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G0 Potato Seed Production Management in Indonesia: An Overview and The Challenges

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ABSTRACT

The availability of Indonesian potato seed and production of potato for consumption depends on the availability and quality of Generation 0 (G0) potato seed. This study aims to observe G0 potato seed production management in Indonesia. Data were collected through Focus Group Discussion (FGD) and survey. Thirty-seven G0 potato seed producers participated in the survey. Data were analyzed descriptively, while the feasibility of the farm budget of G0 potato production was calculated using the enterprise budget method. The results showed that the producers had challenges on capital to broaden the screen house to extend the production scale and limited plantlet availability. Meanwhile, they did not have any problems with other production aspects, such as controlling pests and diseases and the marketing of the G0 seed. Government supports to provide screen houses to fulfil producers' necessity and delegate the legality of potato plantlets are needed to create a better Indonesia's potato seed system.

Keywords: enterprise budget method, G0 potato, seed production

INTRODUCTION

Indonesian potato consumption production tended to increase from 2013 to 2017. The average production increased and accounted for 1,278,191.2 ton due to the rise of potato harvesting land area from 2013 to 2017. The average harvesting land area was about 71,104 hectares, with a productivity rate of 17.1 ton per hectare. Meanwhile, the per capita consumption also grew with an average consumption of 2.01 kg per capita over the last five years (Pusat Data dan Sistem Informasi Pertanian & Indonesia K.P.R., 2018).

Seed support was necessary for the development of Indonesian potato production. The availability of high-quality and affordable seed was important to produce the potatoes in the long term continuously and to provide a benefit for farmers as the producers (Handayani, Sahat, & Sofiari, 2015; Kiloes, Puspitasari, Syah, & Udiarto, 2019; Mulyono, Syah, Sayekti, & Hilman, 2017; Urrea-Hernandez, Almekinders, & Dam, 2016).

Potato seeds become the main attention of potato production because of their influence to yield productivity (Hidayat, 2011; Mulijanti *et al.*, 2015; Wicaksana *et al.*, 2013). Another factor that makes the seed important is the significant allocation of potato seeds in the component cost of potato production. It is accounted for more than 30% (Ridwan *et al.*, 2010).

The cost is higher when using the certified seeds, reaching 47% (Kiloes, Sayekti, & Syah, 2015; Sayaka & Hestina, 2011).

Production potency, seed purity, and resistance to pest and disease are several factors considered by potato farmers when selecting or buying certain potato seed varieties (Adiyoga *et al.*, 2014; Handayani, 2015; Wicaksana *et al.*, 2013). The Indonesian potato farmers generally save their seeds from the previous harvest (Fauzi, Baga, & Tinaprilla, 2016). The seeds are used several times because they could not afford new seeds (Ogola, Orawo, & Ayieko, 2012; Sayaka *et al.*, 2012; Shafarina & Perdana, 2016). Thus, potato production is not optimum (Adiyoga *et al.*, 2014; Mulyono *et al.*, 2017; Wicaksana *et al.*, 2013). The farmers need to be supported for the availability of high-quality and affordable potato seeds. Hence, potato production can increases.

Ideally, the farmer potato production (recalled as the potato consumption) is planted from G4 certified seed. Nevertheless, the availability of certified seeds is limited. Moreover, the price is not affordable for the farmer; hence, they use uncertified derivative seeds (G5 to G7) (Mulyono *et al.*, 2017). The G4 quality is influenced by the excellency of its previous seed (G3).

The potato seed consists of various generations. In Indonesia, the potato generations are grouped into five classes: G0, G1, G2, G3, and G4 (Sayaka *et al.*, 2012). The quality and availability of G0 seed affect the continuity of the next seed classes: G1, G2, G3, and G4, and potato consumption. G0 is free from virus and bacterial wilt disease (the seed contains zero virus and bacterial wilt disease) (Handayani, 2015; Mulyono *et al.*, 2017). The virus presence in the seed and the virus attack on the potato plant will impact the yield (Damayanti & Kartika, 2015; Soesanto, Mugiastuti, & Rahayuniati, 2011). Multiplication of the high-quality G0 seed could be done through tissue culture and a micro tuber (Astarini, Chappell, Scheuring, Thompson, & JR, 2016; Hidayat, 2011; Suliansyah, Helmi, Santosa, & Ekawati, 2017). The potato tissue culture provision will guarantee the G0 and the derivative seed provision (Rainiyati, Neliyati, & H, 2011). Previous studies stated that a potato that originates from G0 seed had increased production in generating its next seed class (G1) compared to other seed classes (from G1 to G2, and on the next generation classes) (Mulyono *et al.*, 2017).

Various studies to increase the G0 seed production have been undertaken (Dianawati *et al.*, 2019; Dianawati *et al.*, 2013; Sumarni *et al*, 2016; Waluyo & Karyadi, 2017). However, research regarding G0 seed production management conducted by the breeder / potato farmers in Indonesia is very limited. The study aims to identify the Indonesian G0 potato seed management production, pictures, and challenges. The results are expected to help understand the required Indonesian G0 seed management production and improvements to encourage the national potato seed system.

RESEARCH METHOD

This descriptive study was conducted from April to December 2017 in 12 districts in six provinces in Indonesia, including: Garut and West Bandung (West Java), Banjarnegara and Wonosobo (Central Java), Simalungun and Karo (North Sumatera), East Lombok (West

Nusa Tenggara), Gowa (South Sulawesi), and Pasuruan, Probolinggo, and Malang (East Java). Locations and respondents were selected purposively. The selected regions were the 12 biggest potato production centres in Indonesia. Also, there were G0 potato seed breeders in those areas (Table 1).

TABLE 1. PROVINCE POTATO PRODUCTIONS IN THE RESEARCH AREAS IN 2017 AND THE RANK (THE BIGGEST TO THE LOWEST POTATO PRODUCTION)

No.	Province	Production (ton)	Rank
1.	North Sumatera	96,893	4
2.	West Java	277,187	1
3.	Central Java	269,476	2
4.	East Java	241,180	3
5.	West Nusa Tenggara	1,804	12
6.	South Sulawesi	31,831	9

Source : Pusat Data dan Sistem Informasi Pertanian & Indonesia (2018)

Thirty-seven respondents were selected through census to G0 potato seed breeders in the research locations and have produced the seed in the last two years (2016-2017). Information about G0 potato respondents was gained from local agricultural institutions, Seed Certification Inspection Office, Parent Seed Institution, Potato Seed Institution, and farmer associations from 12 research area districts.

This study limitation was that some data were incomplete. The information about G0 seed production and the marketing areas were only obtained from 36 respondents; one respondent did not answer. Meanwhile, only 18 respondents had complete data productions, and we assumed that these data were representative for farm feasibility analysis.

The data were collected through Focus Group Discussion (FGD) and survey, using a structured questionnaire. FGD was conducted in the Pangalengan sub-district, engaging eight G0 potato breeders to grasp an insight into the G0 seed production process. Pangalengan was chosen as the FGD location because it was the biggest potato center production in West Java (Ridwan *et al.*, 2010). The FGD result was used as the basic information to design a structured questionnaire for the survey.

Data were analyzed descriptively, while the feasibility of farm budget analysis of G0 potato production was calculated using farm cost and revenue analysis with the following formula as Equation 1 (Ningsih, Felani, & Sakdiyah, 2015; Sundari, 2011).

$$\pi = TR - TC \quad (1)$$

Where, π referred to profit (IDR), TR was total farm revenue (IDR), and TC was total farm cost (IDR).

While the efficiency of G0 potato seed production was calculated using the following formula (Equation 2):

$$R/C\ Ratio = \frac{Revenue}{Cost} \quad (2)$$

Where, If R/C > 1 it means that the farming was efficient, If R/C = 1 it means that the farming achieves breakeven point, and If R/C < 1 it means that the farming was not efficient.

RESULT AND DISCUSSIONS

Respondents Characteristic

The majority of respondents (70.3%) were under 50 years old (Table 2) and categorized as a productive age (Rahmadona, Fariyanti, & Burhanuddin, 2015). The respondents had a good education, about 48.6% of hold associate, bachelor, and postgraduate degrees. A farmer with a higher educational level was more open to accepting new knowledge and innovations (Sasongko, Witjaksono, & Harsoyo, 2014). These can be seen from most of the respondents (73%) who had joined in training, comparative studies, and internships related to G0 potato seed production.

TABLE 2. RESPONDENTS' DEMOGRAPHY CHARACTERISTICS OF G0 POTATO SEED PRODUCTION

No	Variables	Range	Respondents (n=37)	
			Number	%
1.	Educational level	Elementary	3	8.1
		Junior high school	5	13.5
		Senior high school	11	29.7
		Associate degree	3	8.1
		Bachelor	13	35.1
		Postgraduate	2	5.5
2.	Age	20-30	7	19
		31-40	5	13.5
		41-50	14	37.8
		> 50	11	29.7

The motivation to be involved in training/comparative study/internship of potato seed was dominated by the respondent's intention (54%). The rest were motivated by the financial support from some institutions, such as Indonesian Vegetable Research Institute (IVegRI), Wonosobo agricultural institution, Indonesian higher education ministry, Seed Certification Inspection Office; in Indonesia called *Balai Pengawasan dan Sertifikasi Benih* (BPSB), Parent Seed Institution; in Indonesia called *Balai Benih Induk* (BBI), local seed bodies, a company such as Urban Independent Community Empowerment Program; in Indonesia called *Program Nasional Pemberdayaan Masyarakat* (PNPM) Mandiri, or from a university such as Mataram University (UNRAM).

Farmers engaged in training because they want to increase their competency, including knowledge and farming skills. Hence, they could increase their productivity and income (Kuntariningsih, 2013; Manyamsari & Mujiburrahmad, 2014).

Talking about a screen house, the average screen house managed by the respondents for G0 seed production was 222 m^2. Of this, the smallest area was 9 m^2 and the biggest was 3,456 m^2. The majority of the screen houses were self-ownership (64.8%), followed by government ownership (16.2%) (Table 3) managed directly by governments' body, such as BBI, and Potato Seed Institute; in Indonesia called *Balai Benih Kentang* (BBK) or used by farmers as government assistance. Besides, some respondents also used the rented screen house and the government screen simultaneously. The government screen house usually is free of charge.

The screen house had various areas. The biggest screen house area was government-owned (727 m^2), followed by breeder ownership (about 498 m^2) and rented (447 m^2). For some breeders, the expansion of screen houses was challenging because of limited capital. The respondents said that at least more than 100 million was needed to build a 480 m^2 iron frame screen house, and the respondents could not afford it. The North Sumatera G0 potato breeders had a similar opinion regarding the screen house. They stated that they needed around 20 million IDR to build a simple 60 m^2 screen house (Dewantoro, 2017). The desire to expand the screen house increased as the demand for G0 potato seed was higher.

TABLE 3. RESPONDENTS' BUSINESS CHARACTERISTICS

No	Variables	Categories	Respondents (n=37)	
			Number	%
1.	Screen house ownership	Self-ownership	24	64.8
		Rent	3	8.1
		Governments'	6	16.2
		Others	4	10.9
2	Duration to produce G0 seed	1-2 years	10	27.02
		3-5 years	10	27.03
		> 5 years	17	45.95
3	Potato varieties usage	Granola Lembang	34	91.9
		Granola Kembang	7	59.5
		MZ	17	18.9
		Agria	4	10.8
		RgH01	4	10.8
		Medians	4	10.8
		Atlantik	5	13.8
		Others	4	10.8
4	Sources of plantlet	Companies	4	10.8
		Governments	27	73.0
		Others	6	16.2

Considering the time producing G0 seed, about 45.95% of the respondents had done it for more than five years. The three most varieties used by the respondents were Granola Lembang, Granola Kembang, and MZ. Those varieties were used by about 91.9%, 59.5%, and 18.9% of respondents, respectively (Table 3). Fewer respondents also were planted other potato varieties, such as Agria, RgH01, Medians, Atlantik, AR 08, Dayang Sumbi, Merbabu, and Amabile. To date, the Granola variety is the most potato planted by the breeders and potato farmers in Indonesia (Adiyoga *et al.*, 2014; Gunadi, Karjadi, & Sirajuddin, 2014).

In terms of the source of the plantlet, the respondents bought it from various sources. About 73% of respondents bought it from governments' institutions, such as IVegRI, Assessment Institute of Agricultural Technology (AIAT) East Java, Horticulture Seed Garden in Indonesia called *Kebun Benih Tanaman Pangan dan Hortikultura* (KBTPH Kledung), Potato Seed Development Institution in Indonesia called *Balai Pengembangan Benih Kentang* (BPBK), and BBI. The rest (four respondents) bought the seeds from companies. Specifically for the Granola

L, the respondents purchased it from IVegRI Lembang, while the Granola Kembang provided by AIAT East Java (Prahardini, Sudaryono, & Andri, 2016).

The respondents stated that the availability of plantlets from producers was limited. Also, it took time to get the plantlet, especially for areas such as Lombok and North Sumatra. Sometimes, the plantlet is damaged or died when it arrived at the respondent's place. These happened due to a long trip, temperature changing, inappropriate delivery and bad packaging. This result was in line with the previous study, stating that the challenges to distribute potato plantlets to every region in Indonesia is that the plantlet could be damaged when not handled carefully (Hidayat, 2011).

G0 Potato Seed Production Management by The Breeders

Plantlet cutting planting

G0 potato seed production was conducted in the screen house. The production process of all respondents from the six provinces was relatively similar, starting from washing the plantlet roots. Then, it was planted in the seedbed to be made as a mother plant. During the planting, the plantlet was covered for two to three weeks. Respondents from Wonosobo, Garut, and Banjarnegara districts covered it for two weeks. Whilst respondents from Brastagi, Lombok, Pasuruan, Malang, Gowa, and West Bandung districts covered the plantlet for three weeks. The cover was then opened for a week until the root grows. This process is conducted so the plantlet can adapt to its new environment, and it is recalled as acclimatization. Total acclimatization time is about three to four weeks (Dianawati *et al.*, 2019; Waluyo & Karyadi, 2017).

After the plantlet's root was grown, a cutting was done. Ideally, four times cuttings can be done from one plantlet, resulting in 20 to 30 potato seeds (Dirjen Hortikultura, 2014). In reality, the cutting practice was done seven to ten times. Next, they were transplanted to the bigger seedbeds or polybags to produce the G0 tuber. When planting in the seedbed, respondents applied the plant distance of 10 cm x 10 cm or 10 cm x 20 cm.

Respondents used various kinds of plant media for the potato cutting, such as rice husk charcoal, fern root, cocopeat, topsoil, compost, and chicken manure. All respondents used rice husk charcoal and cocopeat as the main plantlet cutting plant media. Some respondents from Wonosobo added fern-root as the media. Whilst the respondents from Garut, Simalungan, and Gowa added fern-root and compost, and West Java's respondents added manure as the media. The media was sterilized by steaming, boiling, or washing and mixing it with chemical materials, such as Basamid, Lysol and Nupam. Sterilization should be done for the potato plant grows well and healthy (Dirjen Hortikultura, 2014).

Fertilizing and spraying

A breeder should pay attention to fertilizing potato plantlet cutting for the optimum G0 potato production. Nine respondents (51.3%) used NPK. It is a basic fertilizer for G0 potato seed production (Dianawati *et al.*, 2019; Hidayat, 2011). Other respondents used Kascing (24.3%), chicken manure (10.8%), SP 36, and KCL (5.4%). Vermicompost

(Kascing) was used in Wonosobo, Banjarnegara, and Simalungun. The fertilization frequency was varied, on average, one to two times during the production.

The most common disease attacking the potato plant is Phytophthora Infestans (Alaux *et al.*,2018; Kumbar *et al.*, 2019). Nine respondents (from Wonosobo, Banjarnegara, West Bandung, Simalungun, East Lombok, Pasuruan, and Gowa) reported that phytophthora attacked their plants, decreasing the G0 potato production by 10 to 100%. To control the disease, respondents sprayed the potato plants using Antracol, Mancozeb, Ridomil or pulled out the infected plant. These attempts could control the disease from 60 to 100%.

The potato tuber moth (PTM) was the dominant insect attacking the respondents' potato plants. The PTM attacked potato leaves and tubers as experienced by 13 respondents from Wonosobo, Garut, West Bandung, Karo, Simalungun, Brastagi, Pasuruan, Malang, Probolinggo, and Gowa, decreasing the potato yield by 5-100%. The respondents succeeded to control the PTM using Mipcinta, Metindo, Sevin, and Decis insecticides, or a natural way by Lantana/Tratapan flower.

Five respondents from Banjarnegara, Wonosobo, Garut, and West Bandung also said that PTM attacked their potatoes, decreasing the yield by 70%. They controlled the pest using Mipcinta, Calicron, and Metindo insecticides. The frequency of spraying in one cycle of G0 production (three months) was varied, ranging from seven to 23 times.

Irrigation and weeding

The potato plant must have enough water and be cleaned from weeds. In contrast, excessive irrigation would decrease potato production (Utami, Rahayu, & Setiawan, 2015). All respondents watered the potato plants regularly (one to three times a week). On average, the watering frequency was 43 times per planting season. As for weeding, on average, the respondents did two to three times per planting season.

Harvesting and post-harvest

On average, Respondents from 12 districts produced eight tubers of G0 seed per plant. The total biggest yield of G0 production resulted from East Java Province, 1,292,300 tubers (Table 4).

TABLE 4. THE AVERAGE OF G0 POTATO YIELD PER PLANT AND THE TOTAL YIELD PER PROVINCE (N=36)

Provinces	Districts	Respondents (person)	Average yield per plant (tuber)	Total yield (tuber)
Central Java	Wonosobo, Banjarnegara	11	7	802,600
West Java	Garut, West Bandung	7	5	642,800
North Sumatera	Simalungan, Karo, Brastagi	5	7	72,600
West Nusa Tenggara	East Lombok	2	16	190,000
East Java	Pasuruan, Malang, Probolinggo	9	7	1,291,300
South Sulawesi	Gowa	2	8	120,000

All respondents were graded and sorted the yield. Then the yield was given a treatment hence they were not easily rotten or attacked by diseases. The treatment was by dipping or stirring the G0 potato tuber into a fungicide/insecticide, such as Metindo or Mipcin, before storing it in a warehouse for two to three months. While storing, the seed was sorted two to four times, and the rotten seed was thrown away.

The Indonesian government encourages the potato farmers/breeders to produce a high-quality G0 seed by certification (Sayaka & Hestina, 2011). In Indonesia, G0 seed certification is conducted by BPSB. However, in the study location, only 18 respondents (48.6%) certified their G0 (Table 5). The rest did not certify the seed due to the complicated certification process and the high cost. Besides, some breeders assumed the quality of their G0 production was good even though it was uncertified.

TABLE 5. NUMBER OF RESPONDENTS BASED ON CERTIFICATION STATUS OF G0 POTATO SEED (N=37)

Certification status	Respondents (per cent)	Percentage (%)
Certified	18	48.6
Uncertified	19	51.4
Amount	**37**	**100**

The G0 Potato Seed Marketing

G0 potato seed production has resulted from respondents in different regions. The survey showed that the three biggest G0 potato seed producers in Indonesia were East Java (1,291,300 tubers), followed by Central Java (802,600 tubers) and West Java (642.800 tubers). About 35 respondents (97.2%) sold their G0 seed to the local breeders or other region breeders in Indonesia. The marketing of G0 seeds is commonly by consumer's order. The percentage of G0 seed production sold by Central Java, West Java, North Sumatra, and East Nusa Tenggara respondents reached 90 to 99% (Table 6).

TABLE 6. G0 POTATO PRODUCTION AND THE MARKETING DISTRIBUTION (N=36)

Provinces	Districts	Total yield (tubers)	Percentage of yield to be sold (%)
Central Java	Wonosobo, Banjarnegara	802,600	90
West Java	Garut, West Bandung	642,800	90
North Sumatera	Simalungan, Karo, Brastagi	72,600	91
West Nusa Tenggara	East Lombok	190,000	99
East Java	Pasuruan, Malang, Probolinggo	1,291,300	81
South Sulawesi	Gowa	120,000	50

The remaining 1 to 10% did not sell the seeds as they were rotten due to a pest attack. East Java respondents sold 81% of the G0 yield, whilst the rest (19%) was not sold as the tuber was too small. The respondents from South Sulawesi only sold about 50% of the G0 and planted the rest.

Previous studies showed that G0 seeds were produced by government institutions as well as collaboration between universities and farmer groups. For example in West Java, the G0 was generated by IVegRI Lembang, then distributed or sold by BBI, PD Hikmah, and Pesantren Darul Fallah Bogor (Sayaka & Hestina, 2011; Sayaka *et al.*, 2012). Meanwhile, the G0 in East Java was produced by AIAT, BBI province, and Horticulture and Crops Seed Supervision and Certification Office in Indonesia called *Balai Pengawasan dan Sertifikasi Benih Tanamanan Pangan dan Hortikultura* (BPSBTPH) of East Java. Later, they were distributed and sold to East Java agricultural institutions, BBI, Pasuruan Agricultural district institution, East Java BPSBTPH and potato breeders (Prahardini *et al.*, 2016).

Central Java G0 seed marketing areas were West Sumatra, Brastagi, Jambi, Pekalongan, Aceh, Kerinci, East Java, Wonosobo, and Banjarnegara. Meanwhile, West Java G0 potato breeders sold the seed around West Java, Jambi, West Sumatra, Dieng, Probolinggo, Pasuruan, Malang, West Nusa Tenggara, Bali, North Sulawesi, East Nusa Tenggara, Aceh, and Makassar. North Sumatra G0 potato seed producers sold the seed around North Sumatra, such as Portibi, whilst, East Lombok distributed the seed to Sembalun-Lombok. East Java G0 production marketed around Central Java, Medan, Papua, Bali, West Sumatra, and East Nusa Tenggara. Whereas half of G0 from South Sulawesi marketed to North Sumatra and Pangalengan.

G0 Potato Seed Production Feasibility

The G0 potato seed production feasibility was measured based on the average of cost and revenue from 18 G0 producers from eight districts in four provinces: Banjarnegara, and Wonosobo (Central Java), Karo, and Simalungun (North Sumatra), Bandung, and Garut (West Java), also Pasuruan and Malang (East Java). The respondents' screen house average size was 152 m2, with the average number of potato plants planted were 3,594 plants/cuttings. The average G0 yield was eight tubers per cutting. The average total production was 21,370 tubers.

The two biggest respondents' production cost was depreciation cost (screen house, seeded, water pump, irrigation, etc.), which was 4.09 million IDR (33%), and planting media, which was 2.46 million IDR (19.9%). Meanwhile, the two smallest production cost allocations were pesticide and screen house maintenance, making up 310,500 IDR (2.5%) and 376,900 (3.1%). The G0 seed was sold at various prices in different regions. Central Java respondents sold it for 1,600 IDR per tuber. While, the price was 1,700 IDR, 3,125 IDR, 2,500 IDR per tuber in West Java, South Sumatera and East Java, respectively. The average G0 price was 2,150 IDR per tuber (Table 7).

TABLE 7. G0 POTATO SEED FARM COST REVENUE ANALYSIS AT FOUR PROVINCES IN INDONESIA (n=18)

Description	Amount (IDR)	Percentage of the total cost (%)
Costs		
Plantlet	1,299,600	10.5
Fertilizer	1,179,900	9.5
Planting media	2,461,700	19.9
Pesticide	310,500	2.5
Labour	2,155,000	17.4
Depreciation	4,087,400	33.0
Other costs (certification, seed treatment, screen rent, fuel)	505,600	4.1
Screen house maintenance	376,900	3.1
Total cost	12,404,100	100
Revenue		
G0 production (tuber)	21,370	
G0 selling price (IDR/tuber)	2,150	
Revenue (IDR)	45,945,000	
Profit (IDR)	33,541,400	
R/C	3.7	

The average G0 cost production and revenue were 12,404,100 IDR and 45,945,000 IDR, respectively, resulting in 33,541,400 IDR profit. Hence, the R/C value was 3.7, meaning that each 1 IDR of G0 seed production cost spent would create the revenue of 3.7 IDR. This finding indicated G0 potato seed production was still efficient to be run by the producers. A previous study showed that the G0 potato seed production is very profitable. The G0 seed production in the 500 m2 size area was 144,000 tubers with the B/C value was 10.3 (Basuki *et al.,* 2020).

CONCLUSION

G0 potato seed production at 12 districts in Indonesia showed that challenges on the G0 production were screen house expansion and the availability of potato plantlets. In contrast, there was no problem with other production aspects, such as controlling pest and disease and marketing the yield. The enterprise budget analysis from four provinces in Indonesia indicated that G0 potato production is efficient and profitable.

Governments and private contributions in providing screen houses that fit with breeder/producer needs will optimize the G0 potato seed business scaling expansion in Indonesia. Whilst, the limited plantlet could be minimized by encouraging legality delegation propagation. It means that the authority should be handed over to G0 potato producers, such as universities or local seed companies around G0 potato seed production areas, to multiply a source seed released by a breeder or a variety owner. In this case, the source seed is propagated through potato cutting.

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REFERENCES

Adiyoga, W., Suwandi, & Kartasih, A. (2014). Sikap Petani Terhadap Pilihan Atribut Benih dan Varietas Kentang (Farmers ' Attitude Towards Attribute Choices of Potato Seed and Variety). *J. Hort*, *24*(1), 76–84.

Alaux, P. L., César, V., Naveau, F., Cranenbrouck, S., & Declerck, S. (2018). Impact of Rhizophagus irregularis MUCL 41833 on disease symptoms caused by Phytophthora infestans in potato grown under field conditions. *Crop Protection*, *107*(August 2017), 26–33. https://doi.org/10.1016/j.cropro.2018.01.003

Astarini, I. A., Chappell, A., Scheuring, D., Thompson, S. M., & JR, J. C. M. (2016). Teknik Pemuliaan Kentang dan Produksi Bibit Kentang Bebas Virus di Texas , USA. *Prosiding Seminar Nasional from Basic Science to Comprehensive Education* (Vol. 2 No.1, pp. 251–256). Makassar.

Basuki, R. S., Khaririyatun, N., Sembiring, A., Nurmalinda, N., & Arshanti, I. W. (2020). Studi Adopsi Benih Kentang Bebas Virus Varietas Granola L. dari Balai Penelitian Tanaman

Sayuran di Kabupaten Garut, Jawa Barat. *Jurnal Hortikultura*, *29*(2), 241. https://doi.org/10.21082/jhort.v29n2.2019.p241-256

Damayanti, T. A., & Kartika, R. (2015). Deteksi Virus-Virus pada Kentang di Jawa Barat dengan Menggunakan Teknik Molekuler. *J. Hort*, *25*(2), 171–179. https://doi.org/10.21082/jhort.v25n2.2015.p171-179

Dewantoro. (2017). Sahula Sipayung, Penuhi Kebutuhan Benih Kentang Petani. Retrieved from http://www.medanbisnisdaily.com/m/news/read/2017/01/23/279610/sahula-sipayung-penuhi-kebutuhan-benih-kentang-petani/

Dianawati, M., Farida, H., & Muhartini, S. (2019). Produksi Benih Kentang G0 Pada Berbagai Volume dan Frekuensi Fertigasi dengan Sistem Irigasi Tetes (Production of G0 Potato Seed on Many Fertigation Volumes and Frequencies on Drip Irrigation). *Jurnal Hortikultura*, *29*(1), 53. https://doi.org/10.21082/jhort.v29n1.2019.p53-60

Dianawati, M., Ilyas, S., Wattimena, G., & Susila, A. (2013). Produksi Umbi Mini Kentang Secara Aeroponik Melalui Penentuan Dosis Optimum Pupuk Daun Nitrogen. *J. Hort*, *23*(1), 47–55. https://doi.org/10.21082/jhort.v23n1.2013.p47-55

Dirjen Hortikultura, K. P. (2014). *Teknis perbanyakan dan sertifikasi benih kentang*. Jakarta.

Fauzi, D., Baga, L. M., & Tinaprilla, N. (2016). Strategi Pengembangan Agribisnis Kentang Merah di Kabupaten Solok. *AGRARIS: Journal of Agribusiness and Rural Development Research*, *2*(1), 87–96. https://doi.org/10.18196/agr.2129

Gunadi, N., Karjadi, A., & Sirajuddin. (2014). Pertumbuhan dan Hasil Beberapa Klon Kentang Unggul Asal International Potato Center di Dataran Tinggi Malino, Sulawesi Selatan. *J. Hort*, *24*(2), 102–113. https://doi.org/10.21082/jhort.v24n2.2014.p102-113

Handayani, T. (2015). Penyediaan Materi Pemuliaan Kentang Melalui Produksi Ubi Mini (G0). In E. Widaryanto, N. Aini, N. Barunawati, & A. Setiawan (Eds.), *Prosiding Seminar Nasional Perhorti 2014* (p. 949). Malang: Fakultas Pertanian Universitas Brawijaya.

Handayani, T., Sahat, J. P., & Sofiari, E. (2015). Ketahanan Lapangan Klon-Klon Kentang Hasil Persilangan terhadap Penyakit Busuk Daun (Field Resistance of Potato Clones to Late Blight). *J. Hort*, *25*(4), 294–303. https://doi.org/10.21082/jhort.v25n4.2015.p294-303

Hidayat, I. M. (2011). Produksi Benih Sumber (G0) Beberapa Varietas Kentang dari Umbi Mikro. *J. Hort*, *21*(3), 197–205. https://doi.org/10.21082/jhort.v21n3.2011.p197-205

Kiloes, A. M., Puspitasari, Syah, M. J. A., & Udiarto, B. K. (2019). Strategi pengembangan usahatani perbenihan kentang di Kabupaten Kerinci. *AGRARIS: Journal of Agribusiness and Rural Development Research*, *5*(1), 21–31. https://doi.org/10.18196/agr.5172

Kiloes, A. M., Sayekti, A. L., & Syah, M. J. A. (2015). Evaluasi Daya Saing Komoditas Kentang di Sentra Produksi Pangalengan Kabupaten Bandung. *J. Hort*, *25*(1), 88–96. https://doi.org/10.21082/jhort.v25n1.2015.p88-96

Kumbar, B., Mahmood, R., Nagesha, S. N., Nagaraja, M. S., Prashant, D. G., Kerima, O. Z., & Chavan, M. (2019). Field Application of Bacillus Subtilis Isolates for Controlling Late Blight Disease of Potato Caused By Phytophthora Infestans. *Biocatalysis and Agricultural Biotechnology*, *22*, 1–7. https://doi.org/10.1016/j.bcab.2019.101366

Kuntariningsih, A. (2013). Dampak Pelatihan terhadap Petani Terhadap Kinerja Usahatani Kedelai di Jawa Timur. *Sosiohumaniora*, *15*(2), 139–150. https://doi.org/10.24198/sosiohumaniora.v15i2.5739

Manyamsari, I., & Mujiburrahmad. (2014). Karakteristik Petani dan Hubungannya dalam Kompetensi Petani Lahan Sempit. *Agrisep*, *15*(2), 58–74.

Mulijanti, S. L., Dianawati, M., Tedy, S., & Sunandarmatan, N. (2015). Peranan Lembaga Pendukung terhadap Usahatani Perbenihan Kentang di Kabupaten Garut. In E. Widaryanto, N. Aini, N. Barunawati, & A. Setiawan (Eds.), *Prosiding Seminar Nasional Perhorti 2014* (p. 949). Malang: Fakultas Pertanian Universitas Brawijaya.

Mulyono, D., Syah, M. J. A., Sayekti, A. L., & Hilman, Y. (2017). Kelas Benih Kentang (*Solanum tuberosum* L.) Berdasarkan Pertumbuhan, Produksi, dan Mutu Produk. *J. Hort*, *27*(2), 209–216. https://doi.org/10.21082/jhort.v27n2.2017.p209-216

Ningsih, K., Felani, H., & Sakdiyah, H. (2015). Keragaan Usahatani dan Pemasaran Buah Naga Organik. *Agriekonomika*, *4*(2), 168–184.

Ogola, J. B. O., Orawo, A. O., & Ayieko, M. W. (2012). Assessment of Factors Affecting the Farmer Demand for Seed Potato in Nakuru District, Kenya. *African Journal of Agricultural Research*, *7*(23), 4151–4157. https://doi.org/10.5897/AJAR12.454

Prahardini, P., Sudaryono, T., & Andri, K. B. (2016). Pengembangan Kentang Varietas Granola Kembang di Jawa Timur. In I. Djatnika, M. J. A. Syah, D. Widiastoety, M. P. Yufdy, S. Prabawati, S. Pratikno, & Badan (Eds.), *Buku Inovasi Hortikultura : Pengungkit peningkatan pendapatan rakyat* (p. 294). Jakarta: IAARD Press.

Pusat Data dan Sistem Informasi Pertanian, & Indonesia K.P.R. (2018). *Statistik Pertanian 2018 Kementerian Pertanian Republik Indonesia*. (A. A. Susanti, B. Waryanto, D. R. T, P. H. Muliany, T. H. A, R. Suryani, … Eds), Eds.). Jakarta: Pusat Data dan Sistem Informasi Pertanian, Kementerian Pertanian Republik Indonesia.

Rahmadona, L., Fariyanti, A., & Burhanuddin. (2015). Analisis Pendapatan Usahatani Bawang Merah di Kabupaten Majalengka. *Agrise*, *XV*(2), 1412–1425.

Rainiyati, J., Neliyati, & H, H. (2011). Proses Penbediaan Bahan Setek Kentang Asal Kultur Jaringan untuk Produksi Bibit Kentang Mini Pada Kelompok Tani di Kecamatan Kayu Aro. *Jurnal Pengabdian Pada Masyarakat*, *52*, 1–7.

Ridwan, H. K., Nurmalinda, S., & Hilman, Y. (2010). Analisis Finansial Penggunaan Benih Kentang G4 Bersertifikat dalam Meningkatkan Pendapatan Usahatani Petani Kentang. *J. Hort*, *20*(2), 196–206.

Sasongko, W. A., Witjaksono, R., & Harsoyo. (2014). Pengaruh Perilaku Komunikasi Terhadap Sikap dan Adopsi Teknologi Budidaya Bawang Merah di Lahan Pasir Pantai Kecamatan Sanden Kabupaten Bantul. *Agro Ekonomi*, *24*(1), 35–43.

Sayaka, B., & Hestina, J. (2011). Kendala Adopsi Benih Bersertifikat untuk Usahatani Kentang. *Forum Penelitian Agro Ekonomi*, *29*(1), 27–41. https://doi.org/10.21082/fae.v29n1.2011.27-41

Sayaka, B., Pasaribu, S. M., & Hestina, J. (2012). Efektifitas Kebijakan Perbenihan Kentang. *Analisis Kebijakan Pertanian*, *10*(1), 31–56. https://doi.org/10.21082/akp.v10n1.2012.31-56

Shafarina, N., & Perdana, T. (2016). Manajemen Risiko Pada Rantai Pasok Kentang Pasar Terstruktur di Kelompok Tani Katata, Pangalengan, Jawa Barat. In T. Perdana, S. Iwann, HS. Agriani, NU.Hesti, RQ.Sara, AH. Mahra, & NW. Sulistyodewi (Eds.) *Prosiding Nasional Pembangunan Inklusif di Sektor Pertanian II 2015* (p 370). Jatinangor Bandung : Departemen Sosial Ekonomi Pertanian Fakultas Pertanian, Universitas Padjadjaran

Soesanto, L., Mugiastuti, E., & Rahayuniati, R. F. (2011). Inventarisasi dan Identifikasi Patogen Tular- Tanah pada Pertanaman Kentang di Kabupaten Purbalingga. *J. Hort*, *21*(3), 254–264. https://doi.org/10.21082/jhort.v21n3.2011.p254-264

Suliansyah, I., Helmi, Santosa, B., & Ekawati, F. (2017). Pengembangan Sentra Produksi Bibit (Penangkar) Kentang Bermut Melalui Aplikasi Teknologi Bioseluler di Kabupaten Solok. *Logista, Jurnal Ilmiah Pengabdian Kepada Masyarakat*, *1*(2), 106–116. https://doi.org/10.25077/logista.1.2.106-116.2017

Sumarni, E., Sudarmaji, A., Suhardiyanto, H., & Saptomo, S. K. (2016). Produksi Benih Kentang Sistem Aeroponik dan Root Zone Cooling dengan Pembedaan Tekanan Pompa di Dataran Rendah. *J.Agron.Indonesia*, *44*(3), 299–305.

Sundari, M. (2011). Analisis Biaya dan Pendapatan Usahatani Wortel di Kabupaten Karanganyar. *Jurnal SEPA*, *7*(2), 119–126.

Urrea-Hernandez, C., Almekinders, C. J. M., & Dam, Y. K. van. (2016). Understanding Perceptions of Potato Seed Quality Among Small-Scale Farmers in Peruvian Highlands. *NJAS - Wageningen Journal of Life Sciences*, *76*, 21–28. https://doi.org/10.1016/j.njas.2015.11.001

Utami, G. R., Rahayu, M. S., & Setiawan, A. (2015). Penanganan Budidaya Kentang (*Solanum tuberosum* L.) di Bandung, Jawa Barat. In *Bul. Agrohorti*, 3 (1), 105-109. https://doi.org/10.29244/agrob.v3i1.14833

Waluyo, N., & Karyadi, A. K. (2017). Prosiding Seminar Nasional Agroinovasi Spesifik Lokasi Untuk Ketahanan Pangan Pada Era Masyarakat Ekonomi ASEAN. In A. N. Dermiya, S. Yusnaini, N. Yuliana, U. Hasanuddin, & R. A. Erwanto (Eds.), *Prosiding Seminar Nasional Agroinovasi Spesifik Lokasi Untuk Ketahanan Pangan Pada Era Masyarakat Ekonomi ASEAN Bandar Lampuang* (pp. 826–833). Bandar Lampung-Lampung: Balai Besar Pengkajian dan Pengembangan Teknologi Pertanian.

Wicaksana, B. E., Muhaimin, A. W., & Koestiono, D. (2013). Analisis Sikap dan Kepuasan Petani dalam Menggunakan Benih Kentang Bersertifikat (*Solanum tuberosum* L.) (Kasus di Kecamatan Bumiaji, Kota Batu. *Habitat*, *XXIV*(3), 184–193.