

# A Current Situation of Agricultural Practices: A Report on Cultivation Methods from an Isolated Village in Java's Karst Mountains

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**Abstract.** Farmers interviews with focus group discussion and a yield observation were conducted to understand the current condition of agricultural practices and cultivation method by the local people in Gunungkidul, Yogyakarta, the largest Karst area in Indonesia. Participatory Rural Appraisal was conducted to observe and monitor the respondent with the total number of respondents interviewed was nine. This study aims to provide insights into the agricultural practice of the remote community. The finding of this study showed that traditional agricultural practices combined with innovative intercropping methods were so important for local people to ensure food security and sustaining livelihoods. This study suggests exploring advanced techniques and technologies to improve the traditional intercropping methods. Further research should also investigate the long-term socio-economic and environmental impacts of these practices to enhance sustainability in similar resource-limited areas.

## 1 Introduction

Gunungkidul, Yogyakarta, Indonesia's Karst Mountain region is home to a distinct and intricate environment that has long served as the foundation of the area's agricultural sector. The region's rough topography, limestone formations, and scarce water supplies make it difficult for conventional farming methods to thrive [1,2]. Due to unsustainable agricultural practices, it has been discovered that the karst ecosystem in Indonesia is extremely vulnerable to environmental degradation [3–5]. The people of Karst area have long since adapted to these circumstances, creating creative agroforestry systems called "kebun campuran" that combine cattle, trees, and a range of crops [5,6].

In Gunungkidul, traditional farming practices are essential for the sustenance of local communities. Rice remains a crucial crop, cultivated using traditional and sustainable methods alongside other crops in intercropping systems. According to the Statistics Indonesia [7], over 10.45 million hectares of rice were harvested in Indonesia, yielding approximately 54.75 million tons of unhusked rice, which was then processed into about 31.54 million tons of milled rice. This production not only ensures local food security but also significantly

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boosts the national economy. Rice farming is a vital source of income for many rural communities, as highlighted by the BPS and regional statistics agencies.

Rice farming plays a critical role in supporting livelihoods, also in karst areas. Farmers rely on traditional tools and methods, and combine multi cultivated cash crops, to enhance productivity and maintain ecological balance. However, few reports are available about recent agricultural practice and cultivation methods in the Karst area. It is important to examine how is the recent of agricultural practices differs with Karst conditions.

In the present study, we conducted farmer interviews and a yield survey in Gunungkidul, Yogyakarta province, Indonesia, where agricultural practice in Karst Mountain has been implemented for long time ago. Our study area is characterized by the highest proportion of agricultural activities in rainfed and livestock activities, which is very important for the local people in order to adapt to the water scarcity and change of climate in Indonesia. In addition, our study is continuing the last report in the isolated village, Gunungkidul, for the past decades [8]. In the present study, we determined how agricultural practices and cultivation methods influence to their local livelihoods.

## 2 Research method

### 2.1 Study area

The study area was conducted in an isolated village of Karst Mountain area in Girisubo District, Gunungkidul Regency, Yogyakarta, called Wotawati village. The approximate coordinates for Wotawati village are Latitude: -8.0926 (8° 5' 33.36" S) Longitude: 110.7143 (110° 42' 51.48" E). Wotawati village is located in valley between two hills and the hills is border to Wonogiri regency Cetral Java, and a little bit far from the main road. The village is also located in the ancient Bengawan Solo River which is known as one of the longest rivers in Java. The area of the village is divided into four neighborhood units to ensure the smooth functioning of community life, enhancing local governance, and improving the quality of life for residents.



**Fig.1.** Water Reservoirs of household.

The karst landscapes of Gunungkidul's southern region, which includes this village and generally in Girisubo district, are created by limestone which characterized by a rugged karst landscape with limited surface water. The existence of underground rivers and historic river basins in this area raises the possibility that ancient Bengawan Solo had an impact on the development of these characteristics. Farmers in this area have responded by creating creative strategies for managing water. These include digging underground rivers and springs for

irrigation and building rainwater gathering systems. Using a rainwater gathering system and storing water in artificial reservoirs are two popular methods for effectively conserving water (Figure. 1).

## **2.2 Data collection and analysis**

The data was collected from March 20th to March 31st, 2024. Participatory Rural Appraisal was conducted to observe and monitor the respondent. The total number interviewed was nine households. This study aims to provide insights into the agricultural practice of this remote community through participatory observation and in-depth interviews with local stakeholders. The challenges, innovations, and strategies that are unique to this agricultural landscape will be discussed. The data variables are the name of head household, number of family, number of migrants in each household, status in the village, number of lands owned for agricultural activities, number of livestock, main activities, and agricultural practices. We also observe the field and draw how the agricultural system is and what the cultivation method is in the village, and what kind of materials the local people use for agricultural activities. The data collected were analyzed by using descriptive analysis and drawing visualize the filed survey data to easily capture their actual activities. To understand the current situation, we compared the literature review and the last report with verbatim discussion.

## **3 Results and discussion**

### **3.1 Socio-economic condition of Households surveyed in Wotawati village**

Table 1 showed a summary of the respondents' demographics, social standing, and economic activities within a village setting. The data describes the relationship between age, family structure, migration, social roles, and economic activity, emphasizing the importance of intercropping cultivation and livestock farming for ensuring a secure livelihood.

The respondents aged between 29 and 70 show a diversified representation of different age sets in society. The family sizes of the participants in this countryside range from four to ten people, which is congruent with average family sizes. A significant proportion of the households have migrants as part of their immediate families, a feature that is common to many households in these. Respondent E for example has seven members who work outside the locality; hence happens to have the highest number. On the contrary respondents C, D and F do not have any relatives who do migrate in search of jobs. The research findings demonstrate that households depend on various external sources for livelihoods.

Diverse positions of responsibility held by different respondents in the village. These include an RT leader, Mulyo's group leader, head of Karang Taruna and a village head among others. There are also perspectives supporting the idea that the respondents have been actively participating in leadership and administration within the community. One case is respondent B who is 68 years old, and he is currently holding the position as a Head of Village RT 04 and respondent H at age 29 is working as village chief which indicates that people from both generations are actively involved in leadership positions.

Agriculture and livestock are the main livelihood activities. Intercropping is the most common agricultural practice among respondents, which reflects how important it is for maintaining soil fertility as wells as maximizing land used in the area. The fattening of cattle and goats is a major economic activity in livestock farming. For instance, respondent A who is a farmer told that he practices intercropping, does farm work and keeps livestock like cattle.

They have three plots of land each which they own and another three that they rent, making it six altogether. They also own one head of cattle each and four goats.

Other activities from non-farm exist too in this village. Respondents C and F are both engaged in furniture services besides their farming activities. When farmers diversify their practices, they minimize risks and create other avenues to generate additional income. Another example is respondent C who heads the farmers' group; his farm comprises 5 plots he owns himself and 2 plots rented by him. He is into cattle farming as well as works that deal with furniture indicating a more holistic approach towards living standards.

The diversity in family structures, migration patterns, social roles, and livelihood activities underscores the complexity of rural life and the various strategies employed by households to secure their livelihoods. This information is invaluable for understanding the socio-economic dynamics of rural communities and designing interventions that support sustainable agricultural practices and improve livelihood security.

### **3.2 Intercropping system for livelihood security in Karst Area**

We observed the agricultural field to see how the agricultural system is by the local with indigenous knowledge in Wotawati village. The cropping system they used is intercropping with several cash crops such together in one period of cultivation. The cultivated cash crop by local people are usually similar between household. In one plot of agriculture area, they likely to cultivate two to three crops, such as rice, corn, and cassava. This intercropping system is norm in the area, and strategy of local people to adapt for their livelihood.

Intercropping systems in Karst environments can improve agricultural output and sustainability through many methods. Intercropping has the potential to enhance soil fertility. Various crops exhibit distinct nutrient demands and root architectures, resulting in enhanced soil nutrient consumption. Leguminous plants have the ability to capture and convert atmospheric nitrogen, which results in the enrichment of the soil for future crops. This is especially beneficial in the nutrient-deficient soils found in Karst regions. Research has demonstrated that the practice of intercropping corn with legumes such as groundnut can substantially enhance the presence of nitrogen in the soil [9].

Intercropping has also the potential to enhance water usage efficiency, a crucial factor in water-deficient Karst regions. Various crops possess distinct water requirements and root depths, enabling more efficient utilization of accessible water. Perennial plants have the ability to tap into underground water sources, whereas annual plants rely on water found near the surface. This synergistic utilization of water resources minimizes rivalry and improves the overall efficiency of water usage. A study conducted by Lithourgidis et al. [10] suggests that intercropping can enhance water conservation and enhance crop production in drought conditions. Furthermore, intercropping has the potential to improve pest and disease control. Plant diversity can disturb the habitat of pests and mitigate the spread of illnesses. Intercropping maize with beans can effectively decrease the occurrence of stem borers and fungal diseases. This is because the beans can serve as a physical barrier or release compounds that discourage pests, as stated by Ratnadass et al. [11]. The implementation of this integrated pest management strategy is especially advantageous in areas where farmers have restricted availability of chemical pesticides.

The intercropping practice also yields substantial economic advantages. Intercropping can offer a more secure and varied income stream for small-scale farmers in Wotawati Village. Through the cultivation of various crops, farmers can reduce the likelihood of crop failure caused by pests, illnesses, or unfavorable climatic conditions. In addition, intercropping can ensure a consistent and uninterrupted availability of food and fodder

**Table 1.** Household characteristic in Wotawati village

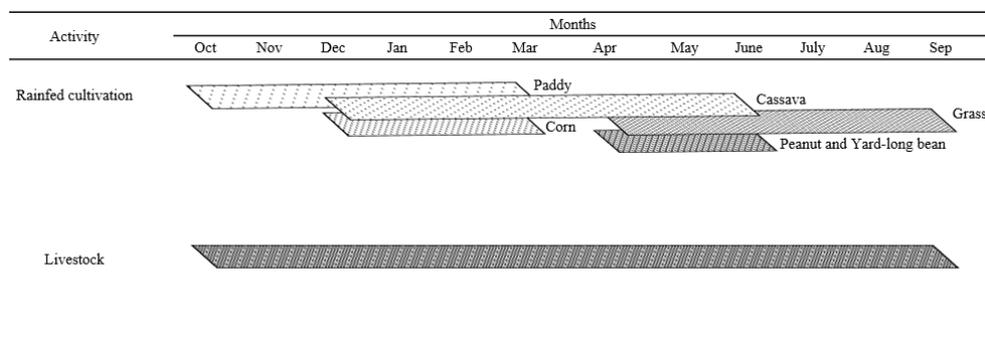
No	Respondent	Age	No. Family member	No. Migrant (working outside village)	Status in the village	Livelihood activities	No. Plot area of Land Holding (Own)	No. Plot area of Land Holding (Rent)	No. Cattle	No. Goat
1	A	54	4	2	Farmers	Intercropping cultivation activities, farm work, livestock farming - fattening	3	3	1	4
2	B	68	6	2	Head of RT 04	Intercropping cultivation activities, farm work, livestock farming - fattening,	1	1	1	3
3	C	58	7	0	Head of farmer group (Margo Mulyo)	Intercropping cultivation activities, Livestock farming - fattening, Furniture services,	5	2	1	0
4	D	57	5	0	Head of Karang Taruna (Putra Bengawan)	Intercropping cultivation activities, farm work, livestock farming - fattening,	3	0	2	4
5	E	70	10	7	Head of RT 02	Intercropping cultivation activities, farm work, livestock farming - fattening,	2	0	1	0
6	F	61	4	0	Head of RT 01	Intercropping cultivation activities, Livestock farming - fattening, Furniture services,	2	0	2	2
7	G	60	4	2	Head of RT 03	Intercropping cultivation activities, farm work, livestock farming	1	1	0	4
8	H	29	5	1	Head of Village	Intercropping cultivation activities, Village officials, livestock farming - fattening,	2	0	2	2
9	I	62	6	2	RT Treasurer	Intercropping cultivation activities, farm work, livestock farming - fattening,	4	0	2	2

throughout the year, thereby improving both food security and animal output. Altieri et al. (2015) found that varied farming systems, such as intercropping, had greater resilience to both environmental and economic shocks.

### 3.3 Cultivated crops, planting season, and cultivation method in present cropping system

#### 3.3.1 Cultivation crops and planting season

Under rainfed conditions, the intercropping system in Wotawati Village includes rice, cassava, corn, sorghum, peanuts, elephant grass, and yard long bean. This diverse cropping system is designed to make the most of the local climate, aiming to maximize resource use and improve food security and income generation. The illustration of cultivation crops and planting season is shown in Figure 2.



**Fig. 2.** Planting season calendar.

Rice is a major crop in Wotawati Village, primarily cultivated from October to March during the rainy season. Two varieties of rice are grown: red rice and white rice. Red rice is typically grown for commercial purposes due to its higher nutritional value and market appeal, providing a valuable source of income for farmers. White rice is mainly consumed by households. The practice of incorporating rice residues into the soil helps to improve soil fertility by adding organic matter and nutrients [12].

Cassava is planted from December to June, taking advantage of both the late rainy season and the early part of the dry season. As a drought-tolerant crop, cassava is well-suited to the challenging conditions of the Karst region. Often intercropped with legumes, cassava helps to increase soil nitrogen levels, benefiting subsequent crops. Its deep root system also helps to stabilize the soil and prevent erosion [13]. Corn is grown from December to April, overlapping with the cassava planting season. Corn is a versatile crop that serves as both food for humans and feed for animals. Intercropping corn with legumes such as groundnuts can enhance soil nitrogen content, reduce the need for chemical fertilizers, and improve water use efficiency and pest management [10].

Although not specifically listed in the planting calendar, sorghum is a resilient cereal that can be integrated into the intercropping system. Sorghum is known for its resistance to drought and poor soil conditions, making it suitable for the Karst region. Intercropping sorghum with legumes helps to improve soil fertility and provides a balanced diet for both humans and livestock [11].

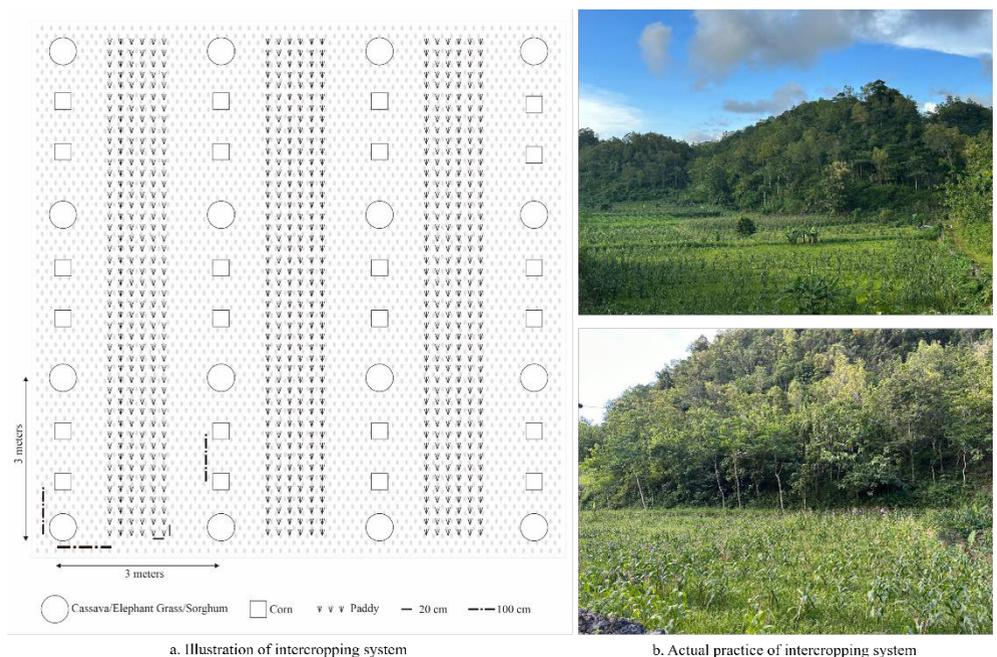
Ground nuts and yard long beans are grown from April to June, following the main rainy season. These legumes play a crucial role in enhancing soil fertility through biological nitrogen fixation. Intercropping legumes with cereals such as corn or sorghum can lead to better overall crop performance and soil health. Groundnuts and yard long beans provide

essential proteins and nutrients, contributing to household food security [9]. Elephant grass is cultivated from April to the end of August and serves as a critical fodder crop for livestock. Growing elephant grass during the dry season ensures a continuous supply of fodder when other green feed sources are scarce. Intercropping elephant grass with legumes can improve soil fertility and produce high-quality fodder, supporting livestock health and productivity [14].

The intercropping system in Wotawati Village exemplifies sustainable agricultural practices tailored to local conditions. By growing a variety of crops with different growth habits and nutrient requirements, farmers can optimize land use, improve soil health, and enhance water use efficiency. This diverse cropping system also provides multiple income streams and nutritional sources, contributing to overall livelihood security [15,16]. Research consistently supports the benefits of intercropping in improving agricultural sustainability, particularly in resource-limited environments like the Karst regions [10,11,17].

### 3.3.2 Cultivation method

In Wotawati Village, nine families use an intercropping method where they grow rice, corn/sorghum/elephant grass, and cassava together in the same plot during a single planting season. This strategy aims to maximize land use, improve soil fertility, and boost agricultural yields. Typically, rice is planted between two rows of corn and cassava, which are spaced three meters apart. This arrangement enhances space and resource efficiency. The rice plants are spaced 20 cm apart to ensure adequate sunlight and nutrient access. Corn is planted one meter away from the rice, allowing it to grow tall without overshadowing the rice. Similarly, cassava is planted one meter from the corn, allowing its extensive roots to grow without disrupting other crops. The illustration and actual cultivation method in the area is shown in Figure 3.



**Fig. 3.** The illustration (a) and actual cultivation system (b)

Intercropping allows farmers to optimize the use of sunlight, water, and soil nutrients. For instance, rice benefits from the shade provided by taller corn plants, reducing water

evaporation from the soil and helping to retain moisture. Cassava, with its deep root system, extracts nutrients and water from lower soil layers, which is advantageous in dry conditions (Lithourgidis et al., 2011). The diverse root structures and plant residues from different crops improve soil composition and increase organic matter levels. Rice residues add organic matter to the soil, enhancing fertility and water retention. Corn and cassava roots break up compacted soil and improve aeration. Additionally, intercropping with legumes like groundnuts enhances nitrogen fixation, reducing the need for synthetic fertilizers [18,19].

Traditional agricultural tools are essential for maintaining efficient farming practices in Wotawati Village. One of the key tools is the sickle (Figure 4a), indispensable for cutting grass and harvesting crops. Its curved blade makes it easy for farmers to cut through stems, making it perfect for harvesting rice and other crops. The sickle is cost-effective and requires minimal maintenance, making it an ideal choice for small-scale farmers. Hasan et al. and Sarkar et al. [20,21] note that traditional sickles are widely used in rural areas due to their simplicity and effectiveness in harvesting operations.

Threshers are another vital tool in Wotawati Village (Figure 4b), mainly used for manually threshing rice seeds. Unlike modern mechanical threshers, these traditional devices operate by pedaling, allowing farmers to efficiently separate rice grains from the husks. This manual method is especially useful in areas with limited access to electricity or fuel. Using pedal-operated threshers reduces labor costs and helps maintain the quality of rice grains. Kebede et al. [22] emphasize the importance of traditional threshers in rural agricultural systems, highlighting their role in enhancing post-harvest processing efficiency.

The "gathul" is a traditional weeding tool extensively used in Wotawati Village (Figure 4c). Designed for uprooting weeds, it helps farmers maintain clean and healthy fields. Regular weeding is crucial to prevent weeds from competing with crops for nutrients, water, and sunlight. The simple design of the *gathul* allows farmers to manually remove weeds, which is particularly important in intercropping systems where mechanical weeders might not be practical. Karim et al. [23] indicate that traditional weeding tools like the *gathul* are vital in sustainable agricultural practices, contributing to improved crop yields and soil health.



a. Arit / sickles

b. Perontok /  
threshers

c. Gathul

d. Garuk

**Fig. 4.** Traditional tools used for agriculture activities in Wotawati village.

The "garuk" are also commonly used in Wotawati Village for preparing planting land (Figure 4d). These tools help level the soil, remove debris, and create a smooth seedbed for planting. Proper land preparation is essential to ensure good seed-to-soil contact, promoting germination and early plant growth. Traditional rakes, with their simple yet effective design, enable farmers to prepare their fields efficiently without relying on modern machinery. Niyogi et al. [24] suggest that the *garuk* are effective in enhancing soil structure and preparing land for planting, thereby supporting sustainable farming practices.

Traditional tools such as sickles, threshers, *gathul*, and *garuk* are integral to agricultural activities in Wotawati Village. These tools are cost-effective, easy to maintain, and play a significant role in ensuring efficient and sustainable farming practices. Relying on these traditional tools highlights the importance of indigenous knowledge and practices in rural agricultural systems. Various studies note that integrating traditional tools with modern agricultural techniques can enhance productivity and sustainability in small-scale farming communities [22–25].

## 4 Conclusion and recommendation

In the secluded village of Wotawati, located in the Karst Mountain region of Gunungkidul, Yogyakarta, traditional agricultural practices combined with innovative intercropping methods are essential for ensuring food security and sustaining livelihoods. The villagers actively engage in monitoring and implementing these methods, using tools like sickles, threshers, *gathuls*, and rakes. Their intercropping system, which includes rice, corn, sorghum, elephant grass, and cassava, is specifically designed to maximize land use, enhance soil health, and increase productivity. This holistic approach not only boosts agricultural efficiency but also protects the local ecosystem and supports the village's socio-economic stability. By merging indigenous knowledge with contemporary agricultural techniques, Wotawati Village stands as a model for sustainable farming in areas with limited resource. This study suggests exploring advanced techniques and technologies to improve the traditional intercropping methods in Wotawati Village. Further research should also investigate the long-term socio-economic and environmental impacts of these practices to enhance sustainability in similar resource-limited areas.

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