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The Utilization of Agricultural Waste as One of the Environmental Issues in Egypt (A Case Study)

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Abstract: Agricultural wastes in Egypt amount range from 30-35 million tons a year of which only 7 million tons as animal feed and 4 million as organic manure are being utilized. These crop residues results after harvesting in the farm of leaves, stem and shelves which are characterized as Coarse plant by-products and big size, chemically low in protein and fat contents. Also it is high in lignin and cellulous contents. The problem of agriculture wastes becomes very obvious and aggregated after the harvest of summer crops. That is because at this time of the season, the farmer is in a rush to re cultivate his land therefore getting ride of the wastes has his highest priorities, usually by burning. This method, burning not only is considered an economic loss but also has harmful effects on the environment. These harmful effects are emission of poisons gases to the air and reducing the microbial activities in the soil. In addition, storing these wastes in the field after compacting may make it suitable environment for reproduction and growth of pests and pathogens that will attack new crops.Therefore, utilization of agriculture wastes in any other environmentally friendly way is very important. These can be done by:-

1- Compost production by fermenting the agricultural in the main way for recycling them.
This will help in re fertilizing the soil organically and reduce the production cost.

2- Animal feed production:- by treating some wastes such as rice straw by Urea or ammonia to increase its nitrogen content hence its nutritional value.

3- Food production.

· This can be done by growing mushroom on agricultural wastes such as rice straw as a substrate. This means the conversion of wastes to economic, nutritional human food.

· Growing vegetables on rice straw compacted bales in areas where soil disease and salinity are constrains.

1- Energy production
Bio gas

I t can be concluded that recycling agriculture wastes is a must for environment as well as economical saving. This recycling will not only increase agricultural production but also will improve its quality.

Kew words: Agricultural waste, Composting, Animal feed, mushroom production and Biogas

INTRODUCTION

Egypt is 97% desert and only 5% of the land area is actually occupied with less than 4% of the land is suitable for agriculture. The agricultural activates result in "the yield" which is economic part of the crop and less important part which used to be called "agricultural waste". Therefore, agricultural waste is defined as the outcome of agricultural production following the different harvesting activities. With the introduction of technology in the agricultural process, waste has become a burden because of the entailed destruction and pollution of the environment. In addition, Statistics point out that agricultural waste reaches 30 million tons on the national level. The type and quantity of agricultural waste in Egypt changes from one village to another and from one year to another because farmers always cultivate the most profitable crops suited to the land and the environment. Several factors have aggravated the problem including the absence of environmental awareness and the low level of knowledge and skills affecting the behavior of peasants in handling agricultural waste. In addition, burning agricultural waste in the rice cultivated fields generates many poisonous and harmful oxides and hydro- carbonates (the black cloud).

Egypt has an agricultural tradition which goes back thousands of years. Egyptian farmers were good at making use of crop residues for building, heating, livestock feeding and fertilizing. With modernization of

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agriculture, as well as economic and social development leading to deep changes in rural energy and the structure of feedstuffs, the traditional approaches for utilization of crop residues have subsided and plans to expand this tradition in the future. In order to combine the old traditions with modern technologies to achieve sustainable development, waste should be treated as a by-product.

The main problems facing rural areas today are agricultural waste, sewage and municipal solid waste. However, few studies have been conducted on the utilization of agricultural waste for composting and/or animal fodder, and none of them has been implemented in a sustainable form [1]. In addition**,** many farmers now view the practice of residue utilization as an extra cost with small returns, and that the best way in to get rid of the residues by dumping, open burning, etc. But the hazards to the environment of such practices can no longer be ignored. Attitudes must, therefore, change from considering crop residues as undesired wastes, for which some use must be found, to those of considering such residues as an integral part of agricultural production. There are many new approaches and methods for utilizing crop residues that have become attractive and profitable such as composting, animal fodder and energy production. Several research and development programs are underway in several European countries, the U.S.A, China, India and other countries to use biomass. However, The five crops with the highest amount of waste are which must be focused on rice, corn, wheat/barley, cotton and sugar cane.

On the national level, there are many efforts particularly those of the ministry of the environment and the ministry of agriculture to find solutions for the problem and avoid environmental degradation. Those efforts must be encouraged, increased and implemented on large scale.

2-Agricultural Waste in Egypt:

2.1 Estimation of Crop Residues: The proportion of straw, or stover, to grain varies from crop to another and according to yield level. The yield is a function of total biomass and the harvest index (the grain to straw ratio). A harvest index of 0.5 indicates that the biomass produced comprises 50 per cent grain and 50 per cent straw. Lower harvest indices means higher proportions of straw. The height of cutting will also affect how much stubble is left in the field: many combine-harvested crops are cut high; crops on small- scale farms may be cut at ground level by sickle or uprooted by hand.

Two different methods can be used to calculate the amount of crop residues generated. The first one, used for woody residues from perennial crops, is based on the cropped areas. This method assumes that crops grow with a more or less standard planting density, which in practice may not be true. The type of management (traditional or advanced) as well as the crop variety (local variety, improved and/or clonal variety) can result in large differences in the amount of crop as well as residue obtained from a particular cropping area. This method is, therefore, limited to particular plantations under specific conditions (eg, coffee plantations, tea plantations, palm trees ..etc). The second method of calculation of crop residues, often used for annual crops, is to use a residue-to-product ratio (RPR). Several RPRs for different crops have been suggested by different authors (see, for example, [2,3]). Variations in the reported values have been attributed to differences in seed varieties planted, moisture content of the crop residues, and method of harvesting. Table (1) gives the RPR values used by FAO in estimating crop residues in the Asian region, and those given recently by Lai [3] for the estimation of crop residues in the world,

There are three crop cultivation seasons in Egypt. Winter crops are cultivated at the beginning of the winter season in October/November, their growth period lasts until early summer of the next year. They are harvested in May/June. These crops include grains such as wheat and barely, legumes (beans, lentil), sugar crops (sugar beat, sugar cane), fibers (flax), fodders (clover, green, fodder), aromatic and medicinal plants, and vegetables. The second group of crops (summer crops) is cultivated at the beginning of the summer season In May (cotton is planted earlier in March/April) and its growth period extends to the end of autumn in the same year (October). These crops include grains such as rice, maize and sorghum; oily crops (soy bean, peanut, sesame and sunflower); sugar crops (sugar cane); fodders (alfalfa, green fodder)t fiber (cotton, kenaf), aromatic and medicinal plants, and vegetables. Fruits are cultivated both in winter and summer. The third group of crops is known as Nili crops and these are cultivated in the middle of summer (July/August) and their growth period continues until the beginning of winter. These crops include rice, maize, sorghum, and oily crops and fodder similar to these grown in the summer season. Both winter and summer crops account for the bulk of agricultural products in Egypt.

3. Utilization of Crop Residues: Crop residues are organic and biodegradable. Utilization technology must either use the residues rapidly, or the residues must be stored under conditions that do not cause spoilage or render the residues unsuitable for processing to the desired end product. There are many methods for utilizing agricultural waste in Egypt which can be summarized as follows:

3.1Composting: Composting is the aerobic decomposition of organic materials by microorganisms under controlled conditions. Agricultural waste is rich in organic matter. This matter is derived from the soil and the soil needs it back in order to continue producing healthy crops. In addition, Geisel, [4] and El-Haggar, [1] reported that composting is one of the best known recycling processes for organic waste to close the natural loop. The major factors affecting the decomposition of organic matter by micro-organisms are oxygen and moisture. Temperature, which is a result of microbial activity, is also an important factor.

The other variables affecting the process of composting are nutrients (carbon and nitrogen), pH, time and the physical characteristics of the raw material (porosity, structure, texture and particle size). Aeration is required to recharge the oxygen supply for the micro-organisms. The passive composting method is the recommended technique for the Egyptian environment for technical and economic reasons. The main advantages of composting is the improvement of soil structure by adding organic matter as well as utilizing agricultural waste that can cause high levels of pollution if burned.

Because composted materials usually contain some biological resistant compounds, a complete stabilization (maturation) during composting may not be achieved.

The time required for maturation depends on environmental factors within and around the composting pile. Some traditional indicators can be used to measure the degree of stabilization such as decline in temperature, absence of odour, and lake of attraction of insects in the final products [1] .

In addition, A grower's guide, [5] . mentioned that Aerobic composting systems can be classified as turned windrows, aerated static piles, passive static piles or windrows, and aerobic in vessel systems. In any aerobic system, composting is most rapid when microbial activity is mazimized. This accomplished by using starting material that have proper balnce of carbon and nitrogen and keeping compost pile moist yet well aerated (see Table 3).

Concerning size of materials Geisel, [4]concluded that material decomposes best if it is 0.5 to 1.5 inches in size. Soft, succulent tissues do not need to be chopped into very small pieces, but hard or woody tissues should be reduced to smaller pieces in order to decompose rapidly. Decomposition occurs primarily on or near the surfaces of particles, where oxygen diffusion into the aqueous films covering the particle is adequate for aerobic metabolism, and the substrate itself is readily accessible to microorganisms and their extra cellular enzymes. Small particles have more surface area per unit mass or volume than large particles, so if aeration is adequate, small particles will degrade more quickly. Whereas , Gray and Sherman, [6] and Gray et al. [7] recommend a particle size of 1.3 to 7.6 cm (0.5 to 2 inches), with the lower end of this scale suitable for forced aeration or continuously mixed systems, and the upper end for windrow and other passively aerated systems.

A theoretical calculation by Haug [8] suggests that for particles larger than 1 mm in thickness, oxygen may not diffuse all the way into the center of the particle. Thus the interior regions of large particles are probably anaerobic, and decomposition rates in this region are correspondingly slow. However, anaerobic conditions are more of a problem with small particles, as the resulting narrow pores readily fill with water due to capillary action. These issues are addressed more fully in the section on factors leading to anaerobic conditions.

Regarding carbon to nitrogen ratio Geisel, [4] showed that the mixture of materials in the compost pile should have a carbon to nitrogen ratio of 30 to 1. Because of the bulk of dry materials and the fact that green material shrinks even more upon drying, we can use a 1 to 1 volume to approximate the 30 to 1 ratio of carbon to nitrogen. This may need to be adjusted depending on the nitrogen content of the green material or if manures are added to the pile. Matted materials exclude the oxygen necessary for rapid decomposition.

Some green items, such as grass clippings, also tend to mat if not mixed thoroughly with ray materials.

Whereas, composting works best if the moisture content of the pile is about 50 percent moist, not soggy. Too much moisture slows decomposition and produces a disagreeable odor due to the activity of methane-producing microorganisms. If the organic material is too dry, decomposition will be very slow or may not occur at all. Heat is supplied by the respiration of the microorganisms as they break down the organic materials [4]. In addition, excess moisture, inadequate porosity, and excessive pile size, all of these factors make it more difficult for oxygen to penetrate throughout a pile before it is depleted, or allow airflow to short-circuit around large zones which become anaerobic. One of the mechanisms of oxygen transport is diffusion, which is function of the concentration difference between the outside air (21% oxygen) and the oxygen concentration in the interior of the pile (if anaerobic, zero). In a passively aerated or windrow system, diffusion is assisted by natural convection, but that assistance is probably limited to the upper and outer parts of the pile [9]. A compost pile needs to be turned to prevent it from overheating and to aerate and thoroughly mix the materials. If the internal temperature of the pile exceeds (71°C), the necessary microorganisms are killed, the pile cools, and the whole process of composting must start again from the beginning. Turning is done to move to the center the material that is at the outer edge of the pile. This way, all the material reaches the optimum temperature at various times. Due to heat loss around the margins, only the central portion of the pile is at the optimum temperature [4] .Oxygen uptake rates measured in compost vary widely, from less than 1 to over 10 g O_2/kg volatile solids per hour [8].

Regarding maturity of compost, CCQC, [10] reported that immature and poorly stabilized composts may pose a number of problems during storage marketing and use. However, maturity is the degree or level of completeness. For any grower considering the use of compost, the issue of quality is critically important. Many factors can be considered in determining compost quality (see Table 4)[5] Maturity is not described by a single property and therefore maturity is best assessed by measuring two or more parameters such as C: N ratio, Carbon Dioxide evolution or respiration, oxygen demand, Dewar heating test, Ammonium : Nitrate ratio, Ammonia concentration , Volatile organic acids concentration and plant test as shown in Table (5).

3.2 Animal feed:

3.2.1 Treatment with Urea and Injection with Ammonia: Most developing countries, the problem is in the limited availability of protein sources although great efforts have been and are being made to find alternative supplements [11,12]. On the other hand, Crop residues have a high fiber content and are low in protein, starch and fat. Cell walls of straw primarily are lignin, cellulose, and hemicelluloses as shown in Table (6).

Therefore, the traditional method of increasing live stock production by supplementing forage and pasture with grains and protein concentrate may not meet future meat protein needs. Use of the grain and protein for human food will compete with such use for animal feed. In addition, the conversion of many available residues directly to human food presents problems when the source of the residues is not food grade.

These problems may be circumvented by utilizing residues to feed domesticated animals. Many crop residues have been used directly as animal feed. This help in covering the deficiency of animal foodstuffs in Egypt which reaches more than 3 million tones of energy a year. However, transforming wastes into animal foodstuffs would help in a greater deal in overcoming this deficiency. This is because these wastes have a high content of fiber that, low protein, starch and fat makes them not easily digestible and the size of the waste in its natural form might be too big or tough for the animals to eat. To overcome these two problems several methods were used to transform the agricultural waste into a more edible form with a higher nutritional value and better digestibility [1].

Whereas, mechanical and chemical treatment methods were used to transform the shape of the roughage (waste) into an edible form, the chemical treatment method with urea or ammonia is more feasible than the mechanical treatment method. The best results were obtained by adding 3% of ammonia (or urea) to the total mass of the waste. It is recommended to cover the treated waste with a wrapping material usually made out of polyethylene (2 mm thickness). After 2 (summer) - 3 (winter) weeks, the treated waste is uncovered and left for 2-3 days to release all the remains of ammonia before use as an animal food [1] . On the other hand, rice straw is high in lignin and silica. Both those components play an important role in reducing the digestibility of straw.

The crude protein content of rice straw is generally between 3 - 5 percent of the dry matter. Any crop residue with less than 8 per cent crude protein is considered inadequate as a livestock feed because it is un-likely that such residues, without supplementation, could sustain nitrogen balance in animal.

Rice straw is the most abundant feed resource for ruminant animals in Vietnam especially during the dry season [13]. They added that methods for increasing its nutritive value by ammoniation using urea or anhydrous ammonia are well established and are being applied in many countries in Asia. When urea is used in the wet ensiling system, the usually recommended level is 4 kg urea per 100 kg air-dry straw, little over half of which remains in the straw when this is finally fed to the animal. In addition, response to ammoniation has two components: an increase in digestibility due to partial specification of the lignin-cellulose-/hemi-cellulose linkages and a greater feed intake arising from the greater supply of ammonia to the rumen microorganisms. Many authors have similar results with treated rice straw with urea or ammonia [14-17].

The feeding of molasses-urea blocks is another related technology widely used for improving animal performance on fibrous crop residues bringing about increases in feed intake and also in digestibility [18-20].

Pre-treatment with a source of ammonia such as urea or ammonium bicarbonate can greatly enhance both the intake and digestibility of straw, and will improve the productive performance of the animals [21].

3.2.2 Silage Production: Corn silage is a major feed ingredient for cattle diets in Egypt and other countries.

Because of the large role that corn silage plays in cattle rations, methods to improve its nutrient value have been tested and implemented for many decades. Silage additives are added to fresh forage at the time of ensiling and it has been estimate that 30-35% of all silage produced has an additive added to it. The positive effects of additives include lower pH, greater content of lactic acid (and acetic acid in some cases), greater dry matter recovery, improved digestibility and improved aerobic stability of silages when exposed to air. There are four general types of additives used in silage production; bacterial inoculants, enzymes, acids and non-protein nitrogen.

Ammonia addition to silage increases lactic acid compared with untreated silages (Huber, et. al. [22], Kung, et. al. [23]) and compared with urea [24]. Lopez [24]concluded that lactic acid production is directly related to the buffering capacity of the silage additive. Free ammonia is much related to the buffering capacity of the silage additive. Although feed intake reductions can often be positively correlated with acetic acid in silage, , the relationship is not one of cause and effect. Production of acetic acid by inoculants or by direct addition is not a result of poor fermentation and should not cause a reduction in intake [25]

4-food Production:

4.1 Mushroom Production: Application of rice straw for plantation of mushrooms is well known in Egypt.

There are some large farms and many small farms producing mushroom mostly in the Delta. There are some institutes and universities carrying research and training courses in Egypt. In this respect the consumption of mushroom in Egypt is quite low, therefore the amount of straw used by this way remains very limited but still sesible and promising.

Oyster mushrooms (*Pleurotus spp.*) have become increasingly popular in recent years and are now cultivated in many subtropical and temperate countries. Commercial cultivation is usually carried out on straw but the non-composted cotton waste supplemented with rice bran and calcium carbonate used in Singapore also proved an effective substrate. Rice straw is an essential substrate for the growing of *Agaricus bisporus* in Asia.

In Japan, Taiwan and Korea, rice-straw composts have been used for many years with consistent results. Rice straw has enough nutrients and regarded as the best material for mushroom growing in all countries which produce rice, e.g. China, the Philippines and Indonesia [26].

In addition, cotton waste can be used for mushroom production . Waste, generated from the mechanical processing of raw cotton prior to spinning, provides an ideal substrate for the growth of some edible mushrooms notably *Volvariella volvacea* the Chinese or Straw Mushroom and the Oyster Mushrooms (*Pleurotus spp*). About 7% of lint (i.e. fibre) waste is produced in spinning. However, this primary waste is quite valuable and can be re-used in various ways but the residual or secondary wastes have little value and are therefore attractive for the purpose of growing mushrooms. Whereas, Straw mushrooms are highly perishable and must be marketed within 1-2 days. They tend to liquefy when refrigerated but have a shelf life of about 3 days when stored at room temperature.

4.2 Cultivated on Compacted Rice Straw Bales: Abdel-Satar, [27]. Concluded that cultivated vegetable crops on compacted rice straw bales such as straw berry, pepper, tomato, Cucumber and okra in open field or under green house were promised method to utilize rice straw residues. Also, the cultivation on compacted rice straw bales was used in the soil which, suffered from soil born diseases and high salinity. In addition, after harvesting the vegetable crops, the agricultural wastes will be thoroughly mixed with rice straw and used as compost for a soil to increase soil fertility. The compacted rice straw bales were used for two years.

5. Energy Production:

5.1 Bio Gas: Biogas is the anaerobic fermentation of organic materials by micro-organisms under controlled conditions. Biogas is a mixture of gasses mainly methane and carbon dioxide that results from anaerobic fermentation of organic matter by bacteria. Biogas is ranked low in priority in Egyptian energy policy and there is no estimate of the share of biogas of the total biomass potential [1].

Studies on the use of energy in rural Egypt (Alaa El Din et al,) [28] have shown that 76.4% of the gross energy consumed originated from burning crop residues and dung cakes, while 23.6% of the needs were met by conventional sources, e.g. kerosene, butagas and electricity. The efficiency of releasing energy from biomass by direct burning in primitive stoves is very low (5-10%). The contribution of crop residues and animal dung to net energy used in rural areas represented only one-third of total energy consumption, while conventional sources met about two-thirds. In addition, The organic matter content in Egyptian soils is 2%, a level which is considered very poor and needs annual addition. Besides,. The available crop residues after harvest are estimated at about 22.6 million tons, out of which about 13.7 million tons or 61% are used for direct burning. Animal droppings, principally of cows and buffaloes, are used as organic manure ("Balady manure") or as fuel for rural cooking.

Removal of these nutrient-rich resources from the fields deprives the farmer of much needed fertilizer and their replacement often means the use of chemical fertilizers at a severe financial and energy cost.

Biogas technology has become therefore interesting as a way to improve the energy release from agricultural residues, save plant nutrients, and improve health conditions and quality of life in the villages [29].

Also, Biogas technology attracted the interest of Egyptian scientists and rural developers because of the numerous benefits realized from it. In 1980,

Agricultural Research Center (ARC), Ministry of Agriculture (MOA), National Research Center (NRC), Egyptian Academy of Scientific Research and Technology (EASRT) and Faculty of Agriculture at Fayoum; Cairo University started research programs to introduce the biogas technologies in rural Egypt.

Soils and Water Research Institute (SWRI) ARC started since 1980 a research and demonstration program to promote the biogas technology in rural communities and new reclaimed lands. Biogas Training Center at Mushtohour in the Delta Region was constructed by SWRI ARC to help the biogas users in construction, maintenance, and utilization of biogas technology. More than 900 biogas digesters were constructed, operating in various governorates so far, with different capacity, gas utilization, and environmental impacts [30].

Three types of biogas digesters are applicable in rural Egypt; the first is the Indian type which is fed with animal droppings. This digester is provided with gravel basin to produce air dried biogas manure. The second type is the Chinese biogas digester which is fed with crop residues and vegetable wastes. The major constraints in rural areas are scarcity of animal droppings and large amount of crop residues. So, the ARC modified the design of the traditional biogas digesters to suit the Egyptian farms. The new system is a two-stage fermentation system fed with both animal droppings and crop residues to cover the energy consumption for household [30].

Table 1: Residue -to- Product Ratios (RPR) of Different crops

Residue	FAO (1998)		Lai (2005)	
	RPR	Moisture content	RPR	Moisture content
Rice straw	1.76	13%	1.5	Air dry weight
Wheat straw	1.75	15%	1.5	Air dry weight
Barely straw	1,75	15%	1.5	Air dry weight
Maize stalk	2.00	15%	1.0	Air dry weight
Maize cob	0.27	8%	------	------------
Cotton stalk	2.76	12%	1.5	Air dry weight
Sugar cane (tops)	0.30	10%	0.25	Air dry weight
Sugarcane(bagasse)	1.29	50%	0.25	Air dry weight
Rice husk	0.27	12%	----	---------------

Table 2: The estimated amount of agriculture waste in Egypt

Crop residues	Amount (million tons)
Cotton stalks	1.6
Rice straw	3.6
Maize residues	4.5
Sugar cane residues	6.8
Wheat straw	6.9
Barely straw	0.2
Sugar beet residues	0.32
Trees trimming residues	1.7
Vegetable residues	0.71
Banana residues	1.7

Table 2: Continue

Beans straw	0.35
Lentil straw	0.012
Pea straw	0.042
Public garden residues	1.14
Sorghum residues	1.2
Sesame straw	0.56
Date palm residues	0.66
Potato	0.317
Tomato	1.11
Total	33.4

Table 3: Main criteria for aerobic composting.

Factor	Acceptable Range	Optimum Range
Starting Materials		
C:N ratio	20:1-40:1	25:1-30:1
Particle size	1/8-2	Varies with material
Thermophilic Stage		
Water content	40-70 %	50-60%
Oxygen concentration	>5%	>10%
pH	5.5- 9.0	6.5-8.0
Temperature	110-150°F	125-140 °F

Table 4: Compost quality criteria

Chemical	Biological	Physical
C:N ratio	Activity	Particle size
Nutrients	Weed seeds	Contaminants
Salts	Animal / human pathogens	
pH	Plant pathogens	
Metal compounds	Pathogen suppression	
Organic compounds(pesticides, etc.)	Plant response (bioassay)	

Table 5: Maturity index for compost a (stability) methods [10]

Method	UNITS	Very mature	Ratingmature	Immature
SOUR TEST	O_2/unit TS/hr	<0.5	0.5-1.5	>1.5
CO_2 test	C/unit Vs/day	<2	2-8	>
SCL CO_2	C/unitVs/day	<2	2-8	>8
WERL CO_2	C/unit Vs/day	<5	5-14	>14
Dewar	Temp.rise (°C)	<10	10-20	>20
Solvita ©	Index value	7-8	5-6	<5
NH_4 :NO_3-N Ratio	No units	<0.5	0.5-3	>3

Table 5: Continue

Total NH_4 -N	ppm, dry basis	<100	100-500	>500
VOA or VFAs	ppm, dry basis	<200	200-1000	>1000
Seed Germination	% of control	<90	80-90	<80
Plant Trials	% of control	<90	80-90	<80

SOUR TEST = Specific Oxygen Uptake Rate
SCL = Soil Control Laboratory
WERL=Woods End Research Laboratory
Dewer = Dewer Self Heating Test
VOA or VFAs = Volatile Organic or fatty acids concentration

Table 6: The chemical composition of some crop residues in Egypt

Crop residues	Cellulose(%)	Hemi-cellulose(%)	Lignin(%)	CrudeProtein(%)	Ash(%)	Digester factor (%)
Rice straw	34.20	27.9	10.20	2.00	16.20	23.60
Wheat straw	39.00	36.00	9.60	2.60	7.80	38.20
Barely straw	40.40	28.10	9.10	2.70	8.10	37.80
Bean hay	42.10	21.30	13.20	4.85	7.40	42.90
Barseem hay	39.20	17.90	14.80	4.30	8.20	48.60
Maize stalks	38.10	32.80	7.90	3.70	6.40	40.90
Corn cobs	37.40	37.90	5.80	2.10	7.40	61.60
Cotton stalks	49.40	12.90	22.00	3.60	6.50	24.80
Rice hulls	39.10	13.70	11.00	3.70	21.90	23.70

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