

ISDA'T GABI CULTURE

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Hito with gabi		
	Quantity	Value (P)
LAND DEVELOPMENT		
- Plowing (P400/1,000 m ² /day)	2 days	800.00
- Diking & Plot construction(3x) 4 persons (@ P 300.00/day)	7 days	8,400.00
- Nets fencing (1 roll @6,000/roll),	1 roll net B-net 6,000/roll	6,000.00
- Bamboo(15 pcs @ 120/pc)	15 pcs @ 120/pc	1,800.00
- 2 Wooden gates	200/unit	400.00
Total land development cost	Maximum use is 4 croppings	17,400.00
OPERATIONAL COSTS/CROPPING		
- Gabi Seedlings P 0.50 seedlings	1800	900.00
- Hito fingerlings (P 1.00/fingerling)	5,000	5,000.00
- Feeds	24 bags @ 620.00	14,880.00
- Harvesting (3 Laborer) (250.00/laborer/day)	2 days	1,500.00
- Other Expenses (Transportation expenses, food, water, etc.)		4,500.00
- Farmer- labor 2 man-hours/day (4 mos or 120days/8 hours)	30 days @300/ day	9,000.00
TOTAL		Php 40,130.00

GROSS RETURNS (HITO)		
	QUANTITY	VALUE
Sale of Fish 80 % survival (P 80.00/kg)	800 kg	P 64,000.00
Value of corms produced (average of 15 corms/plant hill P 2.00/corm)	27,000 corms	P 54,000.00
TOTAL		Php 118,000.00

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Introduction

The culture of fish in gabi or taro (*Colocasia esculenta* L) plots is an agro-aqua integrated farming technology found to be technically practical and profitable for household-backyard food production micro-business and village nutrition. The production of gabi can bring significant benefits to areas where root crops are major staples. In the Philippines, the integrated technology was adapted initially in Central Luzon in mid -1980's. There were several isda't gabi projects in the provinces of Nueva Ecija, Tarlac, Bulacan and Bataan.

The integration of two crops, isda (fish) and the root crop gabi requires minimum investment from marginal fish farmers. The practice encourages diversification of farm products other than fish. The integrated culture of isda and gabi results in increased soil fertility, reduction of weeding cost and optimization of soil use and farm space. Gabi is less susceptible to pests and never require use of pesticides.

Experiences and accounts of farmers show very promising contribution of isda't gabi culture to improve the family nutrition, increase income and upgrade the standard of living of marginal farmers. A gabi tuber weighed one-half kilogram in four months when planted in a rice-fish culture project. When planted as a single commodity in an unfertilized but old fishpond, the same variety of gabi attained a weight of 1.5 kg in five months. A verification trial done in 1982 in the province of Bataan showed that tilapia attained a daily gain weight of 0.89 g/fish/day and grew to a final weight of about 121 g in 135 days. The fish relied on natural food and were not provided with commercial feeds. Some 50 heads of ducks were raised in a head pond where water passed through before reaching the isda't gabi pond. Duck manure could have fertilized the culture pond, hence the good harvest of tilapia and gabi.

fertilized at the rate and method mentioned in the preceding topic. Harvesting gabi can start five months after planting. It is advisable to harvest the gabi totally after a year because by this time they might have occupied the whole trench or a larger area intended for rice.

ECONOMICS

Tilapia w/ Gabi

A verification trial on gabi fish culture conducted in Bataan showed a production of tilapia comparable to the yields attained in fishponds. When stocked at the rate of 20,000 per hectare, the fish gained a weight of 89 grams per day and grew to a marketable size of 120.97 grams in 135 days. On the other hand, when planted at the rate of about 18,000 seedlings per hectare gabi produced an average of 15 corms per plant (270,000 corms per hectare) in the same culture period. Gabi fish culture can provide a net profit of about Php 362,000 per hectare in five months. However, gabi culture faces a marketing problem as explained in the preceding of the topics.

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- Plowing (P400/1,000 m ² /day)	2 days	800.00
- Diking & Plot construction(3x) 4 persons (@ P 300.00/day)	7 days	8,400.00
- Nets fencing (1 roll @6,000/roll), bamboo(15 pcs @ 120/pc)	1 roll net B-net 6,000/roll 15 pcs @ 120/pc	6,000.00 1,800.00
- 2 Wooden gates	200/unit	400.00
Total land development cost	Maximum use is 4 croppings	17,400.00
OPERATIONAL COSTS/CROPPING		
- Gabi Seedlings P 0.50 seedlings	1800	900.00
- Fingerlings T. nilotica size 10 (P1.00/fingerling) 80 % survival	2000	2,000.00
- Feeds	15 bags @ 620.00	9,300.00
- Inorganic Fertilizer Basal Fertilizer, Chicken manure (P 60.00/bag)	400 kgs (8 bags @ 825/bag) 75 bags	6,600.00 4,500.00
- Harvesting (3 Laborer) (250.00/laborer/day)	2 days	1,500.00
- Other Expenses (Transportation expenses, food, water, etc.)		4,500.00
- Farmer- labor 2 man-hours/day (5 mos or 150days/8 hours)	37.5 days @300/ day	11,250.00
TOTAL		Php 44,900.00

GROSS RETURNS (TILAPIA)

	QUANTITY	VALUE
Sale of Fish 80 % survival (P 70.00/kg)	400 kg	P 28,000.00
Value of corms produced (average of 15 corms/plant hill P 2.00/corm)	27,000 corms	P 54,000.00
TOTAL		Php 82,000.00
NET RETURN		Php 37,100.00

necessary during this period because of the depletion of natural food due to shading by the full grown gabi.

The harvest of gabi can start after five months. Maturity of harvest is signalled by a declined in the height of the plants and general yellowing of the leaves. Only big ones are harvested for the market. Tubers are harvested with the use of the spade, a shovel or a spade fork. Harvesting is done carefully to avoid damage to tubers.

Total harvest of gabi and fish is recommended after a year to ensure better harvest in the next cropping period. Harvested corms can be planted again or sold at a profitable price.

GABI-FISH CULTURE PRACTICES

Gabi culture is also incorporated in the following fish production practices:

Gabi Culture in Pond

Gabi can be grown along the dikes of fishponds. They are planted in rows at the average water line with 45 to 70 centimeters spacing between hills. The fertilizer applied on the ponds may also support the growth of the gabi. Nevertheless, side dressing with complete fertilizer (12-24-12) may be applied to facilitate better production. The fertilizer is applied at two tablespoonfuls per plant. It is placed into the holes dug about 10 centimeters from both sides of the plant. Afterwards, it is covered with fined soil.

Cultivation of gabi along the dikes of fishponds is profitable. However, adoption of the system is discouraged in hatchery ponds. Gabi growing along the dikes hinder the monthly seining or collection of fingerlings.

The space lost in the trenching design mentioned is utilized by gabi. The additional income from gabi offsets the decrease of rice yields from the space used for trenches. Gabi plants also help minimize dike erosion.

Corms and suckers are planted along the sides of the dikes with spacing of 70 to 80 centimeters between hills. The gabi are

Gabi as Vegetable Component

Gabi is a perennial, tropical plant grown primarily as a root vegetable for its edible corm, and secondarily as a leaf vegetable. Root is abundant in carbohydrate and rich in calcium. In its raw form, some plants are toxic due to the presence of calcium oxalate, although the toxin is easily destroyed by cooking or can be removed by steeping or soaking taro roots in cold water overnight.

Gabi is a fast growing root crop grown everywhere in many parts of the world. In other countries, it is called by other names, including dasheen, arrowroot or cocoyam. It is an ancient crop or earliest cultivated plants grown for its edible corms, stalks and leaves. The plant is widely used throughout the world, in Africa, Asia, the West Indies and South America. It is very important staple food in the Caribbean, Hawaii, Solomon Islands, American Samoa, West Samoa, Fiji, Sri Lanka, India, Nigeria, Indonesia, New Herbrides, Tonga, Niue, Papua, New Guinea, Egypt, Philippines, and others. In the Southern United States, gabi or taro is used as a supplement to potatoes.

Gabi is one of the important root crops in the Philippines. It ranks third in popularity to root crop farmers. It is usually planted at the backyards and even behind houses and does not require big areas to multiply.

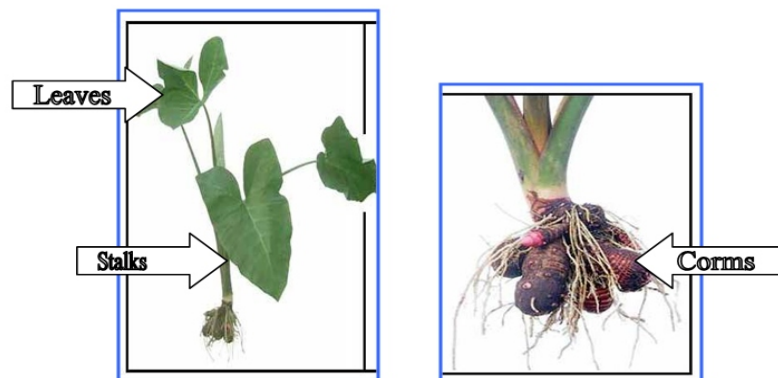


Figure 1. Different parts of taro

Nutritional values and uses

Gabi leaves are rich in vitamins and minerals and are good source of thiamin, riboflavin, iron, phosphorus, and zinc. Gabi also contains greater amounts of Vitamin B-complex than whole milk. The cooked leaves have the same nutritional value of spinach. The leaves are very good source of Vitamin B6, Vitamin C, niacin, potassium, copper, and manganese. Gabi corms are very high in starch and are good source of dietary fiber.

Aside from being used as staple food like potato in some countries, gabi is utilized in various ways. It is cooked in various dishes with shrimps, beef, pork and fish. It is also used as flavor enhancer in ice cream and other food products. It is made into noodle, taro cake, pie, jam, chips, variety of sweet snacks, and fried taro balls. Leaves are used in various spicy dishes like vegetables. Stems are pickled. Leaves and stems are sun-dried and stored for later use. Taro roots are dried to make flour which was said to make excellent pancakes when mixed with wheat flour.

Gabi is considered a health food, good for the immune system, particularly as a deterrent against malaria, yellow fever and dengue. It is also mashed-raw into a plaster to treat boils and inflammation. Roots can be used for treating insect bites.

Gabi is considered superior over other starchy staples. Its digestibility has been estimated to be 98.8 percent. The size of the taro starch grain is one-tenth that of potato and easier to be assimilated, so it can be used by persons with digestive problems. Gabi flour and other products have been used extensively for infant formulae in the US and have formed an important ingredient of proprietary canned baby foods. Taro is especially useful to persons allergic to cereals and can be consumed by children who are sensitive to milk. People eating taro are found to have excellent dental conditions like healthier teeth and gums. In Hawaii, it reduced incidence of pneumonia, diarrhea, enteritis and beri-beri among babies born on Hawaiian plantations.

The pest begins as purple-brown water-soaked lesions on and under the leaf (See figure 10). The pest can spread from plant to plant by wind and splashing rain. It results in lowering the quality of leaves, leading to reduced harvest.



The spread of the pest can be controlled by cutting off and burning old, dried and affected leaves; Adapting crop rotation practices; and planting the vigorous and healthy corms.

In other countries, pests and diseases affecting leaves and corms were reported. Control was done by intensive spraying of chemical pesticides. Such practice is extremely tedious, expensive, and reported to be not totally effective.

In the Isda't gabi project, the application of chemicals or pesticides to control diseases is discouraged because the culture gabi is integrated with fish farming.

Water Management

Water level is kept at a depth of about three centimeters for one week after the gabi are planted. When bigger gabi seedlings are used, the water depth is increased gradually to about 10 to 15 centimeters in seven more days. The fish are stocked when this depth is attained.

Harvesting

The fish are harvested after five months. The paddy is drained and the fish are either handpicked or caught with a scoop net. If fertilizer is applied at the rate and method recommended, tilapia will attain a weight of not less than 100 grams each at harvest time. The fingerlings produced can be retained for further growth. However, it is more advisable to remove all the fish at harvest time. The paddy is reflooded and restocked at the rate of 5,000 to 7,000 fingerlings per hectare. Rations of supplemental feeds are

unopened ones. Corms and suckers are detached from the mother plant and their roots are out to one half centimeter long.

The planting materials should be planted as soon as they are detached from the mother plant. If not at once, they must be kept moist by covering them with a wet net, jute sack or old clothes to prevent dehydration.

Planting

A day before planting, line the field by using a planting board or a marking gauge to facilitate planting. Planting gabi is very similar to planting rice in irrigated fields. Gabi are planted 0.45 meter apart while rows are one meter away from one another. Rows face east-west direction to expose the water to sunlight for a longer period of time. Exposure to sunlight is needed to maintain the production of the natural food of the fish.

Stocking of Fish

Tilapia nilotica (Oreochromis nilotica) is recommended species for gabi-fish culture. Fingerlings weighing six to ten grams are stocked at the rate of 10,000 to 20,000 fingerlings per hectare when the leaves of the planted gabi start to open, or when the plant can withstand deeper water of about 10 centimeters. Verification trials on fish stocking rates are still conducted to further check recommendation.

Fertilization

Animal manure is broadcasted before the first plowing to thoroughly incorporate into the soil. Apply about 3,000 to 5,000 kilograms of manure per hectare as basal fertilizer. To maintain the growth of plankton, manure of either chicken, duck or pig is applied at 3,000 kilograms per hectare per month. This quantity is divided into four and each portion is applied weekly.

Pest

An unidentified pest was observed to damage the leaves of gabi in experimental plots conducted at NIFTDC, Dagupan City.

Nutritional content per 100 grams

Nutrients

Peticles (Stalks)	Corms	Leaves	
Edible Portion (%)	81.0	55.0	84.0
Moisture	77.5	79.5	93.8
Food energy (cal)	8.5	69.0	19.0
Protein (gm)	2.5	4.4	0.2
Fat (gm)	0.2	1.8	0.2
Total carbohydrates (gm)	19.1	12.2	4.6
Fiber (gm)	0.4	3.4	0.6
Ash (gm)	0.8	2.0	1.2
Ca (mg)	32.0	2.68	57.0
P (mg)	64.0	78.0	23.0
Fe (mg)	0.8	4.3	1.4
Na (mg)	7.0	11.0	5.0
K (mg)	514.0	1237.0	367.0
Vit A (IU)	Tr	20385.0	335.0
Thiamine (mg)	0.18	0.1	0.01
Rivoflavin (mg)	0.04	0.33	0.02
Niacin (mg)	0	2.0	0.2
Ascorbic acid	10.0	142.0	8.0

With regards to industrial use, taro has starch granules varying in size from 1 to 6.5 micrometers which can be useful as additive to render plastics biodegradable.

Varieties of Gabi

In the Philippines, gabi plants are divided into two major varieties: upland and lowland varieties. The upland varieties that can be grown both in lowland and upland areas are Gabing Tagalog, Gabing Cebu, Purple Leaf, Karayo, Kabaloy, Negros Green Leaf, and Gabing Leyte. The lowland varieties which thrive in wetlands or highly irrigated areas include Princesa, Quezon White, Quezon Green, Ilocos Batek, Viscaya, Green Batek and Bikol Purple. Those varieties that can grow in wet areas are selected for isda't gabi project.



Taro leaves from BFAR- Manila

Gabi 'Tahig from CLSU

Fish Component

There are fish species that are suitable for farming together with gabi. Some of the common species are the following:

Tilapia (*Oreochromis niloticus*)

Tilapia is a highly-priced commodity especially in the rural areas. It is the most recommended species of fish in all integrated farming systems in the country because it grows faster than any other freshwater species. It has a wide tolerance to adverse water conditions, and is adapted to crowding.



Feeding of tilapia is inexpensive. Tilapia is omnivorous and can feed on variety of food such as plankton, algae, rice bran, commercial feed, and kitchen wastes. Fingerlings of various sizes are available everywhere in the country. They mature in a short span of time and are easy to propagate.

African Catfish (Hito)

Catfish or hito is a very popular fish for farmers with less growing area or with small fishponds. The species is hardy and can grow very well at high stocking density than any other species. They can live in shallow ponds dark environment. Hito is omnivorous and can grow on variety of feedstuffs like kitchen wastes, cooked entrails of poultry and livestock, and commercial fish feeds. They are easy to breed and fingerlings are commercially available. They grow very fast at about 5 g/fish/day. They can be harvested after three months of culture. The market price ranges from PhP 80 - 150 / kg.



Fence made of net or plastic sheet of at least one foot in height installed around the culture paddy is necessary to prevent the catfish from escaping. It is the biological behavior of the fish to

C. Gates and Screens

Water supply and drainage gates need screening devices to prevent escape of stocked fish and entrance of unwanted fish species. Water spillways must also be properly screened.

BASIC CONSIDERATION IN MANAGEMENT

In the management of isda't gabi culture, the following must be considered:

Land Preparation

The preparation of the paddy for gabi-fish culture is similar to that of a lowland rice paddy. Land preparation influences the yields of gabi and fish. Improper land preparation may cause serious weed problems that could hamper the growth of plankton and complicate harvesting of fish. Good land preparation mixes organic material with soil and forms a hard layer (plow) which reduces water effect leaching losses.

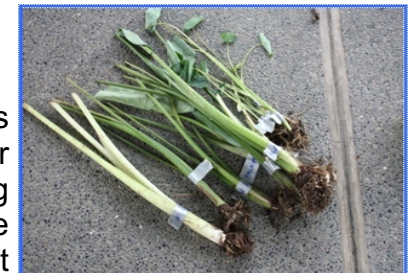
Plow and harrow the field three to four times to soften the ground. Set the distance between rows using stakes and string. Construct the rows of planting beds, initially using the plow and then using spade. Make the canals between rows deep as possible. Connect the canals by constructing deep canals across at the two ends of the rows.

Planting Gabi

Gabi are planted with the use of materials given below, following these steps:

Planting materials

Small corms and suckers growing from the sides of mother plants are normally used as planting materials. Mother plants may also be used by cutting all the leaves except



can be planted in plots. One to three plants can be planted per m². A hectare without fish can have a planting density of 10,000 to 45,000 plants/ha. With fish, the number of planting materials needed is lower in density, to provide ample space for the fish. Higher planting density will produce more small corms, and the average yield per plant or per hill is reduced. At last part of the cropping season, the gabi is expected to fully shade the growing area, resulting to least growth of fish natural food like algae and plankton. Consequently, the gain-weight per fish decreases. Spacing between gabi plants of approximately 90x60 cm is common. However, too wide spacing may result to luxuriant growth of weeds. Weed control may become a serious and time consuming activity.

The fish will grow in canals, constructed in-between rows of gabi, which are deepened to accommodate passage and growing of fish. The distance between rows (gabi plant) is about 1 m. The width of the canal passage between rows is about 50 cm. The species of fish suitable for this farming design is tilapia, catfish and ulang. When catfish is preferred, a one-foot high fence made of net, plastic sheet or used tarpaulin is installed on the peripheral dike to avoid escape of catfish. The fence will also discourage the entry of frogs and snakes that could serve as predators of the

2. Gabi planted along the peripheral dike

Constructed or old ponds can integrate gabi farming system by planting along the periphery of the dike near the water edge. The distance of the plant is about 50 cm when many planting material are available. When the dike is newly constructed, the plants will help prevent erosion of dikes. The plant may also absorb excess nutrients in the water produced by excessive feeding and block sunlight and prevent overgrowth of weeds on the dike.

C. Dikes

The dikes of the paddies should be higher than the normal height used for rice paddies. Stronger to contain and retain more water with minimal loss. A dike with a base of 0.75 to one meter and a height of 0.70 to 0.80 meter is satisfactory.

swim out of the paddy by jumping or crawling especially at night or during rainy days. Water inlet and outlet gates must be properly screened to prevent escape of stocks and entrance of unwanted fish species.

Freshwater prawn (Ulang)

Ulang is a high-value aquaculture species that can be grown simultaneously with gabi. Highly productive strains have been domesticated and hatchery production of post-larvae (PL) was



established many years ago. Ulang can be grown to marketable size in 120 - 150 days with more than 75% survival rate. Feeding regimen includes natural food, kitchen wastes and various plant materials like boiled corn grits, squash and other vegetables, rice bran and commercial feeds.

Ulang is considered a high-value species. It commands price ranging from P200 to 250 /kg. The paddy should be fenced, similar to what was described when catfish is used. All water inlets and outlets must be properly screened to avoid escape of ulang and entry of wild carnivorous species like mudfish or dalag.

Site Selection

Sites intended for isda't gabi culture project must meet the following basic criteria:

A. Type of soil

The soil must have an excellent water holding capacity. Poor soil results in loss of water through percolation and leakage. Soil with high percentage of clay is preferred. Old rice paddies or earthen ponds can be used for isda't gabi project. Designs of culture area and farming system will depend on the existing growing area.



B. Quality and Quantity of Water Supply

The water supply must be free of pesticides or chemicals that would kill fish. Water should be available when needed. Wells and springs are excellent sources.

Water from communal irrigation canals/ reservoirs and rivers can also be used provided that necessary precautionary measures are observed. Irrigation waters may sometime contain toxic materials because farmers tend to clean their pesticide-



sprays in irrigation canals. Irrigation water also harbors carnivorous fish species. Screening devices must be installed in water supply and outlet gates to avoid entry of wild fish species.

C. Accessibility to the source of inputs

Application of organic fertilizers is vital to support the growth of both gabi and fish. Gabi and tilapia grow better with manure or soils rich in organic matter. A basic consideration in isda't gabi culture is accessibility to source of animal manure. Chicken manure is the most common manure in the market. However, in places where chicken manure is not available, duck manure can be used. Integrated duck-raising in the system can be recommended when chicken manure is unavailable. Ducks are fenced in one corner or one side of the project area, allowing them to swim in a limited area. Covering the duck pen with rice hay is an effective way to collect the wet duck manure. The hay (with manure) is then soaked or applied in strategic areas of the Isda't gabi project.

In the growing of other species like hito and ulang, availability of commercial feeds and other feedstuffs must be considered.

D. Accessibility to the market

In most gabi culture projects located in remote areas partial-harvesting of the root crop is done to meet the demand of the

community or market. Harvesting on time can maximize profit from both gabi and fish because the shading effect from mature, but unharvested gabi (in plot planting of gabi) may hinder the growth of natural food, like plankton which is important food for tilapia.



Farm Layout and Construction

Growing ponds for Isda't gabi integrated culture may be designed and constructed following the guidelines enumerated below:

A. Size of paddy

Gabi is ordinarily grown in paddy fields or ponds where water is supplied by rainfall or by supplemental irrigation. They grow very well in the wild in wetlands. Cool, flowing water yields the best crop. In the Philippines, few gabi farmers were observed to have planting areas of more than 500m². Nevertheless, in simultaneous isda't gabi farming, the area mentioned may be practical for pond preparation, water management, multi-stage cropping of gabi and isda, easy harvesting of fish and sustained marketing of harvests. If culture or farming in larger area is preferred, the area can be divided in smaller area of 500 m² or smaller for manageability.

B. Designs

The isda't gabi paddy or pond can be designed to optimize the harvest of fish as major crop and gabi as minor or supplemental commodity. The following are two designs that may be adapted:

1. Gabi planted in rows or plots

When irrigated rice paddies will be used for the project, gabi