Introduction To
Rice Cultivation & Management

Promoting Of Smallholders Rice Production

One of the important activities of the promotion of smallholders rice cultivation and production project in PNG is to Produce, Improve and Disseminate rice instruction, information and materials to smallholders rice farmers to enhance their knowledge and skills for rice cultivation.

Currently there is a huge demand for information on rice cultivation in Lumi area, Sandaun Province and the country at large emanating from the growing interest of farmers and other people who want to grow and consume their own grown rice rather than imported rice.

This basic Rice Cultivation Manual is a guide intended to educate farmers to equip them with knowledge and skills of rice cultivation. The Manual is also intended to enhance the farmers appreciation, understanding and awareness of the rice production system, which entails pre-harvest operations from land preparation to harvesting and post harvesting processes, from the produce for consumption and for seed production and storage for the next cropping. Some of the features in the manual provides comparative analysis between the rice cultivation and PNG traditional root crop cultivation. It highlights the variation in the production and management practices and inputs of two main production systems (up land or low land) that provides information on utilization of simple low input post – harvest processing technologies and the production of good quality seeds.

Index

Introduction

The rice is a food and cash crop as other grain crops. It is for consumption and for sale to earn money. Rice is an introduced plant like many other grain crops to most Papua New Guineans, even though we are subsistence farmers, we do not really know how to grow rice and manage the whole field ourselves. Many of the farmers are just planters and not farmers. Farmers they do care for their crops, while planters don't care. However, the National Food Security imposed the policy with their objectives, nutritional status and living standards of the people of Papua New Guinea should be improved. Therefore, with this basic training each farmers should now be able to see and make huge difference in the rice and other related grain crops.

Rice is the seed of the monocot plants Oryza sativa (Asian rice) or Oryza glaberrima (African rice). As a cereal grain, it is the most important staple food for a large part of the world's human population. It is the grain with the second-highest worldwide production, after maize (corn). Rice is the most important grain with regard to human nutrition and caloric intake, providing more than one fifth of the calories consumed worldwide by people. Rice is normally grown as an annual plant, although in tropical areas it can survive as a perennial and can produce for up to 30 years.The rice plant can grow to 1–1.8 m (3.3–5.9 ft) tall, occasionally more depending on the variety and soil fertility. It has long, slender leaves 50–100 cm (20–39 in) long and 2–2.5 cm (0.79–0.98 in) broad. The small wind-pollinated flowers are produced in a branched arching to pendulous inflorescence 30–50 cm (12–20 in) long. The edible seed is a grain 5–12 mm (0.20–0.47 in) long and 2–3 mm (0.079–0.12 in) thick.

Rice cultivation is well-suited to countries and regions with low labor costs and high rainfall, as it is labor-intensive to cultivate and requires ample water. Rice can

be grown practically anywhere, even on a steep hill or mountain. Although its parent species are native to Asia and certain parts of Africa, centuries of trade and exportation have made it commonplace in many cultures worldwide.

While flooding is not mandatory for the cultivation of rice, all other methods of irrigation require higher effort in weed and pest control during growth periods and a different approach for fertilizing the soil.

The seeds of the rice plant are first milled using a rice huller to remove the chaff (the outer husks of the grain). At this point in the process, the product is called brown rice. The milling may be continued, removing the bran, i.e., the rest of the husk and the germ, thereby creating white rice. White rice, which keeps longer, lacks some important nutrients; moreover, in a limited diet, which does not supplement the rice, brown rice helps to prevent the disease beriberi.

Either by hand or in a rice polisher, white rice may be buffed with glucose or talc powder (often called polished rice, though this term may also refer to white rice in general), parboiled, or processed into flour. White rice may also be enriched by adding nutrients, especially those lost during the milling process.

Growing Rice

(1) ADVANTAGES OF RICE:

- Saves your money – own grown rice.
- Surplus, sell some to earn money any time.
- Full of enrichment, more nutritious.
- Supplement to food shortage.
- Can be stored for at least 1 year and 6 months (one and half years)
- Takes only 2- 3 Months mature to harvest.
- Easy to carry to longer distances.

(2) DISADVANTAGES OF RICE:

- Weeds can affect your rice yields.
- Needs more men power to work in the bigger fields.
- Must have own tools and equipment.
- Larger fields needs more men power and also will destroy environment.

(3) RICE CYCLE:

If you are good rice farmer, you should look after yourselves with rice. Remember that rice is a seed - just like other seed plants you begin with seed and you will finish with seeds. Rice seed is very important because will help in the near future when harvesting rice for milling. Don't mill all the rice at once always save some for replacement and also keep the rice seeds in a proper place after harvesting and drying.

(4) UPLAND AND LOWLAND:

Grow rice in the water (lowland or wetland). Rice grows well and produces more yields or production. These varieties are better to grow in the water logged areas or swampy land: the varieties are Nari 1- 5, 15, 16 and 17. They also grow well in the temperate and cold regions and can also be grown in the dry land areas, but can't produce much seeds.

The dry land rice are Tru kai, (TCS 10), IR10, Golden mountain land and many others. These varieties of rice grow very well in the dry land areas which are rich and contains much nutrient in the soil. However, upland and lowland rice both grow well and gives high yielding and quality production depending on the management per yield by each farmer.

RICE PRODUCTION

OUTLINE:

(A) Post Harvesting
(B) Planting Method
(C) Thressing
(D) Straining and Drying
(E) Milling and Packing
(F) Storing Method
(G) Weeding and Mulching
(H) Cooking Method

(A) Post Harvesting

There are three ways of harvesting rice:

(1) TIP HARVESTING:

Harvest when rice begins to turn yellow from the tip of the rice to the edge. All rice must turn yellow or golden brown before you harvest them.

(2) PANICLE HARVESTING:

Harvest from the top of the rice, through selecting and picking. This is when all rice grains turn yellow or golden brown before you could harvest them.

(3) STOCK HARVESTING (SWEEP):

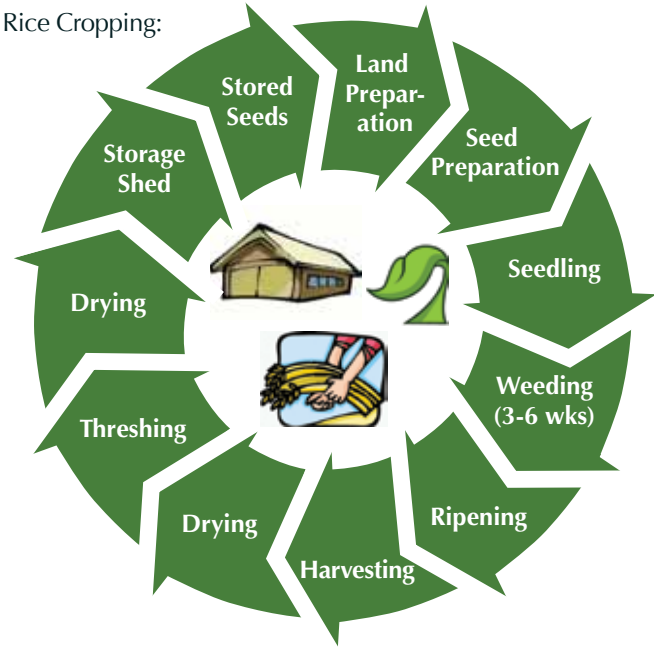
Harvest at the base level when all the rice grains turn yellow or golden brown. However, it normally happens when you harvest your rice three (3) times already at the same field.

Remember – NARI, 1-5, 15, 16, 17 harvested when they are still green with spotted black on them. Over ripe rice may affect the milling process This may sometimes crushes into pieces and get mixed with good rice and spoil it.

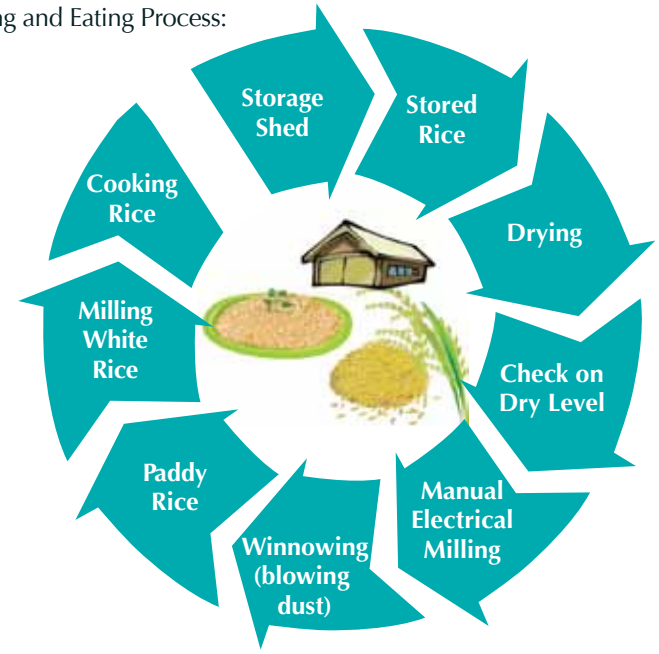
NARI rice are harvested when they are three (3) months mature and golden mountain (TCS10) are harvested when at the stage of two (2) months and two (2) weeks. TCS-10, is a variety of golden mountain and both are hybrided from tru kai. Both have the larger grain than Nari ones. Nari ones have smaller grain, but depends on the soil nutrients and management.

RICE AND FOOD CROP PRODUCTION STRUCTURE:

Basic Rice Cropping:



Milling and Eating Process:



(B) Planting Method:

This method depends upon the physical landscape or the geographical location of the land area that you want to plant your rice. This does not border about accurate measurement of planting. As long as you plant them in rows and allow space between each plant so that would allow space for you to pass through during the harvesting and weeding periods.

All the seeds have to be stored up to three (3) months only for planting and if more than that required period the seeds would be of no use. Be careful during harvesting and planting season remember not do mix the varieties of rice seeds. For instance when planting TCS10, you must always put a mark to avoid confusion with other varieties. Also remember to keep exact dates and months that you plant, this should assist you monitor your rice from the planting up to the harvesting period so that you can know the exact date for harvesting the paddy/rice.

Normally, TCS10, space between the rows is required at 20x40cm apart for planting and NARI is spacing at 30x30cm between each plant. The required seeds you can plant should only be four (4) seeds per hole. The same field can be used to plant only three (3) times and after the third planting you must shift over to new location.

(C) Thressing:

This would also depend on the weather, if it is a fine day you can dry them in the sun and if the weather is unreliable then you may have to leave them inside the bag for at least three(3) days (method known as steam process) when you bit , jump or step on the grain that makes the grain becomes loosing from its stock and that makes the grain easily drying up.

(D) Straining & Drying:

The paddy–the rice with the skin–should have to be always washed to get rid off the skin ones and leaving only the paddy ones behind ready for milling. For instance, you may soak the paddy into either the buckets, dishes or larger dup of water, so that allows the skin ones to drift and the paddy ones will be sinking down to the bottom of those containers. The skin ones drifting above the water should be removed using the strainers to strain them out then throw them away. The paddy or good ones could now be dried out getting them ready for the milling process.

That paddy can only be dried in the sun for only one and half – two and half days only for the costal areas and probably could take three (3) – five (5) days drying especially for Lumi area. And picking straight from the garden drying is normally three (3) days or six (6) days for Maiwetem and Lumi area would be recommended either inside the bags or in the direct sun drying.

(E) Milling & Packing:

Through the milling process eventually the white grain comes out is very hot therefore, you will have to let white grain of rice to cool down before packing. That white grain must be spreaded over a wider area using canvas to allow cooling down. Do not pack when the rice is still hot that definitely will cause moisture and will become sticky and taste sour when eating.

PROCESS:

- Pack them in the plastic bag, (1kilogram)
- Plastic cup holds 200grams x 5 cups loading = (1kg)
- Sealer Machine
- Hanging or standing scale for weighing.
- Record the weight before and after milling.
- Milling time is due twice a week, every Thursdays and Mondays.
- Milling operates starts at 9.00 am and stops at 3.00pm.
- Quality drying is when all the paddy/rice becomes brownish in colour.
- The skin becomes loosing easily when peels off with tour fingers.
- Not causing tooth ache when cracking the paddy with your teeth, but the paddy should be cracking into half.

These will be the main signs which you will detect to prove the real quality paddy drying getting ready for the milling process.




(F) Storing Method:

Because of the cold climate you have to be very careful of storing your white grain rice. You can store them in all other bags but its best you store them in the copra bags so that would last for longer periods.

Stock feed bags, stored up to 6-10 months period {Both without preservation chemical.}

Copra bags, stored up to 6-12 months period {Without preservation chemical.}

Without preservation chemical can be stored up to one (1) year six (6) months.

Any white milled rice without preservation chemical must be consumed within 2 weeks period only.

In this case you should dry all the milled rice for three (3) days before storing them away and that can last long.

(G) Weeding & Mulching

Weeding & Mulching is another part that contributes towards the bearing of the rice or paddy. The paddy needs a proper management to give a larger quality of production. The mulching help keeps the unwanted weeds away from the growing rice in the field.

Mulching helps:

(a) Keep the nutrients back to the soil.

(b) Hold the water back in case dry season might arise.

(c) Keep the plant from drying up during dry seasons.

Remember, weeds need to be weeded three times for all other varieties of rice and not the golden mountain, TCS,10, that applies the weeding two times the third one applies when the plants are at the flowering stage. At that point of time do not disturb the rice plants until all bear seeds, otherwise you will get nothing out from you plants in the field.

(H) Cooking Method:

Measure using finger tip add water level up to first finger joint.

Control the fire when boiling keep the firelight steady and until water level reduces also you must reduce the fire as well.

Use the same cup to measure both the rice & water, for instance; 2 cups of water = 1 cup of rice. Or 2 cups of rice = 4 cups of water. .

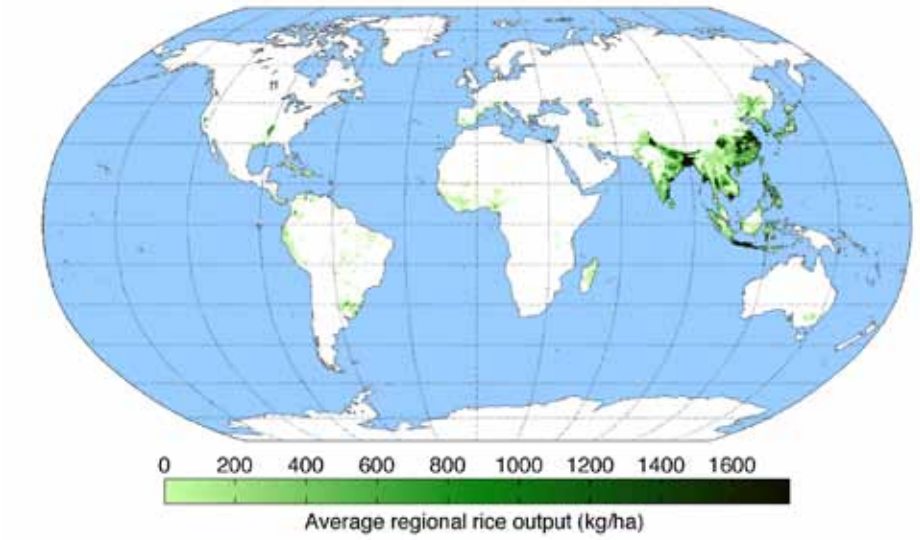
ABOUT RICE

History of domestication production and commerce

OUTLINE:

(I) Production
(J) Harvesting, Drying & Milling
(K) Distribultion
(L) Cultivation/Environment
(M) Pests and Diseases
(N) Rice Types
(O) Rice Growing Ecology
(P) Nutritional Information
(Q) Comparison to Other Staples

Worldwide rice production



(I) Production

Rice is a major food staple and a mainstay for the rural population and their food security. It is mainly cultivated by small farmers in holdings of less than 1 hectare. Rice is also a wage commodity for workers in the cash crop or non-agricultural sectors. Rice is central to the food security of over half the world population. Developing countries account for 95% of the total production, with China and India alone responsible for nearly half of the world output. World production of rice has risen steadily from about 200 million tonnes of paddy rice in 1960 to over 678 million tonnes in 2009. The three largest producers of rice in 2009 were China (197 million tonnes), India (131 Mt), and Indonesia (64 Mt).

In addition to the gap in farming system technology and knowledge, many rice grain producing countries have significant losses post-harvest at the farm and because of poor roads, inadequate storage technologies, inefficient supply chains and farmer's inability to bring the produce into retail markets dominated by small shopkeepers. A World Bank – FAO study claims 8% to 26% of rice is lost in developing nations, on average, every year, because of post-harvest problems and poor infrastructure. Not only do these losses reduce food security in the world, the study claims that farmers in developing countries lose approximately US$89 billion of income in preventable post-harvest farm losses, poor transport, the lack of proper storage and retail. One study claims that if these post-harvest grain losses could be eliminated with better infrastructure and retail network, in India alone enough food would be saved every year to feed 70 to 100 million people over a year.

(J) Harvesting, Drying and Milling

Unmilled rice, known as paddy (Indonesia and Malaysia: padi; Philippines, palay), is usually harvested when the grains have a moisture content of around 25%. In most Asian countries, where rice is almost entirely the product of smallholder agriculture, harvesting is carried out manually, although there is a growing interest in mechanical harvesting. Harvesting can be carried out by the farmers themselves.

(K) Distribution

Because of the importance of rice to human nutrition and food security in Asia, the domestic rice markets tend to be subject to considerable state involvement. While the private sector plays a leading role in most countries, agencies such in Indonesia, in the Philippines and in Vietnam are all heavily involved in purchasing of paddy from farmers or rice from mills and in distributing rice to poorer people. The PNG government needs to act and develop strategies and actions to the people of it's country.

(L) Cultivation and Environmental Impacts

Rice cultivation on wetland rice fields is thought to be responsible for 6–29% of the anthropogenic methane emissions annual. Rice requires slightly more water to produce than other grains.

Long-term flooding of rice fields cuts the soil off from atmospheric oxygen and causes anaerobic fermentation of organic matter in the soil. Current contributions of methane from agriculture is ~15% of anthropogenic greenhouse gases. Methane is twenty times more potent a greenhouse gas than carbon dioxide.

As a result of climate change, rising temperatures and decreasing solar radiation during the later years of the 20th century have lead to rice yields decreasing in many parts of Asia, compared to what would have been observed had the temperature and solar radiation trends not occurred. The yield growth rate had fallen 10–20% at some locations.

(M) Pests and Diseases

Rice pests are any organisms or microbes with the potential to reduce the yield or value of the rice crop (or of rice seeds). Rice pests include weeds, pathogens, insects, nematode, rodents, and birds. A variety of factors can contribute to pest outbreaks, including the overuse of pesticides, improper irrigation, and high rates of nitrogen fertilizer application. Weather conditions also contribute to pest outbreaks. For example, rice gall midge and army worm outbreaks tend to follow periods of high rainfall early in the wet season, while thrips outbreaks are associated with drought.

Crop protection is imperative to manage crop pests in such a manner that future crop production is not threatened. Sustainable pest management is based on four principles: biodiversity, host plant resistance (HPR), landscape ecology, and hierarchies in a landscape – from biological to social. Rice plants produce their own chemical defences to protect themselves from pest attacks, but need your help as a farmer to gain the best yields = best profit.

Among rice cultivars, there are differences in the responses to, and recovery from, pest damage. Therefore, particular cultivars are recommended for areas prone to certain pest problems. The genetically based ability of a rice variety to withstand pest attacks is called resistance. Three main types of plant resistance to pests are recognized as nonpreference, antibiosis, and tolerance. Nonpreference (or antixenosis) describes host plants which insects prefer to avoid; antibiosis is where insect survival is reduced after the ingestion of host tissue; and tolerance is the capacity of a plant to produce high yield or retain high quality despite insect infestation. Over time, the use of pest resistant rice varieties selects for pests that are able to overcome these mechanisms of resistance. When a rice variety is no longer able to resist pest infestations, resistance is said to have broken down. Rice varieties that can be widely grown for many years in the presence of pests and retain their ability to withstand the pests are said to have durable resistance. Mutants of popular rice varieties are regularly screened by plant breeders to discover new sources of durable resistance.

Major rice pests include the brown planthopper, the rice gall midge, the rice bug, the rice leafroller, rice weevils, stemborer, panicle rice mite, rats and the weed Echinochloa crusgali.

Major rice diseases include Rice ragged stunt, Sheath Blight, and tungro. Rice blast, caused by the fungus Magnaporthe grisea, is the most significant disease affecting rice cultivation. There is also an ascomycete fungus, Cochliobolus miyabeanusthat causes brown spot disease in rice.

(N) Rice Types

There are four major categories of rice worldwide: indica, japonica, aromatic and glutinous. The different varieties of rice are not considered interchangeable, either in food preparation or agriculture, so as a result, each major variety is a completely separate market from other varieties. It is common for one variety of rice to rise in price while another one drops in price.

Unpolished rice grains with bran

Polished rice grains

Aromatic rices have definite aromas and flavours; the most noted cultivars are Thai fragrant rice, Basmati, Patna rice, Vietnamese fragrant rice, and a hybrid cultivar from America, sold under the trade name Texmati. Both Basmati and Texmati have a mild popcorn-like aroma and flavor. In Indonesia, there are also red and black cultivars.

The many varieties of rice, for many purposes, are distinguished as long-, medium-, and short-grain rices.

Right: Uncooked, polished, white long-grain rice grains.

Above: Unmilled to milled rice, from right to left, brown rice, rice with germ, white rice (Japanese rice)



Rice is cooked by boiling or steaming, and absorbs water during cooking. It can be cooked in just as much water as it absorbs (the absorption method), or in a large quantity of water, which is drained before serving (the rapid-boil method).

(O) Rice Growing Ecology

Rice can be grown in different environments, depending upon water availability. Generally, rice does not thrive in a waterlogged area, yet it can survive and grow. It can also survive flooding.

- **Lowland, rainfed,** which is drought prone, favors medium depth; waterlogged, submergence, and flood prone
- **Lowland, irrigated,** grown in both the wet season and the dry season
- **Deep Water or floating rice**
- **Coastal Wetland**

Upland rice is also known as **'Ghaiya rice'**, well known for its drought tolerance.

(P) Nutrients and the Nutritional Importance of Rice

Rice is the staple food of over half the world's population. It is the predominant dietary energy source for 17 countries in Asia and the pacific, 9 countries in North and South America and 8 countries in Africa. Rice provides 20% of the world's dietary energy supply, while wheat supplies 19% and maize 5%.

A detailed analysis of nutrient content of rice suggests that the nutrition value of rice varies based on a number of factors. It depends on the strain of rice, that is between white, brown, black, red and purple varieties of rice – each prevalent in different parts of the world. It also depends on nutrient quality of the soil rice is grown in, whether and how the rice is polished or processed, the manner it is enriched, and how it is prepared before consumption.

An illustrative comparison between white and brown rice of protein quality, mineral and vitamin quality, carbohydrate and fat quality suggests that neither is a complete nutrition source. Between the two, there is a significant difference in fiber content and minor differences in other nutrients.

(Q) Comparison of Rice to Other Major Staple Foods

The table on the following page shows the nutrient content of major staple foods in a raw form. Raw grains, however, aren't edible and cannot be digested. These must be sprouted, or prepared and cooked for human consumption. In sprouted and cooked form, the relative nutritional and anti-nutritional contents of each of these grains is remarkably different from that of raw form of these grains reported in this table.

Nutrient content of major staple foods

COMPONENT (per 100g portion)	STAPLE: Maize/Corn [a]	Rice [b]	Wheat [c]	Potato [d]	Cassava [e]	Soybean [f]	Sweet Potato [g]	Sorghum [h]	Yam [y]	Plantain [z]
Water (g)	76	12	11	79	60	68	77	9	70	65
Energy (kJ)	360	1528	1419	322	670	615	360	1419	494	511
Protein (g)	3.2	7.1	13.7	2.0	1.4	13.0	1.6	11.3	1.5	1.3
Fat (g)	1.18	0.66	2.47	0.09	0.28	6.8	0.05	3.3	0.17	0.37
Carbohydrates (g)	19	80	71	17	38	11	20	75	28	32
Fiber (g)	2.7	1.3	10.7	2.2	1.8	4.2	3	6.3	4.1	2.3
Sugar (g)	3.22	0.12	0	0.78	1.7	0	4.18	0	0.5	15
Calcium (mg)	2	28	34	12	16	197	30	28	17	3
Iron (mg)	0.52	4.31	3.52	0.78	0.27	3.55	0.61	4.4	0.54	0.6
Magnesium (mg)	37	25	144	23	21	65	25	0	21	37
Phosphorus (mg)	89	115	508	57	27	194	47	287	55	34
Potassium (mg)	270	115	431	421	271	620	337	350	816	499
Sodium (mg)	15	5	2	6	14	15	55	6	9	4
Zinc (mg)	0.45	1.09	4.16	0.29	0.34	0.99	0.3	0	0.24	0.14
Copper (mg)	0.05	0.22	0.55	0.11	0.10	0.13	0.15	-	0.18	0.08
Manganese (mg)	0.16	1.09	3.01	0.15	0.38	0.55	0.26	-	0.40	-
Selenium (mcg)	0.6	15.1	89.4	0.3	0.7	1.5	0.6	0	0.7	1.5
Vitamin C (mg)	6.8	0	0	19.7	20.6	29	2.4	0	17.1	18.4
Thiamin (mg)	0.20	0.58	0.42	0.08	0.09	0.44	0.08	0.24	0.11	0.05
Riboflavin (mg)	0.06	0.05	0.12	0.03	0.05	0.18	0.06	0.14	0.03	0.05
Niacin (mg)	1.70	4.19	6.74	1.05	0.85	1.65	0.56	2.93	0.55	0.69
Pantothenic acid (mg)	0.76	1.01	0.94	0.30	0.11	0.15	0.80	-	0.31	0.26
Vitamin B6 (mg)	0.06	0.16	0.42	0.30	0.09	0.07	0.21	-	0.29	0.30
Folate Total (mcg)	46	231	43	16	27	165	11	0	23	22
Vitamin A (IU)	208	0	0	2	13	180	14187	0	138	1127
Vitamin E, alpha-tocopherol (mg)	0.07	0.11	0	0.01	0.19	0	0.26	0	0.39	0.14
Vitamin K (mcg)	0.3	0.1	0	1.9	1.9	0	1.8	0	2.6	0.7
Beta-carotene (mcg)	52	0	0	1	8	0	8509	0	83	457
Lutein+zeazanthin (mcg)	764	0	0	8	0	0	0	0	0	30
Saturated fatty acids (g)	0.18	0.18	0.45	0.03	0.07	0.79	0.02	0.46	0.04	0.14
Monounsaturated fatty acids (g)	0.35	0.21	0.34	0.00	0.08	1.28	0.00	0.99	0.01	0.03
Polyunsaturated fatty acids (g)	0.56	0.18	0.98	0.04	0.05	3.20	0.01	1.37	0.08	0.07

[a] corn, sweet, yellow, raw
[b] rice, white, long-grain, regular, raw
[c] wheat, durum
[d] potato, flesh and skin, raw
[e] cassava, raw
[f] soybeans, green, raw
[g] sweetpotato, raw, unprepared
[h] sorghum, raw
[y] yam, raw
[z] plantains, raw

Thank You

This ends the Basic rice training workshop. Maiwetem wishing you all the very best with this Participant's Manual. Please make this manual becomes a reality then it will bear a better fruit in the near future for all of you are now participating at this basic rice training at Maiwetem village. Bye, bye everyone!

Booket Written By:

Mathew Akon - Senior Project Officer, Tenkile Conservation Alliance and Jim Thomas - Director, Tenkile Conservation Alliance.
Ph.# (675)72869545 / Email: mangimaunten@gmail.com

Photography:

Photographs of Maiwetem village by Matthew Jeff – 2010-2012

Acknowledgements:

We acknowledge Mr. Tony Benedict from West Link Solar Energy System for sponsoring this draft Manual to guide the rice farmers within the entire Lumi area.

We also would acknowledge Jim & Jean Thomas of Tenkile Conservation Alliance for the final edition & printing to this first edition 2012.

Final acknowledgement goes to Aus Aid our collaborating partners who have come in partnership in funding this great initiative in terms of six rice milling machines.

"Introduction To Rice Cultivation & Management"

Produced by: Tenkile Conservation Alliance
P.O Box 1304 Wewak, ESP
Papua New Guinea
Web: www.tenkile.com
Email: help@tenkile.com