Manufacture of Organic Fertiliser from Poultry Slaughterhouse Waste Rendering Plant Sludge Using Delta-D Technology

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Introduction:

Poultry slaughterhouse waste (PSHW) consists of, blood, feathers and other body parts of chicken (broilers) that cannot be sold or used for value addition. A few years back, this waste caused major disposal problems in broiler farms in Sri Lanka. The most popular disposal method that was adopted was to dump the waste in underground waste dumps, away from human settlements and water bodies. The highly nutritious, high protein high nitrogen, high phosphorous, leachate of these underground waste dumps caused pollution of soil and ground water and the surface runoffs sometimes polluted surface water bodies, such as rivers and lakes. With environmental laws becoming more and more stringent and the authorities becoming more forceful, most of the major chicken producers have installed Waste Rendering Plants (WRP), which convert PSHW into high protein poultry feed. However, WRPs have not been able reduce waste to zero, since, after separation of the solids as feed to WRP, there is a liquid effluent that has to be treated. Prior to sending this liquid effluent to activated sludge treatment plants, the suspended solids are skimmed out in Settling Tanks and Dissolved Air Flotation (DAF) Tanks and are called the Rendering Plant Sludge (RPS). RPS has around 30% solids and 70% water and cannot be composted or biologically treated due to its high fat content, which is more than, 10% on a wet basis and 33% on a dry basis. RPS cannot be incinerated too, due to the very high moisture content. Due to this difficulty, RPS is buried in lined underground waste dumps.

The author undertook a research project, to convert RPS into organic fertilizer, using Delta-D Technology, for a leading broiler chicken producer, Nelna Farms, in Hanwella, in the Western Province of Sri Lanka in August, 2007. After appropriate laboratory research, a method was developed to digest the organic components in RPS, such as, collagen, fat and protein using the digestive fluid Delta-D, mixing with saw dust or agricultural waste to enhance the Carbon:Nitrogen Ratio to around 30:1 and finally neutralizing the mass with powdered dolomite and rock phosphate. The organic fertilizer produced was tested for around 1 year by applying to flowering plants, vegetables plots and tender and mature fruit plants and the yields were extremely satisfactory. In November 2008, the author carried out a demonstration on the process of manufacture at the Nelna Factory, in the presence of the Plant Manager (PM) and his staff and around 100 kg of organic fertilizer produced at the demonstration were handed over to PM for testing. The fertilizer was tested for around 1 year and in December 2008, the PM informed the author that Nelna Farms are planning to establish a plant to convert RPS into Organic Fertiliser using Delta-D Technology.

This paper presents information regarding the process of Manufacture of Organic Fertiliser from Poultry Slaughterhouse Waste Rendering Plant Sludge Using Delta-D Technology.

Key Words:
Organic Fertiliser, Poultry Slaughterhouse Waste, Rendering Plant Sludge, Delta-D Technology

1.0 Introduction

1.1 Environmental Impact of Poultry Slaughterhouse Waste (PSHW)

Poultry slaughterhouse waste (PSHW) consists of, blood, feathers and other body parts of chicken (broilers) that cannot be sold or used for value addition. A few years back, this waste caused major disposal problems in broiler farms in Sri Lanka. The most popular disposal method adopted was to dump the waste in underground waste dumps, away from human settlements and water bodies. The highly nutritious, high protein, high nitrogen, high phosphorous, leachate, of these underground waste dumps, caused, pollution of soil and ground water and the surface runoffs polluted surface water bodies, such as rivers and lakes.

1.2 Poultry Slaughterhouse Waste Rendering Plant Emissions

With environmental laws becoming more and more stringent and the authorities becoming more forceful, most of the major chicken producers, in Sri Lnaka, have installed Waste Rendering Plants (WRP), which converts PSHW into high protein poultry feed. However, WRPs have not been able reduce waste to zero, since, after separation of the solids as feed to the WRP, there is a liquid effluent that has to be treated.

At Nelna Farm, one of the largest broiler chicken manufacturers in Sri Lanka, located in Hanwella, around 25 km from Colombo, prior to sending this liquid effluent to the activated sludge treatment plant, the suspended solids are skimmed out in Settling Tanks and Dissolved Air Flotation (DAF) Tanks. The daily production of this Rendering Plant Sludge (RPS) is around 1000kg and has around 30% solids and 70% water. RPS cannot be composted or biologically treated due to its high fat content, which is more than, 10% on a wet basis and 33% on a dry basis. Due to this difficulty, RPS is buried in lined underground waste dumps.

1.3 The Research Project

The author was requested by the management of Nelna Farms, a leading broiler chicken producer, whose factory is located in Meethirigala, 50km from Colombo, the capital city of Sri Lanka, to provide an environmentally, technically and economically feasible solution to the RPS problem, in August 2006. The author undertook the research project, to convert RPS into organic fertilizer, using Delta-D Technology, since, organic fertilizer could be easily sold in the market and whatever costs which are incurred in the manufacturing process could be recovered with a profit margin. After appropriate laboratory research, a method was developed to digest the organic components in RPS, such as, collagen, fat and protein using the digestive fluid Delta-D, mixing with saw dust or agricultural waste to enhance the Carbon:Nitrogen Ratio to around 30:1 and finally neutralizing the mass with powdered dolomite and rock phosphate. The organic fertilizer produced was tested for around 1 year by applying to flowering plants, vegetables plots and tender and mature fruit plants and the yields were extremely satisfactory. In November 2007, the author carried out a demonstration on the process of manufacture at the Nelna Factory, in the presence of the Plant Manager (PM) and his staff and around 100 kg of organic fertilizer produced at the demonstration were handed over to PM for testing. The fertilizer was tested for around 1 year and in December 2008, the PM informed the author that Nelna Farms are planning to establish a plant to convert RPS into Organic Fertiliser using Delta-D Technology in 2009.

1.4 Introduction to Delta-D Technology

Delta-D Technology is a process invented and patented by the author to rapidly digest all types of organic waste into mineral rich organic fertiliser by mixing with a digestive fluid called Delta-D, followed by the addition of mineral powders, such as, rock phosphate, calcite, dolomite, etc.

The main advantage of Delta-D Technology, is that, digestion can be done within a few hours, whereas, traditional processes, such as, composting and biogas generation require more than 3 months to digest organic waste. For example, if Urban Solid Waste (USW) is to be treated with traditional waste treatment processes, large quantities of USW have to be stockpiled for several months, requiring large extents of land.

The composition of the digestive fluid has to be varied according to the composition of the organic waste that has to be decomposed, as well as, the rate at which the organic matter is to be digested. The composition of the digestive fluid required to digest high cellulose materials, such as, saw dust, straw or paddy husk will be different to that required to digest low cellulose high polysaccharide and high moisture material, such as, fruit and vegetable waste, which in turn will be different to that required to digest low polysaccharide, high protein material, such as, fish and meat waste. Hence the composition of the digestive fluid will be decided on the basis of the waste to be digested at any given time. The composition of the digestive fluid has to be varied according to the level of disinfection required in the organic fertilizer, as well. For example, if the organic waste consists of highly infectious material, such as, rotten fish, meat, sewage, or clinical waste produced in hospitals, etc., the composition of the digestive fluid can be adjusted to automatically increase the temperature of the digestive mix to 100^0C or more, so that all harmful pathogenic micro-organism are automatically destroyed.

After the digestion is complete, the digested mass is neutralized using a mineral powder mix. The composition of the mineral powder will depend on the required composition of the final product, which will be an organic fertilizer containing water soluble N, P, K, Mg, Ca and other nutrients. One of the most important properties of Delta-D is that it only catalyses digestion, which means that after the digestion process is over the Delta-D originally added will remain in the system and it is possible to use the residual Delta-D to digest more and more organic matter.

1.4.1 Types of Delta-D Available for Digestion of Wastes and Optimal Ratios

Since there are different types of wastes, Delta-D of a single specific composition will not be able to digest all these wastes efficiently. Hence, Delta-D of different compositions are available to choose from, based on the type of waste that has to be digested. Delta-D types and optimal ratios for rapid digestion, are as follows. The recommended ratio for addition of mineral powders to neutralize Delta-D is, 4kg ERP and 2kg Dolomite per 1 litre of Delta-D

- **(a) Delta-D^C** is specifically for high cellulose materials, such as, straw, sawdust, grass, leaves of plants, waste paper, etc. **The optimal ratio of Delta-D^C to dry cellulosic waste is 1 litre per 30 kg.**
- (b) **Delta-D^P** is specifically for high protein material, such as, excreta of animals, poultry farm waste, fish waste, slaughterhouse waste, etc. **The optimal ratio of Delta-D^P to high protein waste is 1 litre per 20 kg.**
- **(c) Delta-D^V** is specifically for low cellulose high moisture material, such as, fruit and vegetable waste, cooked food waste, etc**. The optimal ratio of Delta-D^V to this type of waste is 1 litre per 50 kg.**
- **(d) Delta-D^{USW}**is specifically for urban solid waste, which is a mixture of, fruit and vegetable waste, cooked food waste, waste paper, leaves of plants etc. **The optimal ratio of Delta-D^{USW} to waste is 1 litre per 30 kg.**

1.4.2 How Does Delta-D Digest Organic Matter?

Organic waste comprising plant and animal wastes contain simple molecules, such as, monosaccharides, amino acids, etc., as well as, complex molecules, such as, polysaccharides, proteins, collagen, chlorophyll, etc. Delta-D has a chemical combination that can digest all types of natural organic matter by catalyzing the following reactions, followed by mobilization of microorganisms available in soil to further digest organic waste and produce beneficial effects for plants.

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1. Mobilisation of enzymes already available in plant and animal waste.
2. Hydrolysis.
3. Oxidation.

3. Catabolism (Breaking down complex molecules, such as, cellulose, starch, proteins, oils and fats into monosaccharides, amino acids, etc.).
4. Conversion of organic N, P, K, Ca, Mg, Na, Fe, Mn, Mo, etc. into inorganic, water soluble forms.

1.4.3 Benefits of Organic Fertiliser

1.4.3.1 Increase of Water and Carbon Dioxide (CO_2) Levels in the Soil and Atmosphere due to Microbial Activity in Organic Soil

When organic fertilizer (OF) is applied to soil, the soil becomes organic due to the presence organic carbon, amino acids, phosphates and other organic nutrients which are conducive to microbial growth. Hence, atmospheric microbes start living in the soil and rapidly multiply in numbers. Due to micro-organic respiration activity, a carbon dioxide (CO_2) rich environment is created in the environment. In the atmosphere the CO_2 concentration is only 0.03%, where as, it has been reported by researchers that in an organic soil environment CO_2 levels can be as high as 0.8%. Moreover, it has been well established by researchers that the CO_2 level in ground water in an organic soil environment is very much higher than otherwise. Moreover, organic soil is permeable, can absorb and retain more water.

Water (H_2O) and carbon dioxide CO_2 are the main reactants in Photosynthesis (a reaction that occurs in leaves of plants, energized by sunlight), which produces Glucose, by combining CO_2 and H_2O, according to the following famous reaction. Hence, agricultural yield in an organic environment will be much higher, due to the higher availability of CO_2 and H_2O, than in an inorganic environment.

$$6\ CO_2 + 6\ H_2O \text{ -------------- } C_6H_{12}O_6 + 6\ O_2$$

1.4.3.2 Nitrogen Fixation by Microorganisms in Organic Soil

Nitrogen (N) is an essential plant nutrient, since, it is required to produce Chlorophyll ($C_{55}H_{54}N_4Mg$) and for other metabolic reactions that occur in a plant. The growth of leafs in a plant is mainly due to the presence of N and the above mentioned photosynthesis reactions occur in the leaves of plants. If a plant does not have many leaves, its growth will be greatly retarded due to low levels of photosynthesis. Hence, large quantities of N fertilizer, such as, Urea, Ammonium Sulphate, Diamonium Phosphate, etc., is imported to Sri Lanka at a massive cost, for all types of agriculture. The annual import of Urea is more than 300,000 MT and the cost was more than Rs. 30 Billion in 2008. Since, Urea is produced from natural gas (a petroleum derivative), whenever petroleum prices increase in the international market, the price of Urea also increases.

Despite the fact that N is freely available in the atmosphere as N_2 (air contains 79% N_2), it cannot be absorbed by a plant. However, when Organic Fertiliser is applied to soil, microorganisms start living in the soil because organic fertilizer provides food for them. With time microorganic population increases in the soil. Many of these microorganisms synthesise proteins by taking N from air. Hence, after some time, the N level in the soil increases. This is called nitrogen fixation, where, N_2 available in the atmosphere (air) is captured and put into the soil by micro organisms, free of charge. Hence, when a seed is planted in organic soil, it will develop a large root system due to the high permeability of the soil and subsequently grows very fast due to the high availability of water, CO_2 , N and other minerals in the organic environment. Moreover, when the soil is rich in organic matter, the soil will capture and retain water, the soil will be much cooler and the respiration of the roots will be much higher due to the high porosity of the soil.

1.5 Current Status of Implementation of Delta-D Technology in Sri Lanka

Delta-D Technology has been demonstrated at several government institutions, such as, The Institution of Engineers of Sri Lanka, Ministry of Agriculture (Govijana Mandiraya) University of Moratuwa, Horana Urban Council, Maharagama Urban Council, Lanka Phosphates Ltd., The Central Environmental Authority, and several leading private companies, such as, The Lodge Habarana, The Confifi Group of Hotels, Pussellawa plantations, Horana Plantations, CIC Fertilisers, Keells Food Products, Nelna Farm, Mandarin Farm and several other poultry farms. These demonstrations were attended by dignitaries, such as, Hon. Minister Chamal Rajapakse, Hon. Minister Chandrasena, Hon. Vasudeva Nanayakkara, Chancellor of The University of Moratuwa - Vidya Jothi Dr. Ray Wijeywardena, Director Engineering Mahaweli Authority of Sri Lanka - Eng. Neil Bandara, Director of Waste Management Authority – Mr. Priyantha Samarakkody, Head of the Department of Chemical and Process Engineering of the University of Moratuwa -Dr. Ajith De Alwis, Chairman of the Chemical Engineering Section of the Institution of Engineers of Sri Lanka – Eng. Clarence Perera and a large number of engineers, university lecturers, university students, members of NGOs, private companies and government institutions.

The author has also trained more than 4000 farmers, agriculturists and entrepreneurs in Delta-D Technology, by conducting workshops in most of the agricultural areas of Sri Lanka. Most of these personnel have commenced their own self employment type projects, where, they convert plant and animal wates into organic fertilizer for their own use.

2.0 The Research Project

2.1 Introduction:

The research project, was commenced in August 2006, at the request of the Plant Manager of the Nelna Farms and was conducted at No: 88A, Gimpatha Rd., Wattalpola, Panadura. The main object of the research project was to find a technically, economically and environmentally feasible solution to the Rendering Plant Sludge (RPS) problem in the Nelna Farm, at Meethirigala, which processes 14,000 birds per day. The daily production of 5500kg of PSHW is sent to the rendering plant (RP) from which around 1000kg per day of RPS is produced as a byproduct.

2.2 Properties of RPS Samples of Nelna Farms

Around six sealed plastic barrels, each containing around 50 kg of RPS was delivered by Nelna Farms for trials. When the seals were removed, it was found that RPS emitted bad odour and that it was already undergoing anaerobic fermentation, with gases coming out. The barrels were resealed until usage for trials. The analysis analysis submitted by Nelna Farms is given in Table 1.

Table 1 – Average Composition of RPS at Nelna Farm

Material	Total Moisture	Total SS	Fat Content in SS	Protein Content in SS	Others in SS
RPS	70%	30%	38%	54%	8%

2.3 Average Chemical Compositions of Fats and Proteins in RPS

The chemical compositions of individual fats and proteins present in RPS was not available. Hence, with regards to the composition of chicken fat, the author had to use data, released by Department of Animal and Wild life Sciences, University of Pretoria, South Africa in Table 2, from which, it is evident that fatty acids with C 14 to 20 are available in chicken fat, of which, some are unsaturated and saturated fatty acids.

With regards to the composition of chicken protein, the author had to use data pertaining to flash dried rendering plant sludge, available in the web site, www.griffinind.com (18), given in Table 3..

Table 2 - Average Fatty Acid Composition (Molar%) of Chicken Fat From Chicken Production Lines in South Africa by E. Van Marle-Köster and E.C. Webb, Department of Animal and Wildlife Sciences, University of Pretoria, South Africa.

Poultry Type	Molar % of Fatty Acid of which No of C Atoms : No of Unsaturated Bonds =14:0	Molar % of Fatty Acid of which No of C Atoms : No of Unsaturated Bonds =16:0	Molar % of Fatty Acid of which No of C Atoms : No of Unsaturated Bonds =16:1	Molar % of Fatty Acid of which No of C Atoms : No of Unsaturated Bonds =18:0	Molar % of Fatty Acid of which No of C Atoms : No of Unsaturated Bonds =18:1	Molar % of Fatty Acid of which No of C Atoms : No of Unsaturated Bonds =18:3	Molar % of Fatty Acid of which No of C Atoms : No of Unsaturated Bonds =20:1
Koekoek (n=160)	1.05	24.58	7.92	8.23	45.28	12.18	1.54
New Hampshire (n=160)	0.85	25.83	9.85	7.74	44.27	10.12	1.92
Naked-Neck (n=113)	1.15	25.10	8.19	7.82	42.74	12.87	2.34
Lebowa-Venda (n=120)	1.29	22.17	7.98	6.99	45.06	14.44	2.05
Ovamba (n=105)	0.92	23.71	9.23	6.07	46.68	12.72	1.33
Cobb	0.92	26.62	8.78	8.37	43.11	9.58	2.42

Table 3 – Amino Acid Profile of Flash Dried Poultry Protein from Rendering Plant Sludge

Amino Acid	Mass %	Amino Acid	Mass %
Aspartic Acid	5.37	Isoleusine	2.63
Threnine	3.08	Leucine	4.85
Serine	2.88	Tyrosine	2.37
Glutamic Acid	8.75	Phenylalanine	2.84
Proline	4.77	Histidine	1.71
Glycine	6.17	Lysine	4.30
Alanine	4.11	TSAA	2.51
Cystine	1.07	Arginine	5.14
Methionine	1.44	Tryptophan	0.70
Valine	3.19	Taurine	0.45

2.4 Trials on Aerobic Composting of RPS

A few trials were carried out to ascertain the possibility of composting RPS, using naturally occurring aerobic microorganism. The method followed was to mix 1 kg of RPS with 10kg of saw dust (SD) in the ratio 1

Problems in Direct Application of Delta-D Technology to Produce Organic Fertiliser (OF) from RPS

Trials conducted on natural micro-organic composting of RPS were not successful, due to the high mortality rate of aerobic microorganism, resulting from the high fat content in RPS. Although Delta-D Technology has been developed to digest high protein waste material, such as, fish and meat waste from markets and slaughterhouses, by using the digestive fluid Delta-D^P, it was found that Delta-D^P cannot be directly used on RPS, since, the protein in RPS was coated with fat. Hence, it was necessary to develop a system to deal with the fat.

2.2 Dispersion of Coagulated Fat Using an Emulsifier

The author decided to use a fat emulsifier, which would disperse the coagulated fat in the 70% water, already available in RPS. The preconditions were, that, the emulsifier (E) should not adversely affect, the process of manufacture of OF using Delta-D Technology and the micro-organic activity of the soil after OF is applied to it. The emulsifiers, the recipes, the list of equipment and the manufacturing process used in the trials are given in Section 2.3.

2.3 The Recipes and the Manufacturing Process

The list of ingredients, the list of emulsifiers, the list of equipment and the manufacturing process given below are similar to the standard method used in the process of manufacture of organic fertilizer (OF), using Delta-D Technology, from high protein waste, such as, fish, meat, market and slaughterhouse wastes, with the exception, that, for RPS, a fat emulsifier was used as prior to the manufacturing process.

Table 4 – The List of Ingredients Used in RPS Based Organic Fertiliser Manufacturing Trials

Ingredient	**Quantity**
Rendering Plant Sludge (RPS)	100kg
Emulsifier (E)	300g
Delta-D^{P}	5L
Saw Dust(SD)	50kg
Eppawela Rock Phosphate Powder (ERP)	20kg
Dolomite (D)	20kg

Table 5 - The List of Emulsifiers Used in RPS Based Organic Fertiliser Manufacturing Trials

Name of Emulsifiers (E)	**Concentration (w%)**
Sodium Lauryl Sulphate (SLES)	70
Sodium Linear Alkyl Benzene Sulphonate (SLABSA)	96
Coconut Oil Soap (COS) Powder(mainly has Sodium salts of lauric, myristic and palmitic acids)	60
Palm Oil Soap (POS) Powder(mainly has Sodium salts of palmitic, stearic and oleic acids)	60

Table 6 - The List of Equipment Used in RPS Based Organic Fertiliser Manufacturing Trials

List of Equipment	**No. of Units**
200L Plastic Barrels	01
Paddle Type Vertical SS Shaft 2HP Electric Mixer	01
Weighing Scale	01
Gauge 24 SS Mesh with	01

2.3.1 The Manufacturing Process

(a) 100kg of RPS was taken into the 200Lplastic barrel and mixed using   mixer, driven by a 2 HP motor, rotating at 350 rpm.
(b) While the mixing was in progress, 300g of E was gradually added and the mixing process was continued until the mixture was uniform.
(c) 5L of Delta-D^P was added to the mix and mixing was continued for around 30 minutes, until the redish colour of RPS became dark brownish.
(d) While mixing was continuing, 50kg of SD was gradually added until the SD was well mixed with the digestive mass. The mixture was stored for 2 days, allowing Delta-D^P to digest the mass.
(e) After 2 days, 20kg of ERP was added and the mixing was continued until a unform mix was obtained and was stored for 1 day to allow Delta-D^P to react with ERP.
(f) After 1 day, 20kg of D was added and the mixing was continued until a unform mix was obtained and was stored for 1 day to allow Delta-D^P to react with D.
(g) The product was sifted through the 24G SS mesh and oversizes on the mesh were recycled back to the step

Observations were recorded, with respect to each Emulsifier used, during the entire manufacturing process.

2.3.2 Observations Recorded During the Manufacturing Process With Respect To Emulsifiers

(a) Use of SLES as Emulsifier **–** Emulsification was efficient and quick with moderate froth.
(b) Use of SLABSA as Emulsifier **–** Emulsification was efficient and quick with very high froth.
(c) Use of COS as Emulsifier **–** Emulsification was unsatisfactory and very slow with very low froth.
(d) Use of POS as Emulsifier **–** Emulsification was unsatisfactory and very slow with very low froth.

2.3.3 Selection of Emulsifier

Due to high froth formation in SLABSA, the plastic barrel over flowed and the mixing process was interrupted several times. Due to this reason, it was decided to use SLES, although, both SLES and SLABSA were good emulsifiers to emulsify fat in RPS.

2.4.0 Manufacture of Large Samples of OF from RPS for Agricultural Trials

Since, experiments carried out on the manufacturing processes yielded satisfactory results, it was decided to convert 3000kg of RPS into OF, using Fat Emulsification Based Delta-D Technology. The manufacturing process was carried out, batchwise, in 200L plastic barrels using the electrical mixer that was used in the experiments. All cost components , such as, material, electricity, labour, packing and overheads were taken into account. Table 4 gives all relevant data regarding production costs and profits.

Table 7 – Schedule of Costs and Profits in Production and Sale of OF from RPS

Ingredient	Qty/day	Unit Price(SLR)	Cost (SLR)
RPS	1000kg	Nil	Nil
SLES	3kg	900.00	900.00
Delta-D[p]	50L = 75kg	150.00	7500.00
Saw Dust	500kg	2.00	1000.00
ERP	200kg	10.00	2000.00
Dolomite	200kg	6.00	1200.00
Total Production of OF	1950kg		
Total Material Cost			12600.00
Cost of Electricity			100.00
Labour Cost			3000.00
Packing Costs			800.00
Total Overheads (inl			2000.00
Total Production Cost			18500.00
Cost per kg			8.50
Selling Price			20.00
Profit per kg			11.50
If Prod per day	2170kg		
Prod per day			24955.00
Profit per year (300 days)			7,486,500.00

Results of laboratory analysis of organic fertilizer (OF) manufactured from Rendering Plant Sludge (RPS) are *given in Table 5.*

Table 8 – Nutrient Levels in OF Manufactured from RPS Using Delta-D Technology

Free H_2O	Organic C	Soluble N	Soluble P	Soluble K	Ca	Mg	Others
36.4%	28.6%	6.4%	3.1%	0.7%	2.6	1.3	20.9%

3.0 Agricultural Trials

Agricultural trials were conducted by the author by applying OF to vegetable plots, flowering and fruit bearing plants, and the results have been satisfactory. Personnel at Nelna Farms have independently tested OF by applying to their own cultivations of fruits, vegetables, etc., and have endorsed the productivity of the fertilizer. Hence, discussions will be commenced with Nelna Farms to establish OF production facility at the poultry farm in Meethirigala, in the near future.

4.0 Conclusions

1. RPS cannot be composted by natural microorganisms due to the high fat content.
2. RPS cannot be directly converted into OF by Delta-D Technology due to the high fat level..
3. The high fat content has to be first emulsified by a suitable emulsifier. The most suitable emulsifier according to the research study was Sodium Lauryl Ether Sulphate.
4. After fat emulsification it was possible to manufacture OF from RPS using Delta-D Technology.
5. The cost of production OF was far below the selling price, clearly indicating high profitability.
6. Hence RPS, which causes a major environmental problem has been converted into a, value added, income earning product.

5.0 Acknowledgements

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References

1. Perera S.A.S., Patented Process for Rapid Digestion of All Types of Biomass into Organic Fertiliser a Solution to the Urban Solid Waste (USW) Problem and to the Fertiliser Problem in Sri Lanka, Proceedings of The 22nd International Conference on Solid Waste Technology and Management, organized by Widener University, held in Philadelphia, USA, during the period 18-21 March 2007.

2. Perera S.A.S., Manufacture of Organic Fertiliser from Vegetable Market Garbage (VMG) Using Eppawela Rock Phosphate (ERP) and Its Effects on Rice Cultivation,Proceedings of The 22nd International Conference on Solid Waste Technology and Management, organized by Widener University, held in Philadelphia, USA, during the period 18-21 March 2007.

3. Perera S.A.S., P. Ratnaweera and J.N. Meegoda, Sustainable Agricultural Practices for Developing Nations, Proceedings of the International Conference on Soil and Rock Engineering, Organised by The Sri Lanka Institute of Geotechnical Engineers, held in Colombo, Sri Lanka in August 2007.

5. Perera S.A.S., Sustainable Agriculture through Delta-D Technology, a Solution to Urban Solid Waste and Global Warming, Proceedings of The 23rd International Conference on Solid Waste Technology and Management, organized by Widener University, held in Philadelphia, USA, during the period 30March-02April 2008.

6. Perera S.A.S., Perera M.A.S., Manufacture of Bioethanol from Vegetable and Fruit Waste in Sri Lanka, Proceedings of The 23rd International Conference on Solid Waste Technology and Management, organized by Widener University, held in Philadelphia, USA, during the period 30March-02April 2008.

7. Perera S.A.S., Delta-D Technology, a Technically, Economically and Environmentally Feasible Solution to the Urban Solid Waste(USW) Problem and the Fertiliser Problem in Sri Lanka, Transactions-2007 Volume1 – Part B , Annual Sessions of The Institution of Engineers, Sri Lanka.

8. Perera S.A.S.,Delta-D Initiated Microorganic Digestion of Saw Dust into Organic Fertiliser – A Technically, Economically and Environmentally Feasible Solution to the Saw Dust Problem in Sri Lanka, Engineer-Volume 41, Journal of The Institution of Engineers, Sri Lanka, October 2008, ISSN-1800-1122

9. www.soo.co.in/fertilizer.htm
10. www.actahort.org
11. www.brusselsgreentech
12. http://www.mirror.org/ken.roberts/compost.html
13. www.answerbag.com/q
14. weblife.org/humanure/chapter8
15. www.springerlink.com/index/Q1L4Q9L000M53845.pdf
16. www.gardenopus.com/Sawdust.htm
17. vegweb.com/composting/what-not.shtml
***18.* www.idrc.org.sg/en/ev**
19.**Waste** management: the **poultry** industry avmajournals.avma.org/doi/pdf/10.2460/javma.2003.223.55 - Similar pages
by EN Gingerich - 2003 - All 3 versions
20. Perdue Works to Minimize **Poultry Farm** Runoff, **Waste** www.environmentalleader.com/2009/01/09/perdue-works-to-minimize-**poultry**-**farm**-runoff-**waste**/ -
21 Animal **Waste** and the Environment www.engr.uga.edu/service/extension/publications/c827-cd.html - 16k -
22 UPC fact sheet on the Environmental Impact of the **Poultry** Industry www.upc-online.org/fouling.html - 13k - Cached -
23. Flash Dried Poultry Protein**, www.griffinind.com/FPS-Flash.php - 41k - Cached - Similar pages**