Research Highlights on Potato and Late Blight (*Phytophthora infestans* Mont de Barry) In Benguet , Philippines: An Overview

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4th ASIABLIGHT INTERNATIONAL CONFERENCE

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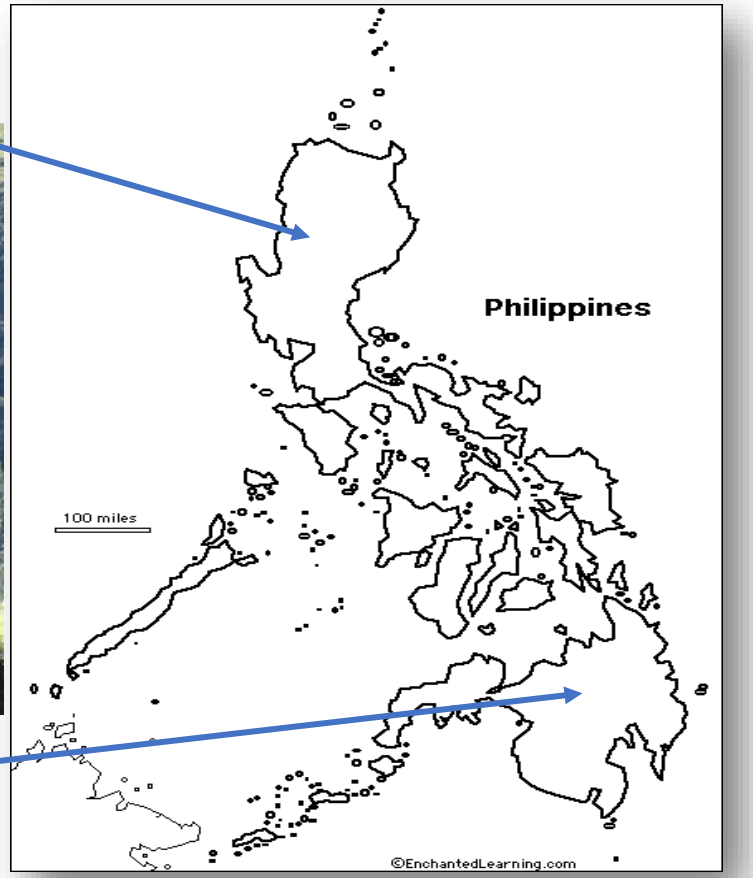
- ✓ **Cordillera Administrative Region (CAR) supplies 83% fresh potatoes**
- ✓ **Benguet produced 74%**
- ✓ **National Ave. yield=15t/ha**
- ✓ **Benguet Ave yield= 19t/ha**
- ✓ **Both volume and area planted to potato is decreasing yearly at a corresponding rate of 1.09 and 0.63% for the last five years**
- ✓ **33, 610.29 metric tons in 2024**

- NORTHERN PHILLIPINES (BENGUET&MT. PROVINCE)

1,300-2500masl
10,960 crop has



- SOUTHERN PHILIPPINES (DAVAO AND NORTHERN MINDANAO)

•800-1100 masl
•1987 crop has

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- 1704- potato was introduced in Luzon, Philippines
- 1846- it was first grown in Benguet and thrives well
- Potato-generally a vegetable crop in the Philippines, 4,735 hectares area planted
- It accounts for 3-4 Billion pesos contribution to economic security or 20% GDP.
- A cash crop for the highland farmers, local employment : 24,985 farm holders and employing 130,000 farmer/laborer.
- 88% used Informal seed system while only12% quality seeds from Formal seed system
- Only 2 most popular varieties grown: Granola(60-80DAP, susceptible to LB) and Igorota (90-120 DAP, moderately resistant to LB)

Granola

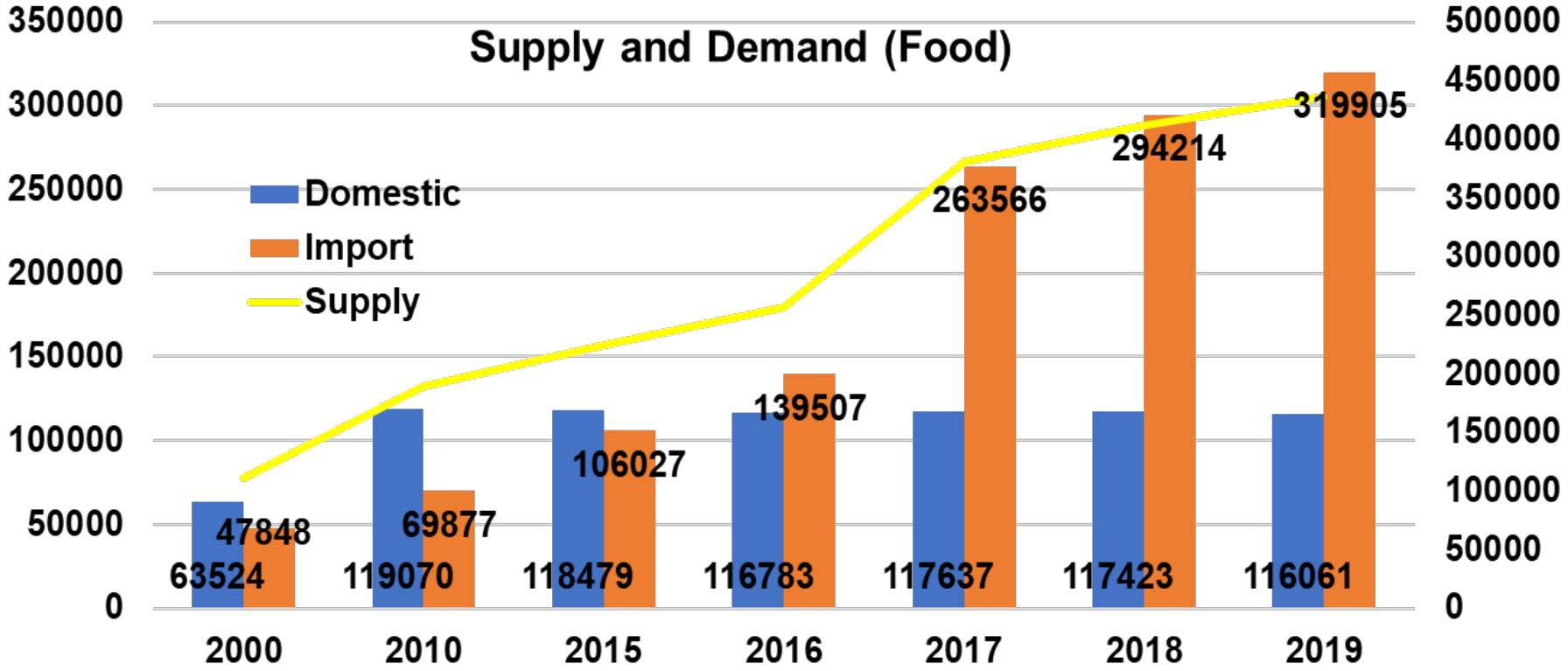
Igorota

Transporting potatoes to other islands

- The country imported 20,246 MT of fresh potato (PSA, 2017) and 121,652 MT pre-fries (HIS GTA, 2017) which is equivalent to 243,304 MT fresh potatoes making the country as one of the fastest growing fry importers in the world (HIS GTA 2017).
- Changing lifestyle of new generations
- Growth in potato-based snack food enterprises 15-17% annually
- Growth in fast food chains 5-20% annually

Hauling potatoes up to the market road

Supply and Demand of Potato in the Philippines



- **Per capita consumption is 1kg.yr (domestic produce), 2.88 kg/yr with imported potato**
- **Remarkable increase of imported potato pre-fries for the last 5 years**

*** Amount of pre-processed wt. were converted fresh wt**

Source: PSA 2020, IHS GTA-PNZ, 2017, Business Mirror2019

Potato Production 2019-2023 (PSA, 2024)

Year	Production Volume (MT)	Average Yield (MT/ha)
2019	132,000	16.5
2020	134,000	16.7
2021	136,000	17.0
2022	138,000	17.2
2023	140,000	17.5

Volume of Imported Pre-Processed Potatoes in the Philippines (PSA, 2024)

Year	Volume of Imports (MT)
2019	46,887
2020	50,000
2021	55,000
2022	60,000
2023	65,000

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Summary Table of Imported Fungicides in the Philippines

Year	Volume (kg)	Value (USD)	Notable Trends
2019	2,000	5 million	Initial growth in demand for crop protection.
2020	3,500	7 million	Increased awareness of fungal diseases.
2021	5,000	10 million	Rise in domestic agricultural production.
2022	7,500	15 million	Expansion of commercial farming practices.
2023	10,000	20 million	Significant growth driven by climate change impacts.

Issues in Potato Industry

- Chips industry consumes about 1,260 tons to 1,920 tons potato chips per year
- 34 importers of potato snacks or ready-to-eat potato products
- Insufficient supplies of quality seeds, limited volumes of quality seeds coming from government agencies
- Pest and diseases – Late blight, Bacterial wilt, Potato Cyst Nematode, Leaf miner
- Environmental stress – erratic climate ;mostly rainfed area ; seasonal production and limited clean farms
- High production cost 206,400PhP/ha (29,485RMB) (3,753$)
- Weak linkage with the private sector, weak farmers' organizations
- Policy – product standard; isolation /protection of clean areas
- Only one government agency is accredited as source of pre-basic seeds, NPRCRTC-BSU
- Bulking of seeds in the field has been very slow because of the presence of bacterial wilt and potato cyst nematode
- Farmers sell all their produce if the price is high, even though it came from G0, G1

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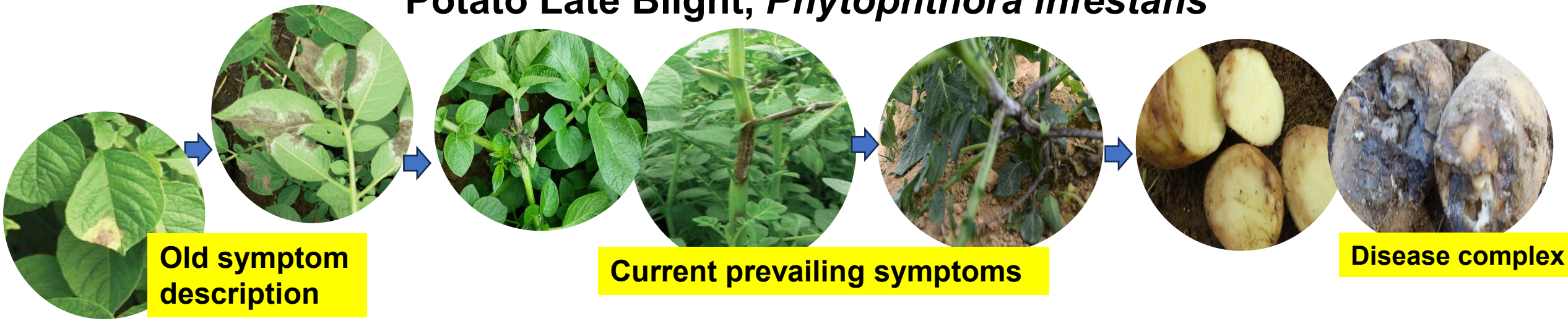
Potato Late Blight, *Phytophthora infestans*



Old symptom description

Current prevailing symptoms

Disease complex

- ✓ Late blight disease tops among the production challenges identified
- ✓ Farmers spray at 3 days interval accounting to 17% of fungicide costs during rainy season , **with conditions favorable for infection**.
- ✓ Without chemical spray, 80-100% losses are incurred, thus it is inevitable to use fungicide.
- ✓ Farmers are aware that prevention is better than cure
- ✓ Cocktailing of fungicide spray is a common practice
- ✓ **Research endeavors on late blight of potato commence with the collaboration of the International Potato Center (CIP), in the 1980's**
- ✓ **1991, identification of *P. infestans* races using R-genes differential plants showed that late blight races in Benguet exist in rather complex form (Ai, 1992)**

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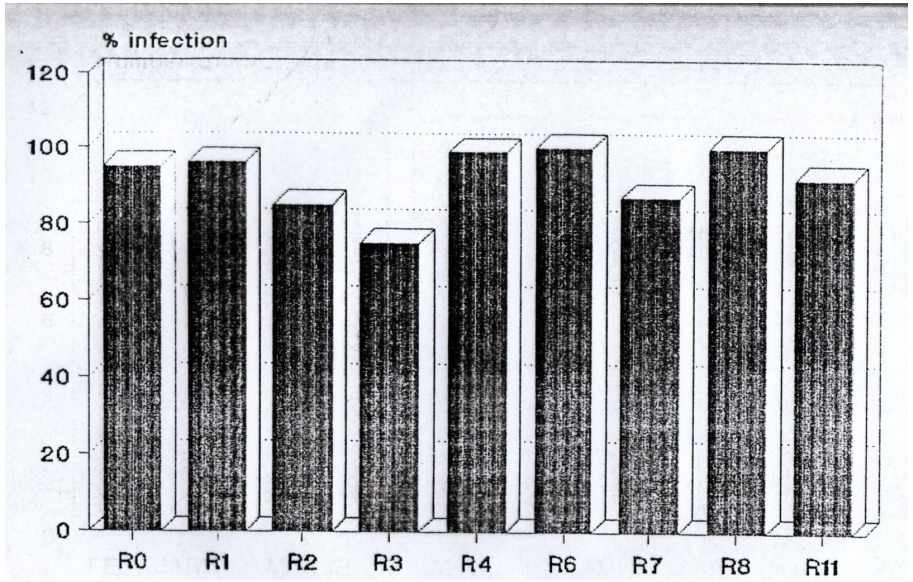
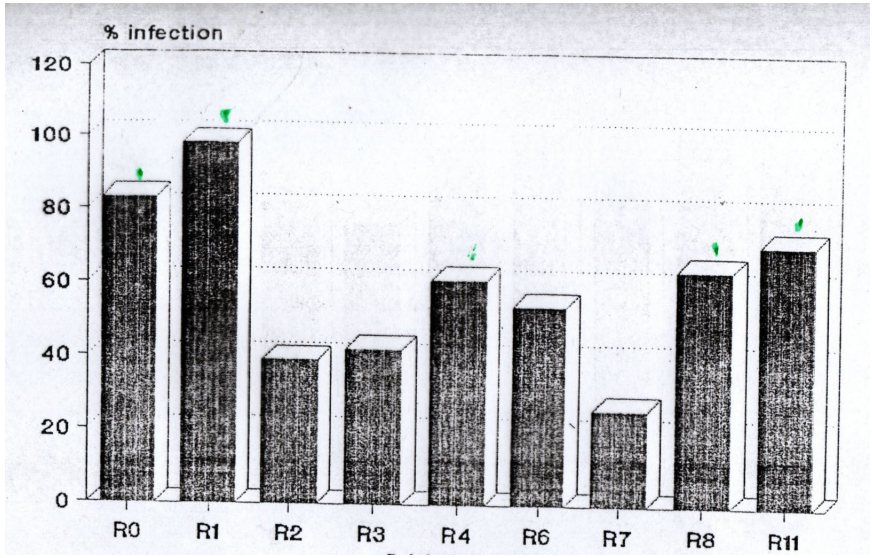
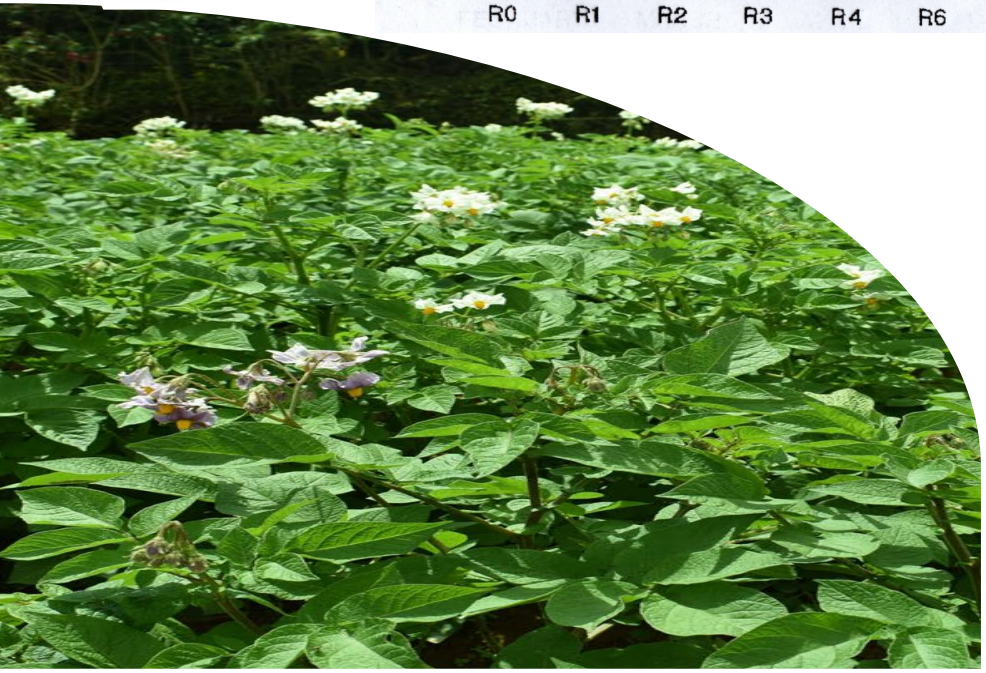
Virulence of Different *P. infestans* Races (1992) from Buguias, Benguet (1129-2,342 masl)



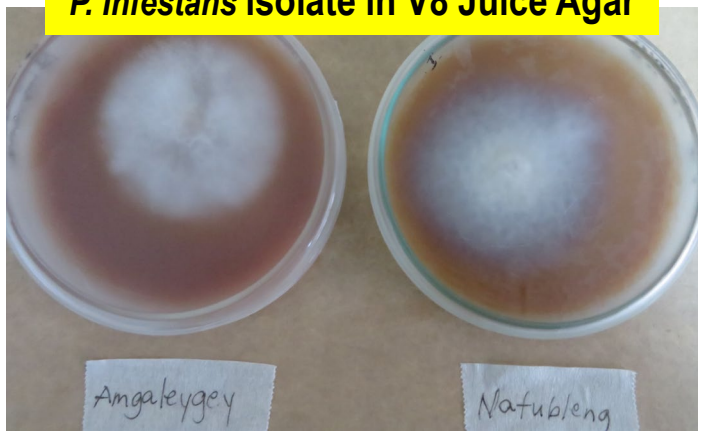
Virulence of Different P. infestans Races (1992) from La Trinidad, Benguet (1,330masl)



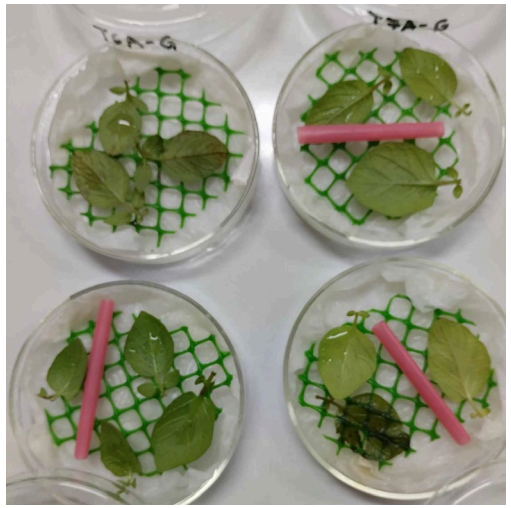


- **Higher virulences of *P. infestans* races recorded from isolates collected in Buguias, Benguet compared to those in La Trinidad, Benguet**
- **Increasing trend in the amount of virulence of *P. infestans* was observed from dry season towards rainy season.**
- **R-genes differential plants were used to identify P. infestans races using the "Detached leaf Technique"**

P. Infestans isolate in V8 Juice Agar



Detached leaf Technique



Frequency of _P. infestans_ virulence from 25 isolates collected in Benguet Between the months of February -June, 1992.

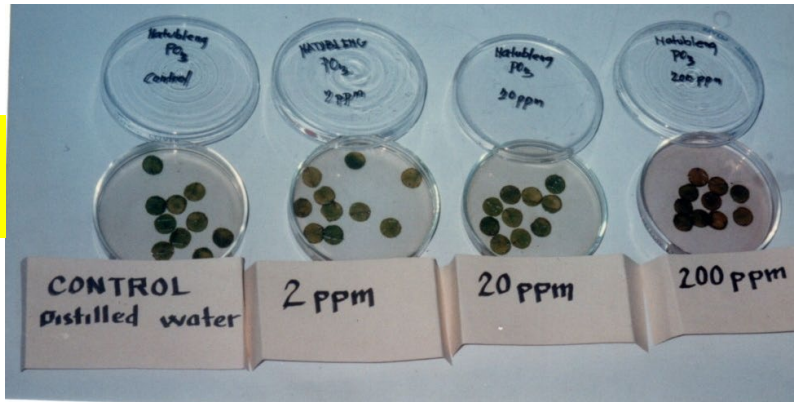
Virulence (Race)	No. of Isolates
R 1.2.3.4.6.7.8.11	9
R 1.2.2.4.6.(7).8.11	2
R 1.2.3.4.6.7.(8).11	1
R 1.2.3.4.6.7.(8).11	1
R (1).(2).3.4.6(7).8	1
R 1.2.3.4.(6).7.8.11	1
R 1.(2).3.4.6.7.8.	1
R 1.(2).4.6.(7) 8.11.	1
R 1.2.4.6.8.11.	1
R 1.2.6.8	1
R 1.3.4.8	1
R 1.3.(4).6.7.(8).11.	1
R 1.3.4.6.(7).(8).11	1
R 1.4.8.11.	1
R 1.4.(6).(7).8.11	1
R 2.3.4.6.(7).8(11).	1

- Only 8 virulent races observed in dry season but, 11 virulent races in rainy season
- 1989, _P. infestans_ races:0.1.2.3.4.5.10.11 were found in Benguet and race combination 2.4 was the only complex race discovered (Chien, 1989)

Metalaxyl Sensitivity Test

- None, A2 mating type, according to Turkensteen, (1990)
- Pure Metalaxyl requested from Syngenta
- Used 2, 20, 200 ppm
- Pure culture of *P. infestans* isolate –2000zoospores/ml inoculated in leaf discs abaxial side 20ul
- 10 leaf discs/treatment, floating method
- Sporulation observed after 5-7 days under microscope

Leaf Discs Floating Technique



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Degree of sporulation of different late blight isolates taken from different potato cultivars at 2, 20 and 200ppm pure Metalaxyl

Variety	Collection site	Elevation (masl)	Degree of Sporulation		
			I	II	III
Granola	Betag, La Trinidad	1,330	+++	++	+
Aziza	Tuludan, Atok	1,780	+	+	+
Escort	Tuludan, Atok	1,780	+	+	+
Granola	Tuludan, Atok	1,780	+++	+++	+
Granola	Paoay, Atok	1,500	+	+	+
Granola	Cot-cot, Buguias	1,910	+	+	+
Granola	Loo, Buguias	1,500	+++	++	+
Granola	Ballay, Kabayan	1,800	+++	++	+
Granola	Boga, Bauko	1,600	+++	++	+
Granola	Digos, Davao del Sur	1,979	+++	++	+
Igorota	Sayangan, Atok	1,500	+++	++	++
Atlantic	Sayangan, Atok	1,500	++	++	+

- All inoculated leaf discs floated in different Metalaxyl concentrations showed different degrees of lesion sporulation

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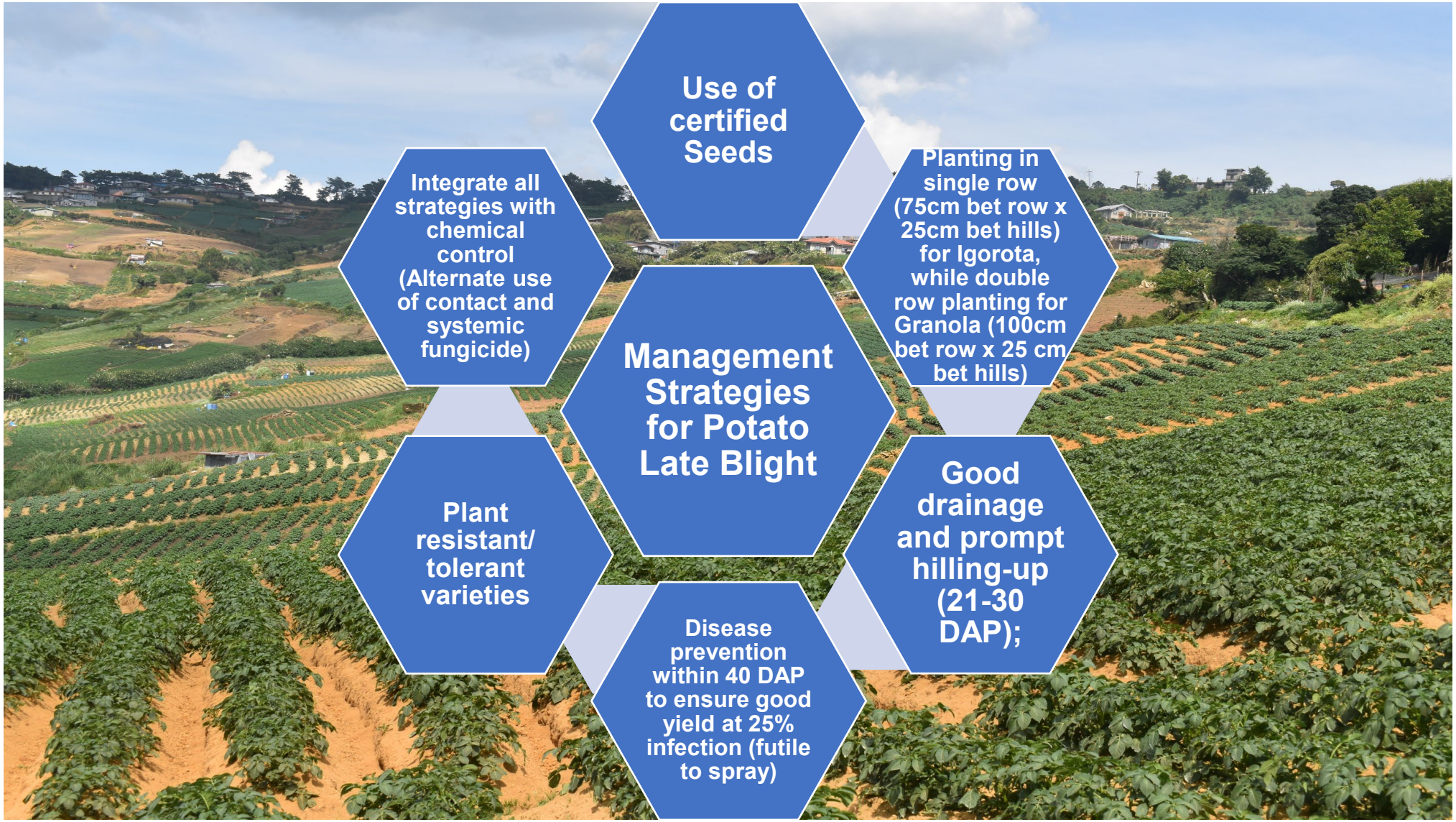
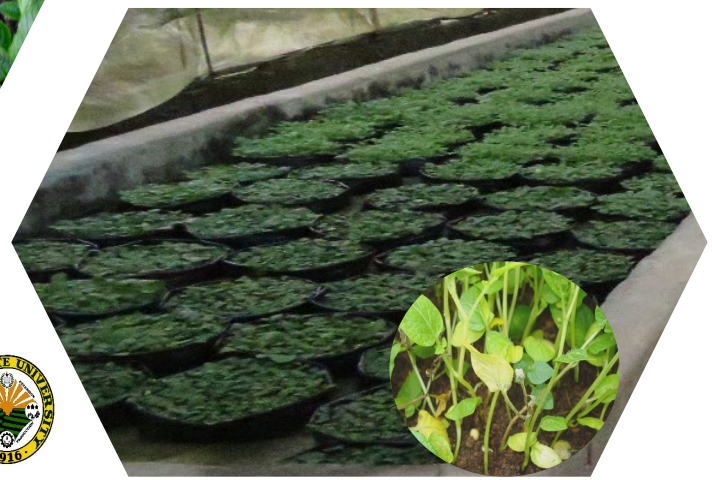


Management of Potato Late Blight

- ✓ Planting in single row (75cm bet row x 25cm bet hills) for Igorota, while double row planting for Granola (100cm bet row x 25 cm bet hills);
- ✓ 70 Apical Cuttings in one pot (7x7x11”) for rooting instead of 100pcs;
- ✓ Use of quality seeds (generations 1-7) , good drainage and prompt hilling-up (21-30 DAP);
- ✓ Disease prevention within 40 DAP to ensure good yield;
- ✓ Once plants infection reached 25%, chemical control becomes futile;
- ✓ Use of resistant varieties (Solibao, Bengueta) combined with longer spray interval (7-14 days) with Mancozed (Perez and Diccion,1996)



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Drip irrigation significantly increased survival rate and yield (weight) of Granola and Igorota and lower production cost per tuber produced compared to conventional irrigation method.

- ✓ Percentage Survival
- ✓ Plant Vigor
- ✓ Late Blight Resistance
- ✓ Biomass
- ✓ Yield

Higher Gross Income w/ Lower break-even price **Lower production cost/tuber**

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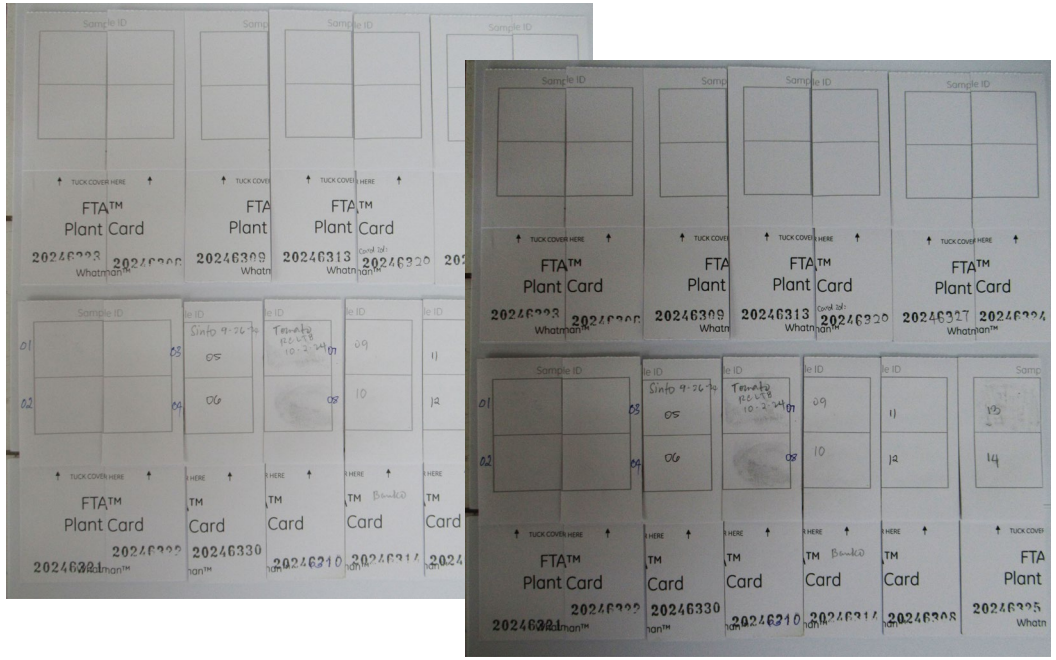
Common Fungicide Formulations for Potato Blight in Benguet

Trade Name	Active Ingredients
Infinito SC™ 687.5	Fluopicolide + Propamocarb
Ortiva Top 325 SC	Azoxystrobin + Difenoconazole
Ridomil Gold MZ 68 WG	Metalaxyl-M + Mancozeb
Bravo Weather Stik	Chlorothalonil
Agri Tin Flowable	Triphenyltin hydroxide
Daconil 2787 WP 75	Chlorothalonil
Prevecur	Famoxadone, Cymoxanil
Equation Pro	(Active ingredient varies by formulation; often includes fluopyram)
Moximate 505WP	Moxifloxacin (may vary by formulation)
Cymoxanil	ymoxanil (often used in combination with other fungicides)
Famoxadone	Famoxadone, Cymoxanil



On-going and Futures For PLB control (Philippines)

- **Continue collection of *P. infestans* isolates for DNA and mating type analysis**
- **Philippines in high risk for more virulent physiological races due to importation of misdeclared potatoes (table/ware potatoes sold as seeds)**
- **Majority of farmers resist shifting to other variety, insist on using Granola (Germany, 1980's)**
- **Based on DNA test result at CCCAP, out of 104 isolates, 30 were identified of A2 mating type (European origin)**

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Farmer observation/Assessment on the effect of quality plant materials and POT adopted

QUALITY PLANTING MATERIALS

	Frequency N=43
✓ Increase yield by 20-30% compared to old kept seeds	15
✓ More vigorous growth characteristics	14
✓ More resistant to pest attack and diseases like late blight	33
✓ Dormancy of tubers is shorter w/ good multiple sprouts	12
✓ Better storability (less number of rotten tubers)	1
✓ Lesser farm expense	1
✓ The succeeding croppings (generations 2-5) gave higher Yield (bigger tuber and better tuber shape)	6

Potato Clones Under Trial for Resistance to *P. infestans*

On-going and Futures For PLB control

Advance clones

R7667
PT0933
G5588
R7671
G5601
R7660
R6131

Clones On-going trial

Entry clones
302285.31
302285.27
302281.15
302280.23
302306.19
302304.27
302288.39
302306.36
302288.14
302289.41

CPF 11
CPF 12
CPF 28
CPF 29
CPF 31
CPF 33
CPF 37
CPF 40

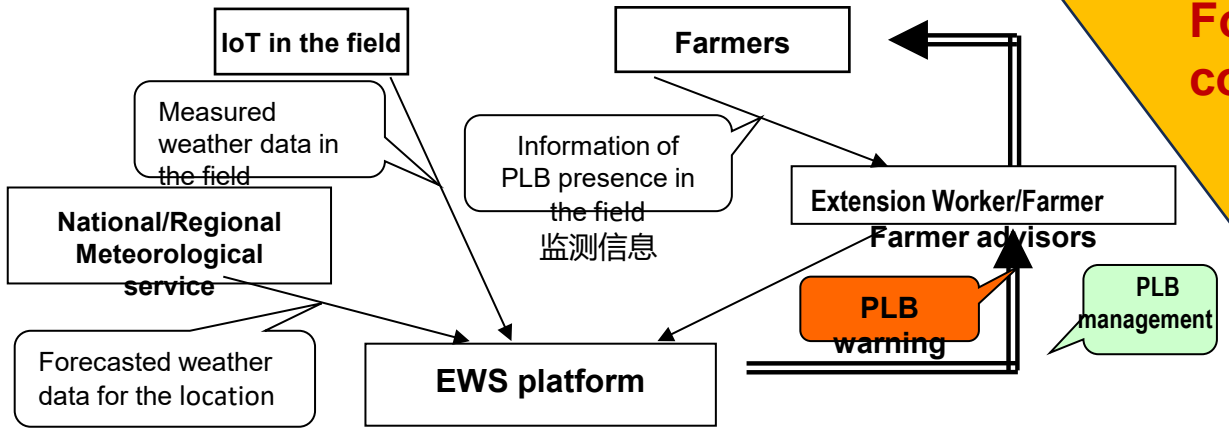
Colored and common

- **1). Advance Yield Trials of Canlaon Potato Flower Clones and Evaluation of Colored Potato Clones (BSU-funded)**

RH., Rainfall, etc) in the field during potato growing season

Model 01

Model 02



On-going and Futures For PLB control

The Frame work of EWS for PLB Management

马铃薯晚疫病监测预警体系结构示意图

- **Suggested and shared by Dr. Tongle Hu, Hebau Agricultural University (2024)**

2). Potato Late Blight Intelligent Monitoring and Early Warning System Integration and Application in Benguet, Philippines (Joint project: MOST-China and DOST-Philippines, funding?)

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