

Towards Prosperity by Biomass Utilization of Whole Rice Plant

Rice Bio Park



INDIA-MYANMAR FRIENDSHIP PROJECT

RICE BIO-PARK

**FULLY FUNDED BY THE MINISTRY OF EXTERNAL AFFAIRS,
GOVERNMENT OF THE REPUBLIC OF INDIA**

EXECUTED BY M.S. SWAMINATHAN RESEARCH FOUNDATION (MSSRF), India

in partnership with

Department of Agricultural Research, Yezin, Nay Pyi Taw, Ministry of Agriculture,
Livestock and Irrigation of the Republic of the Union of Myanmar



Shri. T. S. Tirumurti
Secretary (Economic Relations)

The invigoration of the agriculture sector and the development of the rural Economy is a national priority for both India and Myanmar. It recognize the pivotal role and potential of agriculture in our respective development paths.

Through the creation of the Rice Bio-Park at the Department of Agricultural Research in Nay Pyi Taw, the Government of India has been able to share our own experience and capacities in rice productivity and rice biomass utilization with Myanmar. This novel collaborative brings together agriculture, science and innovation for the benefit of small farmers in Myanmar.

The successful completion of this joint project funded by the Government of India and executed by the world-renowned M.S. Swaminathan Research Foundation in partnership with the Department of Agricultural Research of the Ministry of Agriculture Livestock and Irrigation of Myanmar reinforces the close and vibrant development partnership between India and Myanmar. As long-standing partners and neighbours, this is a matter of mutual satisfaction for both countries.

The Rice Bio-Park houses small scale units to produce marketable commodities, a training center with residential and storage facilities, an administrative building and an integrated knowledge center. We are confident that this ecosystem will add strength to Myanmar's agricultural sector, improve food security and enhance avenues of income for small farm families. This will be valuable given the centrality of rice in Myanmar's agricultural economy and the livelihood opportunities that market-driven rice-related products can generate.

We hope to see the Rice Bio-Park grow into a leading research center for rice that can be replicated across Myanmar. Further, this Bio-Park symbolizes the potential for agricultural cooperation between India and Myanmar. I am confident it will pave the way for deeper engagement between our two countries.

New Delhi
14-11-2018



T. S. Tirumurti
Ministry of External Affairs
New Delhi



Prof M S Swaminathan
Founder, MSSRF

Myanmar is a prosperous agricultural country. The farmers are selling the rice grains only but they are not aware of the hidden wealth available in the entire biomass of the rice plant. Further, they lack the knowledge of utilizing bio-masses of the rice plant like rice straw and the byproducts generated in rice milling. The major biomass, the rice straw which is at 1:1 grain to straw ratio is not utilized for getting any income. It is generally burnt in the field causing pollution problem. Rice straw as such is not a nutrient feed to ruminants. The lignin present in the rice straw coats the rumen of the ruminant animals impairing digestion of the straw. By de-lignification, the rice straw can be converted in to a better feed. Rice straw is not available in sufficient quantities in some provinces of Myanmar. Transporting the straw in bulk poses the problem of volume. Hence it is to be compressed in to blocks for reducing the cost of transport.

Technology is available for preparing nutritious feed blocks by incorporating materials containing more protein and minerals. Rice straw can be used as a material for preparing mushroom and also for preparing paper. The husk is the major rice milling byproduct. It is 22% on the weight of grains. Raw rice milling is in vogue in Myanmar. The husk and husk ash have many beneficial uses. The black ash acts as a better carrier

material for producing Bio-fertilizers. The rice bran is rich in nutraceuticals. Myanmar population consumes white rice on removing the bran. By stabilizing the bran its shelf life can be increased. By adopting this technique the rice bran can be utilized for human food instead of using as poor animal feed.

Considering the above beneficial effects, utilization of entire Biomass of rice plant is considered as a necessity. With the aim of increasing the income and employment opportunities among rice farmers of Myanmar, a Rice Bio-Park has been established at Nay Pyi Taw. It contains various units for utilizing rice straw, husk ash, bran, small broken, rice products preparation, cattle, poultry and fish feed preparation, spirulina, azolla, vermi-compost and ethnic food up-gradation laboratory, the details of which have been provided elaborately in this informative, illustrative and attractive Brochure.

I am happy that one of my dream projects is becoming a reality. After my developing the idea of Rice Bio-Park the first one I established was at the International Rice Research Institute (IRRI) at Los Banos, Philippines. The second one is in Myanmar. I am particularly grateful to Dr. Pillaiyar for his dedicated work.

Chennai
20-10-2018

Email: founder@mssrf.res.in



Dr. Madhura Swaminathan
Chairperson, MSSRF

"The Rice Bio-Park is a stellar example of the application of science and technology to utilize every part of the rice plant for higher productivity and incomes. Let this be a model for enhancing livelihoods of small paddy producers in South and South East Asia. I wish the project all success".

Chennai
22-10-2018

Introduction



PADDY AND POVERTY LIVE TOGETHER is the main say in developing and under-developed countries. The earning opportunity for Rice Farmers is less when compared to those engaged in plantation, horticulture and cash crop farming as the number of man days work requirement for rice farming is less than that for other farming systems. Hence the customary saying that THE RICE FARMERS BORN IN DEBT, LIVE IN DEBT AND DIE IN DEBT. This situation can be wiped out only by providing opportunities for enhancing their earning capacity by fully utilizing the entire Rice Biomass by technological intervention with value addition.

With this in view, this Rice Bio-Park with does it yourself training and capacity building module is established for the full utilization of the farm bio-resources like rice straw, rice husk, bran, broken brown rice, white broken and whole white rice by value addition. In doing so the nutritive value of the food and feed would automatically be enhanced.

Rice Biomass Availability in Myanmar (2016 - 2017)

Total production of paddy : 12.5 Million Metric Tonnes (MMT)

Straw availability at 1:1 ratio : 12.5 MMT

A

Paddy available for milling = (12.5 MMT minus 5% for seed and losses)

Net available paddy for milling : 12.45 MMT

Husk Content = $12.45 \times 22\%$ = 2.739 MMT

B

Brown rice availability = 12.45 MMT minus 2.739 MMT = 9.711 MMT

Bran Availability 10% on brown rice = 0.9711 MMT

C

TOTAL BIOMASS FOR BIOCONVERSION
A + B + C = 16.21 MMT



Rice Straw Utilization

Rice straw is a poor Ruminant feed. A chemical known as "lignin" is present in rice straw to an extent 6 to 7 % and it prevents the digestibility of straw. Hence it is to be removed before feeding straw to the Ruminants. The process of removing lignin is known as delignification.



Delignification Process

Straw is delignified by spraying urea solution. Four kilo of urea dissolved in 64 liters of water is sprayed over 100 kg of straw spread in layers and trampled well to make the mass air tight. After 21 days the cover is removed, the straw is dried and kept for day to day feeding.



Burning of Rice Straw in the Field itself

Farmers, instead of utilizing the straw for ruminant feed burn it in the field causing pollution. There are better methods of utilizing this straw for Ruminant feed. Preparation of Nutritious Feed Block, mushroom culture and paper making are some of the profitable ventures rather than burning the straw in the field.

Preparation of Nutritious Feed Block From Rice Straw



The straw without burning can be collected and de-lignified. After drying, this de-lignified straw can be crushed in a straw crushing machine. A boiling slurry is made with 75 gram of starch, 45 gram of ground nut cake, 20 gram of mineral mixture and 10 gram of salt in 650 ml of water. This slurry is mixed well with 850 gram of the above crushed straw and placed inside the hydraulic press. A pressure of 2000 PSI is applied. Material for two more blocks as prepared above can also be placed into the hydraulic pressing machine with a separating sheet to form three blocks. At the end 2500 PSI for 15 minutes is applied. Then the three blocks can be taken out by the mechanism provided for the same.

The above feed blocks are dried in sun, packed, kept in safe place and used for feeding the Ruminants on a later date.

Mushroom Production Using Rice Straw

Mushrooms are a rich source of nutrients, particularly proteins, minerals and vitamins such as vitamin B, C and D. The content of niacin is comparable to its levels found in pork or beef. Mushrooms are also good source of minerals. They are rich in phosphorus, potassium and iron but are low in sodium. About one third of the total iron in mushrooms is in the available form. In addition to these, some other interesting features in the nutritional qualities of mushrooms are (i) lack of starch (ii) low fat content (iii) low calorific value (iv) presence of a variety of sugars and their derivatives and (v) high fiber content. Hence, they are said to be the 'delight of diabetics'.

Make rice straw bundles (Diameter 8-10 inches, Length 3 Feet). Soak rice straw bundles in water (8-10 hrs). Likewise arrange rice straw bundles across 1st layer up to five layer. Arrange 4 rice straw bundles on the ground layer & add 400 g rice straw mushroom spawn. Cover rice straw bundle heap with plastic sheet. Cover rice straw bundle heap with thatch again. After 15 days, 1st batch of mushroom can be harvested (~ 5Kg). Mushroom harvesting can be continued from one batch cultivation up to 4 to 6 times in (2-3) days interval. Both button and oyster mushroom can be cultivated by using rice straw.



Paper/Card - Board Making Utilizing Rice Straw

Hot Process

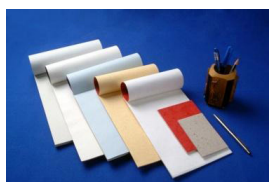
The materials required in this process are: rice straw, starch, rosin, alum, caustic soda, sodium silicate and water. Potassium hydroxide is used for bleaching the straw and the optional item are dyes.

The steps involved in preparing paper or cards are:

- | | |
|---|--|
| • | Cook the straw of size 1 inch length by boiling with potassium hydroxide solution for 5 to 6 hours. |
| • | Wash the cooked straw under running water and crush it by using a wooden mortar and pestle. Alternatively a wet grinder can be used for pulping the treated straw. |
| • | Remove the dirt by screening the above material. |
| • | Wrap the pulp with cheese cloth and squeeze out the water. |
| • | Then sheet is formed by mixing the pulp with water, starch, rosin, powdered alum and sodium silicate. For thick paper, use less water and for thin paper use more water. Then paper pulp is formed. |
| • | Dip the mold and deckle in to the vat or basin to catch as much pulp as necessary to make paper of desired thickness. |
| • | Tilt the mold and deckle back and forth to spread evenly. |
| • | Separate the deckle from the mold and lay the molded pulp on cheese cloth. |
| • | Cover the pulp sheet with cheese cloth and with a rolling pin, squeeze out excess water. Alternatively, 30- 40 pulp sheets with cheese cloth can be placed in the platform of a hydraulic press and pressed gently till the last drop of water is removed. |
| • | Separate the pulp sheet and lay it on the drying board. |
| • | Remove the blotter or cheese cloth and the sheets are dried in the sun. |
| • | Dyeing is done by mixing the pulp in the desired dyes for 10 minutes for getting various colour shades. |

B. Cold Process

Cotton cloth waste (30 %), Paper waste (40 %) and Rice Straw (30 %) are pulped in a beating machine. To this pulp, talcum powder, sodium silicate, starch, rosin and alum are added and crushing continued. This pulp is utilized for making paper/board. This paper/board after polishing is cut into desired size and made into value added products like writing paper, files, invitation cards, visiting cards, greetings cards, paper bags etc.



Other Uses of Rice Straw

Organic fertilizer, Composting (rural level; industrial level), Carbonized Rice straw/hulls in bricks, Composites, High-end applications; active carbon, Biofuels (from lignocellulose), rice straw fibers in pulp and paper applications (bleached fiber in paper (replacing kraft pulp), simple paper used as cigarette paper, for lamp shades or partition walls are some other uses of rice straw. Finer paper also can be made from it, especially together with other sorts of cellulose, like hemp), Filler in paper board (replacing wood dust) and Natural fiber composites can also be made from rice straw

Rice Products

It is the habit of rice eaters to consume some delicacies and snacks prepared out of either whole or broken rice (noodles-strand, sheet or other forms). Some fried snacks are also prepared with garnishing. Some nutritious and crispy products can be prepared from rice. These products have more shelf life and if kept under air tight packing, they maintain crispness for a few months. Three products under this category are described below

1. Popped Rice

- Water (5 to 6 %) is added to paddy, thoroughly mixed and kept in bags overnight.
- This paddy is added to hot sand in the pan (200 °C) and stirred (20 seconds) till the complete popping occurs.
- Then it is graded to separate broken and husk.



2. Flaked Rice

- This product is prepared from a special type of parboiled paddy. Paddy is soaked in water for 2 to 3 hours, water drained, kept overnight and this soaked paddy is roasted in sand to a moisture of about 20% and flattened in the edge runner to the decide thickness of flakes.
- Flaked rice is graded to remove broken and packed.
- Husk + Bran + Flaked rice powder are packed separately.



3. Expanded Rice

- Hot water is prepared in a metallic drum at 80°C, paddy added, mixed, chaff and impurities are removed and left in the oven without further heating. Next day morning water is drained fully.
- This paddy is roasted at 200°C for about 20 seconds, surface dried, milled in huller to remove bran, surface moisture moved and mixed well with 2-3 % saturated salt solution, kept in gunny bag for 5 minutes and then roasted in sand at 250 °C.
- The expanded rice is graded and packed.



Rice Milling



Myanmar grows wet season and summer season paddy. At both seasons farmers face problem in drying and milling. During wet season for want of dryers, they sell the paddy immediately to merchants. During summer they dry it in sun leading to heavy breakage. Most of the existing rice mills have many defects such as absence of destoner, polishing in stages, absence of colour sorter etc. This results in low rice recovery. Taking into consideration of these defects, a modern rice mill has been erected with facilities such as cleaner, destoner, pneumatic sheller, return paddy sheller, unshelled paddy separator, four stage polishers, thick grain remover, silky polisher, broken separator, colour sorter and packaging machine. During summer 40 to 50 % breakage in brown rice occurs in Myanmar. This, while polishing gets size reduction and forming grits and powder resulting in low rice recovery. To avoid this, provision is available for removing brown rice broken and on destoning can be marketed as slow digesting rice (Dia rice). The 2nd, 3rd and 4th polished bran is stabilized and used for human consumption. Nitrogen packaging machine also is available.

Stabilized Bran

Rice Bran contains quality oil, protein, cholesterol lowering waxes; anti-tumor compounds; antioxidants including vitamin E and oryzanol; rich in minerals and dietary fiber. The 2nd , 3rd and 4th polished bran in the rice mill available at Rice Bio-Park is separately cleaned in a bran sifter soon after polishing. Rice bran contains an enzyme lipase which splits the oil into free fatty acids rendering the bran unsuitable for human consumption. Heating bran to 105°C for 5 minutes inactivates lipase. This step is known as stabilization of bran. In this modern rice mill set-up, the bran is immediately stabilized as above. Now, this stabilized bran can be used in food preparations.





Husk and Husk Ash Utilization

Paddy contains about 22 % of husk. In Myanmar paddy is milled under raw condition. The husk obtained is not properly used. In this Rice Bio-Park husk is used for preparing husk ash. This husk ash is utilized for water purification, village level zero energy cold storage, construction of low cost insulation houses and as a carrier for bio-fertilizer.

1. Water Purification

Villagers use water containing some impurities. To remove these impurities, a low-cost device using rice husk ash as filter medium has been developed. Three mud pots are kept one above the other on a stand as shown in the picture. In these mud pots, three holes are made at the bottom. Above this holes, rice husk ash is filled over a coir mat to three fourth level. These pots filter the muddy water when poured at the top and the purified water is collected in a pot kept at ground level. The husk ash adsorbs not only bacteria but also the impurities. The bad smell, if any present also is removed in this system. It is sufficient if the husk ash is replaced twice in a year. The clarification capacity of rice husk ash is said to be ten times more than that of sand filter.



Mudy Water



Purified Water

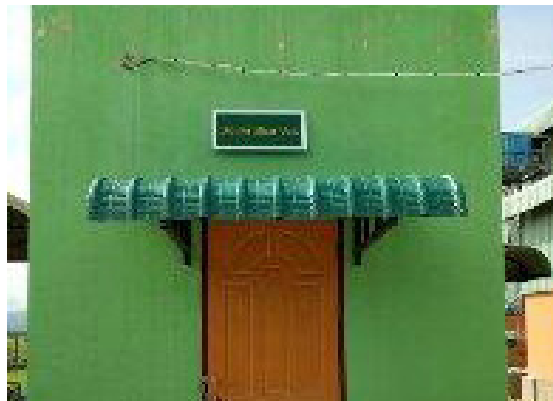


2. Village Level Zero Energy Cold Storage

Considering the perishable nature of fruits and vegetables farmers are compelled to sell their produce on a day to day basis. In order to keep the above produce for a week a zero-energy cold chamber using paddy husk ash as insulating material has been designed. The temperature inside in the cold chamber is less by 8 to 10 °C than that in atmosphere. The humidity is maintained always at about 90%. The perishable produces maintain the original condition for 7 to 10 days. In between two brick walls husk ash is filled for 2 inches as shown in the picture.

3. Low Cost Insulation Houses

Before laying cement concrete or brick layer for roof, paddy husk ash is filled to a thickness of six inches over a flat or corrugated metal sheet with adequate supports. Husk ash has very good insulation property and hence can be mixed with cement to an extent of 20-25% for plastering the walls.





Bio-Fertilizer using Husk Ash

Bio-fertilizers enhance the nutrient availability to crop plants (by processes like fixing atmosphere nitrogen or dissolving phosphorous present in the soil) and also impart better health to plants and soil thereby enhancing crop yields in a moderate way. Many carrier materials are used for the multiplication of the organisms. Rice husk ash is found to be one of the carrier materials for bio-fertilizer production.

The carrier preparation consists of preparation of black husk ash, powdering, neutralization and sterilization. The ferment/broth and carrier will be mixed, bagged in polythene bag, cured and stored.



Mash Feed Machine for Cattle and Poultry

Cattle are fed with feed in the form of mash or pellets. In the Rice Bio-Park, a mash feed machine has been installed. It consists (400 kg per batch) of root duct, magnet, grinder, mixer, screw conveyor and raw material input hopper. Raw materials like maize, broken rice, cakes etc can be ground and mixed with bran, mineral mixture and salt to the desired size.

List of trainings imparted at Rice Bio-Park

1. Rice straw utilization

- Delignification of rice straw
- Preparation of nutritious feed block from rice straw
- Mushroom culture using rice straw
- Paper/card - board making utilizing rice straw

2. Husk and husk ash utilization

- Water purification
- Village level zero energy cold storage
- Bio-fertilizer production using husk ash as carrier

3. Preparation of ready to cook/ready to eat rice products

- Popped rice
- Flaked rice
- Expanded rice

4. Preparation of mash feed for cattle and poultry

5. Azolla culture for poultry and fish feed

6. Vermiculture using rice straw and husk



Number of days:

3

Number of participants:

25

farmer/ batch

Number of trainings
conducted till 2018:

10
times

Number of farmers trained

325

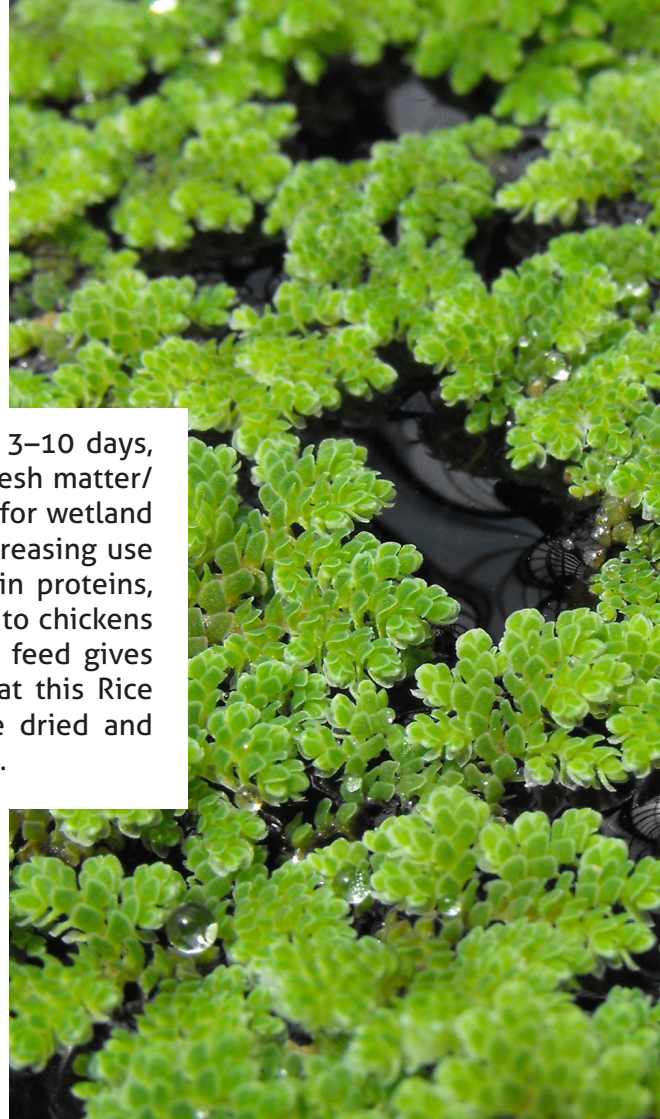
Spirulina Cultivation for Poultry and Fish Feed

Spirulina are multicellular and filamentous blue-green microalgae. Spirulina has been used as a complementary dietary ingredient of feed for poultry and used as a source of protein and vitamin supplement to aqua feeds. Spirulina appears to have considerable potential for development, especially as a small-scale crop for nutritional enhancement, livelihood development and environmental mitigation. With around 60 per cent protein content, spirulina's rapid growth means it yields 20 times more protein per unit area than soybeans, 40 times more than corn, and over 200 times more than beef. Spirulina production uses a medium consisting of a bio-gas slurry, 2–3 g of sea salt or chemical medium (potassium dihydrogen phosphate, cooking soda and sodium chloride).



Azolla Culture for Poultry and Fish Feed

Azolla is a highly productive plant. It doubles its biomass in 3–10 days, depending on conditions and yield can reach 8–10 tonnes fresh matter/ha. In addition to its traditional cultivation as a bio-fertilizer for wetland paddy (due to its ability to fix nitrogen), Azolla is finding increasing use for sustainable production of livestock feed. Azolla is rich in proteins, essential amino acids, vitamins and minerals. Feeding Azolla to chickens and egg production of layers, as compared to conventional feed gives better results. Shade net system of cultivation is adapted at this Rice Bio-Park for Azolla cultivation. After harvest Azolla will be dried and included as one of the ingredients in the poultry and fish feed.



Vermiculture using Rice Straw and Husk

Vermi-compost is the product of the composting process using various species of earthworms to create a heterogeneous mixture of decomposing vegetable or food waste, bedding materials and vermicast. This process of producing vermi-compost is called vermi-composting.

At this Rice Bio-Park, an attempt is made to use paddy straw and husk as feeding materials for earthworms to produce vermi-compost.



Vermi-compost

LABORATORIES

Rice Mill Laboratory

Farmers bring paddy with high moisture, high impurities and that will yield high broken. Before milling, samples of the paddy stock are drawn and analyzed for the above refractions so as to avoid a poor milling result from the modern rice mill.

For this purpose a mini de-husker has been installed. The random samples drawn is shelled in this de-husker, the extent of broken brown rice is determined. If it is more than 13%, this lot of paddy is not suitable for milling. Then the farmer has to decide as to whether he can continue milling in this modern rice mill irrespective of the extent of breakage which will be resulting on milling. The brown rice is polished in the mini-polisher installed. Then the farmer will be knowing the extent of broken that he would be getting at the end of milling in the modern rice mill. This mill laboratory contains a purity board to find out the extent of damaged/discolored grains and other impurities. A broken analyzer is also available. In order to find out the purity of the variety a digital caliper is available. With this device the length and breadth and L/B ratio can be determined and the paddy can be classified as to whether it belongs to slender/medium/bold groups.



Rice Mill Laboratory

Paddy containing more than 12.5% moisture is not suitable for milling. If the moisture content is more than this level the farmer will be advised to dry the commodity still further. For this purpose moisture meters are available in this laboratory. Two packet balances to weigh small quantity of different refractions are also available. This laboratory is intended for assessing the quality of paddy before milling and advising the farmer to take appropriate action for conditioning his paddy. During milling milled rice samples will be drawn periodically, analyzed for broken and suitable advice given to the mill technicians to adjust the extent of polish.



Microbiology Laboratory

This laboratory is intended for producing bio-fertilizers (*Azospirillum* and *Rhizobium* bacteria) using husk ash as carrier material. This laboratory contains laminar air flow chamber, autoclave, rotary shaker, microscope, colony counter and BOD chamber. The culture preparation consists of mother culture, flask culture, starter culture and fermentor broth. The carrier preparation consists of preparation of black husk ash powdering, neutralization and sterilization. The ferment or broth and carrier will be mixed, bagged in polythene bag, cured and stored.



Ethnic Food Upgradation Laboratory

Different types of ethnic foods are prepared at home and at markets for day to day consumption. Both waxy and non-waxy rices are used along with various ingredients. It may be vegetarian or non-vegetarian dishes. There seems to be no documentation about the nutritive value of these ethnic foods. In order to ascertain the nutritive value and to upgrade the nutrient content by incorporating rice based material particularly stabilized bran this laboratory has been set up. It is programmed to survey the important ethnic foods and analyze their constituents including microelements and vitamins. School children, pregnant women and lactating mothers would be the target group for finding out the nutritional effect of the commonly used ethnic foods. It is contemplated to link up with one medical college to assess the weight gain, changes in blood samples and other clinical parameters. Some of the important equipments for analyzing carbohydrates, protein, fat, minerals and vitamins are available in this laboratory.

Products of Rice Bio-Park



De-lignified rice straw



Complete nutritious feed block from rice straw



Rice straw mushroom



Rice straw paper



Rice straw paper value added products



Rice straw paper value added products





Milled rice



Stabilized rice bran



Brown rice broken (Dia-rice)



Milled rice flour



Mash feed for cattle and poultry



Azolla for poultry and fish feed



Popped rice



Puffed rice



Flaked rice



Puffed rice value added products



Flaked rice value added product

Rice Bio Park



Rice Bio-Park is an Adventure for
Harnessing Science for Increasing the
Income of the Farmers and to
emancipate them From
Hunger and Poverty



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