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ORIGINAL ARTICLE

Community's Perception and Willingness to Adopt Rainwater Harvesting as Water Source in Sitio Pulot-Bae, San Antonio, Kalayaan, Laguna, Philippines

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***Abstract*:** The availability of adequate water is one of the important needs of well-being. Located at the eastern portion of Laguna Lake, Sitio Pulot-Bae, Barangay San Antonio, Kalayaan is one of the Geographically Isolated and Disadvantaged Areas (GIDA) in the Philippines. The artificial lake and shallow springs are the sources of drinking and domestic water of Sitio. The insufficiency of clean water supply affects the health of the population and their economic development especially the livelihood. Rainwater harvesting is one of the best options and a vital supplementary source of clean water. This study aimed to determine the community's perception and willingness to adopt the implementation of rainwater harvesting (RHW) system as water source. Out of 55 respondents, 49.1% rated the project to be very effective and 30.9% as effective. According to the respondents, the daily occurrences of rain at night is the primary factor that influence the efficiency of the system. In terms of household's willingness to adopt, 80% of the respondents "strongly agree" and 16.4% "agree" with implementing the system in their area. Other respondents considered the distance of the project from their houses, possible payment for the system, and effectiveness during the dry months. Overall, most of the surveyed respondents (98.2%) want to use the system as their domestic water source. The households (89.1%) are also willing to give payment for using the collected rainwater. The payment would be allotted for the maintenance and repair of the system. At the household level, 94.4% are interested to have their private RWH. The results of the study would promote the practice of rainwater harvesting among the community. Further, it would help the local government to formulate the appropriate water management, as well as support to RWH system as intervention in establishing alternative water source.

Keywords: Rainwater Harvesting, Willingness to Adopt, Perception, Philippines

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1. Introduction

Sitio Pulot-Bae is a very rural community located in Bgy. San Antonio, Kalayaan, in the Eastern portion of Laguna, Philippines. It is one of the Geographically Isolated and Disadvantaged Area (GIDA) in CLABARZON according to Department of Health (DOH). Sitio Pulot-Bae could be reached through boat transportation or mountain hiking from the Municipality of Kalayaan.

The man-made lake and natural springs or "pawis ng bato", as the community called it, are the sources of drinking and domestic water of the Sitio. Sito Pulot-Bae as part of the barangay boundary of San Antonio has fair potential for groundwater development due to its high elevation. The remote location of the Sitio and its being a disputed community lessened the chance to access potential development for a water system. The insufficiency of clean water supply affects the health of the population and their economic development especially their livelihood. Based on the preliminary interview, there are cases of chronic diarrhea which sometimes lead to death. However, the community had no economic capacity to establish other alternative sources of water.

The limited access to safe water is a major problem that needs to be addressed. It is a great challenge to provide the required safe and enough water to the communities. As water scarcity and water stress increases, there is also an increased demand of water resources. With the aim to provide additional water supply, rainwater harvesting system is one of the potential sources.

Rainwater harvesting is one of the best options and a vital supplementary source of clean water to alleviate water scarcity. It is a traditional practice and a sustainable method of rainfall collection and storage that could easily be used for potable and non-potable purposes (Rahman et al., 2014). Rainwater harvesting has been adopted by many nations. Rainwater harvesting system, as one of the tools of green building and sustainable development, reduces the water demand on municipal supplies and the negative impacts such as flooding associated with increase run-off (Jones & Hunt, 2010). Thus, this study assessed the community's behavior towards the adoption of the system.

1.1 Objectives

The main objective of the study is to assess the local community's behavior towards the use of rainwater harvesting system. Specifically: (1) determine the community's perception (knowledge, attitude and practices) of RWH; (2) determine the household's willingness to adopt RWH as alternative water source; and (3) identify the factors affecting household's willingness to adopt and willingness to invest on their own RWH.

2. Methodology

2.1 Study Area

The study was conducted in Sitio Pulot-Bae, two neighboring sitios, Barangay San Antonio, Kalayaan (Figure 1). It is situated in the Eastern portion of Laguna lake. Sitio Pulot is situated in 121°34'23.80" East, 14°19'26.82" North while Sitio Bay is situated in 121°34'10.56" East, 14°19'34.67" North. The area is surrounded by Caliraya lake formed by the pumped water from Laguna Lake for Kalayaan Pumped Storage Power Plant to generate electricity. The topography in the area is generally high with approximately 300 meters elevation above sea level.

Spring and manmade lake are the primary water sources of the community. The spring source is under Level I classification. It is commonly adopted in rural areas where households are scattered.

The Sitio Pulot-Bae is considered as Type IV Philippine climate based on PAGASA classification. The rainfall has no distinct season and evenly

distributed throughout the year. This type of climate has no dry season. Additionally, the geographical location of the area is prone to Eastern monsoon and storms.

Sitio Pulot-Bae is composed of 419 total populations. It has 80 households based on 2018 barangay survey. One elementary school is found in the area with 72 students. The existing population at the household and school level are considered as potential beneficiaries of the RWH project.

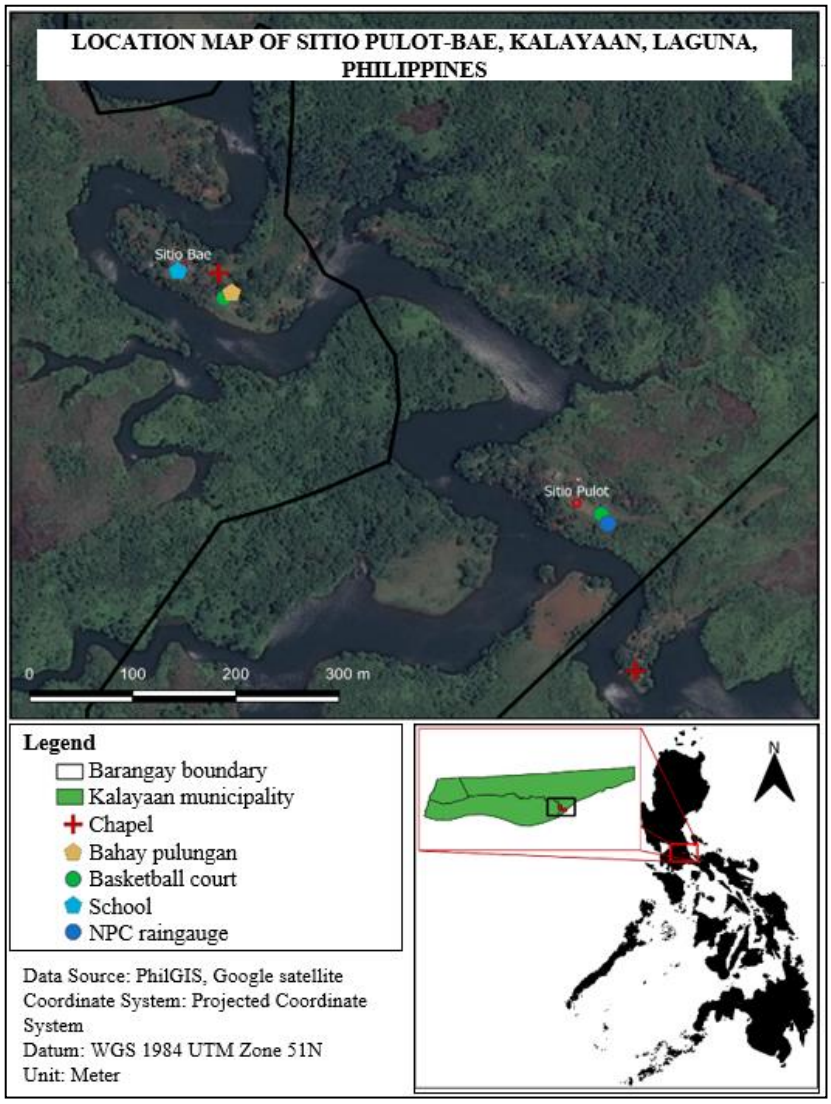

Figure 1 Map of the Study Area in Municipality of Kalayaan

2.2 Primary Data Gathering

The study assessed the (1) respondent's socio-demographic and economic profile, (2) water utilization, (3) practices on water treatment, and (4) perception (knowledge, attitude, practices), and (5) willingness to adopt RWH system as an alternative water source.

Knowledge, attitude, and practices (KAP) is a participatory methodology that is generally used by the policy makers and implementers to assess the needs and gaps at various levels of population. In this study, KAP survey helped determine the current awareness, understanding, behavior, and practices of the local community about rainwater harvesting. This served as baseline data, depth study could be recommended. This also helped capture and prioritize the necessary intervention and improvement in the implementation of pilot project.

Household survey and Key Informant Interview (KII) were conducted to acquire information of

community's attitude towards rainwater harvesting system. The study surveyed 55 out of 80 households in the area. The household surveys were done through convenient sampling method. The 55-sample size has 93% confidence level and p=0.7 and ±5% level of precision calculated using the Cochran equation (Israel, 2013).

The respondent's profile, perception, and attitude on adoption of RWH were analyzed using descriptive statistical tool through SPSS v.21.

2.3. Scope and Limitations

All households in the center area of Sitio were surveyed. The accessibility of other farther households was a limitation of the study due to safety concerns. In every household, the head of the family (mother or father), or any household member ages 18 and above was a respondent as long as knowledgeable about their household water utilization and could answer the survey questionnaire.

The study involved the local government officials and other stakeholders for the KII.

3. Results and Discussions

3.1 Socio-demographic and Economic Profile of Households

The respondents are comprised of 18.2% male and 81.8% female. Majority of the respondents are mother who stays in the house doing household chores. Majority of the respondents are married (87.3%) and belong to the 30 – 39 working age group.

All surveyed respondents are migrants in the area. Mostly are from the Bicol region and the livelihood, work and relatives are the main reasons of migration. The average residency is 20.41 years. Mostly (38.2%) claimed that they have been residing in the area for 21 – 30 years. The overall average household size is 4.98, slightly higher compared to the national average of 4.4 in year 2015.

Despite large areas unable to grow crops, farming (31%), of vegetables and fruits as common crops, is still their primary source of income of the surveyed households. Based on the previous study (Cuevas et al., 2017) and according to the observation of the locals, some of the reasons of barrenness of the area are the deficiency of phosphorus and potassium of the soil. Application of fertilizers and nitrogen fixing plants are recommended to improve the soil quality. Some of the suitable crops are rice, maize, potato, cassava, beans, cucumbers, onions, sugar cane, and banana. Meanwhile, business (16%) such as selling of harvested crops, vegetables, livestock, and poultry is the second source of respondent's income. Selling of yantok and rattan raw products are the top business. Other sources of income are salary as laborer and from fishing.

The Philippine Statistics Authority (2015) reported the monthly food and poverty threshold for a family of five at Php 6,329.00 to meet the basic needs of food and Php 9,064.00 for both food and non-food needs. In comparison to the national poverty index, 90.9% of the respondents are below poverty threshold level while only 9.01% is above the poverty threshold level. The average income of the respondents is Php5,416.36. The low income from farming could be associated to low harvested crops due to soil type in the area.

3.2 Water Demand

The study estimated the water consumption per activity of the surveyed households. Table 1 showed the results of the survey in comparison with the proposed minimum water requirements of the PIDS. The community has an average drinking demand of 1.62 l/c/d which is slightly lower than the proposed minimum of 2 l/c/d. The result implies that respondents are drinking enough water as required

by the body. The estimated amount of water for cooking and dish washing at 3.99 l/c/d is close to the suggested 4 l/c/d requirements of PIDS. Overall, majority of the households used 24.25 liters per day for drinking, cooking and washing dishes. In terms of other domestic activities, the study could not account the water demand due to direct usage from the source. The lower consumption of the locals might also attribute by the limited water supply in the area. Thus, accounting of water consumption is important to determine whether the water supply can supplement the demand. This would help the local government to visualize the water needs of the community and how to improve and develop their water resources. Mostly, the household head (45.5%) is responsible in collecting water for the family followed by the children (18.2%).

Table1 Water sources and demand of the respondents

Activity	Water sources	Water demand*	PIDS proposed basic requirements*
Drinking	Spring	1.62	2
Cooking, Dish washing		3.99	4
Bathing	Lake	Direct use	23
Laundry			5
Toilet flushing			20
Farming			
Livestock rising			

*****liter/capita/day

Majority of the respondents (76.4%) had no expenses on water because of the direct access on springs and lake water (Table 2). On the other hand, some bought their water from barangay proper of San Antonio due to water shortage during dry months. In relation to the water supply, 50.9% of the respondents are experiencing water shortage during dry months, March to May. Due to high demand during this season, the locals waited for two hours before the water regenerates in the spring. In rainy season, the water is enough to supply the whole community. Some of the locals are practicing the collection of rainwater.

The water shortage is a common issue in rural areas where access to adequate water is a big challenge. Additionally, this could be attributed by lack of financial to buy water, climate condition, improper utilization, and lack of awareness among rural communities. The monitoring of water availability and quality could be helpful to better understand the cause of water shortage and to improve and develop the water sources.

Table2 Water expenses and sufficiency

	Frequency (n=55)*	Percentage
Water expenses		
None	42	76.4
<P100.00	12	21.8
P101.00-P200.00	1	1.8
Water sufficiency		
During dry season		
Yes	27	49.1
No	28	50.9
During wet season		
Yes	55	100
No	0	0

*****n – number of respondents

3.3 Water Treatment

Drinking of contaminated water could cause health risk especially among small children. According to the respondents, water boiling was done for drinking of small children to avoid stomach pain and diarrhea.

Once a month application of chlorine at the spring source was conducted by the barangay health center. However, cases of waterborne diseases were still recorded among 25.5% of the surveyed households. Commonly, the most affected age group are from 1 to 4 years old. The case of diarrhea is one of the top 10 causes of morbidity in the municipality of Kalayaan.

Several water treatments are proven to be effective for the removal and inactivation of microbial pathogens such as boiling, household sand filtration, and domestic chlorination. Based on the survey, 61.8% of the respondents boil and filter the water before using for drinking, cooking and washing dishes. Water treatment mostly practiced during rainy season when the water is turbid or cloudy. Boiling of water is the most common and old method for treating water that could destroy the pathogenic bacteria, viruses and protozoa at a certain temperature. Numerous investigations on temperature requirements to inactivate the bacteria, viruses, and protozoa are summarized by the World Health Organization (2015). According to the WHO recommendations, the water should reach the rolling boil to destroy pathogens. However, the treatment could not remove the turbidity or cloudiness of water. The boiled water should be stored in a clean and covered container to avoid another contamination.

3.4. Perception (knowledge, attitude and practices) on RWH

The local perception on effectiveness and potential of rainwater harvester is essential to the implementation of the system and its sustainability. Out of 55 respondents, 49.0% rate the project to be very effective and 31% rate as effective (Figure 2). According to the community, the daily occurrences of rain during nighttime is the primary factor of efficiency of the system.

Additionally, the volume of collected rainwater would depend on the storage tank installed. The larger tanks could store and provide more rainwater supply. The use of collected rainwater would help the students and teachers to lessen their time in fetching as well as provide clean water. On the other hand, the 18% of the respondents questioned the effectiveness of the system to provide enough water during the dry months.

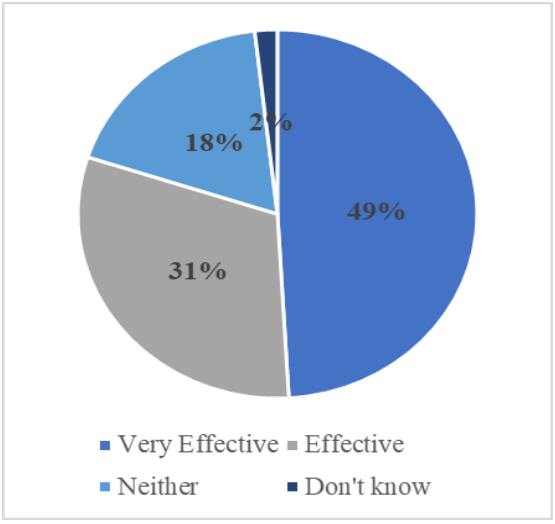

Figure2 Rate of effectiveness of the RWH system

The study hypothesized a high level of social and political acceptability of Sitio Pulot-Bae in the implementation of RWH system. Among the 55 respondents, 80% are strongly agree and 16.4% are agree in the implementation of the system in the area (Figure 3). On the other hand, the 3.6% are neither agree nor disagree considering the distance of the project in their houses, possible payment for the system, and effectiveness of rainwater harvester during dry months.

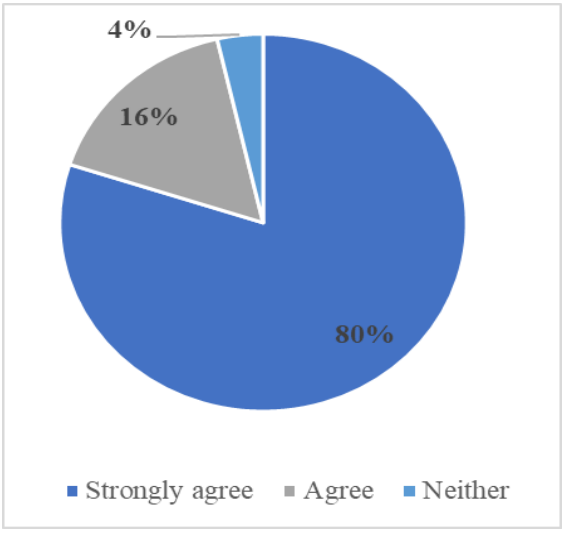

Figure3 Rate of acceptability of the RWH system

3.5 Willingness to Adopt the RWH System

Table 3 summarized the attitude of the community to willingly adopt the RWH system. Most of the surveyed respondents, 98.2% want to use the system as their water source. The 89.1% of households are also willing to pay to use the collected rainwater. The payment would be allotted for the maintenance and repair of the system. Overall, the respondents are willing to give payment ranging from less than 1 peso up to 10 pesos per liter. Majority (59.2%) will pay less than P1.00 per liter of rainwater. The study observed that the basis of their payment is the current price of tap water per container from barangay proper. On the other hand, there are 11.0% of households who are not willing to pay due to lack of financial but willing to help in the management of the project. Concerning the maintenance, 94.5% of the respondents are willing to volunteer to regularly clean and secure the system. To ensure proper management and sustainability of the project, the creation of organization or group in the community level would be necessary. Based on the result, 92.7% are willing to join the organization or group and participate in the activities. The households are interested and willing to attend trainings on proper management of rainwater harvester.

Table3 Response of the community towards RWH system

	Response (%)	
	Yes	No
Wants to benefit from the system	98	2
Willing to give payment	89	11
Willing to manage the system	95	5
Willing to join a group for management	93	7

The RWH system was promoted at the household level, about 96.4% of the respondents are interested to have their own RWH not considering the expenses of the installation and other factors such as roofing materials. According to them, the local government should prioritize the improvement of their water sources such as installation of rainwater harvester for every house. The study listed the advantages and challenges of having private RWH based on respondents.

Advantages:

- Near source of water
- Less time and effort to fetch water
- Alternative/additional supply
- Rainwater is cleaner compared to existing water supply

Challenges:

- Type and size of roofing materials
- Size of storage container/tank
- Quality of roofing materials
- Availability of water treatment
- Maintenance of the system

3.6 Factors Affecting Community's Attitude Towards RWH System

3.6.1 Socio-demographic and Economic Factors

Correlation analysis using Spearman's rho was done to determine whether the socio-demographic and economic characteristics of the households are significant to their attitude towards rainwater harvester (Table 4). It was assumed that these factors could affect their willingness to accept and pay for the operation and maintenance of RWH. However, the results revealed that only age and years of residency are positively correlated to the acceptability rate of respondents on the implementation of RWH at 0.01 significant level. This mean that the longer the years of residency, the more willing to accept the RWH. The knowledge of the community on rainfall condition in the area

might contribute on their decisions to accept the technology. Additionally, their acceptance might be associated with their concern to have additional water sources for a long period of time. The age profile is positively related with the willingness to manage the system at significant level of 0.05. Majority of the respondents belong to working age group which are more capable to work for the management of the system. The rainwater users are significant but negatively correlated to the perception on effectiveness of RWH. The result implies that even few households are practicing rainwater collection, many are believing that implementation of RWH would be effective.

All other socio-demographic and economic factors are not significantly correlated towards the respondent's attitude and perception on RWH system.

Table4 Summary of Spearman's rho correlation results showing only the significant socio-demographic factors affecting the attitude and perception of respondents toward RWH

FACTORS		Acceptability rate	Willingness to manage	Effectiveness of RWH
Age	Correlation Coefficient	.414**	.270*	
	Sig. (2-tailed)	.002	.046	
	N	55	55	
Years of residency	Correlation Coefficient	.346**		
	Sig. (2-tailed)	.010		
	N	55		
Rainwater user	Correlation Coefficient			-.510**
	Sig. (2-tailed)			.000
	N			55

**Correlation is statistically highly significant at the 0.01 level (2-tailed)

*Correlation is statistically significant at the 0.05 level (2-tailed)

3.6.2 Other Significant Factors

Linear regression analyses were done to determine other factors (behavior or preference) that significantly correlated to attitude of community towards the implementation of RWH system. These include acceptability of the technology, willingness to pay upon using the collected rainwater, and willingness to join the creation of organization to manage system. The results are showed in Table 5. The household's perception on effectiveness of the system is positively significant to the acceptability rate at 0.01 level. It means that the higher the respondent's perception of effectiveness, the higher their acceptability rate of the system. These factors would help in planning of scaling the pilot project into a community level.

The preference of respondents to benefit from the system is highly significant and positively correlated with their willingness to pay for the rainwater. Most of the households preferred to pay but with a

condition that the rainwater should be guaranteed safe to use. They are more willing to use and pay if the water could be a source of drinking. Furthermore, they will most likely to spend in clean water than to spend in hospitalization. However, the price of water should be at low cost according to them.

The attitude of studied households to have private RWH is statistically significant to their willingness to join an organization. This reflect that community are willing to cooperate for the management of the system. This is a positive result for the local government to conduct capacity building among the households.

The participation of local community as primary beneficiaries is important to ensure the sustainability of the system. The study determined the preference, attitude and perception of the household towards implementing of the system through social survey. According to the households, the system would be very effective during rainy months but not in dry periods. The community's knowledge on rainfall intensity and distribution could be one of the factors that affect their perception on effectiveness of the system. The high rate of acceptability to adopt and invest on private system and willingness to use the rainwater for drinking and domestic purposes implied a high feasible option to promote and practice the rainwater collection at the household level. Further, the interest of the community to volunteer and create a group to manage and improve the system is a positive response towards sustainability. The willingness of the community to pay for rainwater is another advantage attitude that would be helpful in the maintenance of the system. However, the local government should be the major responsible entity to support financially the water source of the people.

Table5 Summary of linear regression results showing only the significant factors affecting the respondent's attitude towards RWH

FACTORS		**Acceptability rate**	**Willing to buy rainwater**	**Join organization**
Perception on effectiveness	Correlation Coefficient	.362**		
	Sig. (2-tailed)	.007		
Wants to benefit	Correlation Coefficient		.389**	
	Sig. (2-tailed)		.003	
Own RWH	Correlation Coefficient			.320*
	Sig. (2-tailed)			.017

**Correlation is significant at the 0.01 level (2-tailed)

4. Conclusion

Sitio Pulot-Bae as a remote area of Kalayaan, Laguna has no adequate water sources. The community rely on the shallow springs and man-made lake of Caliraya for drinking and domestic water supply. The quality of existing water supply does not comply with the standard guidelines of the Philippines for drinking. An appropriate treatment such as boiling, and filter is recommended before drinking to avoid the high potential waterborne diseases especially among children. On the other hand, the study area has a microclimate

which rain occurs mostly daily due to its mountainous and forested location. The high amount of rainfall is a great potential source of water for the community

The RWH system was introduced in the area and assed the attitude of the community towards the use of the system. There was a high social and political acceptability rate based on the community's willingness to adopt, to give payment for the collected water, to invest their own RWH as well as to create and join a group for the management. The socio-demographic condition of the household, perception of effectiveness of the system, and potential benefits are significant factors that affect their willingness to adopt the technology.

The involvement of local government unit, local community, and other agencies or groups in the implementation are necessary to ensure the sustainability and efficiency of the pilot project. The trainings and other awareness activities on water utilization and RWH system would be helpful to further improve the system and management. The cost of the system affects the attitude of the community's acceptability, thus financial assistance from the government is needed.

5. Recommendations

Promote the collection and use of rainwater for domestic purposes at the household level. Also, educate the local community and provide financial assistance to utilize the available rainwater and implement the appropriate harvester.

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