INTERNSHIP REPORT

TERI: The Energy and Resource Institute

December 2022

Akshaya A. Karekar
PROGRAM ZOOLOGY- MSC PART 2,
SCHOOL OF BIOLOGICAL SCIENCES AND BIOTECHNOLOGY
GOA UNIVERSITY

Contents

Introduction:

The energy and resources institute (TERI) is a research institute in New Delhi that specializes in the fields of energy, environment and sustainable development. TERI has a global presence with many centres in India and abroad. One of the branches of TERI is located in St. Cruz, Panaji Goa. TERI's key focus lies in promoting clean energy, water management, pollution management, Sustainable agriculture and climate resilience.

The internship was held at TERI, located in village of Santa Cruz, Goa. It was conducted for a period of 30 days, which started from 1st December 2022 to 3rd January2023. I along with six of my batch-mates were assigned the work of Aquafeed Preparation and setting up of small-scale Aquaponics system. Our Guides for the internship were Dr. Fraddry D'Souza and Dr. Elroy Pereira, who briefed us on how we had to go about with the internship.

TERI has created an environment that is enabling, dynamic and inspiring for the development of solutions of global problems in the field of energy, environment and current patterns of development which are largely unsustainable. The strength of the institute lies in identifying and articulating intellectual challenges straddling a number of disciplines of knowledge, research, training and demonstration projects leading to development of specific problem based advanced technologies that help carry benefits to society at large.

In Goa at St.Cruz, Panaji, the centre also takes up variety of environmental issues pertaining to marine and coastal areas such as impact of antifouling paints on marine ecosystem, harmful algal blooms impacts, agricultural and developmental activities impact on coastal ecosystem. TERI coastal Education Hub is a platform for providing ecological knowledge on conservation of coastal ecosystem and resources to the people. The AquaTech park at the Hub showcases live demonstrations and hands on activities on different aquaculture technologies such as mussel and oyster cultivation, crab farming, fin fish cage culturing including Aquaponics. Also, various other activities are conducted such as organic kitchen gardening, dairy and pig farming, biogas technology and vermicomposting. TERI deals with development of low-cost fish feed using microalgae. Small to large test set ups are established for trail runs of development of feed formulation for different fishes like Tilapia, Pearlspot, Rohu, Catla and common carp.

Objectives:

The main objectives of the internship are as follows:

1. Formulation of Fish feed using whole algae and de-oiled algae.
2. Conduction of feeding experiment and comparison of growth of fishes with formulated fish feed and Grow Well fish feed.
3. To setup a small-scale aquaponics setup.

Work done:

Fish Feed preparation using Whole algae and De-oiled Algae :

Fish feed are the feed which is given to the fishes including crustaceans to produce the energy and essential nutrients they need for their maintenance, movement, normal metabolic functions and growth. The fish feed can be natural food or supplied by fish farmers. The requirements of the fish feed is mainly based on different quantity and quality according to the their different sizes, reproductive states, feeding habits and digestive anatomy. Also, the feed requirements are influenced by environmental variations such as temperature, the resources of natural food available.

To prepare the experimental fish feed, we used the ingredients such as De-oiled algae, whole algae, fish meal, wheat bran, groundnut oil cake, vitamins and minerals and the binder. The 3 diets were prepared for the fishes: Diet 1a, Diet 1b and Diet 2. The feed ingredients such as fishmeal and de-oiled algae were already in powered form. The equipment's that are used for the preparation of the fish feed were small farm scale mixer cum grinder. The Groundnut cake was dried and powdered using the grinder. The wheat bran and fish meal were dried and it was sieved to remove the lager particulates. Each diet was made of 1kg.

Ingredients in Diet 1a: De-oiled algae, fish meal, wheat bran, groundnut oil cake, vitamins and minerals and binder. Diet 1b was prepared using the same ingredients with de-oiled algae except the wheat bran. And Diet 2 was prepared using the same ingredients with whole algae, except the de-oiled algae.

Steps followed for preparation of formulated fish feed:

1. All the ingredients were grinded and weighed as per the quantity required for each diet.
2. For a particular diet, the necessary ingredients were mixed and dough was made by adding 100ml of warm water in the dough at a time. Total 800 ml of warm water was added in each diet
3. The dough was then spread on the tray and was kept for sun drying
4. The dough was flipped after every 20 minutes till it was completely dried and with no moisture content.
5. The feed was dried completely and was powdered with the help of grinder.
6. This feed was then stored in the air tight container and was labelled as diet 1a, 1b and diet 2.

Fish meal Sieving

Wheat Bran seiving

Ground nut Oil cake

Mixing of all the ingredients

Dough of all the ingredients

Sun drying the dough

Preapred Diets

Grow well Commercial Feed

Aquarium tank cleaning

Aquarium water gets dirty and turbid easily due to the fish excreta and fish food remains. The water quality can be maintained by partial water change and by using biofilters. Biofilters help to remove debris, ammonia and nitrates and also aerates the water.

12 tanks were cleaned and was filled with the new fresh water to house the fish seeds/fingerlings for the feeding experiments. In tanks the biofilters and aerators were also added. About 200 Tilapia fingerlings/ seeds were brought from Green lake Farm Majorda along with the Grow-well feed. (Commercial fish feed).

The following steps were carried out before the fishes were transported in fish tank:

- The fishes which were brought in polythene bag, was first washed externally.
- The plastic bucket was half filled with the water, followed by which the bag containing fishes was placed in bucket and opened slowly to allow the fishes to come out in the surrounding water.
- The fishes were then weighed. For this a bowl filled with water was kept on weighing machine and teared. This fish was immersed in the bowl and the weight was noted down.
- The fishes were segregated in 3 groups based on the weight of the fishes.
  Group 1- the weight of the fishes was 4-7g.
  Group 2- the weight was 3-4g
  Group 3- the weight of the fishes were 0.5 – 2.8 g
- Group 3 contained the largest number of fishes, from this group segregation was done again.
- We only considered the fishes belonging in the range of 1.5- 2.5g and the fishes that were not in this range were discarded.
- The six fishes from the selected category were added in each of the 12 tanks and the rejected fishes were kept in separate tank
- The tanks were labelled according to the diet plan. 3 tanks were kept for Diet 1a, 3 tanks for diet 1b, 3 tanks for diet 2 and 3 tanks for the control in which only the Grow-well feed was fed to the fishes.
- On day 0 the fishes were only fed with the grow well feed. The growwell feed was given from day 0 to day 2.

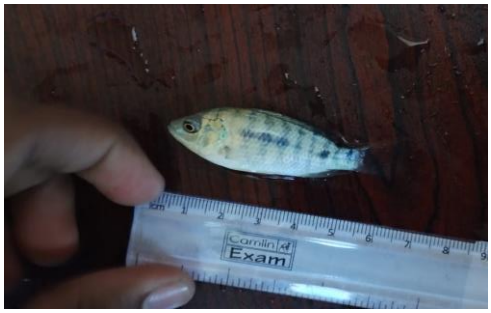
- The vials were filled with the prepared fish feed according to the diet plan for 14 days. The fishes were fed according to 6% of their body weight.

Every day the vials were put in the tanks according to the diet plan followed: i) on day 7 each fish was weighed and its length was measured using the scale. ii)according to the increase in weight the amount of feed was increased. iii) on day 14, the similar procedure was carried out to measure the weight and length of the fishes.

Cleaning Of tanks

Tilapia Fingerlings

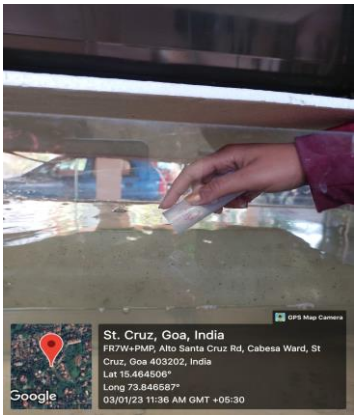
Introducing of fishes in water



Measuring length of the fishes

Weighing the fish

Feed Vials



Feeding of the diets to fishes

Weight and length observations for different diets:

1. **Control**

Day 0

Fishes in the weight range of 1.5g -2.5g were considered.

Day 7

Tank 1		**Tank 2**		**Tank 3**	
length	**weight**	**length**	**weight**	**length**	**weight**
5.5 cm	3.29g	6cm	2.62g	6.1cm	4.55g
6cm	3.30g	6.5cm	4.91g	6.1cm	5.02g
6.6cm	4.49g	6cm	4.2 g	6.8cm	4.42g
6cm	2g	5cm	3.28g	7.2cm	5.72g
5.6cm	2.90g	6cm	3.88g	6.2cm	4.8g
5.9cm	3.35g	6cm	1.75g	5.9cm	4.12g
Average -	3.22g	**Average-**	3.34g	**Average-**	4.77g

Day 14

Tank 1		**Tank 2**		**Tank 3**	
length	**weight**	**length**	**weight**	**length**	**weight**
6cm	3.37g	6.5 cm	2.83g	6.0cm	4.15g
6.4 cm	4.53g	6.7cm	6.04g	6.7cm	5.83g
7cm	4.50g	6.5cm	5.03g	7.4cm	7.41g
6.3cm	2.4g	5.5cm	4.0g	7.3cm	4.85g
5.9 cm	3.1g	6.2cm	3.98g	6.5cm	5g
6.1cm	3.7 g	6.3cm	2.5g	6.2cm	4.62g
Average-	3.6g	Average-	4.06 g	Average-	5.31g

2. **Diet 1a**

Day 0

Fishes in the length range of 1.5g- 2.5g were considered.

Day 7

Tank 1		**Tank 2**		**Tank 3**	
length	**weight**	**length**	**weight**	**length**	**weight**
6cm	1.61g	5.5cm	2.73g	6.5cm	4.95g
6cm	2.40g	5.8cm	3.04g	6.2cm	4.01g
6cm	3.64g	5.5cm	2.65g	5.6cm	2.84g
6.1cm	1.97g	5.4cm	2.44g	6.5cm	4.32g
6cm	1.61g	6cm	2.72g	6.6cm	5g
6cm	2.00g	5.6cm	2.65g	5.5cm	2.68g
Average-	2.205g	Average-	2.705g	Average-	3.96g

Day 14

Tank 1		Tank 2		Tank 3	
length	**weight**	**length**	**weight**	**length**	**weight**
6.2cm	4.24g	6cm	3.41g	7cm	5.73g
6.5cm	4.83g	5.9cm	3.07g	7.1cm	4.55g
6.7cm	3.23g	5.5cm	5.19g	7cm	4.7g
6.3cm	5.33g	7cm	5.21g	6.9cm	4.50g
6.9cm	5.06g	6.1cm	4.5g	6.7cm	3.39g
6.7cm	4.06g	5.9cm	4.1g	7cm	3.98g
Average-	4.51g	Average-	4.24g	Average-	4.47g

3. **Diet 1b**

Day 0

Fishes in the weight range of 1.5g- 2.5 g were considered.

Day 7

Tank 1		**Tank 2**		**Tank 3**	
length	**weight**	**length**	**weight**	**length**	**weight**
6.3cm	3.91g	5.5cm	2.96g	5.9cm	3.90g
6.2cm	4.60g	5.5cm	2.75g	6cm	4.01g
5.5cm	2.66g	5cm	2.27g	6cm	3.44g
5.4cm	2.63g	5cm	2.41g	6cm	2.97g
6.3cm	3.44g	5.5cm	2.85g	5.8cm	3.24g
5.8cm	3.63g	5.5cm	2.60g	6.2cm	5.64g
Average-	3.47g	Average-	2.64g	Average-	3.83g

Day 14

Tank 1		**Tank 2**		**Tank 3**	
length	**weight**	**length**	**weight**	**length**	**weight**
5.5cm	2.95g	5.6cm	3.13g	6cm	3.86g
6.3cm	4.01g	5.6cm	2.87g	6.5cm	4.48g
6.7cm	4.31g	5.3cm	2.55g	6.5cm	4.23g
5.9cm	3.83g	5.2cm	2.67g	6.2cm	3.1g
5.6cm	4.89g	5.7cm	2.97g	6cm	3.44g
6.5cm	3.1g	5.8cm	2.85g	6.4cm	5.70g
Average-	3.84g	Average-	2.84g	Average-	4.135g

4. **Diet 2**

Day 0

Fishes in the weight range of 1.5g -2.5g were considered.

Day 7

Tank 1		**Tank 2**		**Tank 3**	
length	**weight**	**length**	**weight**	**length**	**weight**
5.8cm	3.23g	5.9cm	3.30g	6.3cm	3.94g
6cm	2.23g	6cm	3.26g	5.6cm	2.95g
5.9cm	2g	5.5cm	2.87g	6.5cm	4.46g
6.5cm	4.30g	5.9cm	3.41g	6.3cm	4.08g
5.9cm	3.30g	5.5cm	2.95g	6.2cm	3.83g
5.9cm	3.05g	5.5cm	1.60g	6.4cm	4.34g
Average-	3.01g	Average-	2.84g	Average-	3.93g

Day 14

Tank 1		**Tank 2**		**Tank 3**	
length	**weight**	**length**	**weight**	**length**	**weight**
5.9cm	3.30g	6cm	3.95g	6.5cm	4.62g
6.4cm	2.34g	5.9cm	3.5g	5.7cm	3.34g
6.2cm	3.03g	5.7cm	3.01g	5.7cm	5.24g
6.7cm	4.5g	6cm	3.60g	6.2cm	4.2g
6.1cm	3.51g	5.9cm	2.98g	6.4cm	3.98g
6cm	3.20g	5.9cm	2.1g	6.5cm	4.51g
Average-	3.31g	Average-	3.19g	Average-	4.31g

Proximate Analysis of fish feed

When the fishes are reared in high densities, they require high quality, nutritionally complete and balanced feed to grow rapidly and remain healthy. Thew series of nutritional analyses that are performed are called proximate analysis and this seeks to estimate the different components of feed.

The proximate analysis divides the food into six fractions: moisture, ash, crude protein, ether extract, crude fibre and nitrogen free extractives and fixed carbon.

The total moisture includes air dry loss moisture and inherent moisture. Air dry moisture, which is not linked to organic matter, is the loss of weight resulted by drying at room temperature. Inherent moisture content is determined by heating an air-dried coal sample at 105-110c under specified conditions until constant weight is obtained.

Fixed carbon is the carbon found in the material which is left after volatile materials are driven off. This differs from the ultimate carbon content of coal because some carbon is lost in hydrocarbons with the volatiles.

Ash is the impurities consisting of inorganic matter from the earths crust like limestone, iron and trace elements. It is the incombustible material remaining after combustion of coal.

Importance of proximate analysis of fish feed in aquaculture

- Proximate Feed analysis can accurately measure content of nutrients in formulated feed.
- With the proximate analysis feeds are assessed so that a judgment can be made as to their nutritive value and the part that they can play in meeting an animal's requirements from different nutrients.
- The knowledge of the proximate composition of different fish species is very important, especially when it is to be consumed. The health risk associated with consuming fish that accumulates heavy metals in their bodies far outweighs the nutritional benefits that may be derived from such fish species. And it helps to predict the level of safety associated with their consumption.

Procedure for proximate analysis of fish feed:

1. 5g of fish feed of each diet was taken in motor and pestle.
2. It was homogenised with 10ml of distilled water.
3. Centrifuged at 3000rpm for 15 mins

4. After centrifugation, supernatant was used for the analysis of carbohydrates and proteins.

Carbohydrate Analysis test

For carbohydrate analysis, 1ml of supernatant of each diet was taken in test tubes and 5ml of anthrone reagent was added. The 4 test tubes (control, diet 1a,1b, and 2) were kept in water bath for 15 mins and OD was taken at 620nm.

Observation table:

Diet	O.D (620nm)
Control(growell)	2.895
Diet 1a	2.903
Diet 1b	2.948
Diet 2	2.807

Protein Analysis:

The following procedure was carried out to analyse the protein content:

1ml of supernatant of each diet was taken in test tube. 5 ml of Lowry's reagent was added in each test tube. Incubate the test tubes at room temperature for 10 mins. Then 0.5 ml folins reagent was added and again it was incubated at room temperature for 10 mins and then OD was taken at 660nm.

Observation table:

Diet	O.D (660nm)
Control(growell)	2.895
Diet 1a	2.936
Diet 1b	2.822
Diet 2	2.864

Moisture analysis

To analyse the moisture content following procedure was followed:

I. The weight of empty crucible was taken.
II. Measure 1g of feed

III. Then take the weight of feed and crucible together.

IV. Keep the crucible along with the feed in the oven at 105C for 1 hour.

V. Take the weight after taking the crucible out of the oven.

Results of Feed Analysis:

It was found that the **control (grow well)** had 0.089 mg/ml carbohydrates, 615.9ug/ml of proteins and moisture content was 5.01%.

Diet 1a contained 0.090 mg/ml carbohydrates 660.4ug/ml proteins and 2.40% moisture content.

Diet 1b had 0.091mg/ml of carbohydrates, 600.42ug/ml proteins and 6.23% moisture content.

Diet 2 contained 0.087mg/ml carbohydrates, 609.3ug/ml protein content and 10.52% moisture content.

Carbohydate Analysis Test

Protein analysis Test

Taking OD of the tests

Samples placed in spectrophotometer

Aquaponics set up

Aquaponics is a food production system that couples aquaculture (raising aquatic animals such as fish, crayfish, snails or prawns in tanks) with the hydroponics (cultivating plants in water) whereby the nutrient-rich aquaculture water is fed to hydroponically grown plants, where nitrifying bacteria convert ammonia into nitrates. Along with the fish and their waste, microbes play an important role to the nutrition of the plants.

Aquaponics is a big hope for sustainable organic crop production, aquaculture and water consumption. The fish waste is recycled and used for plant growth instead of throwing it in the oceans. The water is recirculated in a closed system lowering the consumption of this resource.

The fishes used for aquaponics are freshwater fishes such as tilapia and barramundi because they tolerate better diverse water conditions and they grow fast. Trout can also be used especially for lower water temperatures. Snails and shrimps can also be used in aquaponics.

The vegetables that can be grown for small scale aquaponics set up includes Lettuce, argula, mint, herbs, decorative flowers, spring onions, Amaranths, radishes, spinach, chilli plants and other small vegetables.

Benefits of Aquaponics

- Aquaponics is the way to grow the fishes and vegetables at the same time.
- Aquaponics doesn't require the use fertilizes because the fish provide rich nutrients for the plants through their waste output.
- Regular pesticides or other chemicals can't be used in aquaponics as they would harm the fishes and this results in healthier and organic vegetables.
- Plants can be grown in very small space, and have a great harvest
- Plants grow fast. Plants and fish production can be done in a controlled temperature environment.
- Water is used in a closed system and circulated effectively, reducing the consumption and water bills

Work done

At TERI, to setup an aquaponic system, we read many reference articles and came up with simple and unique diagrammatic representation of aquaponic system. As soon as the diagram was finalised a list of requirement material was made.

The materials were brought from nearby stores such as PVC pipes, zip tags, aquarium pump, endcaps, hydroponic cups, and additional requirements such as rubber tubes, M-seal and Drill machine, solvent cement and silicon glue. Using all the materials the aquaponics set up was made.

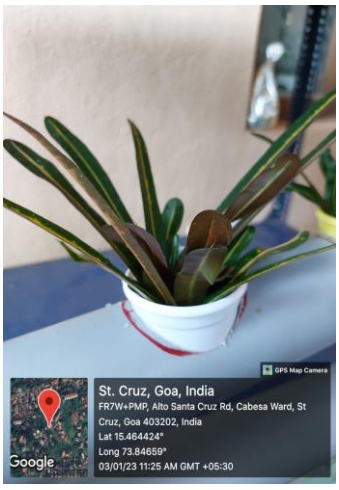
Procedure followed for setting up of aquaponics system:

1. An iron stand was cleaned and was placed near the electric socket.
2. Holes were drilled on the PVC pipes according to the required size using drill machine
3. The PVC pipes were fixed on the stand using zip tags in zig-zag manner.
4. Small holes were drilled on the end cap to pass the rubber tubes.
5. These end caps were fixed on PVC pipes with the help of solvent cement.
6. The rubber tubes were passed through the holes and fixed using M-seal.
7. The last pipe was positioned in the tank for clear water to come back in the tank.
8. A biofilter having ammonia converting bacteria was placed in the tank.
9. The ratio for placing plants: fishes in the aquaponic system was mentioned in the research article as 2: 1 and thus in this aquaponic set up we placed 5 tilapia fishes and 10 different variety of plants such as hydrilla, ferns and crotons were planted.
10. Hydroponic Net pots were placed in the holes drilled into pvc pipes. Expandable gardening clay balls were added in pots and the plants were introduced.

    In this way the small-scale aquaponics system was constructed.

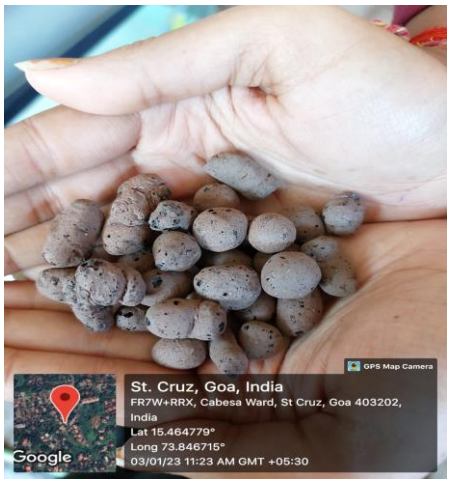
Hydrilla

Ferns

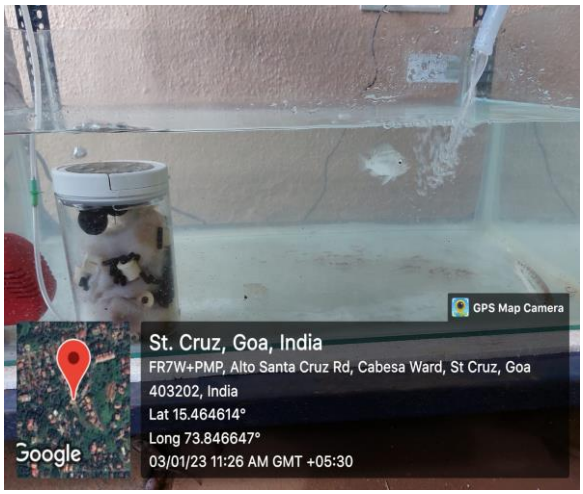


Crotons

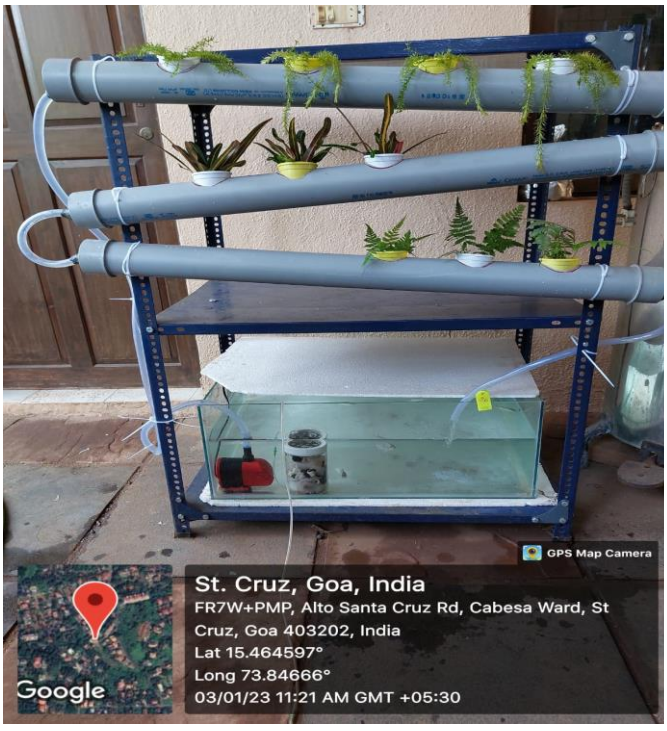
Expandable Gardening Clay Balls



Expandable Clay Balls



5 Fishes in tank of aquaponics system



Small scale Aquaponic set up

Conclusion

In the feeding experiment conducted, it was found that fishes fed with the Grow well feed showed the higher growth rate (weight and length) as compared to the fishes fed with experimental diet consisting of De-oiled and whole Algae. A small scale aquaponic setup was built using easily available materials.

Learning outcome

In this one-month internship program

1. we learnt to formulate fish feed.
2. We attained skills on maintenance of tank, introducing fingerlings in the tanks and measurement of weight and length of fishes.
3. We learnt about the proximate analysis testing of fishes such as carbohydrates analysis test, protein analysis and moisture content.
4. We also gained an experience on setting up of small scale aquaponic system.

The internship was very useful, where I got to apply all my knowledge practically. Certainly, this internship will help me in my future endeavours. Overall, it was a pleasant leaning and experience to remember.

Picture of group members with the guides, Dr.Fraddry D'souza and Dr. Elroy Pereira