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The Use of Organic Residues in Rural Communities

Edited by Cyril A. Shacklady

THE UNITED NATIONS UNIVERSITY

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THE USE OF ORGANIC RESIDUES IN RURAL COMMUNITIES

Proceedings of the Workshop on Organic Residues in Rural Communities held in Denpasar, Bali, Indonesia, 11-12 December 1979, under the auspices of the Indonesian Government Institute of Sciences (LIPI), the Government of the Netherlands, and the United Nations University

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From the CHARTER OF THE UNITED NATIONS UNIVERSITY

ARTICLE I

Purposes and structure

1. The United Nations University shall be an international community of scholars, engaged in research, post-graduate training and dissemination of knowledge in furtherance of the purposes and principles of the Charter of the United Nations. In achieving its stated objectives, it shall function under the joint sponsorship of the United Nations and the United Nations Educational, Scientific and Cultural Organization (hereinafter referred to as UNESCO), through a central programming and co-ordinating body and a network of research and post-graduate training centres and programmes located in the developed and developing countries.

2. The University shall devote its work to research into the pressing global problems of human survival, development and welfare that are the concern of the United Nations and its agencies, with due attention to the social sciences and the humanities as well as natural sciences, pure and applied.

3. The research programmes of the institutions of the University shall include, among other subjects, coexistence between peoples having different cultures, languages and social systems; peaceful relations between States and the maintenance of peace and security; human rights; economic and social change and development; the environment and the proper use of resources; basic scientific research and the application of the results of science and technology in the interests of development; and universal human values related to the improvement of the quality of life.

4. The University shall disseminate the knowledge gained in its activities to the United Nations and its agencies, to scholars and to the public, in order to increase dynamic interaction in the world-wide community of learning and research.

5. The University and all those who work in it shall act in accordance with the spirit of the provisions of the Charter of the United Nations and the Constitution of UNESCO and with the fundamental principles of contemporary international law.

6. The University shall have as a central objective of its research and training centres and programmes the continuing growth of vigorous academic and scientific communities everywhere and particularly in the developing countries, devoted to their vital needs in the fields of learning and research within the framework of the aims assigned to those centres and programmes in the present Charter. It shall endeavour to alleviate the intellectual isolation of persons in such communities in the developing countries which might otherwise become a reason for their moving to developed countries.

7. In its post-graduate training the University shall assist scholars, especially young scholars, to participate in research in order to increase their capability to contribute to the extension, application and diffusion of knowledge. The University may also undertake the training of persons who will serve in international or national technical assistance programmes, particularly in regard to an interdisciplinary approach to the problems with which they will be called upon to deal.

ARTICLE II

Academic freedom and autonomy

1. The University shall enjoy autonomy within the framework of the United Nations. It shall also enjoy the academic freedom required for the achievement of its objectives, with particular reference to the choice of subjects and methods of research and training, the selection of persons and institutions to share in its tasks, and freedom of expression. The University shall decide freely on the use of the financial resources allocated for the execution of its functions . . . .

PREFACE

A Workshop on Organic Residues in Rural Communities was convened in Denpasar, Bali, Indonesia, 11-12 December 1979, under the auspices of the Indonesian Government Institute of Sciences (LIPI), the Government of the Netherlands, and the United Nations University. Its purpose was to discuss ways and means in which unused organic residues in rural areas of developing countries could be best utilized and turned to human benefit. The workshop generated recommendations for concrete research and development projects to be undertaken in Indonesia.

In total, 52 participants attended the workshop: 24 from Indonesia and 28 from abroad. The foreign participants came from Australia (2), Fiji (1), France (1), India (2), Japan (2), Malaysia (1), the Netherlands (7), the Philippines (3), Sri Lanka (1), Sweden (1), Tanzania (1), Thailand (1), the United States (1), Unesco (1), and the United Nations University (3). Of the Indonesian participants, 10 represented universities and 14 government research institutions.

The meeting was organized in the form of plenary and working group sessions. A general description of bioconversion activities within the programme of the United Nations University was given, followed by the presentation of a number of papers on various aspects of bioconversion. A general discussion was held at the end of each session of the plenary. There were 17 scientific papers presented in these four plenary sessions, covering the importance of residues for various purposes, the agicultural residues available, and the current ways of using them. Summaries of the panel discussions are printed here along with the papers for each session.

After the presentation of all papers, the working group meeting discussed and formulated possible research and development project proposals. Originally, it was planned to have three working groups, to discuss fibrous wastes, carbohydrate residues, and other residues. Because of the obvious interest among the participants, a fourth group on biogas was also formed. These working groups discussed proposals for research and development projects that could be funded by sponsoring bodies. The

recommendations of the three initial working groups are summarized and a fuller report of the group on biogas is given at the end of this book. A small team then formulated follow-up actions and research and development proposals for bilateral co-operation between Indonesia and the Netherlands.

We are grateful to the United Nations University, the Government of the Netherlands, the Office of the State Minister for Research and Technology, the Ministry of Agriculture, the Ministry of Education and Culture, the provincial government of Bali, and all others who have contributed to the workshop, for all of their efforts and support to make this gathering possible.

The Indonesian Institute of Sciences

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OPENING ADDRESS

H. Tb. Bachtiar Rifai
Chairman, Indonesian Institute of Sciences

In this gathering you will review the situation of organic residues in Indonesia as well as in other countries to assess the availability and avenues of utilization of these residues and their effects on the environment.

Among the economic features of such a country as Indonesia and perhaps the countries of some of our foreign guests are a high population growth rate and agricultural production. The effort to produce food for the growing population inevitably generates enormous quantities of organic residues that are not utilized or, at best, are under-utilized. Some of these residues are exerting a strain on the environment.

Another feature of countries like ours is the inadequate development of secondary and tertiary industries. Whether the secondary commodity is used or not depends entirely on economic and social constraints. There must be an economic incentive to utilize these residues, even though they are pollutants, and the necessity to abate that pollution should already be an economic incentive. In Indonesia the inadequate use of these residues is due either to their wide dispersal among small production centres – which creates collection and transportation problems – or simply to a lack of the necessary technological information and skill. Serious efforts should be made to find economical ways to utilize these residues. If this can be done beneficially, they will no longer be wastes, but become new resources to add to our existing, limited ones. In this respect, use of residues means better resource utilization.

These residues are cheap, abundant, and renewable. To deal with them we need to build a multidisciplinary venture impinging on all aspects of the economic life of the community. The basis for their utilization is their chemical composition. This includes recognition of the components that could make the residue valuable, e.g., the carbon to nitrogen ratio, or appropriate nutrients, vitamins, and growth factors. Analysis of inert fractions is also very important because they may change the physical characteristics of the residue and affect its use. Detailed information on the

characteristics of the residue will determine the appropriate and environmentally sound technology that should be employed to prepare it for use.

There is no one best approach to organic residue utilization. In each and every situation, possible alternatives need to be evaluated in order to choose the most suitable technology to achieve the desired environmental, economic, and social objectives.

RESIDUES OF IMPORTANCE AS POTENTIAL ANIMAL FEEDS IN INDONESIA

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Introduction

A detailed description identifying the specific by-products or waste materials in Indonesia that could be used for animal feeds, with or without processing, should preferably be based on a survey. The survey should then aim to quantify, describe, and determine the quality of each potential by-product or waste and place it in proper perspective as to amount available, location, and possible problems that might be associated with its application.

The typical small land-holders in Indonesia generally use almost all agricultural residues they generate, and an improved export marketing system has provided an outlet for those by-products not used on the farm. There are times, however – such as just after harvest – when the residues are in excess of the farmers' needs and disposal becomes a problem. Proper processing could turn these by-products into an asset, particularly in the feeding of animals. This paper presents a broad view of potentially useful by-products and wastes that might be used as animal feeds in Indonesia.

Background

The Republic of Indonesia lies within the tropical zone (between 6° N and 11° S latitude) and consists of a spread of water dotted with islands in an area as large as the whole of Europe. The average year-round temperature is 28° C (23°-35° C), and humidity is high except in the cooler, mountainous area. Rainfall is heavier in the west than in the east, averaging 4,000 mm per year in Bogor (West Java) and only 60 mm per year in the Nusa Tenggara Islands. The population is now about 135 million, with a 2.3 per cent yearly growth rate.

The GNP in 1978 was US$850 million, with agriculture accounting for about half of this amount. Unfortunately, there are few processing centres for agricultural products,

so much of the food raised is exported. Because of uneven distribution in local production, this often means that some areas have food shortages. This is exacerbated by an unbalanced distribution of population, with 60 to 70 per cent of the people living in Java, which makes up only 6 per cent of the total land area of Indonesia. This means that any extension of agriculture in Java is limited by land constraints. Furthermore, 75 per cent of all Indonesian livestock is raised in Java.

Except on a few dairy farms and beef cattle ranches, animals are raised in small numbers (one to five head of cattle or five to ten sheep per farmer). There are some medium-sized cattle ranches in Sulawesi and on the Nusa Tenggara Islands. Only 10 per cent of all poultry is raised on medium-sized poultry farms; the rest is family owned.

Rice is by far the main staple crop and occupies the largest agricultural area. Most food is produced by small land-holders who individually sell any excess produce to nearby markets. Most of Indonesian land is dominated by forests, with agriculture covering only 6 per cent of the total land area. Constraints to land ownership and the resulting small-farm system means that small-scale agricultural production is the rule. For this reason, agricultural wastes and by-products are few and widely dispersed, so that collecting enough to make it economically feasible to process it for use as feed will require many farmers to work co-operatively.

Current Animal Industries

Fish comprises most of the animal protein in the Indonesian diet because it is cheap. Beef and poultry are also consumed; pork is not as popular. Fresh dairy products are not readily available because the cows are raised only in the mountainous areas of East, Central, and West Java. The government is expanding the beef and poultry industries through schemes (BIMAs and PUTP) that provide credit and some technical input for small-scale production.

Cattle. Most of the 10 million head of cattle and buffaloes in Indonesia are in Java and Madura, and are generally kept as draught animals or as investments. Farmers do not usually feed their cattle protein concentrates. Grass and agricultural by-products and wastes are the main feed supplies; the latter are used to the extent that a farmer can produce or find them near his farm. These cattle are therefore sold when the farmer needs money, and no particular live weight is attained before they are taken to market. Old and unused animals are the ones slaughtered at abattoirs. The domestic price of beef is at present around Rp 2,500/kg (US$4) in cities and is not related to quality.

Pigs. The raising of pigs in Indonesia is restricted to certain areas. Data from 1978 showed a population of 4 million pigs, of which 1.3 million are concentrated in North

Sumatra and around 1 million in Bali and the Nusa Tenggara Islands. The major limiting factor in expanding pig development (besides feed supply) is religion. The pig competes with humans for the limited amount of grains available; therefore, another source of feed is required. Most pigs are kept as scavengers rather than on a commercial basis.

Poultry. Like pigs, poultry require a high-protein feed; however, "kampung" chickens (estimated at around 97.5 million in 1976) are all kept as scavengers. Kampung hens produce about 30 to 40 per cent of all eggs consumed in Indonesia, and an estimated 80 per cent of all poultry meat is supplied by these birds. The preference for the kampung chicken and its abundant numbers ensure the primary place of this bird over broilers and better-laying breeds for many years to come. The poultry industry is growing, although not as fast as in other ASEAN countries.

Indonesia's duck population is the largest in the ASEAN region (15.2 million in 1976). Duck eggs are widely consumed, often in salted form, but there is little demand for duck meat. In Java ducks are generally kept in small flocks of 40 and are allowed to graze in the paddy fields that supply them with small fish, snails, etc. for their protein needs. The feeding system for ducks in Alabio (South Kalimantan) is more advanced and is based on sago, rice bran, water snails, fish, and coconut pressmeal. These ducks also have a higher laying capacity than the Javanese ducks.

Potentially Useful By-products and Wastes in Indonesia

Agricultural By-products and Wastes

Rice, as the largest crop, has a potential by-product in the form of *rice straw.* A common practice in East Java is to burn this straw in the field and return the ash to the soil, whereas in West Java the straw is left in the field and ploughed in later during cultivation. The use of rice straw for animal feed is already practised, although not maximally. The yield is about 2.3 tons of dry matter per hectare, and production varies all over Indonesia. Several rice mills are in operation in Java, generally in the vicinity of the large cities, and there are also mills on the other islands. Products such as rice bran, rice polishings, and hulls are available in various quantities, depending on how much the mills produce. *Rice bran* (dedak) and *rice polishings* (bekatul) are used as feed for poultry, pigs, and some dairy cattle because they are relatively cheap and do not require processing. Recently, doubts have arisen concerning their value for animal feed because of a high phytate and phosphorus content. The main drawback to using rice milling by-products is that mills are widely scattered and it is difficult to collect them continuously from many mills in large quantities, thus making central treatment impractical. For instance, a rice bran oil factory in Krawang (near Jakarta) is at the moment not operating because of a lack of a fresh supply of bran.

Except in some areas such as Lampung and South Sumatra, corn (maize), like rice, is generally produced in small quantities by individual farmers. *Corn stover* (about six tons of dry matter per hectare) is already fed to cattle, but is not used if there is no livestock near the place of harvest. Corn cobs are generally burned.

Sweet potatoes and *cassava* are also commonly grown in rural areas. Their leaves are fed to cattle, sheep, or goats. Sweet potato and cassava have no waste products of any significance because their by-products are known to the farmer as good-quality roughages. Cassava is primarily a food and export commodity, and no waste is available in large quantities. The export price determines the amount of cassava available for local use. The potential production of the leaves is, however, about 1 ton of dry matter per hectare for cassava and about 1.5 tons of dry matter per hectare for sweet potatoes.

Legume straw from peanuts, soybeans, mung beans, bush beans, and other beans is not wasted in Indonesia, but its nutritive value could be increased by better drying methods. The decreasing number of livestock in rural areas may result in some accumulation of legume straw. The yield of peanut and soybean straw is approximately 2.7 tons of dry matter per hectare.

Banana trees are found all over Indonesia, but banana plantations are rare. The stems and leaves, containing about 80 per cent of the total weight, are not usually fed to cattle, except in Timor during the dry season. They are used to supply water to the animals, with *Leucaena* leaves as the major source of protein. *Leucaena* is also often used as a cover crop for young plants on coffee plantations, but there are indications that in future it will not be used for this purpose because its growth is difficult to control. The high mimosine content is a limiting factor to its use as feed, and the new low-mimosine *Leucaena* from Peru is more promising. It has been introduced to Indonesia but is still not widely used.

Heretofore the availability of *rubber seeds* has been overlooked, and they are now collected by hand. Considering the large rubber plantations in Indonesia, this by product is worth looking into as an animal feed. However, the raw seeds are unpalatable and can cause diarrhoea in animals.

Animal Industry By-products and Wastes

The abattoirs located in large cities are the main source of animal wastes. *Rumen contents* and *manure* are the major residues, and in Java some abattoirs slaughter 250 head per day. The wastes are generally used as fertilizer. *Hooves and horns* are both exported and used as raw materials for handcrafted items, as are the bones. *Animal blood,* although not completely collected at the abattoirs, provides a protein source for human consumption after the application of simple processing treatment. *Blood meal* is also available in the market as animal feed. Organs such as the gall bladder,

pancreas, thyroid, uterus, etc. are wasted but could be useful for the production of hormones. No gut residue is available from abattoirs.

Manure is the main waste product from the pig and poultry industries. Of the 95 million or so birds in Indonesia, fewer than 10 per cent are raised commercially in units ranging from 200 to 1,000 birds per farm. There is no indication of available feather meal, and recycling of poultry manure to feed ruminants is in the initial stages. In the pig industry, conversion of waste to biogas is practised, but is limited to a few medium- and large-sized pig farms. The majority of pigs in Indonesia are raised in small numbers as scavengers.

Fishing industry residues are often abundant in fish markets. Unsold fish are generally preserved by salting and sold for human consumption; they are relatively cheap and serve as a major protein source in the daily diets of most people. But fish meal is also produced by a drying process using the free solar energy source of the tropics. Small fish-meal operations exist in Java and South Sumatra. Fish trimmings, heads, intestines, and trash fish are sometimes available and often appear to be wasted or infficiently preserved. This is largely because fishing is scattered over a wide area and ice is not available in remote areas for preserving small, local catches. The possibility of ensiling these after either microbial or acid preservation is promising.

Industrial By-products

There are many coconut plantations in Indonesia, but waste is not available. The stems are used as building material in the rural areas. Copra is collected, dried, and sent to coconut oil factories that produce *coconut oil cake* as a by-product. This is already used as a feed for animal production, but over two-thirds of Indonesia's production is exported. The protein content is 17 to 20 per cent, with an energy value of 2.5 kcal ME/g dry matter. On occasions the capacity of the factories to extract the oil may be overloaded, so the oil cakes can vary widely in oil/fat content.

Peanut oil cake is also available as a by-product from this oil extraction industry and is also an animal feed. This by-product, in the form of fermented peanut, has a market for human consumption. Palm kernel oil industries exist in Java and Sumatra, but 90 per cent of the *palm kernel oil cake* is at present exported, leaving no residue in Indonesia.

Wheat milling by-products. Although all wheat is imported, substantial quantities of bran and pollard are available. There are only two companies (in Jakarta and Bali) with a production close to 0.5 million tons annually. The nutritional value of bran is well known; however, again, 95 per cent of the total by-product is exported.

There are 19 small-scale and 3 large-scale *fruit canning* industries in Java, Sumatra,

and Sulawesi, but no information is available on the waste potential from these canning operations.

A by-product from the forestry industry that might be used is *sawdust.* There are about 29 million ha of forestland with a capacity of 43 million m^3 of logs per annum. The big saw mills are located in Kalimantan and Sumatra, but unfortunately in areas carrying few livestock. About 10 percent of the total wood residue in a saw mill is sawdust, and about 54 percent is total waste (trimmings, chips, etc.). These percentages depend on the type of wood, type of saw, etc. The use of sawdust for animal feed is not practised, and these products are at present used mostly as raw materials for building materials such as hard-board. In the plywood industry, about 0.7 to 1 per cent of the total by-product is sawdust and 6.5 per cent plywood trimmings with a total recovery of only 39 to 40 per cent.

Sugar cane provides a potentially useful waste, and the increasing demand for sugar will increase the size of sugar plantations. These, in turn, will produce more tops. About 150,000 hectares of land are at present planted with sugar cane, and about 16 tons of top material per hectare are available at harvest. Sugar cane top composition is: 6 per cent crude protein, 37.4 per cent crude fibre, 42 per cent nitrogen-free extract, 2.4 per cent fat, and 29.4 per cent dry matter.

Bagasse, available after extraction of cane juice, is at present not efficiently used. It is available in large quantities, concentrated to some degree near sugar factories. Some of this material is used in the paper industry, but most is used as a cheap energy source for people who live near sugar factories. *Molasses* is a high-energy feed for animals that is at present fed only to horses. Most of it is used for alcohol production.

Others

Alang-alang grass (*Imperata cylindrica* Beauv.) has been shown to have at least the same nutritive value as elephant grass (*Pennisetum purpureum*) when cut at 30-day intervals. Its cultivation for feed is not recommended, however, and its present use is as roofing material for houses in rural areas. The rest of it is burned off. Alang-alang grass covers an estimated 20 million ha, and this is increasing because of shifting cultivation practices over the years. It might have some value as a feed and at the same time this might help to control the spread of the grass.

Although Indonesia is an oil-producing country, *oil residues* are not at present available. This is because Indonesia exports crude oil instead of refined oil, and therefore no refinery from which hydrocarbon fractions could be obtained is operating. Costs of single-cell protein production from oil residues are unattractive at present, but might become more feasible under certain circumstances at some future date.

Material known as *"pasar" waste* – consisting of anything from cellulose to plastic

and metal scraps – is generated primarily in urban areas and is constantly accumulating. Recycling has been investigated but is not yet being carried out; separation of heavy metals is a problem. Its disposal is essentially a problem of urban sanitation. It does not seem possible to convert it into animal feed, and, even if it were, the process would have little relevance to rural community conditions.

Overview of Potentially Useful Residues in Indonesia

The potential as animal feed materials of the by-products and wastes we have discussed can be fulfilled only if they meet the following criteria:

a. They must be present in amounts large enough to justify the capital investment necessary to make them suitable for use.
b. The by-product or waste must be such that only the minimum amount of processing of a type amenable to village technology is required to improve its value as animal feed.
c. The by-product or waste should be located in an area reasonably close to the point of final use, and the material should be gathered in a concentrated amount or be easily capable of collection with existing equipment.
d. The product resulting from treatment of the residue must be accepted by local farmers and acceptable to their animals.

Given these considerations, the major by-products and wastes that might have a potential and be worth looking into are:

1. *Rice/corn straw.* The production of rice and corn will not decrease in the future; on the contrary, it will increase so more straw will become available. The 8.3 million hectares under cultivation for rice will produce 8.3 x 2 million tons of straw. The main constraint will be collection of the material.

2. *Sugar cane.* The tops and bagasse are not being used at present and generally are burned. The high lignin content is a challenge, and the development of a method to upgrade bagasse as a digestible fibre source or as a substrate for single-cell protein production would be useful.

3. *Rubber seed.* Although at present not used, this product has potential as a feed material. It is easily gathered and is rich in carbohydrates. Work should be carried out to determine and remove the factor(s) responsible for its unpalatability and adverse gastro-intestinal effects.

4. *Wood.* Sawdust also has a potential as feed and is concentrated at saw mills located in Kalimantan.

5. *Pig and poultry waste.* Waste from these animals as manure in the animal industry