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Ex post impact assessment of pineapple technology on peat soil

(Penilaian impak *ex post* teknologi nanas di tanah gambut)

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Abstract

Ex post impact assessment of pineapple technology adopted on peat soil was carried out by using the adapted Sustainable Rural Livelihoods Framework (SRLF). Data was gathered by personal interview involving 100 pineapple growers in four districts in Johor. Results of the study revealed that the adoption of modern variety, crop and resource management, plant health management and post harvest technologies as recommended by MARDI was low. In general the technology for pineapple cultivation on peat soil had given positive impact on farmers' income. The average farm productivity for Gandul and Moris varieties was higher than expected while the average farm productivity of Josapine was lower. The majority of farmers managed to generate average net income ≥RM3,000 per month as targeted. Unlike Josapine, the crop husbandry technology for Gandul and Moris had been an industry led technology. Any intervention by policy makers should focus on supporting their prices. The technology for Josapine cultivation should be fine-tuned after a few decades.

Introduction

Pineapple is a popular non-seasonal fruit and widely cultivated on peat soil in Johor, Peninsular Malaysia. Pineapple can be consumed fresh, used for cooking and for processing into canned pineapple, pineapple juice, jam, pickles, candy and other products.

Pineapple canning industry in Johor started more than 100 years ago pioneered by the Chinese community in Singapore. Before the establishment of oil palm and cocoa industries a few decades ago, pineapple had contributed significantly to the Malaysian economy.

The rapid development of the pineapple industry in the 1970s and 1980s had made Malaysia one of the three major world producers of pineapples. However, the pineapple industry had been diminishing in terms of acreage and fresh fruit production.

The acreage of pineapple had been decreasing over the years. During RMK3 period (1976–1980), the average yearly acreage was 12,700 ha, but decreased to 6,700 ha during RMK8 period (2001–2005), a reduction of almost 50%. However, there was indication of improvement in the area cultivated with pineapple in the early years of RMK9 (2006–2010). The average area cultivated during the period was 10,000 ha.

The downfall of the Malaysia's pineapple industry was attributed to many factors. It was believed that deterioration of peat soil quality resulting from prolong usage for pineapple production had affected

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crop productivity. Pineapple yield decline on peat soil was most likely due to a nematode *Paratylenchus* species (Nik Masdek 2007). Detailed studies of the nematode population in the soil and root of pineapple plants at various growth stages from several affected commercial farms showed the population of *Paratylenchus* species to be high.

The introduction of plantation crops such as rubber and oil palm that provided options for pineapple growers to earn better income also affecting the pineapple production. In the late 1980s and early 1990s many farmers had changed pineapple to oil palm, resulting in significant reduction in pineapple area and production.

Policy decisions regarding the placement of Malaysia Pineapple Industrial Board (MPIB), a governing body responsible for pineapple development in the country, from one ministry to another had affected the morale of stakeholders in the industry that might indirectly affect the pineapple productivity as well. Furthermore the price of pineapple sold for the canning industries was not attractive at all. Farmers would prefer to plant pineapple for fresh market due to its higher price (Raziah 1996).

With regard to new technologies aimed at enhancing the development of the pineapple industry, Nanas Johor was released in 1985 followed by the introduction of Gandul variety in 1992 to replace Masmerah variety for the canning industry. The introduction of Gandul variety had boosted up the average pineapple farm productivity from 6 t/ha in 1992 to almost 40 t/ha in 1996, before it went down again due to mass conversion of pineapple farms to oil palm by farmers for a better income (Raziah 1996).

In 1996 Josapine, a new variety for fresh market was released. MARDI also released a new technology for transporting fresh pineapple using sea shipment to overseas markets in 1999. Josapine had been widely accepted by consumers, and many farmers had been cultivating the species which is capable of providing high return. In 2004, new pineapple variety, N36 for fresh consumption and also for processing was released. Maspine variety, which was supposed to be substitute for Gandul was released in 2005.

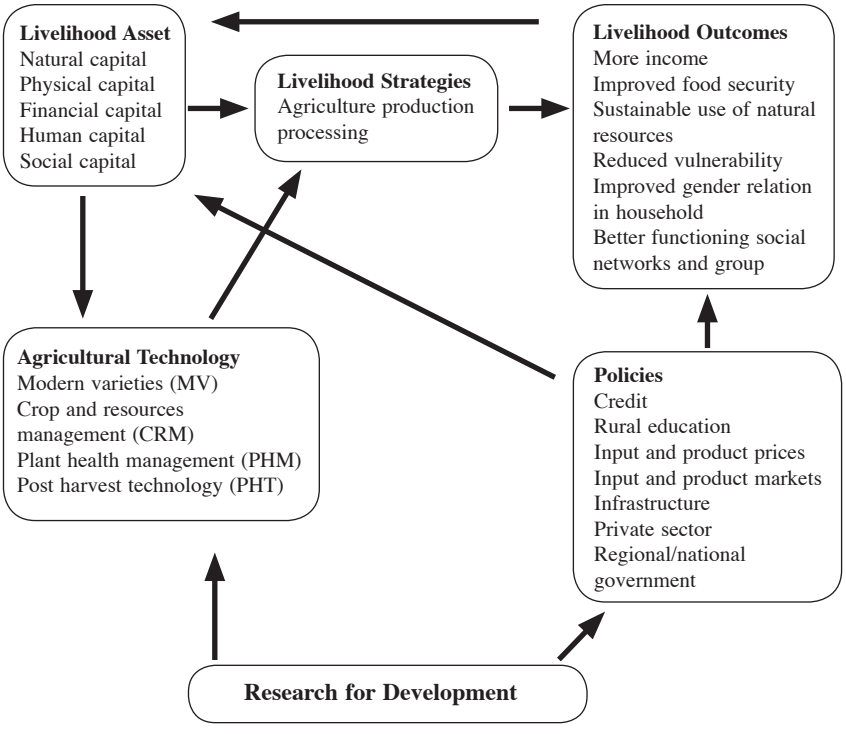
Despite the new technologies released by MARDI since the 1980s, the sustainability of the pineapple farm sectors was still at stake due to many unidentified factors. Therefore, this paper is aimed at identifying the status of technology adoption by farmers, determining the technology impacts on farmers' income and finally suggesting new area of research to enhance future development of the pineapple industry in the country.

Methodology

Impact studies faced conceptual as well as empirical challenges due to the complexities of the relationships between agricultural technology and rural livelihoods. The goals of agricultural technology development change from increasing food production to the broader aims of reducing poverty both in less developed and developing countries. In Malaysia, agricultural technology development is aimed at increasing food production for food security reasons, increasing exports to reduce high deficit in balance of trade on food items and more importantly increasing farmers' income and make agricultural sector as competitive as the other sectors in the economy.

The sustainable rural livelihoods framework (SRLF) has been used by a growing number of researchers and development organizations in the world including the United Nations Development Program (UNDP), the Department for International Development (DFID) in the United Kingdom and non-governmental organizations (NGOs) such as CARE and Oxfam (DFID 1997).

In this study, the adapted SRLF (*Figure 1*) was used to assess the ex post impact of pineapple technologies on farmers' income with reference to four key technologies; modern variety (MV),



Source: DFID (2007)

Figure 1. A sustainable livelihoods framework with agricultural technology.

crop and resource management (CRM), plant health management (PHM) and post harvest technology (PHT). The targeted net income for members of the "Taman Kekal Pengeluaran Makanan" (TKPM) was RM3,000/month (DOA 2007), and this would be the bench mark for pineapple growers income in this study.

Primary survey was conducted in four districts in Johor namely Batu Pahat, Pontian, Muar and Kluang involving 100 respondents (about 5% of the population). Johor is known to be the major pineapple producing state in Peninsular Malaysia. The distribution of the respondents from the four districts is shown in *Table 1*.

Structured questionnaire was used in data collection. The questionnaire was divided into four sections: 1) respondents' and farms background, 2) agronomic practices, 3) farms' production costs, prices of output and revenues for one crop cycle, and 4) problems encountered by farmers in pineapple cultivation.

On the agronomic practices, farmers' practices were compared against the technology recommended by MARDI as bench marks. The lists of technology recommended were based on information gathered from *Buku Panduan Penananan Nanas* published by MARDI in 1996 and reprinted in 2009.

For each agronomic practice, starting from land preparation to harvesting and field transportation, a scale of 0–3 was assigned: 3 = practise technology recommended, 2 = practise some of the technology recommended, 1 = practise technology sourced from others and 0 = did not practise technology at all. A qualitative judgement was used to assign the scale for technology utilization.

Descriptive analysis was performed on the data and presented in the form of cross tabulation.

Results and discussion

Respondents' profile

The summary of the respondents' background is presented in *Table 1*. The majority of farmers (>90%) were males. More than 38% were 41–50 years old and more than 30% were relatively older, 51–60 years old. The majority of pineapple growers (87%) had gone through primary and secondary levels of education. Those involved in pineapple cultivations were mostly full time farmers (67%). The majority of pineapple growers (41%) earned RM1,000–RM2,000 per month, followed by those who earned higher income of RM2,001–RM3,000 monthly (28%). Most of the respondents had been involved in pineapple cultivation for a long time. About 20% of them had been involved in the activity for more than 20 years and 30% had between 11–15 years experience in pineapple cultivation.

Background of farms

The average farm size planted with pineapple in the area studied was about 12 ha. It ranged from a small plot of 0.8 ha to a big estate of 210 ha (*Table* 2).

Table 1. Districts selected and profile of pineapple growers in Johor

		Percentage	Total respondents (n)
District:	Muar	28	100
	Kluang	15	
	Batu Pahat	28	
	Pontian	29	
Gender:	Male	98	99
	Female	2	
Age (years):	20–30	3.0	99
	31–40	15.2	
	41–50	38.4	
	51–60	30.3	
	>60	13.1	
Education levels	Never been to school	4	100
	Primary	39	
	PMR/SPM	48	
	STP/Diploma	7	
	Others	2	
Main occupation	Farmers	67	100
	Pensioner	4	
	Business	7	
	Government	4	
	Private	4	
	Others		14
Household income (RM/month)	<1000	9.0	78
	1000–2000	41.0	
	2001–3000	28.2	
	3001–4000	3.8	
	>4000	18.0	
Experience in pineapple cultivation (years)	1–5	18.2	99
	6–10	18.2	
	11–15	30.3	
	16–20	12.1	
	>20	20.2	

Table 2. Summary of pineapple area planted and area planted by varieties

	Hectare	Percentage respondents	Total respondents (n)
Area planted	0.8–4.8	42	100
	5.0–9.3	28	
	10–19.2	17	
	20–40	9	
	75.6–210	4	
Area planted by variety	0.1–2.0	45.3	53
Josapine	2.1–4.0	15.1	
	4.1–6.0	7.5	
	6.1–8.0	5.7	
	>8.0	26.4	
Moris	0.1–2.0	27.4	73
	2.1–4.0	26.0	
	4.1–6.0	12.3	
	6.1–8.0	2.7	
	>8.0	31.5	
Gandul	0.1–0.5	14.3	14
	0.6–1.0	21.4	
	1.1–1.5	7.1	
	1.6–2.0	14.3	
	>2.0	42.9	
Other varieties	1.1–1.5	40	5
	1.6–2.0	40	
	>2.0	20	

About 4% of the farms were considered as big with the range size of 75.6–210 ha. However, the mode of farm size was 2 ha. About 42% respondents were cultivating pineapple on farm sizes of 0.8–4.8 ha and 28% on farm sizes of 5–9.3 ha.

The majority of farmers cultivated Moris (73%) followed by Josapine (53%), Gandul (14%) and other varieties (5%). Some farmers cultivated more than one variety of pineapple on the same plot of land.

For Josapine, the majority of farmers (45%) planted it on a small area (0.1–2 ha) while 26% farmers planted it on larger area (>8 ha). For Moris, the majority of farmers (32%) planted it on a larger area while 27% planted it on farm size of 0.1–2 ha and another 26% on farm size of 2.1–4 ha. As for Gandul, the farm size ranged from 0.1 ha to more than 2 ha., and majority (43%) planted it on a farm size of more than 2 ha (*Table 2*).

Technology adoption

Modern varieties There were three main varieties of pineapple planted in the areas studied. Moris variety was the main choice among pineapple growers (73%) followed by Josapine (53%), Gandul (14%) and other varieties including N36 (5%).

The relatively new variety Josapine was not fully accepted by the farmers since its introduction in the 1990s. The high cost and not easily available planting materials, its susceptibility to bacterial heart rot (BHR) and the need for more intensive crop care and maintenance causes this variety to be the second choice among pineapple growers.

The main canning pineapple variety was Gandul. It had low percentage of total soluble solid (TSS) and acid but its golden flesh colour was an asset for canned

products. Gandul was still the preferred variety for canning instead of the newly introduced varieties namely N36 and Masmerah.

The technologies adopted by the farmers were analysed and compared against those recommended by MARDI. The summary result is presented in *Table 3*.

Treatment of planting materials Planting materials need to be treated with fungicide such as Benlate before planting to prevent fungal infection later on. The majority of farmers (66%) did not treat the planting materials as recommended, 29% followed the recommendation from other sources and only 5% followed the proper procedure as recommended by MARDI.

Table 3. Status of technology adoption by pineapple growers in Johor

Variables	*3	*2	*1	*0	No. of respondents
Treatment of planting materials	5%	0%	29%	66%	100
Land clearing and preparation	94%	5%	0%	1%	100
Infrastructure preparation	41.5%	14.9%	4.3%	39.4%	94
Planting distance					
(i) Josapine	51.0%	0%	49.0%	0%	51
(ii) Moris	36.9%	0%	63.1%	0%	65
(iii) Gandul	46.2%	0%	53.8%	0%	13
Planting density (plant/ha)					
(i) Josapine					
3 : >43,000	8.2%	2.0%	89.8%	0%	49
2 : 43,000					
1 : <43,000					
(ii) Gandul					
3 : >35,800					
2 : 35,800	27.9%	4.4%	67.6%	0%	68
1 : <35,800					
(iii) Moris					
3 : >62,000					
2 : 62,000	7.7%	7.7%	84.6%	0%	13
1 : <62,000					
Fertilizer application (rate & frequency)					
3 : >3,654					
2 : 3654	6.7%	0%	93.3%	0%	75
1 : <3,654					
Weed management	9%	89%	1%	1%	100
(i) Pre-emergence pesticides	10%	87 %	2%	1%	100
(ii) Post emergence pesticides	0%	6%	86%	8%	100
Flower induction and fruit growth hormones	1.0%	36.1%	62.9%	0%	97
Pest and disease management	9%	0%	1%	90%	100
Fruit harvesting: fruit maturity index	30%	70%	0%	0%	100
Fruit transportation	18%	61%	11%	10%	100

*3 = Practise technology recommended; 2 = Practise partially the technology recommended;
1 = Practise technology from other sources; and 0 = Did not practise technology

Land clearing and preparation The area identified for planting need to be cleared by using herbicides such as Paraquat. Burning is recommended under suitable weather condition to enhance the soil fertility and at the same time to kill pathogens. In this study, most of the farmers (94%) followed what was recommended.

Planting distance and planting density Many farmers did not follow the specified planting distance recommended based on varieties resulting in lower plant densities than expected for the majority of the farms. The percentage of pineapple farmers who followed the recommended planting distance were 51% for Josapine, 37% for Moris and 46% for Gandul. The rests mostly followed the recommendation from other sources. For the three varieties planted, 68–90% of the farms had planting densities lower than the recommended rate.

Fertilizer application The estimated amount of fertilizer needed is 3.7 t/ha. Results of the study revealed that more than 90% farmers acquired less than 3.6 t/ha. Nevertheless, they were provided with fertilizer subsidy at the rate of RM1,750/ha. Assuming that the farmers fully utilized the fertilizer subsidy, the amount of fertilizer applied still less than the recommended rate for the majority of farms.

Weed management Heavy machinery and equipment were not recommended to be used on peat soil. A combination of both methods; mechanically using *cangkul* (or other tools) and using herbicides were recommended to control weeds in pineapple farms.

Based on the survey, only a small number of farmers (10%) adopted both methods to control weeds before planting. The majority of farmers (87%) were using either one of the methods recommended. After planting, the majority of respondents (86%) used recommendation sourced from others to control weeds.

Flower induction and fruit growth hormone Inducing flower by using chemical is a normal practice adopted by pineapple growers. For the ratoon plants, flower induction is done to get an even harvest. For newly planted large scale area, flower induction is carried out to regulate or stagger the yield to avoid over supply at certain times.

In general, all farmers used the technology for flower induction and fruit growth hormones. However, only 1% of the farmers followed MARDI's recommendation while 36% partially followed the stated recommendation. The majority of farmers (63%) adopted the practices based on recommendation from other sources.

Pest and disease management Pests and diseases, if not properly controlled, tend to affect pineapple yield and quality. From this study, only 9% of the farmers followed MARDI's recommendation on ways to control pests and diseases while 1% followed recommendation from others. However, the majority of farmers (90%) did not do anything to treat pests and diseases in their farms.

Post harvest technology The maturity index for pineapples varies according to variety. From this study, about 30% farmers followed exactly what was recommended by MARDI while the rests (70%) followed partially what was recommended.

After harvesting, the fruits are usually collected using bamboo rattan and transported to a collection centre. In this study, 18% farmers used the appropriate technology for on farm handling and transportation and 61% partially used the recommendation. About 11% did not follow the recommendation from MARDI while 10% did not use any technology at all.

Technology impacts

The ex post impact of pineapple technology was analysed by looking at the livelihood outcome in terms of farmers' income. The

net income as targeted for the members of TKPM at RM3,000 per month was made as a bench mark and compared against the net income received by the pineapple growers. Analysis on productivity, gross income and cost of production were done prior to the calculation of the net income.

Productivity For Josapine, only 30% farmers managed to achieve the expected yield above 39 t/ha while the rests achieved lower yield (*Table 4*). The average yield of Josapine was lower than expected (35 t/ha).

For Moris, the majority of farmers (61%) managed to achieve the expected yield of 30 t/ha and more. However, the average yield of Moris at 34 t/ha was higher than expected.

For Gandul, only 33% farmers managed to achieve the expected yield above 55 t/ha while the majority achieved lower yield. However, the average yield for Gandul was higher than expected (59 t/ha).

Price and gross income Based on the survey, the average price of Josapine variety was the highest (RM3.67/fruit) followed by other pineapple varieties (RM2.00/fruit), Moris (RM1.87/fruit) and Gandul (RM0.26/fruit).

The average gross income for pineapple farms based on this study was about RM27,000/ha. The average gross income for Josapine was the highest (RM36,000/ha) followed by other pineapple varieties (RM25,000/ha), Moris (RM23,000/ha) and Gandul (RM16,000/ha) (*Table 5*).

Production costs The production costs included in this study were the variable costs or direct costs. Infrastructure and development costs were not included in the calculation as they involved a long-term life-span. The average cost of production for pineapple was about RM17, 000/ha and varies according to varieties (*Table 5*). It was difficult to isolate the individual production costs of pineapple by varieties because some farmers planted more than one variety on the same plot of land. However, based on the response from farmers who planted a single variety, the average cost of production for Gandul was found to be the highest, followed by Josapine and Moris.

In general, the major cost components were planting materials (50%), fertilizer application (18%) and harvesting (7%). The other important cost components were treatment of planting materials, transportation of fruits and weed control.

Table 4. Summary of pineapple productivity and average productivity by varieties

Productivity (t/ha)	3*	2*	1*	Average productivity (t/ha)	Total respondents
Josapine 3: >39 2: 39 1: <39	30.2%	0%	69.8%	35	41
Moris 3: >30 2: 30 1: <30	52.6%	8.8%	38.6%	34	57
Gandul 3: >55 2: 55 1: <55	33.3%	0%	66.7%	59	12

*3 = High productivity; 2 = Moderate productivity; 1 = Low productivity

Fertilizers were subsidized by the government at the rate of RM1,750/ha for replanting scheme. In this study all farmers received the fertilizer subsidy. Without subsidy, the cost of production for pineapple would be much higher (*Table 6*).

Net income Net income was calculated by subtracting the production costs from the gross revenue. The distribution of the pineapple growers' net income is tabulated in *Table 7*. The majority of farmers (46%) managed to generate a monthly income of ≥RM3,000 per month as targeted for the members of TKPM, DOA. However, 34% received net income less than RM1,000 per month.

The average net income for Josapine was the highest followed by Moris (*Table 6*). For both varieties, the farmers with larger farms tend to receive higher net income due to the economic of scales. However, for Gandul, this study revealed that negative net income for the growers was mainly due to its very low price.

Problems in pineapple cultivation
An open-ended question given to the respondents required them to state down the problems encountered in pineapple cultivation. The problems they listed were summarized into six categories: variety, planting materials, soil, pests and diseases, weeds and fruit harvesting.

The main problem in pineapple cultivation as indicated by the farmers were pests, weeds, exhausted soil condition, diseases, labour shortage especially during harvesting, variety that was susceptible to diseases and sunlights, and high cost and lack of supply of planting materials (*Table 8*).

Table 7. Distribution of pineapple growers' net income (n = 100)

Categories (RM)	Percentage
<1,000	34
1,000–1,999	8
2,000–2,999	12
≥3,000	46

Table 5. Summary of yield, revenue, cost of production and net income per hectare of pineapple grown on peat soil (with subsidy)

Variety	Average yield (t)	Average income (RM)	Average cost of production (RM)	Average net income (RM)	Number of respondents (n)
Overall	40.35	27,032	17,333	10,412	100
Josapine	35.00	36,304	16,897	19,407	17
Moris	34.00	23,173	13,588	9,585	34
Gandul	59.00	16,076	18,377	(2,301)	13
Other varieties	29.54	25,048	Na	Na	Na

Table 6. Summary of yield, revenue, cost of production and net revenue per hectare of pineapple grown on peat soil (without subsidy)

Variety	Average yield (t)	Average income (RM)	Average cost of production (RM)	Average net income (RM)	Number of respondents (n)
Overall	40.35	27,032	19,083	7,949	100
Josapine	35.00	36,304	18,647	17,657	17
Moris	34.00	23,173	15,338	7,835	34
Gandul	59.00	16,076	20,127	(4,051)	13
Other varieties	29.54	25,048	Na	Na	Na

Table 8. Summary of problems encountered in pineapple cultivation

Categories	Problems	Frequencies
Pests	• Monkey • Pig • Rat • Porcupine	43
Weeds	• Wild amaranth • Asystasia	31
Soil	• Reduction in fertility after prolong usage • High water table	31
Diseases	• Gaseous fruits • Heart rot • Black rot	24
Labour	• Shortage of labour for harvesting • High cost of labour	20
Variety	• Susceptible to disease • Susceptible to sunlight	16
Seedling	• High price • Shortage of supply	13
Others	• Lack of market during glut • High cost of fertilizer • Lack of land	13

Conclusion and recommendation

The utilization of new technologies as recommended by MARDI was found to be low in pineapple cultivation. Except for the varieties, the majority of farmers adopted the crop and resource management technologies from other sources. The average productivity of Josapine was lower than expected, while that of Moris and Gandul was higher. The package technology developed for Josapine needs to be fine tuned after almost two decades.

In general, the technology package for pineapple cultivation on peat soil had given positive impact on the farmers' income. The majority of farmers managed to receive a monthly income of ≥RM3,000 as targeted. Without fertilizer subsidy, both Josapine and Moris could still provide reasonably good income to the farmers.

Based on the problems encountered by the farmers, further research should be carried out to determine the most efficient way of controlling pests and diseases, the most realistic and practical planting densities, the most cost-effective fertilizer rate and its application, the suitable crops to be mixed or integrated with pineapple and the appropriate machinery for harvesting and transportation of pineapple on farms.

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Abstrak

Penilaian impak e*x post* teknologi nanas yang diamalkan di tanah gambut dijalankan menggunakan "Sustainable Rural Livelihood Framework" (SRLF) yang disesuaikan. Data dikumpul melalui temu bual bersemuka yang melibatkan 100 penanam nanas di empat daerah di Johor. Keputusan kajian menunjukkan penggunaan varieti moden, pengurusan tanaman dan sumber, pengurusan perosak dan teknologi lepas tuai seperti yang disyorkan oleh MARDI adalah rendah. Pada umumnya teknologi penanaman nanas di tanah gambut memberi impak positif kepada pendapatan petani. Produktiviti purata nanas gandul dan Moris lebih tinggi daripada yang dijangkakan manakala produktivi purata nanas Josapine lebih rendah. Kebanyakan petani berjaya memperoleh pendapatan bersih purata ≥RM3,000 sebulan seperti yang sasarkan. Tidak seperti Josapine, teknologi penanaman nanas Gandul dan Moris diterajui oleh industri. Sebarang campur tangan oleh pembuat polisi perlu fokus kepada sokongan harga. Teknologi penanaman nanas Josapine pula perlu dibaiki selepas lebih dua dekad.