

# Sustainable Potato Production in the Philippine Cordillera Region

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**Abstract**— This study represents the collection of secondary data, focal group discussion, key informants and stake holders workshop to gather information on the existing production of potato in the cordillera region. Results showed that in the Philippines production eventually decreased in 2011 to 2014 with 124,671.18 to 119,140.02 due to limited planting materials and low price. Cordillera Region had the highest production of 102,255.24 mt (32%) particularly in Benguet with 89,918 metric tons with yield of 17.38 tons/ha. Potatoes is locally grown in higher elevations of Benguet and Mt Province with an elevation of 1,200 to 2,000 masl. They are usually being planted two times a year Feb planting and harvested at May while second cropping starts June to Sept to December, however it could be planted the whole year round especially if they have irrigation facilities. Potatoes are being irrigated with the used of ‘sprinkler method in which source of water is from creek. Production cost of potato ranged from 206,400 thousand with a ROI of 74%. High cost includes cost of planting materials (30%) and chemicals with 26 % of the production cost. With the introduction of clean planting materials from tissue culture production cost was lowered. NPRCRTC and BPI-BNRDC are producing potato stem cuttings from tissue culture and are being sold at minimal cost to the farmers at P1.00/cutting. Igorota variety is being sold at NPRCRTC while Granola is being dispersed by BPI-BNRDC. Dispersals was high during the months of February until April. In 2010 to 2014 the total dispersal was estimated. Thru the years the NPRCRTC could produced 700,000 cuttings in year and these are being dispersed to our highland potato growers, in order to renew their planting material and these had improved their production with 30% on thier income. There are four farmers (2 Buguias and 2 La Trinidad) who adapted potato seed production thru the use of potato stem cuttings and was trained by NPRCRTC experts.

**Index Terms**— Igorota variety, potato stem cuttings, seed production, tissue culture

## I. INTRODUCTION

Potato (*Solanum tuberosum* L.), locally known as ‘patatas’, is grown in 130 countries worldwide including the Philippines. It is grown for its tubers, which are rich in phosphorus and vitamins B1, B2, and C. Reports showed that a potato crop produces more edible energy and protein per hectare and per unit of time than practically any other crops (DOST, 2007). The major potato production in the Philippines is concentrated in high elevations particularly in Benguet and Mountain Province with a temperature below 21°C. This temperature is suitable for growth and

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development of quality potato tubers. The major potato producing municipalities of Benguet Province are Atok, Bakun, Buguias, Kabayan, Kibungan and Mankayan and Bauko, Mountain Province. Benguet is represented by different agro-ecological zones suiting the production of high value vegetable crops that are globally competitive.

Potato is one of the important high value crop in Benguet and some parts of Mountain Province. However, at present Philippine production cannot meet the demand due to the increasing number of fast-food chains, hotels, and local potato-based snacks food manufacturers. Potato is generally a cool-season crop grown in areas with elevation ranging from 1000 to 8000 meters above sea level. The growth of potato is greatly affected by temperature, day length, humidity, and soil conditions.

Potatoes are used for a variety of purposes, and not only as a vegetable for cooking at home. In fact, it is likely that less than 50 percent of potatoes grown worldwide are consumed fresh. The rest are processed into potato food products and food ingredients; fed to cattle, pigs, and chickens; processed into starch for industry; and re-used as seed tubers for growing the next season’s potato crop.

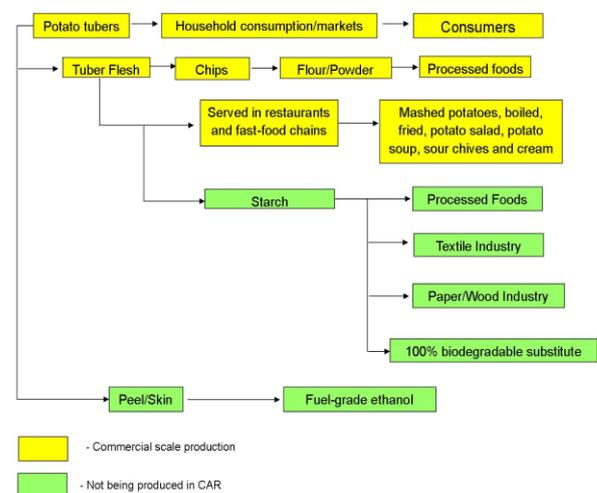


Figure 1. Potato and its by-products produced in Cordillera

### Objective:

1. To gather secondary data on potato production and;
2. To survey and interview key informants, conduct focal group discussions and workshop among stakeholders

## II. METHODOLOGY:

An initial desk study was conducted to collect and summarize information from currently available reports and studies. It provided guidance to issues that needed to be the focus of field research. The field work component of the study

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was conducted using qualitative research techniques particularly value chain analysis workshops, key informant interviews (KII), and focus group discussions (FGDs). Key informants and participants to the workshops and FGDs consisted of farmers, traders, processors, and representatives from relevant government agencies. Key informant interviews were used for collecting data on individuals' perspectives, experiences, and quantitative data. FGDs were effective in generating broad overviews of issues of concerns to the groups or subgroups represented and in the triangulation/vetting of information obtained from the KII.

### III. RESULTS AND DISCUSSIONS:

In the Philippines, the most commonly grown varieties of table potatoes is Granola while the best processing varieties are Igorota. These varieties are being produced in CAR and Region 10. In 2013 Tons of GI Granola, virus free resistant variety and Connect was imported from Holland by a seed company and was distributed to potato growers. They were found promising and yielded ranging from 30-40 tons per hectare.

#### **In the Cordillera Administrative Region (CAR)**

In CAR, Benguet State University released 10 varieties of potato. Granola and BSUPo3, popularly known as LBR or Igorota is planted most of the farmers in Benguet (96%) and Mountain Province because of their high yielding, resistance to late blight, leaf miner. Igorota variety is also recommended for processing not only for table consumption.

Table 3. List of released potato varieties in Benguet State University

VARIETY	POTENTIAL YIELD (t/ha)	CHARACTERISTIC
Igorota 	25-35	Moderately resistant to late blight Recommended for table and processing use
Solibao 	18-40	Moderately resistant to late blight Recommended for table and processing use
Raniag 	21.6-31.3	Moderately resistant to late blight Recommended for table use Recommended for high, mid and low elevation
Granola 	27	Recommended for table use
Ganza 	13-28.6	Moderately resistant to late blight Recommended for table use

Dalisay 	25	Moderately resistant to late blight Recommended for table use
Montanosa 	13-28.6	Moderately resistant to late blight Recommended for table use
Kennebec 	24	Recommended for table and processing use
Agria 	24	Moderately resistant to late blight Recommended for table and processing use
Baraka 	25	Moderately resistant to late blight Recommended for table and processing use
 Gloria BSU PO7 (2007)	23-25	Moderately resistant to late blight Recommended for table and processing use
 Bengueta BSU PO6 (2007)	23-25	Moderately resistant to late blight Recommended for table and processing use

#### A. Production Trends

##### **Global Production**

Potatoes are grown in about 155 countries around the world and more than a billion people worldwide eat potatoes. The world potato sector is undergoing major changes. Until the early 1990s, most potatoes were grown and consumed in Europe and Asia. Asia and Europe are the world's major potato producing regions, accounting for 80 percent of world production in 2014. Shifts in regional pattern reflect the fact that emerging and developing countries are cultivating a growing proportion of total world production. Historically, most potatoes were grown in Europe and North America. However, in 2014, Asia grew more potatoes than any other single region and produced 50% of the total world production

output. Europe continues to contribute sizeable 30% in 2014 though generally declining, share of total production.

The remaining 20% is distributed to other developing countries such as America with 11%, Africa with 8% and Oceanic with 1% contribution from the total world production.

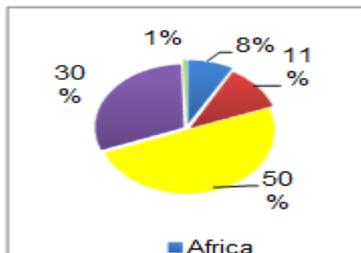


Figure 6. Percentage distribution of potato global production by continent

2013, China remained the largest producer of potato accounting for 25% of world production and 50% of the output from the world. In China, Production has increased nearly fivefold since 1961. Most of the potatoes go directly every year to human consumption. The potato is important to China not only as a staple food, but also as a source of income. In the mountainous northern and southern-west region, production of potato provides cash income. Potatoes are grown primarily for household subsistence consumption in the lower plains (Navarre, 2014).

India is the 2<sup>nd</sup> largest producing country with 45,343,600 MT production. Between 2009-2013, potato production in India increased by almost 131.85 percent, partly in response to growing demand from higher-income urban population. Potatoes in India are not primarily a rural staple but a cash crop that provides significant income for farmers.

World production of potato increased from 334,734,461 in 2009 to 376,452,524 MT in 2013. Potato is produced by about 100 countries. With 376,452,524 MT production in

In Philippines, potato production ranked 99<sup>th</sup> in 2013 with 149,204 MT sharing 0.04 to world production.

Table 4. World production of potato in top ten countries, 2009-2013

Country	Production Volume (tonnes)					% share
	2009	2010	2011	2012	2013	
WORLD	334,734,461	333,617,253	375,076,702	370,594,695	376,452,524	100.00
China	73,230,500	81,533,500	88,290,500	92,762,500	95,941,500	25.49
India	34,390,900	36,577,300	42,339,400	41,483,000	45,343,600	12.04
Russian Federation	31,133,960	21,140,540	32,681,470	29,532,530	30,199,126	8.02
Ukraine	19,666,100	18,705,000	24,248,000	23,250,200	22,258,600	5.91
United States	19,622,475	18,337,537	19,488,460	20,990,738	19,843,919	5.27
Germany	11,617,500	10,201,900	11,837,200	10,665,600	9,669,700	2.57
Bangladesh	5,268,000	7,930,000	8,326,389	8,205,470	8,603,000	2.29
France	7,253,000	6,622,043	7,440,219	6,340,807	6,975,000	1.85
Netherlands	7,180,981	6,843,529	7,333,472	6,765,618	6,801,000	1.81
Poland	9,702,800	8,765,955	8,196,700	9,091,900	6,334,200	1.68
*98-PHILIPPINES	150,758	153,366	147,563	147,690	149,204	0.04
Other countries						33.0

As to productivity, world average yield per hectare is 19.46 tons. The countries United States and Bangladesh top the highest yield per hectare with 46.61 and 44.39 tons per hectare, respectively. The Philippines is again amongst the

lowest yield per hectare of 11.72 tons. In terms of area, India had the widest area harvested with 1,992,200.00 hectares followed with Ukraine with 1,391,625.00 hectares in 2013.

**Table 5. Top ten countries in terms of yield and area**

COUNTRY	TONS /HECTARE	AREA (HECTARES)
World	19.46	19,337,070
United States	46.61	425,730.00
Bangladesh	44.39	443,934.00
Germany	39.82	242,800.00
Poland	22.76	337,200.00
India	18.78	1,992,200.00
China	17.09	5,616,500
France	16.07	160,700
Ukraine	15.94	1,391,625.00
Netherlands	15.58	436,521
Russian Federation	14.64	2,087,824
<b>98-Philippines</b>	11.72	7,890

Area planted in potato in the Philippines has been on a declining trend (Table 6). By 2013, production area was down to about 7,867.75 hectares from 8,129.40 hectares in 2010. Volume of production decreased 44.4 percent in 2014 from 2010 due to decreased in area planted. In 2014, area planted decrease but Philippines produced 119,140.02 MT of potatoes with an average yield of 15.14 MT per hectare.

**Table 6. Potato production trends in the Philippines, 2010-2014**

Year	Area planted		Production volume		Yield/ha	
	hectares	% change	MT	% change	tons	% change
2010	8,129.40	-	124,671.18	-	15.34	-
2011	8,170.95	0.01	120,573.73	(0.03)	14.76	(3.40)
2012	8,095.78	(0.92)	119,569.84	(0.83)	14.77	(0.84)
2013	7,889.53	(2.5)	117,721.64	(1.55)	14.92	(1.57)
2014	7,867.75	(0.28)	119,140.02	(1.20)	15.14	(1.19)
average	8,030.68		120,335.28		14.99	

**Figure 7. Potato production trends in the Philippines, 2010-2014**

The trend of local potato production per region as per BAS records show that production increases from 124,671.18 MT in 2010 to 119,140.02 MT in 2014. The cordilleras produces the bulk accounted for 85.63% of the country's potato production output, followed by Davao Region (8.09%) and Northern Mindanao (5.16%) based on the 2010-2014 BAS data. Production in CAR declined from 107,182.00 MT in 2010 to 102,255.20 in 2014. The decrease in production was brought about by decrease in farm productivity and area planted. In CAR, potato is grown as a cash crop and for home consumption.

**Table 8. Volume production of potato by regions, by year, % share and average % change**

Regions	2010	2011	2012	2013	2014	% share	Ave.% change
<b>Philippines</b>	<b>124,671.18</b>	<b>120,573.73</b>	<b>119,569.84</b>	<b>117,721.64</b>	<b>119,140.02</b>	<b>100</b>	<b>(4.44)</b>
CAR	107,182.0	103,135.4	102,433.7	100,758.1	102,255.2	85.83	(4.60)
Davao Region	9,557.9	9,601.1	9,512.7	9,511.4	9,633.8	8.09	0.79
Northern Mindanao	6,870.0	6,745.0	6,550.0	6,355.0	6,145.0	5.16	(10.55)
Soccsksargen	562.0	589.1	594.6	636.2	650.6	0.55	15.77
Cagayan Valley	440.9	443.1	421.4	427.3	448.3	0.38	1.68
Central Visayas	55.9	57.5	54.9	33.7	7.2	0.01	(87.12)

Among the 14 regions in the Philippines, CAR had the widest production area of potato with 85.83 in 2014. From 6,068.50 MT in 2009, potato production in CAR went down to 5,884.90 or a 3.03% decrease in area planted. Potato is

usually planted in upland municipalities such as Benguet and Mountain Province. Farmers in these areas cultivate potato as cash crop and home consumption for rejects.

**Table 9. Area of production by region**

Regions	2010	2011	2012	2013	2014	% share	Ave.% change
<b>Philippines</b>	8,129.40	8,170.95	8,095.78	7,889.53	7,867.75		(3.22)
CAR	6,068.5	6,115.5	6,083.0	5,892.0	5,884.9	74.80	(3.03)
Davao Region	1,329.0	1,330.0	1,303.0	1,300.0	1,300.0	16.52	(2.18)
Northern Mindanao	568.0	560.0	550.0	543.0	537.0	6.83	(5.46)
Soccsksargen	72.1	74.5	74.8	78.0	78.9	1.00	9.43
Cagayan Valley	70.0	69.0	66.0	64.0	64.0	0.81	(8.57)
Central Visayas	20.8	21.0	18.0	12.5	3.0	0.04	(85.58)

The yield per hectare decreased at an average of 1.30 % per year from 15.43 t/ha in 2010 to 15.14 mt/ha in 2014 CAR has the highest average yield with 17.38 t/ha in 2014 followed

by Northern Mindanao, Soccksargen, Davao Region, and Cagayan Valley with 11.44, 8.25, 7.41 and 7.00 t/ha respectively.

Table 10. Yield per hectare by region

Regions	2010	2011	2012	2013	2014	% share	Ave. % change
<b>Philippines</b>	15.34	14.76	14.77	14.92	15.14	100	(1.30)
CAR	17.66	16.86	16.84	17.10	17.38	87.11	(1.59)
Davao Region	7.19	7.22	7.30	7.32	7.41	48.94	(5.45)
Northern Mindanao	12.10	12.04	11.91	11.70	11.44	75.56	5.91
Soccksargen	7.79	7.91	7.95	8.16	8.25	54.49	3.06
Cagayan Valley	6.30	6.42	6.38	6.68	7.00	46.24	11.11
Central Visayas	2.69	2.74	3.05	2.70	2.40	15.85	(10.78)

From 2010 to 2014, an upward trend in production was registered in the provinces of Mountain Province, Compostela Valley, Nueva Viscaya, South Cotabato, North Cotabato, Ifugao and a downward trend in the provinces of

Benguet, Bukidnon, Sultan Kudarat, Sarangani (Table 11). The top provinces in 2014 are Benguet (75.47%), Mountain Province (10.24%), Compostela Valley (8.07%), Bukidnon (5.16%), and Nueva Viscaya (0.37%).

Table 11. Top ten producing provinces in terms of volume production (tons)

REGION	2010	2011	2013	2014	2014	% share	Ave.% change
<b>Philippines</b>	<b>124,671.18</b>	<b>120,573.73</b>	<b>119,569.84</b>	<b>117,721.64</b>	<b>119,140.02</b>	<b>100</b>	<b>(4.44)</b>
Benguet	95,778.59	90,815.59	90,147.95	88,372.84	89,918.44	75.47	(6.12)
Mountain Province	11,264.56	12,184.50	12,146.82	12,244.15	12,195.00	10.24	8.26
Compostela Valley	-	-	9,496.79	9,495.58	9,618.27	8.07	
Bukidnon	6,870.00	6,745.00	6,550.00	6,355.00	6,145.00	5.16	(10.55)
Nueva Vizcaya	439.15	441.00	419.13	424.88	446.15	0.37	1.59
South Cotabato	214.69	235.13	234.53	260.38	260.12	0.22	21.16
North Cotabato	181.41	194.00	202.78	218.73	239.75	0.20	32.16
Ifugao	138.83	135.32	138.90	141.10	141.80	0.12	2.14
Sultan Kudarat	102.87	97.77	95.07	98.58	94.28	0.08	(8.35)
Sarangani	63.00	62.15	62.17	58.50	56.40	0.05	(10.48)

At the provincial level, Benguet remained the top potato producing area in the Philippines. Benguet had the highest average production area was 4,969 ha while Ifugao and Sultan

Kudarat had the least area planted of potato with 9.90 ha. Among the potato producing provinces in CAR, only Benguet, Ifugao and Mountain Province was among the top 10 producers in terms of area planted in 2014.

Table 12. Top ten producing provinces in terms of area (ha)

REGION	2010	2011	2013	2014	2014	% share	Ave.% change
<b>Philippines</b>	8,129.40	8,170.95	8,095.78	7,889.53	7,867.75	63.16	(3.22)
Benguet	5,174.00	5,176.00	5,157.00	4,969.00	4,969.00	16.47	(3.96)
Davao del Sur	1,325.00	1,325.00	1,298.00	1,295.00	1,296.00	11.52	(2.19)
Mountain Province	885.00	930.00	916.00	913.00	906.00	6.83	2.37
Bukidnon	568.00	560.00	550.00	543.00	537.00	0.80	(5.46)
Nueva Vizcaya	69.00	68.00	65.00	63.00	63.00	0.42	(8.70)
South Cotabato	29.50	31.00	30.50	32.75	33.00	0.29	11.86
North Cotabato	17.30	19.00	20.20	21.78	23.20	0.16	34.10
Sarangani	14.50	14.05	14.33	13.55	12.75	0.13	(12.07)
Ifugao	9.50	9.50	10.00	10.00	9.90	0.13	4.21
Sultan Kudarat	10.80	10.40	9.75	9.95	9.90	63.16	(8.33)

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In terms of yield tons per hectare, Benguet is the leading producing provinces which decreasing trend was observed from 18.51 t/ha in 2010 to 18.10 t/ha in 2014. Low

yields are attributed to scarcity of good quality planting materials, poor soil fertility, high incidence of pest and diseases and flooding.

Table 13. Top ten producing provinces in terms of yield (t/ha)

PROVINCES	2010	2011	2012	2013	2014	% share	Ave. % change
<b>Philippines</b>	15.34	14.76	14.77	14.92	15.14	<b>100</b>	-1.30
Benguet	18.51	17.55	17.48	17.78	18.10	119.55	-2.22
Ifugao	14.61	14.24	13.89	14.11	14.32	94.58	-1.98
Mountain Province	12.73	13.10	13.26	13.41	13.46	88.90	5.73
Bukidnon	12.10	12.04	11.91	11.70	11.44	75.56	-5.45
North Cotabato	10.49	10.21	10.04	10.04	10.33	68.23	-1.53
Sultan Kudarat	9.53	9.40	9.75	9.91	9.52	62.88	-0.10
South Cotabato	7.28	7.58	7.69	7.95	7.88	52.05	8.24
Nueva Vizcaya	6.36	6.49	6.45	6.74	7.08	46.76	11.32
Sarangani	4.34	4.42	4.34	4.32	4.42	29.19	1.84
Negros Oriental	2.72	2.74	3.05	2.69	2.40	15.85	-11.76

Production of potato in CAR went down from 107,181.98 MT in 2010 to 102,255.24 MT in 2014. The lead producers of potato in CAR are Benguet, Ifugao, Kalinga and Mountain

Province. Based on BAS/PSA data, Benguet outyielded the other provinces in CAR. Kalinga had the lowest yield with 23.57 t/ha.

Table 14. Potato production in CAR

Indicators	2010	2011	2012	2013	2014	% share	Ave. % change
<b>CAR</b>							
Volume (MT)	107,181.98	103,135.41	102,433.67	100,758.09	102,255.24	100	-4.60
Area (Hectare)	5,824.00	6,068.50	6,115.50	6,083.00	5,892.00	100	1.17
Yield (MT/ha)	18.40	17.00	16.75	16.56	17.35	100	-5.71
<b>Benguet</b>							
Volume (MT)	95,778.59	90,815.59	90,147.95	88,372.84	89,918.44	87.94	-6.12
Area (Hectare)	4,833.00	5,174.00	5,176.00	5,157.00	4,969.00	84.33	2.81
Yield (MT/ha)	19.82	17.55	17.42	17.14	18.10	104.32	-8.68
<b>Ifugao</b>							
Volume (MT)	138.83	135.32	138.9	141.1	141.80	0.14	2.14
Area (Hectare)	10	9.5	9.5	10	10	0.17	0.00
Yield (MT/ha)	13.88	14.24	14.62	14.11	14.18	81.73	2.16
<b>Kalinga</b>							
Volume (MT)	164.75	168.60	172.35	182.00	225.00	0.22	36.57
Area (Hectare)	51.00	52.75	53.00	55.00	55.00	0.93	7.84
Yield (MT/ha)	3.23	3.20	3.25	3.31	4.09	23.57	26.63
<b>Mountain Province</b>							
Volume (MT)	11,264.56	12,184.50	12,146.82	12,244.15	12,195.00	11.93	8.26
Area (Hectare)	981	885	930	916	913	15.50	-6.93
Yield (MT/ha)	11.48	13.77	13.06	13.37	13.36	77.00	16.38

As of 2014, the Cordillera Administrative Region produces 85.83% of the total potato production in the country. Among the Cordillera provinces, Benguet and Mountain Provinces produce the greatest bulk. The top producing municipalities in terms of area are Buguias with 3,861 hectares; Mankayan

(2,797 hectares), Atok (1,769 hectares), Bakun (1,356 hectares) and Kibungan (888 hectares). In terms of production, however, Mankayan and Buguias lead with 63,507.00 and 63,292.25 metric tons.

Table 15. Potato production (mt) by municipality

Item	2010	2011	2012	2013	2014	% share	Ave.% change
<b>Benguet</b>	160,062.19	169,880.53	238,796.34	234,730.37	210,613.79	<b>100</b>	31.58
Atok	11,965.00	31,085.00	4,198.00	44,630.00	32,468.65	15.42	171.36
Bakun	12,120.00	15,180.00	50,402.00	51,197.00	27,112.00	12.87	123.70
Bokod	1,638.00	1,876.00	1,876.00	280.00	900.00	0.43	(45.05)
Buguias	75,680.00	65,493.00	66,382.00	61,349.00	63,292.25	30.05	(16.37)
Kabayan	2,722.00	6,588.00	3,991.00	3,210.00	4,870.00	2.31	78.91
Kibungan	11,466.50	7,268.00	20,380.00	22,120.00	17,752.00	8.43	54.82
La Trinidad	317.44	282.48	347.13	338.68	341.6	0.16	7.61
Mankayan	44,052.00	41,712.00	90,875.00	51,305.00	63,507.00	30.15	44.16
Tuba	67.50	345.60	320.00	280.00	280.00	0.13	314.81
Tublay	33.75	50.45	25.21	20.69	27.29	0.01	(19.14)

Table 16. Area harvested per municipality in Benguet

Item	2010	2011	2012	2013	2014	% share	Ave.% change
<b>Benguet</b>	<b>8,821.05</b>	<b>7,668.53</b>	<b>14,025.11</b>	<b>12,470.98</b>	<b>11,008.74</b>	<b>100</b>	<b>24.80</b>
Atok	635	1,605	2,190	2,450	1,769	16.07	178.58
Bakun	606	759	2,520	2,560	1,356	12.32	123.76
Bokod	117	134	134	14	45	0.41	(61.54)
Buguias	4820	4,346	3,972	3,914	3,861	35.07	(19.90)
Kabayan	127	287	191	162	253	2.30	99.21
Kibungan	546	316	1,098	1,106	888	8.07	62.64
La Trinidad	18	18	22	20	20	0.18	11.11
Mankayan	1946	184	3,880	2,227	2,797	25.41	43.73
Tuba	5	17	16	14	14	0.13	180.00
Tublay	2	2	3	5	6	0.05	200.00

### Good Agricultural Practice (GAP) for Potato Production

*Soil Requirement.* Sandy loam to clay loam soils with pH ranging from 5.6 to 6.5

Soils with high organic matter.

#### *Land preparation*

Remove weeds and plant debris

Preparation of planting beds by furrowing or hill method

Ridge or single row method of bed preparation is prepared with furrows distanced at 75 cm apart which is preferred during dry season

Double row method plots with width of 1.2 m

Raised beds are chosen to provide effective drainage during the wet season

#### *Fertilization*

Basal application of chicken manure (1 can/12 m<sup>2</sup>) applied first then complete fertilizer (1/2 of recommended rate to avoid leaching and evaporation)

Thoroughly mix fertilizer using a cultivator or Japanese hoe

Side dressing or application between rows of ½ of recommended rate of complete fertilizer and properly cover the base of the plant

Fertilizer requirement is 103 kg N, 42 kg Phosphorus, 211 kg Potash

#### *Required fertilizer*

For Highlands conditions: for table potato – 20 bags complete + 4 tons (834) cans chicken manure is needed but for Seeds purposes – 17 bags complete + 2 tons chicken manure is needed.

For Lowlands conditions; 20 bags complete fertilizer + 2 tons chicken manure

2 bags urea (sidedressed) are needed.

*Planting.* Plant apical portion of tubers should be towards the outer side with distance of 30 x 40 cm

Depth – varies according to planting condition/soil type

Early wet/poor tilth – shallow about 2 cm

Dry/good soil tilth – deeper 2-3 cm

*Irrigation.* Flooding/furrow irrigation is used if there is abundant supply of water and is done every 5-7 days. Depth of water in furrow is filled up to ½ the height of the ridge. Overhead irrigation is done every 2-3 days.

### *Side dressing and Hilling-up*

Side dressing may be done by applying fertilizer around the base of the plants or applied between rows

Side dressing and hilling up when plants are about 8-10 cm tall or approximately 30 days after planting

Side dressing/ split application of fertilizer is recommended to maximize plant absorption of nutrients

### *Crop Protection*

Common diseases include late blight, bacterial wilt and nematodes

Common insects include thrips, potato tuber moth, aphids, cutworm, leafminer

### *Harvesting and Postharvest*

Dehauling is done when the vegetative parts are 80 to 85% senescent.

Dehauling is recommended 5-7 days before digging.

Harvesting is done at 70-90 days for short maturing varieties and 100-120 days for long maturing varieties in cooler areas.

### *Sorting and Grading*

This is usually done in the farm especially when tubers are newly dug and left in the field for skin hardening. Sorting is done to separate good tubers from bad ones. Grading is done to classify potatoes according to size and varieties.

Grades of potatoes are as follows:

Small- 50 grams and below (3.0 – 4.0 cm in diameter)

Medium - 85 grams to 98 grams (6.1 – 7.0 cm in diameter)

Big- 78 grams to 84 grams ( 5.1 - 6.0 cm in diameter)

Large- 85 to 98 grams (6.1 – 7.0 cm diameter)

Extra Large- 99 to 105 grams (7.1 – 8.0 cm in diameter)

Super - 106 – 125 grams (8.1 – 9.0 cm in diameter)

Jumbo - 126 grams and above ( 9.1 cm in diameter)

**Storage.** Table potatoes should be protected from the elements, properly ventilated and stored in a dark place to avoid storage greening.

In-ground storage – delayed harvest system for table potatoes.

### **Technologies generated to improve seed production**



Fig 1. Use of clean planting materials and generation zero as quality seed

Among the new technologies deemed to improve production and ready for pilot testing are as follows:

First and foremost, cultural management practices in the production of Go tuberlets in the green house were modified to increase production. The following results were obtained:

1. Variation in the distance of planting revealed that significantly more tubers were produced at closer planting distance of 2.5 and 5.0 cm between hills;

2. To increase the number of tubers produced, repetitive harvesting produced more tubers compared to the conventional one-time harvesting;

3. More tubers were produced when plants were hilled-up once with a 35% increase in total number of tubers produced while hilling-up twice showed a 42% increase from no hilling up treatments.

4. Exploring hydroponics to lessen disease occurrence and cost of production in using sterilized mountain subsoil.

Through potato cuttings planted in the traditional soil mixture used for Go tuberlets

production had a good star for terms for taller plants and more roots, it did not guarantee a higher yield. The numbers of tubers was though statistically not

significantly was 17 to 22% in higher hydroponically grown plants compared to soil mixed used.

To establish management practices for pea-sized (<3g) generation zero tuberlets, the following were obtained:

Pea-sized tubers are best planted to 2-4 cm deep for earlier emergence and

development of canopy. Bulk of the tubers produced in the variety Igorota were of the

seed-sized which is ideal in further seed bulking;

Pea-sized tuberlets planted at closer distance produced more number of tubers (15x30cm, 20x30cm, 25x30cm).

To establish best pest management strategies that is safe, affordable and equally beneficial to farmers and environment,

5. Soil treated with powdered bleach, BSU compost, Lime, urea, and Lime+ urea (20 kg N/ha + 20 kg CaO) reduced and totally eliminated the population of *R. solanacearum* in the soil.

6. A total of 15.4 ha of potential seed growing areas were surveyed in Benguet and Mt. Province for the presence of bacterial wilt. About 1.43 ha was recorded to be infected. Highest % infection was recorded in Lam-ayan Buguias (68%) followed by Bagtangan, Bakun, (27.38%) with the lowest in Madaymen (7.36%). No bacterial wilt was found in Tulodan, Atok.

Based on the bio-chemical classification of Hayward (1964), *R.* in the highlands is biovar 3 which corresponds to race 1

### c. Management of Bacterial wilt

1. Bacterial wilt (*Ralstonia solanacearum*) was found to be widespread in the 78 hectares surveyed in major potato growing areas in Benguet and Mt. Province. Of the areas surveyed, Tulodan (3.45 ha) and Calasipan (0.15 ha) in Atok, Abatan (0.22ha) and Cabalilian (0.06 ha) in Buguias, Pened (0.78 ha) in Mt. Province did not show any presence of bacteria. Most of the surveyed were infested with potato cyst nematode.

2. BPI- BNCRDC, 2014 showed that *Trichoderma harzianum* application significantly reduced bacterial wilt

infection on potato suppressing *Ralstonia solanacearum* disease of potato. Some farmers are already using trichoderma as control measures for bacterial wilt.

3. Organic fertilizer could reduce the population of bacterial wilt by 53-78%. Among the organic fertilizers tested, BSU compost gave the higher reduction in the population of the bacteria. Most effective rate was at 10 t/ha.

Plants applied with the rate of 6 tons/ha mushroom compost significantly increased. The application of BSU compost at 6 tons/ha increased it but were comparable with processed chicken manure (PCM) at 4 tons/ha (BPI-BNCRDC, 2013). The application of mushroom compost significantly lowered percent weight loss, higher dry matter content and lower soluble solid than chicken dung. Mushroom compost at the rate of 6 tons/ha with 150-225-150 kg/ha NPK significantly increased yields and improved dry matter content.,

4. The application of lime (16 – 20 t CaO/ha), urea (20-40 kg N/ha) and combination of lime and urea (16-20 t CaO and 20-40 kg M/ha) completely eradicated the population of BW in pot experiments. The combination of lime and urea caused the release of the bactericidal ammonium in the soil, thus controlling the multiplication of the bacteria.

5. Formaldehyde did not consistently reduce the population of the soil but could be used as spot drenched to control the spread of the bacteria in the field especially in the seed production.

6. Powdered bleach (calcium hypo chlorite) was effective in controlling the bacterial wilt. The most effective rate is at 12 kg N/ha.

7. Alum has a potential in controlling bacterial wilt as indicated in the inhibition zones in the bioassay tests.

8. Three isolates of microbial antagonist were obtained from the corm and legumes rhizospheres were just as effective as *Bacillus* sp. in reducing the population of BW in the soil.

9. Extract of garlic, chives were found to have bactericidal effects.

10. Rotation with cabbage after potato and carrots after cabbage and legumes after carrots gave the highest reduction of BW population compared monocropping.

11. Local varieties like Igorota, Solibao, Granola and Raniag showed tolerance/resistance to bacterial wilt infection. Among the varieties, preliminary results all have tolerance to bacterial will infection.

12. Climatic factors that affect growth and multiplication of bacteria were studied. For temperature, growth is 0 at 5 C, 38 and 42 C; Lethal temperature for the bacteria was 90 to 100 C; exposure to ultra violet light for 21/2 minutes and above caused the non-growth of the bacteria; no growth of the bacteria was observed in the pH of 2 and 3.

On-farm verification of selected control components showed that application of calcium, hypo chlorite, BSU compost, lime (20 + CaO/ha), urea (40 kg N/ha), lime + urea combination 1 (20 CaO + 40 kg N/ha) and 2 (20 + CaO + 20 KG N/ha) plus the use of clean planting materials reduced population from 80 to 100% of potato and tomato.