TERUNG ASAM SARAWAK TECHNOLOGY PACKAGE

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Front cover page: Fruits of TerungAsam Sarawak (*Photograph*:Shariah Umar)
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Preface

Terung asam, terungdayak or terungiban (*Solanumlasiocarpum*Dunal), later registered as *TerungAsam Sarawak*in the Geographical Indication certificate in 2011, is a well-known wild fruit vegetable among Sarawakians. It is slowly liked by outsiders who have lived in Sarawak or have visited Sarawak as tourists due to its unique eating attributes.

Terung Asam Sarawak (TAS) has been domesticated for decades and is traditionally planted as an intercrop in hill paddy field. Realising it potential, research work on TAS was initiated in late 1980s when Department of Agriculture (DOA) Sarawak was assigned to carry out R&D on indigenous fruits and vegetables by the Ministry of Agriculture, Sarawak. Since then, various information on cultural, agronomic, pest and disease management has been generated. Furthermore, an improved variety, Terung Mas, was released in 1997. Recently, various value-added products have been developed by the

Research Division of DOA Sarawak. Besides, TAS has become a pricy fruit vegetable these days with an average price of RM5.00 per kilogramme in local markets. Thus, there is a potential to promote this crop for commercial cultivation.

I wish to congratulate the authors for their efforts to produce this technology package booklet, which can be used as a guide to assist growers and relevant parties for commercial production of Terung Asam Sarawak.

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1. Introduction (*Shariah Umar*)

Since olden days, *terungasam* or *terungDayak* has always been a favourite to many people in Sarawak as a fruit vegetable, food additive or flavouring in many local dishes. Local growers especially the hill paddy farmers traditionally intercrop it with hill paddy planting. Today, due to incoming demand and high market price, it has been planted as one of the local specialty fruit vegetables throughout the State.

Proximate nutrients composition per 100 g edible portion of the fruit as analysed by the Chemistry Laboratory of Agriculture Research Centre, Semongok is as in Table 1.

The fruits can also be developed into downstream products such as dehydrated slice, jam, fruit rolls, jelly or made into fruit juice and cordial drink. These will add a value to this old crop for commercialisation. Hence, this old crop has a prospect to be developed and promoted as a future 'money crop' for the Sarawak agriculture industry. Furthermore, it was registered under Geographical Indications (GI) certification in

2011 as TerungAsam Sarawak (GI No. GI2010-00002) to ensure its authenticity and great value is protected.

Table 1: Proximate nutrients composition per 100g edible portion of the fruit

Nutrients	Proximate composition
Moisture (%)	89.5
Protein (g)	1.1
Fat (g)	0.9
Carbohydrate (g)	5.8
Crude fibre (g)	1.7
Phosphate (mg)	27
Potassium (mg)	188
Vitamin C (mg)	8

2. Plant Botany (*Shariah Umar*)

Common Name :TerungDayak, TerungAsam
Scientific Name :*Solanumlasiocarpum*Dunal
Family :Solanaceae

General characteristics ofterungasam are as follows:

Root	:	It has tap root system
Growth habit	:	It is a woody perennial herb
Stem	:	The stem is hairy, thorny and woody, can grow to 2.5 m height, upright, spreading branches, sometimes with tinged light or dark purple.
Leaves	:	The leaves are alternate, large green, ovate to ovate elliptic, prickly leaves with 4-6 short, broadly triangular lobes on each side, with smaller secondary lobes, with 5-8 cm long petiole, underside of most cultivars covered with very fine wool-like hair.
Flower	:	Inflorescence of 2-6 flowers. The flowers are small, white-coloured, star-shape petals arrangement and hairy outside.
Fruit	:	The fruits are small to large, globose to oval sourish fruit. Immature fruit is green and turns into normally yellow to orange when ripe, some have tints of dark purple. In other varieties, the ripe fruit is purplish black or cream to

brownish black.

Terungasam flower

Terungasam plant

Diversity of colours and shapes of terungasam

3. Crop requirement (*Shariah Umar*)

3.1 Soil

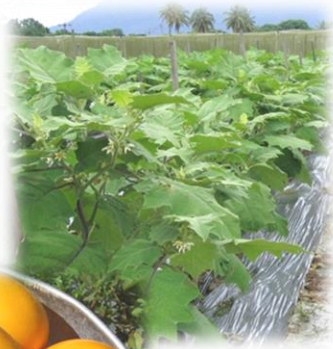
Mineral or loamy soil that is well drained with pH 5.5 to 6.8 and prepared with organic matter is suitable for planting terungasam. It is a water-loving plant especially during fruiting. Therefore, it is very important that the soil can absorb and retain water effectively.

3.2 Climatic

The terungasam can be grown under local condition with temperatures between 25^{o}C and 35^{o}C and with 1,500 mm to 2,000 mm annual rainfall. It can also be planted during the dry season with good irrigation.

4. Recommended Variety (*Shariah Umar*)

Recommended Variety: Terung Mas (ARC-TD-L2)



Uniform plants of the Terung Mas

Uniform fruits of the Terung Mas

The agronomic traits ofTerung Mas are as in Table 2.

Table 2 : The agronomic traits of Terung Mas

Agronomic traits	**Terung Mas (ARC-TD-L2)**
Days to harvest (from transplanting)	132-141 days
Harvest period	26-44 days
Fresh fruit yield	16-26 mt/ha
Days to 50% flowering	59 days after transplanting
Fresh fruit yield	2.6 kg/plant
Fresh fruit number	10.4 no./plant
Fruit size	254 g/fruit
Flesh thickness	14.8 mm
Fruit shape	Oval oblong, uniform
Fruit color	Chrome yellow
pH of juice	4
Acidity	0.64 %
Plant height	132 cm
Plant type	Upright, spreading branches, thorny
Leaves	Large green, lobed leaves with purple tinged prickly stalks.

Bacterial wilt incidence	Moderate to susceptible
Leaf diseases incidence	Moderate

5. Cultural Practices (*Shariah Umar*)

5.1 Nursery

The seeds may be sown directly in the field or seeding trays or polybags in a nursery. To prepare seedlings as transplants, sow 2-3 seeds into small polybags (10 cm x 12 cm) or trays filled with enriched nursery soil. Watering and application of few granules of a common compound NPK fertiliser or well rotted chicken manure would bring the germinated seedlings tohealthy transplants. If seeding trays are used, the 50-hole trays are suitable. Each seeding hole or polybag should only have one seedling after 2 weeks. At the age of 3 to 4 weeks, the healthy seedlings may be transplanted to the field.

5.2 Land preparation

Before planting, the field should be prepared by removal of existing vegetation. For hill slope cultivation, as in hill paddy, direct sowing like

dibbling may be used. On flat to gentle slope, beds measuring 80 cm (W) x 30 cm (H) and 10 m (L) spaced 40 – 60 cm apart should be prepared for transplants. Apply 8-10 kg well mature composted manure and 0.5 kg NPK compound fertiliser for each bed at least a week before transplanting. On non-tilled land, apply similar amount of fertiliser when the seedlings reach the transplanting age.

5.3 Seeding and transplanting

Single row planting is recommended. For both direct seeding and transplanting methods, the spacing should be 1.0 m within row and 1.2 to 1.5 m between rows. Mulching, using dried grass such as lallang (*Imperatacylindrica*), 80% black shade net or silvery agricultural cover,is useful for moisture retention and weed control. Watering regularly helps plant establishment.

5.4 Grafting for bacterial wilt disease control

The growing of terungasam on intensively used land has been almost impossible due to the presence of bacterial wilt disease. Recent grafting technique developed at ARC Semongokhas made it possible now to grow 'Terung Mas' on

'TerungUnggul' (*Solanummelongena*), a disease resistant rootstock. TerungUnggul seeds are available from ARCSemongok.

For grafting, shoots of 2-3 weeks old 'Terung Mas' seedlings are grafted to ‘TerungUnggul’ seedlings using the 'wedge and v-cleft' method to produce the transplants. Prune away extra rootstock shoots to allow better scion growth. Any other known bacterial wilt disease resistant variety may also be used as rootstock.

5.5 Fertiliser and manure

The transplants in each bed may be dressed with 0.5 kg of the compound NPK fertiliser 15:15:15 during vegetative stage or 12:12:17:2+TE for flowering and fruiting stages at 3-4 weeks intervals. At the onset of flowering and fruiting, increase the applications to 0.8 kg. Well composted manure may also be applied at twice a month at 8-10 kg.

5.6 Pruning

Pruning is necessary to reduce pest and disease incidence. Too dense canopy will create a good conditionfor pest and disease attack. Also, too

much of vegetative growth will make harvesting work difficult. Pruning work can commence one week after transplanting by cutting off 1 or 2 of the lower leaves. After that, prune leaves or new shoots that grow belowsix inches from the ground. Pruning also has to be done on the old leaves and unnecessary leaves or shoots/branches which crisscross among them.

Fruit thinning is also suggested when necessary; leave only 1-2 fruits at one point. Thinning of fruit is suggested because excessive fruit will compete with each other for nutrients especially carbohydrate. This carbohydrate drain, can also weaken the plant and make it susceptible to pest and sunburn damage. Benefits of fruit thinning are:(1) the small number of fruits allow them develop to their maximum size besides allowing the fruits to receive more sunlight, so that the skin colour may be improved, (2) lessen the chances of limb breakage due to heavy fruiting and (3) reduce the spread of diseases because less-crowded fruit gives good aeration to the plants.

6. Pest and Disease Management

6.1 Pest management (*NurNajwaHamsein*)

6.1.1 Fruit fly (*Bactroceralactifrons*)

Damage symptoms:
The females oviposit under the peel or in wounds or blemishes on the fruit surface. A black speck can be seen at the oviposition sites. The larva feeds in the fruit causing it to rot, or premature fruit drop.

Control:
i) Practise crop rotation
ii) Wrapping of fruits will help to reduce infestation
iii) Use deltamethrin or cypermethrin during serious infestation
iv) Remove damaged fruit, to remove source of re-infestation

Larva in fruit pulp

6.1.2 Fruit fly *(Atherigonia*spp.*)*

Damage symptoms:
The females oviposit under the peel or in wounds or blemishes on the fruit surface. A black speck can be seen at the oviposition sites. The larva feeds in the fruit and stem causing it to rot.

Control:
i) Practise crop rotation
ii) Wrapping of fruits will help to reduce infestation

iii) Use deltamethrin or cypermethrin during serious infestation
iv) Remove damaged fruit, to remove source of re-infestation

LarvaAdult

Damage on stem

6.1.3 Leaf eating beetle(*Epilachna* sp.)

Damage symptoms:
The beetle feeds on the leaves.

Control:
i) Use deltamethrin or cypermethrin during serious infestation

Adult beetle feeding on leaf

Nymph feeding on leaf

6.1.4 Mealy bug (*Planococcus* sp.)

Damage symptoms:
The bug sucks sap from the stems, fruits and leaves resulting in loss of plant vigour.

Control:
i) Pluck off infested plant parts and destroy them
ii) The insecticides used for the control of the other pests would take care of this pest

Shoots

Stem

Fruit

6.2 Disease management (*Wong Mee Hua*)

6.2.1 Bacterial wilt

Causal agent :
The bacterium *Ralstoniasolanacearum*

Symptoms :
First appears as drooping of leaves without yellowing. The sudden leaf wilting usually occurs during the warmest part of the day. When the stem is cut, brown discolouration of the water-conducting tissues is seen. As the disease progresses, a permanent wilt of the entire plant develops with leaf chlorosis but later turns necrotic. Brownish-black lesions and rotting may also be found on the lower stem, collar region and roots.

Management :
- Use disease-free seeds.
- Raise seedlings from sterilised soils before field planting.
- Avoid planting in the same area where the disease has occurred.

- Disinfect stakes before reuse as well as farm tools after use.
- Remove and destroy infected plants and crop residues.
- Practise crop rotation with non-*Solanum* plants.
- Eradicate weeds as many of them may harbour the pathogen without showing any symptoms.

Early stage showing the infected plant on the right is wilting without foliage chlorosis.

Advance stage showing leaf necrosis and plant dying

Lesion and rotting on the lower stem, collar region and roots

6.2.2 Fusarium wilt

Causal agent :
The fungus *Fusarium* spp.

Symptoms :

- The older leaves turn yellow followed by necrosis of these leaves. As the disease progresses, the younger leaves are also

affected and the whole plant wilts. Dark brown lesions occur at the collar region and develop up the stem. When the bark is removed from the stem, brown discolouration of the water-conducting tissues can be seen.

Management :

- Use disease-free seeds.
- Raise seedlings from sterilised soils before field planting.
- Avoid planting in the same area where the disease has occurred.
- Disinfect stakes before reuse as well as farm tools after use.
- Remove and destroy infected plants and crop residues.
- Practice crop rotation with non-*Solanum* plants.

The debarked stem showing lesions at the collar region and discolouration along the stem.

6.2.3 White root

Causal agent :
The fungus *Rigidoporuslignosus*

Symptoms :

- Infected plants show yellowing of leaves and eventually wilt.
- Stunting may precede the wilting.
- Roots are covered with white, thread-like fungal growth and these aggregation of fungal growth may also be seen extending up the lower stem near the soil line or at the collar region. As the disease progresses, leaves become necrotic and severely infected plants may die.

This disease is usually found on sites previously planted with rubber trees or newly cleared land where old stumps and roots are not properly removed.

Management :

- Remove remnants of stumps and roots of rubber or jungle trees during land preparation.

- Avoid planting in the same area where the disease has occurred.
- Disinfect stakes before reuse as well as farm tools after use.
- Remove and burn infected plants and crop residues.

White, thread-like fungal growth on the lower stem and all over the roots.

7. Yield, Harvest, Post harvest and Product

7.1 Yield (*Shariah Umar*)

The terungasam is a heavy fruit producer and is capable of giving many rounds of harvest if the plants are maintained in good conditions. Ratoon crop is also possible after main peak production period by pruning off the old shoots and manuring the plants to encourage new shoots and obtain further yields.On average the crop may yield about 16 to 20 mt/ha and the farm price could be at RM 2to RM3 per kilogramme.

7.2 Harvest (*Shariah Umar*)

The fruits are ripe and harvestable when the whole fruit attains a strong shining chrome yellow. Fruits green or slightly yellowish should not be harvested, as this would shorten the shelf life of the harvested fruits. At this stage the fruit has a bitter taste.

Harvest on a fine day. Remove fruit by cutting the stalk with a sharp knife or a pair of secateurs. Place fruits in a basket or sack and store in a cool

place before sending out to the market. Avoid physical damage to the fruits. Do not use plastic bags with poor ventilation. Over-heating and physical damages lower the produce quality and reduce shelf life.

7.3 Post harvest and Product Development (*RajmahMuzliRazili*)

7.3.1 Post harvest

It is recommended to store fully ripe fresh terungasam in a chiller or at 10ºC storage temperature. Our study has shown that the quality remains the same for 30 days compared to unripe fruit that can only last for 10 days. After that, the fruits start to wrinkle and brown dark spots also appear. Finally, they will shrink and become soft.

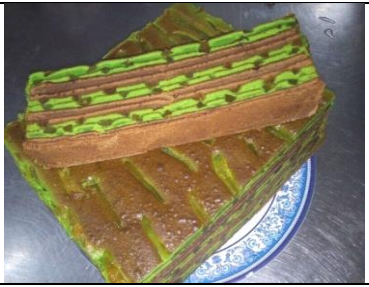
7.3.2 Products development

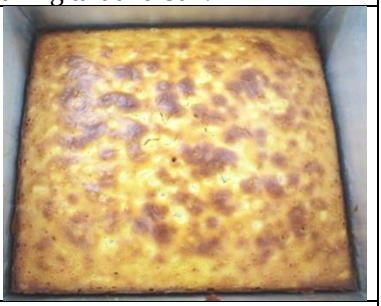
Since 2011, the Post-harvest Sectionatthe Agriculture Research Centre Semongok has developed 15 potential products for commercialisation (Table 3). The recipes are

included in a separate book titled 'ProdukTerungAsam Sarawak'.

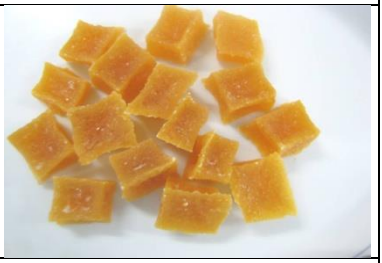
Table 3: Products of TerungAsam Sarawak

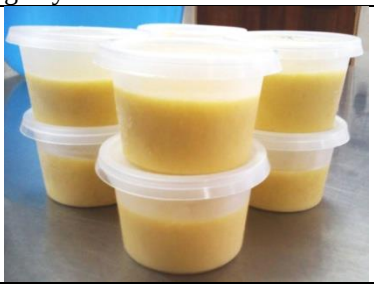
No.	Product	Photo
1.	Dehydrated Terungasam	
Using oven dried method at 65°C for 16 hours. Shelf life: at least 15 months at room temperature.		
2.	Terungasam juice	
Makes a very refreshing drink.		

3.	Gubahan Tiung cake	
Main ingredient: dehydrated terungasam. Suitable for any festival occasion.		
4.	Tiung Chips cookies	
Main ingredient: dehydrated terungasam. Suitable for high tea and any festival occasion.		

5.	Terunga sam jam	
Can be used for making tart and bun.		
6.	Tiung cake	
Main ingredient: dehydrated terungasam. Tastes just like orange cake and the formulation can also be used for making muffin or cup cake. Suitable for high tea and any festival occasion.		

7.	Tiung cheese cake	
Main ingredient : terungasam puree and juice Suitable for any festival occasion.		
8.	Sambalt erungasam	
Can be consumed with rice during lunch or dinner.		

9.	SlicedTerungasam	
As a substitute of asamkeping or gelugur for flavouring.		
10.	Tiung delight	
Main ingredient : terungasam puree Suitable for serving anytime and festival occasion.		

11.	Terungasam cracker	
Main ingredient : terungasam puree Suitable for serving anytime and festival occasion.		
12.	Terungasam ice-cream	
Main ingredient : terungasam puree		

13.	Terungasam Jelly	
Main ingredient : terungasam puree Suitable for dessert and high tea.		
14.	Terungasam in syrup	
Suitable for dessert and can be taken together with ice cream.		

15.	Terungasam in brine		
Suitable to bring outside Malaysia to cook together with fish or chicken.			

8. Costs and Returns(*Shariah Umar*)

8.1Estimated cost for production of terungasam

Bed size : 80cm (W) x 30cm (H) x 10 m(L).
Planting distance :1 m in row @ 1 row/bed.
Plant density :6,150 plants/ha.
Harvesting :136 days after transplanting

Table 4 shows the production cost of terung asam.

Table 4: Production cost of TerungAsam Sarawak

Work type/farm input/asset	Contract/input pricing/depreciation(RM)	Labour		Total cost (RM)
		Labour day*	Cost(RM)	
Seeds[1]	0	0	0	0
Land and beds preparation(contract)	1,000.00	0	0	1,000
Liming[2]	210.70	1	30.00	240.7
Sowing	0.00	5	150.00	150
Planting (transplanting)	0.00	12	360.00	360
Fertilising[3]	12,146.70	36	1,080.00	13,226.7
Weeds control[4]	120.00	0	0.00	120
Plastic mulch[5]	2,400.00	0	0.00	2,400
Pest and disease control[6]	850.00	40	1,200.00	2,050

Table 4: Production cost of TerungAsam Sarawak - continued

Fuel and lubricant for water pump[7]	1,020.00	0	0.00	1020
Irrigation system and water pump maintenence[8]	450.00	0	0.00	450
Harvesting	0.00	120	3,600.00	3,600
Sub-total	**18,197.40**	**214**	**6,420.00**	**24 617.40**
Depreciation**				
Drip irrigation system	700.00			700.00
Water pump	40.00			40.00
Water pump engine	260.00			260.00
Knapsack sprayer	20.00			20.00
Hoe	7.20			7.20
Sore and shed	41.67			41.67
Sub total	**1,068.87**			**1,068.87**
Total	**19,266.27**	**214**	**6 420.00**	**25,686.27**

Note:

[1]Seed- can be obtained from DOA Sarawak or can be produced by the farmer

[2]Lime - dolomite 490 kg/ha on mineral soil(Semongok series) @ RM430/ton

[3]NPK 15:15:15 -0.62 ton @ RM2 410/ton; NPK 12:12:17:2+TE -2.5 ton @ RM2 350/ton; Chicken dung - 29.4 ton @ RM162.50/ton

[4]Weedicide - 8 L @ RM60/4L

[5]Plastic mulch - 40 rolls @RM60/roll

[6]Depends on pest and disease occurrence

[7]6 month@ RM170 per month

[8]6 month@ RM75 per month

*1 labourday= RM30.00; **Depreciation is based on asset depreciation per season for Brinjal (MARDI, 2007)

8.2 Returns

Table 5 shows the estimated return for planting one hectare of TerungAsam Sarawak in one season.

Table 5: Estimated return from planting of TerungAsam Sarawak/ha/season

		Returns based on three selling prices		
Yield(kg/ha)	Return	RM 2.00/kg	RM 5.00/kg	RM 10.00/kg
16000	Gross	32,000.00	80,000.00	160,000.00
(low)	Nett	6,313.73	54,313.73	134,313.73
20000	Gross	40,000.00	100,000.00	200,000.00
(medium)	Nett	14,313.73	74313.73	174,313.73
23000	Gross	46,000.00	115,000.00	230,000.00
(high)	Nett	20,313.73	89313.73	204,313.73

* Gross = yield x selling price: Nett = Gross – cost of production/ha/season

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