of glyphosate to herbicide-tolerant corn (*cont'n....)*

TRIAL SITES

Brgy. Union, Cauayan City, Isabela
Latitude: 16.92°
Longitude: 121.78°
Elevation: 40 masl
Soil type: Clay

Cooperator: Mr. Roland Agcaoili

Brgy. Lote, Baungon, Bukidnon
Latitude: 8.37°
Longitude: 124. 68°
Elevation: 327 masl
Soil type: Adtuyon Clay

Cooperator: Mrs. Leonila Setenta

AREA USED:

- 0.5 has. total
  - 1,000 m^2 each for Treatments 1 and 2
  - 3,000 m^2 for ACB and other arthropod monitoring

TREATMENTS: 2010 - 2014

No.	Treatment
Treatment 1	Two (2) glyphosate herbicide applications at 20 DAP and 45 DAP; without inter-row cultivation
Treatment 2	Two (2) glyphosate herbicide applications at 20 DAP and 45 DAP; with inter-row cultivation
Treatment 3	One (1) glyphosate application at 20 DAP; with inter-row cultivation
Treatment 4	Two (2) hand weedings at 20 DAP and 45 DAP; with inter-row cultivation

TREATMENTS: 2015 – 2019

No.	Treatment
Treatment 1	• Two (2) glyphosate herbicide applications at: ✓ 18-20 DAP and ✓ 35-40 DAP; • With land preparation; • No inter-row cultivation and hilling-up
Treatment 2	• Three (3) glyphosate herbicide applications at: ✓ 7 days before planting, ✓ 18-20 DAP and ✓ 35-40 DAP • No land preparation • No inter-row cultivation and hilling-up

TIMETABLE OF ACTIVITIES

Activity	Schedule
Herbicide application	
• 1st application	20 DAP
• 2nd application	45 DAP
Data gathering for SDR	
• 1st data gathering	Before the 1st glyphosate application
• 2nd data gathering	15-20 days after the 2nd glyphosate application
Data gathering for Weed Cover and Weed Control Rating	
• 1st weed cover rating	Before 1st SDR data gathering
• 2nd weed cover rating	12-15 days after 1st glyphosate application
• 3rd weed cover rating	1 – 2 weeks after harvest

WEED DIVERSITY - CAUAYAN, ISABELA

SPECIES	GROUP
Cyperus rotundus	Sedge
Cyperus iria	Sedge
Cynodon dactylon	Grass
Digitaria ciliaris	Grass
Eleusine indica	Grass
Rottboellia conchinchinensis	Grass
Ageratum conyzoides	Broadleaf
Amaranthus spinosus	Broadleaf
Amaranthus viridis	Broadleaf
Borreria laevis	Broadleaf

WEED DIVERSITY - CAUAYAN, ISABELA

SPECIES	GROUP
Cleome rutidosperma	Broadleaf
Commelina benghalensis	Broadleaf
Commelina diffusa	Broadleaf
Ipomoea triloba	Broadleaf
Ludwigia octovalvis	Broadleaf
Mimosa pudica	Broadleaf
Portulaca oleraceae	Broadleaf
Murdannia nidiflora	Broadleaf
Melochia corchorifolia (Marasaluyot)	Broadleaf
Chromolaena odorata (Marasili)	Broadleaf

WEED DIVERSITY - BUKIDNON

SPECIES	Group
Echinochloa colona	*Grass*
Eleusine indica	*Grass*
Rottboellia conchinchinensis	*Grass*
Ageratum conyzoides	Broadleaf
Amaranthus viridis	Broadleaf
Borreria laevis	Broadleaf
Cassia tora	Broadleaf
Cleome rutidosperma	Broadleaf
Commelina benghalensis	Broadleaf
Commelina diffusa	Broadleaf
Ipomoea triloba	Broadleaf
Synedrella nodiflora	Broadleaf
Murdannia nudiflora	Broadleaf
Centrosema pubescens	Broadleaf
Melon-melon	Broadleaf

SUMMARY OF RESULTS AS OF YEAR 10 TRIALS

- No evolution of weeds resistant to Glyphosate Herbicide
- No change in weed population
- No change in arthropod population

TRT 1 = 2 RUP

TRT 2 = 2 RUP with interrow

TRT 3 = 1 RUP with interrow

TRT 4 = Hand weeding

CORN FARMERS' SURVEY FOR WEED RESISTANCE MANAGEMENT

METHODOLOGY

- A total of 82 farmers were interviewed in Isabela and Bukidnon/CDO
  - 7 barangays comprising 5 municipalities in Isabela
  - 6 barangays belonging to 5 municipalities in Bukidnon/CDO
  - representing 2 topographic locations: plane and sloping areas in Isabela and Bukidnon.
- Date of interview: May 2018 (Bukidnon) and June 2018 (Isabela)
- Areas covered:
  - Isabela: Aurora, Cabatuan, Cauayan City, Ilagan City, Naguilian
  - Bukidnon/CDO: Impasug-ong, Malaybalay, Claveria, Baungon, and Cagayan de Oro City

HERBICIDE USE AND FREQUENCY OF APPLICATION OF CORN FARMERS IN ISABELA BASED ON TYPE OF AREA

Type Of Area	No.	Herbicide Applied	No. of Farmers*	Rates (L/ha)			Frequency of Application	Other Weed Management Practices	
				Min	Max	Ave		Practice	Frequency
level/ plain	1		6	4	4	4	2	No response	21 (95%)
	2		4	2	4	3.0	2	Hilling up	1 (5%)
	3		4	3	4	3.7	2		
	4		3	3	3	3.0	2		
	5		3	2	4	3.3	2		
	6		1	4	4	4.0	2		
	7		1	3	3	3.0	2		
sloping	1		6	2	4	3.0	2-3	No response	20 (100%)
	2		6	2	4	2.8	2		
	3		3	2	2	2.0	2		
	4		2	2	3	2.5	1-2		
	5		1	2	2	2.0	2		
	6		1	2	2	2.0	3		
	7		1	3	3	3.0	2		

TOP 10 DOMINANT WEED SPECIES REPORTED BEFORE AND AFTER HERBICIDE APPLICATION

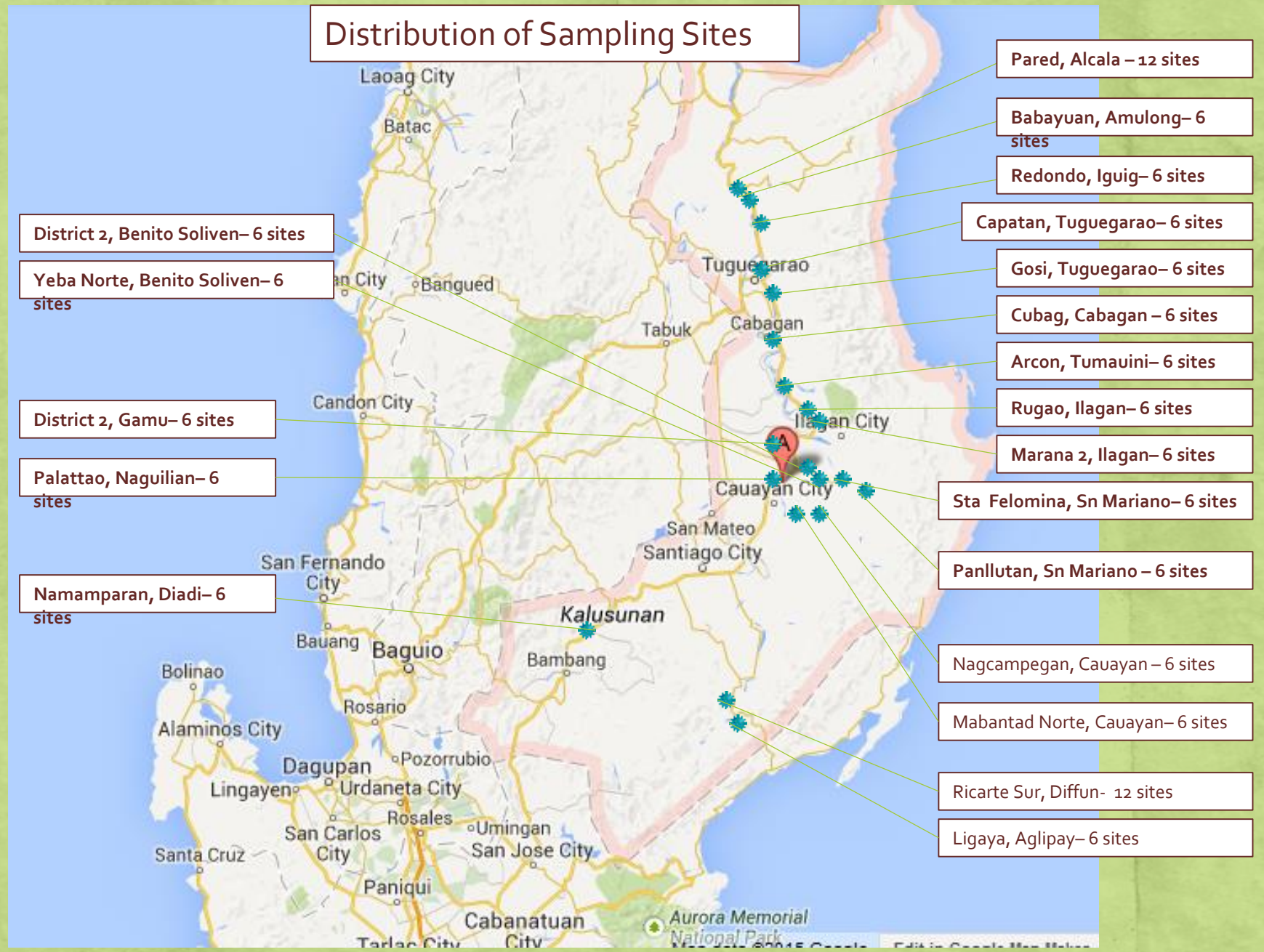
No.	Weeds Before Herbicide Application	Frequency*	Weeds After Herbicide Application	Frequency*
A. Level/Plain				
1	*Ipomoea triloba*	22	*Ipomoea triloba*	17
2	*Amaranthus spinosus*	18	*Commelina spp.*	15
3	*Commelina spp.**	17	*Portulaca oleracea*	14
4	*Portulaca oleracea*	14	*Amaranthus spinosus*	3
5	*Rottboellia cochinchinensis*	9	*Ludwigia octovalvis*	2
6	*Eleusine indica*	8	*Cyperus rotundus*	1
7	*Ludwigia octovalvis*	6	*Euphorbia heterophylla*	1
8	*Trianthema portulacastrum*	3	*Rottboellia cochinchinensis*	1
9	*Euphorbia heterophylla*	2		
10	*Cyperus rotundus*	2		
B. Sloping area				
1	*Ipomoea triloba*	19	*Ipomoea triloba*	15
2	*Rottboellia cochinchinensis*	19	*Commelina spp.*	2
3	*Ageratum conyzoides*	10	*Flemingia macrophylla*	2
4	*Mimosa invisa*	7	*Euphorbia heterophylla*	1
5	*Commelina spp.*	3	*Heliotropium indicum*	1
6	*Euphorbia heterophylla*	3		
7	*Amaranthus spinosus*	2		
8	*Eleusine indica*	2		
9	*Flemingia macrophylla*	2		
10	*Kurimbabet (Unidentified species)*	2		

*Frequency of weed occurrence observed by 40 corn farmer participants in sloping (20) and level (20) areas

**Farmers cannot distinguish the different species of Commelina. Both C. benghalensis and C. diffusa are called "Kulkulasi"*

INCIDENCE OF GLYPHOSATE RESISTANT WEED SPECIES IN GLYPHOSATE TOLERANT CORN PRODUCTION SYSTEMS IN THE PHILIPPINES

TABLE A. MAP OF Sampling Points (GPS: Garmin Oregon)



SUMMARY AND RECOMMENDATION

- Seeds collected from the GT corn sites in the provinces of Isabela (54.55%), Cagayan (27.27%), Quirino (13.64%) and Nueva Vizcaya (4.54%) and screened through **DOSE RESPONSE STUDY** showed susceptibility of *E. indica, E. colona & A. spinosus* to both RR & 2RR Glyphosate application 21 days after spraying.
- First batch screening of Dose Response Study to *I. triloba* collected from Isabela showed 33% to 100% survival rate from RR Glyphosate application (960 g ai/ha) but 100% mortality when same source of seeds were tested with higher dose of 2RR Glyphosate (1920 g ai/ha).

SUMMARY AND RECOMMENDATION

- Second batch screening of *I. triloba* to Dose Response Study were focused on using 2RR Glyphosate to further test susceptibility/resistance. Seeds collected from different sites of GT corn fields in Isabela, Cagayan & N. Vizcaya, when sprayed **18-21 days** from emergence in the pot experiment showed that only plants from sites **64 & 68** showed **33%** survival rate whereas all remaining sites resulted to 100% survival rate from 2 RR Glyphosate 21 days after application. The data showed high resistance of *I. triloba* to 2RR Glyphosate spraying.

SUMMARY AND RECOMMENDATION

- Whether *I. triloba* withstood 2RR Glyphosate application due to **morphological or genetic resistance, further verification studies are recommended** as the DOSE RESPONSE STUDY conducted to **susceptible seeds** from UP Los Baños showed **100% mortality** vs RR & 2RR Glyphosate Dose Screening.

- *I triloba* could be a potential for shifts in weed flora among cited GT corn collection sites.

FOR YEAR 2020 ONWARDS

- WRM monitoring scheme: BPI – PAMG
- "NEW APPROACH ON WEED RESISTANCE MONITORING OF HERBICIDE – TOLERANT CORN"
- INDUSTRY – LED ACTIVITIES

A. FARMERS' SURVEY

- BPI, FPA, DA-RFO, Academe and Industry

B. EDUCATION and TRAINING

C. VOLUNTARY REPORTING

RECORDS

- First tool in any weed management strategy
- Knowing which weeds are problematic and which parts of fields
- Useful in selecting the appropriate herbicides ensuring that optimum weed control is achieved after application
- Very useful where you suspect resistance weeds are starting to become a problem as they will help to identify and address the problem earlier

HERBICIDE RESISTANCE IN RICE

- Two weeds species reported to have evolved resistance in the Philippines
- *Sphenoclea zeylanica* : evolved biotypes resistant to 2, 4 – D
- *Echinochloa crus-galli* :resistant biotypes to both butachlor and propanil

Source: Sy and Mercado, 1983; Juliano etal, 2010; Baltazar, 2017; Heap, 2019

TO CONCLUDE :

- In HERBICIDE MANAGEMENT (HRM)

  Our enemy: INTELLIGENT WEEDS

  - WEEDS will change / adapt; the way they grow and reproduce to avoid all forms of weed control
  - Ability to evolve overtime to **EVADE** control strategies in an attempt to **SURVIVE**

Hence, HRM needs GLM

G: Good **L:** Leadership **M:** Management

THANK YOU