DEVELOPMENT OF ORGANIC PRODUCTION TECHNOLOGY FOR PEANUT

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ABSTRACT

A two-year field experiment was conducted at Organic Farm Site 1 of the La Granja National Crop Research and Development, Bureau of Plant Industry, La Carlota City, Negros Occidental from 2012 wet season to 2013-2014 dry season. The general objective was to develop package of organic production technologies for peanut. Specifically, it aimed to evaluate the performance of peanut as affected by different solid organic fertilizers (SOF) and naturally-fermented solutions (NFS); to determine the best organic production technology that could give the highest pod yield for peanut; and to identify the most profitable organic production technology for peanut. The experiment was laid out in split plot design with three replications using SOF such as commercial organic fertilizer (COF), vermicompost (VC), decomposed carabao manure (DCM), and the control (no solid organic fertilizer) as main plots; and NFS to include fermented malunggay (Fm), fermented saluyot (Fs), fermented bamboo shoot (Fb), fermented native amaranth or "kulitis" (Fk), and the control, without NFS (Fc) as subplots. NSIC Pn 13 was the test peanut variety.

Results on dry pod yield as affected by SOF reveal highly significant differences among treatments during the 2012 wet season and 2012-2013 dry season trials, significant during the 2013 wet season and not significant in 2013-2014 dry season. Increase in dry pod yield was observed on the second cropping application of SOF treatments and increased almost double on the third cropping applications. Yield performance of peanut, NSIC Pn 13 stabilized on the fourth cropping season application of SOF such as COF and VC. On the other hand, DCM treatment after obtaining the highest dry pod yield in the third cropping trial (1.894 t/ha) had yield decline (1.549 t/ha) in the fourth cropping (2013-2014 dry season) trial.

Effect of different NFS was observed significant in 2012 wet season and 2013-2014 dry season, highly significant in 2012-2013 dry season but not significant in 2013 wet season trial. Application of Fs, and Fk was observed to produce consistently high dry pod yields in peanut. Interaction effect of the different SOF as main plots in combination with different NFS as subplots was highly significant in 2013 wet season only.

As to the number of pods per plant, highly significant effect of SOF (main plot) was observed during the 2013 wet season and 2012-2013 dry season, and significant in 2012 wet season. NFS application was significant only during the two dry season cropping trials.

Peanut shelling percentage as affected by different SOF was highly significant in 2012 wet season and 2012-2013 dry season trials only. On the other hand, NFS effect to shelling percentage was highly significant in 2012 wet season and significant in 2012-2013 and 2013-2014 dry season trials. Likewise, significant interaction was noted in both the 2012 and 2013 wet season trials but not in the dry season trials. It was observed that shelling percentage improved through the subsequent use of SOF and NFS.

On 100-seed weight, highly significant result of SOF was only noted during 2012 wet season, and significant in 2012-2013 dry season. In terms of NFS effect, significant differences were observed only in 2013 wet season and 2013-2014 dry season trials. No interaction effect was noted between the SOF (main plot) and NFS (subplot) treatments.

Economic analysis revealed that in terms of net return, DCM x Fk had the highest (Php75,157.50.00), followed by DCM x Fm (Php66,142.50), DCM x Fs (Php65,229.00), DCM alone (Php64,694.25), and COF x Fb (Php61,824.50). On the other hand, return of investment (ROI) was highest in Fk alone with 199.71% followed by the control (zero application of solid organic fertilizer and NFS) with 198.18%, DCM alone with 195.89%, DCM x Fk with 186.30%, and COF alone with 181.67%.

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RATIONALE

Organic agriculture has captured the attention of many countries including the Philippines in response to the evident degradation of natural resources essential to sustain agricultural production. Organic farming is a key to sustainable agriculture as it contributes to the mitigation of greenhouse effect and global warming through its ability to sequester carbon from the soil. According to the Food and Agriculture Organization, many management practices used by organic agriculture such as minimum tillage, returning crop residues to the soil, the use of cover crops, crop rotation, and the greater integration of nitrogen-fixing legumes like peanut, increase the return of carbon to the soil, raising productivity and favoring carbon storage.

Peanut, *Arachis hypogaea* L., is among the legume crops globally considered an important food crop. Being a legume, it is a nitrogen-fixing crop, thus an excellent component in organic farming systems. In addition, its role in the global economy cannot be ignored as it ranks the 13th most important food crop with 50% of its production being used as raw material for the manufacture of peanut oil, 37% for confectionery, and 12% for seed purposes. Moreover, the vegetative part of peanut plant is an excellent hay for feeding livestock because it is rich in protein and has better palatability and digestibility than other fodders (www.agrometeorology .org./files folder/repository/gamp_chapter13B_pdf).

In the Philippines, although peanut production is erratic with national average yield ranging from 800 to 1,000 kilograms per hectare only, it is still profitable to plant peanut when proper cultural management is employed. BAS reported that 26,107.99 hectares of domestic agricultural land was planted to peanut in 2012 which produced 29,133.91 metric tons valued at Php994.26 million.

The Bureau of Plant Industry-La Granja National Crop Research and Development Center is one of the responsible agencies promoting organic agriculture in the country and currently involved in the development of organic seed production technologies for priority crops. Moreover, to improve the production and to encourage more farmers to go into sustainable organic and ecologically safe farming systems, package of technologies for organic production of selected crops must be available and promoted to farmers. In addition, organic seed production is an important part of the country's organic food production systems particularly in attaining improved farm productivity, better farmers' income, as well as to provide safe and healthy foods among Filipinos.

About Organic Agriculture

In the Philippines, interest in organic agriculture is growing especially where there is evident degradation of land resources essential to agricultural production due to excessive use of synthetic fertilizers and chemicals. It has a number of advantages which include: (1) it maintains the life of the soil, not only for the current generation, but also for the future generations; (2) it helps in building richer soil which is obtained from intelligently rotating crops and in so doing reduce soil erosion not to mention the presence of higher quantities of nutritional quality and micro-nutrients from organically produced crops; (3) organically grown food tastes better too; (4) the life of organically grown plants is longer than the plants cultivated by traditional methods; (5) organically grown crop is more drought tolerant (http://www.mixph.com/2009/ 08/what-is-organic-farming-and-its-many-benefits.html).

Ramesh et al (2010) as cited by Kumar N. et al stated that organic farming recorded lower productivity and yield losses but there was an overall improvement in soil quality parameters, indicating better soil health and sustainability of crop production. It is economically feasible to practice organic farming when farmers are able to get premium price for their produce and with reduced cost of cultivation by not depending upon the purchased off-farm inputs.

Reganold et al reported that in the long term organically-farmed soil had significantly higher organic matter content, thicker topsoil depth, higher polysaccharide content, lower modulus of rupture and less soil erosion than the conventionally-farmed soil. Their study indicates that, in the long term, the organic farming system was more effective than the conventional farming system in reducing soil erosion and, therefore, in maintaining soil productivity (http://www.nature.com/ nature/journal/v330/n6146/abs/330370a0.html).

Granstedt, Artur& Lars Kjellenberg reported that organic treatments resulted in a higher soil fertility capacity and in crops with higher quality protein, higher starch content, and a greater ability to tolerate stressful conditions and long-term storage in comparison with the inorganic treatments. Furthermore, the crops produced in the organic treatments developed a structure that can be studied through a picture formation method (Crystallization with $CuCl_2$). This has also been described as a higher organizational level which is evident in terms of both soil and crop formation as a result of the long-term effects of organic manure compared with conventional NPK-fertilizer (http://www.jdb.se/sbfi/publ/boston/boston7.html).

Ebrahimi (2007) averred that agriculture is responsible for approximately 30% of global warming, mainly through carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (NO_2) emissions. It is generally agreed that about one quarter of the main greenhouse gas (CO_2) stems from agricultural sources. According to the UK government, organic farming avoids the very significant carbon dioxide and nitrous oxide greenhouse gas emissions involved in manufacturing, transporting and spreading nitrogen fertilizer and pesticides. Numerous studies have shown that carbon dioxide emissions from organic farming are 40-60% lower per hectare than conventional systems. This is mainly because organic farmers do not use synthetic nitrogen fertilizers http://persianoad.wordpress.com/2007/04/08/organic-farming-tackles-global-warming/).

These are the reasons why we should support organic farming. First, industrial agriculture doesn't singularly pollute farmland and farm workers; it also wreaks havoc on the environment downstream. Pesticide drift affects non-farm communities with odorless and invisible poisons. Synthetic fertilizer drifting downstream is the main culprit for dead zones in delicate ocean environments, such as the Gulf of Mexico, where its dead zone is now larger than 22,000 square kilometers, an area larger than New Jersey, according to Science magazine, August, 2002 (http://www.organic.org/ articles/showarticle/article-206).

Second, mono-cropping and chemical fertilizer dependency has taken a toll with a loss of top soil estimated at a cost of $40 billion per year in the U.S., according to David Pimental of Cornell University. Add to this an equally disturbing loss of micro nutrients and minerals in fruits and vegetables. Feeding the soil with organic matter instead of ammonia and other synthetic fertilizers has proven to increase nutrients in produce, with higher levels of vitamins and minerals found in organic food, according to the 2005 study, "Elevating Antioxidant levels in food through organic farming and food processing," Organic Center State of Science Review (1.05)http://www.organic.org/articles/showarticle/article-206).

About the Test Crop Peanut

Peanut (*Arachis hypogeae*) locally known as "mani" is one of the food legume with commercial importance in the Philippines. It is an annual tropical crop that contributed P682M in domestic earnings in 2006. Peanut is a valuable source of high quality oil (46-50%) and protein (25-30%) (PCAARRD, 2003).

In terms of ecology and fertility requirement, according to Stalker (1997) as cited by Kumar et al (2013), peanut requires abundant sunshine and warm climate for normal development, but does not appear to be sensitive to daylength, though it generally produces more flowers under long day conditions. Temperature also significantly effects development and growth rate of peanut, the optimum temperature between 25-30^{0}C is good for vegetative and reproductive growth. Peanut grows with an average rainfall from 500 to 1200 mm but grows best when average rainfall is more than 500 mm throughout the crop season. The crop also grows well in slightly acidic soils with optimum pH ranged from 5.5 to 6.5.

Although peanut is a legume, it also requires a reasonable amount of organic matter for its full development and production. Phosphorus and calcium are also found to be particularly important in the growth of peanuts. Phosphorus stimulates root growth, thus affecting directly the density of root nodules (Huelgas et al 1990 as cited by Palomar, M.K, 1998).

Among the provinces in the Philippines, the top peanut producers by volume and crop area in 1995 are Isabela, Pangasinan, La Union, Quirino, Cagayan, Ilocos Norte, Ilocus Sur, Aurora, Albay and Iloilo. However, the Cagayan Valley region produced almost half of the country's total peanut production accounting to about 50% of the total peanut production at 14,023MT/ha on the average (Palomar, M.K., 1998).

According to Subrahmaniyan et al (2000) as cited by Kumar N et al (2013), the use of either farm yard manure or vermicompost along with organic amendments like bio-fertilizers and bio-pesticides etc., in rainfed groundnut, found advantageous for sustainable crop production. He also reported that application of farm yard manure at 10 to 15 t ha^{-1} increased the pod and haulm yields and improved the yield parameters like shelling percentage, 100 seed weight and sound mature kernel compared to the recommended dose of fertilizers. This conforms to the report of Jagdev and Singh (2000) as cited also by Veeramani, P. et al that application of farm yard manure increased shelling percentage by 10%, 100 kernel weight by 32%. The study indicates that the groundnut showed greater response to the application of organic manures (i.e, organic farming). Furthermore, organic manure has a profound effect on improving soil physical, chemical and biological properties and enhancing productivity of field crops (Subrahmaniyan et al., 2000).

Foliar spray is often the most effective and economical way to correct plant nutrient deficiencies. During the last decades, foliar feeding of nutrients has become an established procedure to crop production to increase yield and improve the quality of crop products (Roemheld and El-Fouly, 1999 as cited by Veeramani, P. et al). They also cited the report of Abou-El-Nour (2002) that foliar application of nutrients could improve the nutrient utilization and lower environmental pollution through reducing the amount of fertilizer added to the soil and foliar feeding might have actually promoted root absorption of same nutrient or other nutrients uptake (El-Fouly and El-Sayed, 1997).

Fermented sources of foliar application might have contained microbial metabolites in appreciable amount that would have helped in maintaining the opening of stomata for longer period of both optimum and adverse conditions during the crop growth which led to increased leaf area index providing stronger source for sink (Veeramani P et al. 2012).

OBJECTIVES

General Objective:

To develop package of organic production technologies for peanut

Specific Objectives:

1. To evaluate the performance of peanut as affected by different solid organic fertilizers (SOF) and naturally-fermented solutions (NFS);
2. To determine the best organic production technology that could give the highest pod yield for peanut; and
3. To identify the most profitable organic production technology for peanut.

METHODOLOGY

The experiment was conducted for two years (2012-2014) at the Organic Farm Site 1 of the La Granja National Crop Research and Development, La Granja, La Carlota City, Negros Occidental with peanut, variety NSIC Pn13 as the test crop.

Preparation of Experimental Area

Experimental area located in Lot B3 of the center's Organic Farm Site 1 was thoroughly prepared by alternate plowing and harrowing at weekly interval using a carabao-drawn plow and harrow to attain good soil tilt. Prior to planting, a composite soil sample of the experimental area was collected and submitted to the SRA Soils Laboratory for soil analysis (Appendix Table 3).

Preparation of Experimental Test Materials

Test materials used consisted of three solid organic fertilizers (SOF): commercial organic fertilizer (COF), vermicompost (VC), and decomposed carabao manure (DCM) as mainplots. Four naturally fermented solutions (NFS) such as fermented malunggay (Fm), fermented saluyot (Fs), fermented bamboo shoot (Fb), and fermented native amaranth or "kulitis" (Fk) served as subplots.

Commercial organic fertilizer (Organic Blend) used was procured from Fresh Start Organic, Inc. the decomposed carabao manure was sourced from the Philippine Carabao Center at La Carlota Stock while the vermicompost was from the center's vermicomposting project. On the other hand, all NFS were sourced from the center's production lab.

Rate of different SOF treatments was based on the initial soil analysis of the experimental area while the different NFS was sprayed at the rate of 2 tablespoons per liter of water (approximately 352 tablespoons/ha).

The following were the treatments:

Main Plots: Solid Organic Fertilizers (SOF)

COF - Commercial Organic Fertilizer at 1.0 t/ha
VC - Vermicompost at 3.0 t/ha
DCM - Decomposed Carabao Manure at 5.0 t/ha
CONTROL - No Solid Organic Fertilizer

Subplots: Naturally-Fermented Solutions (NFS)
Fm - Fermented Malunggay
Fs - Fermented Saluyot (jute)
Fb – Fermented Bamboo Shoot (labong)
Fk - Fermented Native amaranth or "kulitis"
Fc - Control (No NFS)

Experimental Design and Lay-out

The experiment was laid out following the Split-Plot Design with three replications. Each plot measured 2.4 m x 5 m. Furrows were set 60 cm apart.

Application of Test Materials and Farm Inputs

Solid organic fertilizers such as commercial organic fertilizer (COF), vermicompost (VC) and decomposed carabao manure (DCM) were applied in furrows prior to planting. The amount of solid organic fertilizer applied was based on the result of initial soil analysis: 3.55% N, 16 ppm of P and 178 ppm of K; requiring 0-40-0 N, P_2O_5 and K_2O for peanut. Hence, the rate of application per hectare was: 1.0 tons commercial organic fertilizer, 3.0 tons vermicompost, and 5.0 tons decomposed carabao manure.

Naturally-Fermented Solutions (NFS) such as fermented malunggay (Fm), fermented saluyot (Fs), fermented bamboo shoot (Fb), and fermented native amaranth or "kulitis" (Fk) were sprayed at the rate of 2 tablespoons/liter of water. Weekly spraying of NFS commenced 15 days after planting up to maturity, about 90 to 100 days after planting.

Seed Inoculation and Planting

Prior to planting, peanut seeds, variety NSIC Pn 13 were inoculated with *Rhizobium* at the rate of 10 g per kilogram of peanut seeds. Inoculation was done by placing the peanut seeds in a basin, moisten with water and thoroughly mix the inoculant until all seeds are coated. Inoculated peanut seeds were kept in shaded condition until planted. *Rhizobium* inoculated peanut seeds, variety NSIC Pn 13 were drilled at 1 seed per hill distanced 10 cm apart, then covered with thin layer of fine soil.

Crop Protection

To control lepidopterous insect pests, weekly application of *Trichogramma chilonis* at the rate of 80 strips per hectare was done starting at 15 days up to 35 days after planting. Likewise, spraying of vermitea, agro-bacterial concoction and EM-5 plus was employed when there was an observed disease infection like rust and leaf spot. In addition, planting of repellent plants (marigold) around the experimental area was done to ward-off insect pests.

Weeding and Cultivation

To ensure clean culture, inter-tillage cultivation such as off-barring at 15 to 20 days followed by handweeding and subsequently hilling-up was employed before blooming of the peanut crop. This was to ensure that peanut pegging and pod development would not be disturbed.

Data gathering

Two center rows of each plot served as sample area for gathering of data. The following data were gathered:

1. Dry pod yield (t/ha)
2. Number of seeds/pod
3. Number of pods/plant
4. Shelling percentage
5. Weight of 100 seeds
6. Number of days to blooming
7. Number of days to maturity
8. Insect pest and disease ratings
9. Economic analysis

RESULTS AND DISCUSSION

Field experiment was conducted at Organic Farm Site 1 of the La Granja National Crop Research and Development Center, La Carlota City, Negros Occidental from July 25, 2012 up to March 13, 2014 consisting of two wet and two dry season trials.

Dry pod yield (t/ha)

2012 Wet Season Trial

As shown in Table 1.1, highly significant result was obtained on the dry pod yield of peanut, variety NSIC Pn 13 as affected by the different solid organic fertilizers (SOF) tested. Decomposed carabao manure (DCM) produced the highest pod yield of 1.194 t/ha during the 2012 wet season trial. However, it was comparable to the yield of the control (1.010t/ha) treatment.

In terms of the naturally fermented solutions (NFS), significant difference was noted. Treatments applied with fermented bamboo shoot (Fb), fermented native amaranth (Fk), and fermented saluyot (Fs) produced highest comparable mean yields of 1.076, 1.055, and 1.006 t/ha, respectively. However, no interaction effect was observed between solid organic fertilizers and naturally-fermented solutions on the dry pod yield of peanut during the 2012 wet season trial.

2013 Wet Season Trial

Highly significant interaction between SOF and NFS application was noted on the dry pod yield of peanut, variety NSIC Pn 13 during 2013 wet season (Table 1.2). It was observed that treatment combination of commercial organic fertilizer plus fermented bamboo shoot (COF x Fb) produced the highest dry pod yield of 2.139 t/ha, but comparable with 16 other treatment combinations of SOF and NFS including the control. On the other hand, COF x Fm obtained the lowest dry pod yield of 0.972 t/ha but statistically comparable with VC x Fb (1.528 t/ha), VC x Fk (1.75 t/ha), and VC x Fm (1.722 t/ha). It was observed that even without the application of solid organic fertilizers with or without NFS application peanut produced dry pod yield statistically comparable with those applied with solid organic fertilizers. It can be surmised that because of frequent rains and high volume of precipitation during the growth period of the peanut crop, some of the applied organic fertilizers in the treated plots may have eroded to the adjacent control plots, hence the comparable yield performance.

Table 1.1. Dry pod yield (t/ha) of peanut, NSIC Pn 13 applied with solid organic fertilizers (SOF) and naturally fermented solutions (NFS)during 2012 and 2013 wet season trials, BPI La Granja.

TREATMENTS	Dry Pod Yield (t/ha)									
	Solid Organic Fertilizers (SOF)									
	COF		VC		DCM		CONTROL		Mean (b)	
Naturally-Fermented Solutions (NFS)	2012 WS	2013 WS	2012 WS	2013 WS	2012 Ws	2013 WS	2012 WS	2013 WS	2012 WS	2013 WS
Fm	0.444	0.972 ^{b}	0.89	1.72 ^{ab}	1.23	1.94 ^{a}	0.999	1.58 ^{a}	0.9 ^{bc}	1.56
Fs	0.78	1.83 ^{a}	1.08	1.92 ^{a}	1.25	1.64 ^{a}	0.916	1.19 ^{a}	1.01 ^{ab}	1.66
Fb	1.03	2.14 ^{a}	1.03	1.53 ^{b}	1.11	1.94 ^{a}	1.138	1.44 ^{a}	1.08 ^{a}	1.76
Fk	0.83	1.83 ^{a}	0.89	1.75 ^{ab}	1.39	1.94 ^{a}	1.110	1.42 ^{a}	1.06 ^{ab}	1.74
Control	0.89	1.97 ^{a}	0.69	1.56 ^{b}	0.94	2 ^{a}	0.888	1.42 ^{a}	0.85 ^{c}	1.73
Mean (a)	0.794 ^{c}	1.749 ^{ab}	0.916 ^{bc}	1.695 ^{ab}	1,194 ^{a}	1.894 ^{a}	1.010 ^{ab}	1.410 ^{b}	0.978	1.690

Note: In a column, means followed by the same letter are not significantly different at 5%, DMRT.

Cropping Trials	SOF (a)	NFS (b)	SOFxNFS (axb)	CV (a)	CV (b)
2012 WS	15.99**	2.86*	1.88^{ns}	16.69%	20.33%
2013 WS	6.65*	1.46^{ns}	4.22**	18.02%	14.34%

2012-2013 Dry Season Trial

Dry pod yield of peanut, variety NSIC 13 was highly significantly both among main plot treatments and subplot treatments of NFS during the first dry season trial (2012-2013). However, no interaction effect was noted between solid organic fertilizers (main plots) and naturally fermented solutions (subplots) as indicated in Table 1.2.

On main plots, DCM obtained the highest significant dry pod yield with a mean of 1.316 t/ha but comparable with VC (1.145 t/ha). The control (zero solid organic fertilizer) produced the lowest yield of 0.832 t/ha but statistically comparable with COF (0.982 t/ha).

For the subplot treatments of NFS, Fs produced the highest dry pod yield in peanut with a mean of 1.188 t/ha, but statistically the same with Fk and Fm with 1.097 and 1.083 t/ha. The control (no NFS application) had the lowest significant yield of 0.944/ha.

2013-2014 Dry Season Trial

As shown in Table 1.4, the effect of different solid organic fertilizers (main plots) was found statistically insignificant although peanut dry pod yields from the SOF applied treatments were numerically higher (1.549 to 1.665 t/ha) than the control (zero SOF) with only 1.288 t/ha.

On the other hand, NFS (subplots) application affected significantly the dry pod yield of peanut. Application of Fk yielded the highest with a mean of 1.64 t/ha but statistically the same with the performance of Fs, Fm, and the Control with means of 1.60, 1.55 and 1.52 t/ha, respectively. Fb obtained the lowest yield of 1.36 t/ha but comparable with the control.

No significant interaction effect was observed in the application of SOF and NFS during the second dry season trial (2013-2014).

Based on the four cropping trials, in can be averred that over time, the application of solid organic fertilizers and naturally-fermented solutions improved the yield performance of peanut as shown by the trend of the dry pod yield data (Figure 1). However, after the third cropping trial peanut yield showed gradual decline in the case of COF, VC and abrupt decline in the case of DCM.

Moreover, it was noted as revealed by Figure 2 that dry pod yield of peanut increased during the last two cropping trials (2013 wet season and 2013-2014 dry season)

Table 1.2. Dry pod yield (t/ha) of peanut, NSIC Pn 13 applied with solid organic fertilizers (SOF) and naturally-fermented solutions (NFS) during 2012-13 and 2013-14 dry season trials, BPI La Granja.

TREATMENTS	Dry Pod Yield (t/ha)									
	Solid Organic Fertilizers (SOF)									
	COF		VC		DCM		CONTROL		Mean (b)	
Naturally-Fermented Solutions (NFS)	2012-13 DS	2013-14 DS	2012-13 DS	2013-14 DS	2012-13 DS	2013-14 DS	2012-13 DS	2013-14 DS	2012-13 DS	2013-14 DS
Fm	0.972	1.453	1.277	1.840	1.221	1.646	0.860	1.285	1.083 ab	1.550 a
Fs	1.111	1.644	1.171	1.83	1.582	1.531	0.888	1.395	1.188 a	1.600 a
Fb	1.082	1.569	0.971	1.337	1.249	1.186	0.832	1.344	1.034 bc	1.360 b
Fk	0.916	1.881	1.168	1.518	1.36	1.907	0.943	1.262	1.097 ab	1.640 a
Control	0.832	1.778	1.138	1.686	1.166	1.475	0.638	1.155	0.944 c	1.520 ab
Mean (a)	0.982 bc	1.665	1.145 ab	1.642	1.316 a	1.549	0.832 c	1.288	1.069	1.534

Note: In a column, means followed by the same letter are not significantly different at 5%, DMRT.

Cropping Trials	SOF (a)	NFS (b)	SOFxNFS (axb)	CV (a)	CV (b)
2012-13 DS	13.10**	5.67**	2.11^{ns}	20.83%	12.18%
2013-14 DS	3.80^{ns}	2.75*	1.99^{ns}	22.18.%	14.76%

Number of Pods Per Plant

2012 Wet Season trial

Statistical differences were obtained on the number of pods per plant of peanut, variety NSIC Pn 13 as affected by the different solid organic fertilizers (Table 2.1). DCM produced the highest significant number of pods per plant with a mean of 16.14 but comparable with the rest of the SOF treatments. The control had the lowest with only 6.29.

2013 Wet Season Trial

During the 2013 wet season, highly significant difference was noted on SOF application only. All SOF obtained comparable number of pods per plant ranging from 11.78 to 12.57 but significantly higher than the control with 6.62 (Table 2.1).

Table 2.1. Number of pods per plant of peanut, NSIC Pn 13 applied with solid organic fertilizers (SOF) and naturally-fermented solutions (NFS) during 2012 and 2013 wet season trials, BPI-La Granja.

TREATMENTS	Number of Pods per Plant									
	Solid Organic Fertilizers (SOF)									
Naturally-Fermented Solutions (NFS)	COF		VC		DCM		CONTROL		Mean (b)	
	2012 WS	2013 WS	2012 WS	2013 WS	2012 Ws	2013 WS	2012 WS	2013 WS	2012 WS	2013 WS
Fm	8.83	9.23	15.36	12.63	15.93	12.86	11.73	11.06	12.96	11.45
Fs	14.40	13.20	16.00	12.30	16.30	11.23	16.63	7.93	15.83	11.17
Fb	15.40	14.46	11.80	10.76	15.53	13.06	13.10	10.36	13.96	12.16
Fk	12.86	11.93	11.63	11.96	16.73	12.33	13.16	9.80	13.6	11.51
Control	13.83	13.83	14.76	11.23	16.20	13.36	13.90	8.93	14.67	11.84
Mean (a)	13.06 ab	12.53 a	13.91 ab	11.78 a	16.14 a	12.57 a	6.29 c	6.62 c	14.2	11.63

Note: In a column, means followed by the same letter are not significantly different at 5%, DMRT.

Cropping Trials	SOF (a)	NFS (b)	SOFxNFS (axb)	CV (a)	CV (b)
2012 WS	5.60*	2.20^{ns}	3.43^{ns}	19.10%	11.96%
2013 WS	5.77**	0.53^{ns}	1.91^{ns}	19.23%	15.84%

2012-2013 Dry Season Trial

Highly significantly result was revealed on the effect of different SOF on number of pods per plant during the 2012-2013 dry season (Table 2.2). DCM and VC obtained the highest comparable number of pods per plant with means of 10.54 and 10.14, respectively. The control treatment had the lowest with 6.29 but comparable with COF (7.22).

As to NFS treatments, Fs obtained the highest with a mean of 9.79 but statistically similar with Fk (9.13). The control (no NFS) had the least with 6.93.

2013-2014 Dry Season Trial

Similarly, significant differences were obtained on the NFS treatments wherein except for the control and Fb, all other NFS treatments had comparable means ranging from 11.38 to 12.28 (Table 2.2).

In all the four season trials, no interaction effect of SOF and NFS was obtained on the number of pods per plant. Furthermore, results of the first three cropping season trials (2012 wet, 2013 wet and 2012-2013 dry season) conform to the report of Jagdev and Singh (2000) as cited by Veeramani et al. (2012) that the application of farm manure and other organic amendments improved the number of pods per plant in peanut.

Moreover, results of the two dry season trials corroborated Veeramani et al (2012) that fermented sources (i.e. NFS) of foliar application might have contained microbial metabolites in appreciable amount that would have helped in maintaining the opening of stomata for longer period of both optimum and adverse conditions during the crop growth, thereby affecting the production of number of pods per plant in peanut.

Table 2.2. Number of pods per plant of peanut, NSIC Pn 13 applied with solid organic fertilizers (SOF) and naturally-fermented solutions (NFS) during 2012-13 and 2013-14 dry season trials, BPI-La Granja.

TREATMENTS	Number of Pods per Plant									
	Solid Organic Fertilizers (SOF)									
Naturally-Fermented Solutions (NFS)	COF		VC		DCM		CONTROL		Mean (b)	
	2012-13 DS	2013-14 DS	2012-13 DS	2013-14 DS	2012-13 DS	2013-14 DS	2012-13 DS	2013-14 DS	2012-13 DS	2013-14 DS
Fm	8.23	11.66	10.63	13.66	10.10	12.13	5.50	8.93	8.62 b	11.6 ab
Fs	7.77	12.33	11.70	12.26	12.73	10.60	6.97	10.30	9.79 a	11.38 ab
Fb	6.60	10.80	8.87	9.60	10.97	9.33	6.63	10.66	8.27 b	10.10 b
Fk	7.70	13.66	10.40	12.00	11.47	12.33	6.93	11.13	9.13 ab	12.28 ab
Control	5.80	11.86	9.10	11.26	7.43	9.26	5.40	9.23	6.93 c	10.41 b
Mean (a)	7.22 b	12.06	10.14 a	11.76	10.54 a	10.73	6.29 b	10.05	8.55	11.15

Note: In a column, means followed by the same letter are not significantly different at 5%, DMRT.

Cropping Trials	SOF (a)	NFS (b)	SOFxNFS (axb)	CV (a)	CV (b)
2012-13 DS	15.99**	2.86*	1.88^{ns}	23.83%	15.31%
2013-14 DS	2.38^{ns}	2.69*	0.89^{ns}	20.85%	16.91%

Number of Seeds per Pod

2012 and 2013 Wet Season Trials

As to the number of seeds per pod of peanut, variety NSIC Pn 13, no significant difference was obtained from the SOF (main plot) treatments in both the 2012 and 2013 wet season trials (Table 3.1). However, significant differences were noted among NFS treatments during 2012 wet season only. All NFS treatments had significant number of seeds per pod over the control treatment. On the other hand, no interaction effect was obtained between SOF and NFS treatments in both two wet season trials.

Table 3.1. Number of seeds per pod of peanut, NSIC Pn 13 applied with solid organic fertilizers (SOF) and naturally-fermented solutions (NFS), during 2012 and 2013 wet season trials, BPI La Granja.

TREATMENTS	Number of Seeds Per Pod									
	Solid Organic Fertilizers (SOF)									
Naturally-Fermented Solutions (NFS)	COF		VC		DCM		CONTROL		Mean (b)	
	2012 WS	2013 WS	2012 WS	2013 WS	2012 Ws	2013 WS	2012 WS	2013 WS	2012 WS	2013 WS
Fm	2.16	1.96	2.16	2.00	2.16	2.06	2.00	1.86	2.12 ab	1.97
Fs	2.13	1.96	2.13	2.03	2.13	1.96	2.06	1.86	2.11 ab	1.95
Fb	2.16	1.86	2.23	2.03	2.20	2.06	2.06	1.86	2.16 ab	1.95
Fk	2.00	1.93	2.16	1.93	2.16	1.96	2.16	1.93	2.12 ab	1.94
Control	1.93	1.86	2.06	1.86	2.06	1.86	2.00	1.80	2.01 c	1.85
Mean (a)	2.08	1.92	2.15	1.97	2.14	1.98	2.06	1.86	2.06	1.93

Note: In a column, means followed by the same letter are not significantly different at 5%, DMRT.

2012-2013 and 2013-2014 Dry Season Trials

Significant result on number of seeds per pod was obtained from 2012-2013 dry season trial as affected by different SOF (main plots) treatments. All SOF (main plots) treatments obtained comparable number of seeds per pod with means of 2.0 to 2.04. In addition, highly significant differences were noted on the NFS (subplot) treatments. All NFS treatments had comparable means (2.0 to 2.08) while the control had the least significant number of seeds per pod with mean of 1.84. No interaction effect was observed between SOF and NFS treatments (Table 3.2).

No significant difference on number of seeds per pod was revealed in both SOF (main plots) and NFS (subplots) treatments. Likewise, no interaction effect of the two factors was observed.

Table 3.2. Number of seeds per pod of peanut, NSIC Pn 13 applied with solid organic fertilizers (SOF) and naturally-fermented solutions (NFS) during 2012-13 and 2013-14 dry season trials, BPI La Granja.

TREATMENTS	Number of Seeds Per Pod									
	Solid Organic Fertilizers (SOF)									
Naturally-Fermented Solutions (NFS)	COF		VC		DCM		CONTROL		Mean (b)	
	2012-13 DS	2013-14 DS	2012-13 DS	2013-14 DS	2012-13 DS	2013-14 DS	2012-13 DS	2013-14 DS	2012-13 DS	2013-14 DS
Fm	2.00	1.93	2.07	2.03	2.00	1.96	1.93	2.03	2.00 a	1.99
Fs	2.07	2.00	2.00	2.00	2.14	2.03	1.93	1.93	2.04 a	1.99
Fb	2.00	1.86	2.00	2.10	2.07	2.06	2.00	1.86	2.02 a	1.97
Fk	2.13	1.96	2.07	1.96	2.13	2.03	2.00	1.86	2.08 a	1.95
Control	1.80	1.93	1.87	1.93	1.87	1.80	1.80	1.86	1.84 b	1.88
Mean (a)	2.00 ab	1.94	2.00 ab	2.00	2.04 a	1.98	1.93 b	1.91	1.99	1.96

Note: In a column, means followed by the same letter are not significantly different at 5%, DMRT.

Shelling Percentage

2012 Wet Season Trial

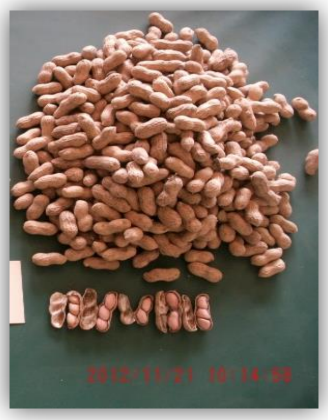
Table 4.1 shows the shelling percentage of peanut, variety NSIC Pn 13 as affected by SOF and NFS treatments. Significant interaction between SOF and NFS was noted during 2012 wet season.

It was observed that application of vermicompost plus fermented native amaranth (VC x Fk) obtained the highest shelling percentage of 71.21%, followed by VC x Fb with 71.04%. COF x Fs had 65.33%, COF x Fb had 64.38%, both COF x Fk and VC x Fm had 64.18%. Except for DCM x Fm, all SOF x NFS treatments produced shelling percentage of 60.65 to 71.21%. Only the control treatment (zero SOF and NFS) and the DCM x Fm produced shelling percentage lower than 60%.

Table 4.1. Shelling percentage (%) of peanut, NSIC Pn 13 applied with solid organic fertilizers (SOF) and naturally-fermented solutions (NFS) during 2012 and 2013 wet season trials, BPI La Granja.

TREAT-MENTS	Shelling Percentage (%) Solid Organic Fertilizers (SOF)									
Naturally-Fermented Solutions (NFS)	COF		VC		DCM		CONTROL		Mean (b)	
	2012 WS	2013 WS	2012 WS	2013 WS	2012 Ws	2013 WS	2012 WS	2013 WS	2012 WS	2013 WS
Fm	60.60 b	78.33 a	64.18 b	77.50 ab	54.56 b	76.66 ab	61.21 ab	76.66 b	60.14 c	75.55
Fs	65.33 a	76.66 a	63.37 b	79.16 a	62.66 a	77.50 a	62.49 a	77.50 a	63.47 ab	77.43
Fb	64.38 ab	75.83 a	71.04 a	76.66 ab	63.74 a	77.50 a	60.65 ab	77.50 a	64.95 ab	76.52
Fk	64.18 ab	76.66 a	71.21 a	75.00 b	63.84 a	79.16 a	60.67 ab	79.16 a	64.98 a	77.08
Control	62.21 ab	79.16 a	66.81 ab	76.66 ab	60.99 a	73.33 ab	57.08 b	73.33 c	61.77 bc	76.66
Mean (a)	63.34 b	77.33	67.32a	77.00	61.16 c	76.83	60.42 c	75.44	63.06	76.65

Note: In a column, means followed by the same letter are not significantly different at 5%, DMRT.



2013 Wet Season Trial

Similarly, significant interaction was observed between SOF and NFS treatments during 2013 wet season. Treatment combinations COF x Fc, DCM x Fk, DCM x Fb, VC x FS, and Fk alone obtained the same shelling percentage of 79.16%. Furthermore, all treatments including the control obtained higher shelling percentage during the second wet season trial as compared to the first wet season trial. The shelling percentage ranges from 75.44% (control) to 77.33% (COF).

2012-2013 Dry Season Trial

Highly significant differences on shelling percentage were obtained on SOF treatments during the 2012-2013 dry season trial. DCM obtained the highest significant shelling percentage with 72.68% but comparable to VC (71.18%). The control treatment (zero SOF) had the lowest significant shelling percentage of 67.69% although statistically similar to that of VC and COF (Table 4.3).

In terms of NFS (subplots) treatments, significant result was obtained. Highest shelling percentage of 73.05% was produced from Fs but comparable with other NFS treatments. The control (no NFS) had the lowest shelling percentage (67.98%) but comparable with that of Fk, Fb, and Fm. There was no interaction effect between SOF and NFS during this cropping trial.

2013-2014 Dry Season Trial

Non-significant result on shelling percentage of peanut, variety NSIC Pn 13 was observed on SOF application during the 2013-2014 dry season trial. Comparing the result from the previous dry season trial, a decline on the shelling percentage of all SOF treatments was noted (Table 4.4).

On the other hand, significant differences were noted on NFS (subplots). All treatments with NFS had comparable shelling percentage means ranging from 65.08 to 71.67%. The control had the lowest with 65.08%, though comparable Fk.

Similar to the result of the 2012-2013 dry season trial, no interaction effect was observed between SOF and NFS on the shelling percentage of peanut.

Results of the first two cropping season trials confirmed the report of Jagdev and Singh (2000) as cited by Veeramani et al. (2012) that the application of farm manure and other organic amendments increased the shelling percentage in peanut.

100-seed weight

2012 and 2013 Wet Season Trials

For the weight of 100 peanut seeds, a highly significant difference was noted among SOF treatments (main plots) with DCM obtaining the heaviest with 52.33 g but comparable to VC with 50.73 g (Table 5.1).

On the other hand, significant difference was observed only on NFS application during the 2013 wet season. Fs (54.17 g) got the heaviest 100 seeds but comparable with Fm (53.3 g), Fb (52.92 g), and Fk (51.25 g). The control treatment had the lightest with 48.17 g but statistically comparable with Fk (Table 5.2). Similarly, no interaction effect was noted between SOF and NFS during the 2013 wet season trial.

2012-2013 and 2013-2014 Dry Season Trials

SOF application significantly affected the weight of 100 peanut seeds during 2012-2013 dry season. All SOF treatments produced statistically comparable 100-seed weight ranging from 50.33 to 50.53 g. The control treatment gave the lightest significant 100-seed weight (46.73 g). It was also observed that there was no significant interaction between SOF and NFS in terms of peanut seed weight (Table 5.3).

2013-2014 Dry Season Trial

Unlike the first year's dry season trial, peanut 100-seed weight did not vary significantly among different SOF treatments (Table 5.4). On the other hand, NFS application obtained significant results on 100-seed weight in peanut. Fs obtained the heaviest 100-seeds with 55 g but comparable to Fb (54.17 g), and Fm (53.33 g). The control treatment produced the lightest with 49.17 g but comparable to that of Fk. Similar to the result of the first dry season trial, no interaction effect of SOF and NFS was noted.

Results 2012 and 2013 wet season trials affirmed the report of Jagdev and Singh (2000) as cited by Veeramani et al. (2012) that the application of farm manure and other organic amendments increased the 100-seed weight in peanut.

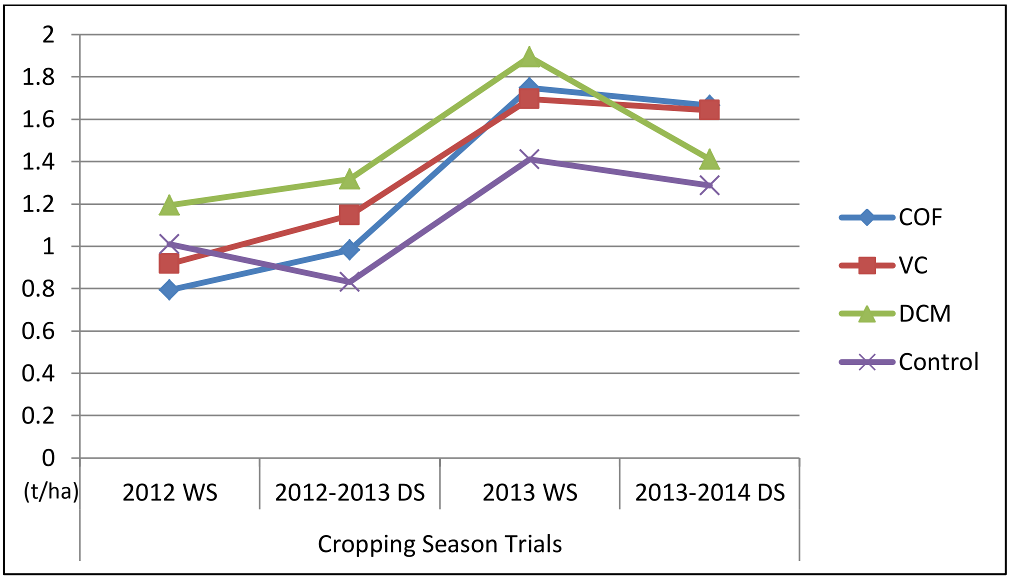
Days to Bloom and Maturity

No significant differences were noted on the number days to bloom and days to mature which range from 25 to 28.90 days, and 105 to 111 days after planting, respectively (Tables 6.1, 6.2, 6.3, and 6.4; Tables 7.1, 7.2, 7.3, and 7.4).

Reaction to Insect Pests and Diseases

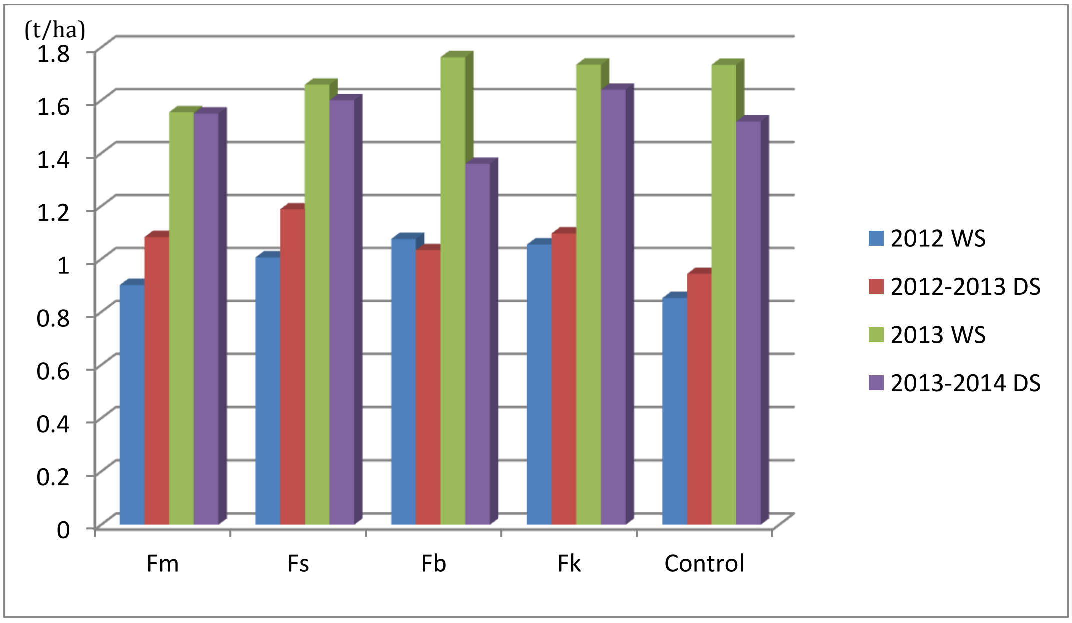
The test plant, peanut variety NSIC Pn 13 was moderately resistant to insect pests such as common cutworm and leaf folder; and diseases such as rust and cercospora leaf spot during the four cropping season trials (Tables 8.1, 8.2, 8.3, and 8.4; Tables 9.1, 9.2, 9.3, 9.4).

Figure 1. Dry pod yield performance of peanut, variety NSIC Pn 13 as affected by different solid organic fertilizers (SOF).



COF- commercial organic fertilizer VC - vermicompost
DCM - decomposed carabao manure Control – no solid organic fertilizer

Figure 2. Dry pod yield of peanut in response to different NFS applications.



Fm – fermented malunggay Fs – fermented saluyot (jute) Fb – fermented bamboo shoot
Fk – fermented native amaranth (kulitis) Control – no NFS

Economic analysis

Table 9 shows the economic analysis of organic peanut seed production through the application of different solid organic fertilizers (SOF) and naturally fermented solutions (NFS). On the basis of net return, the top ten treatments were: DCM x Fk had the highest with Php75, 157.00, followed by DCM x Fm with Php66, 142.50, DCM x Fs with 65, 229.00. DCM alone with Php64,694.25, COF x Fb with Php61,824.50, COF alone with Php61,717.25, Fk alone with Php61,337.25, Fb alone with Php58,346.25, DCM x Fb with Php57,312.00 and VC x Fs with Php56,124.75. Lowest net return was obtained from COF x Fm with Php29,850.00 due to the high cost of commercial organic fertilizer and the low yield obtained from this treatment combination. On the other hand, return of investment (ROI) was highest in Fk alone with 199.71% followed by the control (zero application of solid organic fertilizer and NFS) with 198.18%, DCM alone with 195.89%, DCM x Fk with 186.30%, COF alone with 181.67%, Fb alone with 173.12%, DCM x Fm with 167.21%, Fm alone with 165.57%, DCM x Fs with 164.01% and COF x Fb with 154.73%. Lowest ROI was obtained from COF x Fm with 77.84% which can be attributed to the high cost of commercial organic fertilizer.

Soil Analysis

Results of soil analysis of experimental plots applied with different solid organic fertilizers and naturally-fermented solutions are presented in Appendix Tables 3 to 8. The following observations were made:

Most of the plots applied with SOF had higher organic matter (OM) content after 2013 wet season and 2013-2014 dry season trials. OM/N content of most plots was lower than the initial organic matter content of 3.55% but higher than the control plots (Appendix Table 4). Lower values of OM were observed after the third cropping trial (2012-2013 DS). As cited by Reganold et al, "long term organically-farm soil had significantly higher organic matter", does not hold through yet on the OM content of the experimental plots as per soil analysis.

On the other hand, Phosphorus content of each plot increased every cropping season except in DCM treatment which had lower P during 2012-2013 dry season (Appendix Table 5).

Among SOF, DCM applied plots had higher soil potassium compared with the rest of treatments but lower than the initial K which is 178ppm (Appendix Table 6). Except for the control, highest values of calcium were observed after 2012 wet season trial, and higher than the initial soil calcium content (815ppm) of the experimental plots. Calcium content deceased in the succeeding cropping trials, with 2013-2014 dry season trial having the lowest value (Appendix Table 7). Plots applied with DCM had higher soil magnesium than the rest of the treatments including the control (Appendix Table 8).

CONCLUSION

On the basis of observations and data gathered, the following conclusions are drawn:

1. Solid organic fertilizers significantly affected the yield performance of peanut, variety NSIC Pn 13; consistently significant in the wet season.

2. Naturally-fermented solutions (NFS) gave significant effect to dry pod yield of peanut during the two dry season evaluations but only on the first wet season trial.

3. Interaction effect of solid organic fertilizer and NFS treatments was only highly significant in the second wet season cropping trial.

4. Application of solid organic fertilizers and NFS improve the quality of peanut pods as manifested by higher shelling percentage than the control. Subsequent SOF and NFS

use manifested an increase in shelling percentage in the second and third cropping trials.

5. Decomposed carabao manure (DCM) in combination with fermented native amaranth (Fk) had the highest net return of Php75,157.50 per hectare, although fermented native amaranth alone (Fk) had the highest ROI of 199.71%.

6. Profitable peanut seed production under organic conditions is feasible without sacrificing the seed quality.

7. Soil organic matter content showed erratic trend with most treatments having decreasing values than initial soil analysis of the treatment plots. Similarly, other soil elemental content have erratic trend also.

RECOMMENDATIONS

1. For higher dry pod yield, fertilization using decomposed carabao manure at 5.0 t/ha plus weekly NFS application of fermented native amaranth (kulitis) at the rate of 2 tablespoons per liter of water sprayed starting 15 days after planting up to maturity (90 to 100 days) is recommended; provided that these farm inputs are available and sources are accessible and prices are affordable. It may be more practical to collect the manure of your working carabao(s) including those found in the nearby areas of the farm.

2. For farmers with limited resources, the use of fermented native amaranth (kulitis) only (if available in the farm) can be employed as shown by its ROI of 199.71% and high net profit of Php61, 337.25. However, yield may not be that high as compared to the combined effect of decomposed carabao manure plus fermented native amaranth.

3. The application of commercial organic fertilizer alone is another option as it also produced high net return of Php61, 717.25 and ROI of 181.67%. Furthermore, it would be more viable if the organic fertilizer to be used is produced within the farm so that investment requirement would become lower.

4. Organic peanut seed production would be more profitable and less costly when the organic fertilizers such as decomposed carabao manure, vermicompost and commercial organic fertilizer and NFS used like fermented native amaranth, fermented bamboo shoot, fermented malunggay, and fermented saluyot are produced within the farm.

5. Cultural management practices such as thorough land preparation, timely planting (when the soil has enough moisture), seed inoculation, handweeding and cultivation (off-barring and hilling-up) before blooming of peanut, application of biocontrol agents such as *Trichogramma* chilonis, as well as the spraying of vermi tea and agro-bacterial concoction (optional) also formed part of the package of technologies for organic peanut seed production.

6. To validate further the result of the study, it is suggested that the recommended technologies be pilot tested at farmer's field.

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