Dossier

Waste processing

Domestic and industrial waste management is now a critical issue for African governments because of high urban population growth.

In this context, a pilot waste processing operation to recycle solid slaughterhouse by-products was launched in 1987 at Thiès by the Senegalese Société d'exploitation des ressources animales (SERAS) in collaboration with Agriforce, an economic interest group affiliated with the French Centre de coopération internationale en recherche agronomique pour le développement (CIRAD). The Transpaille system is used to recycle these solid by-products and blood, thus producing biogas and compost. This compost is being tested for block propagation of plants and the liquid wastes are purified by a lagooning technique. An economic assessment of the Thiès operation will determine whether the project could be extended to the Dakar slaughterhouse to reduce the pollution of Hann Bay.

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- **Transpaille: energy, fertilization, cleansing**
- **Marketing compost as seedling nursery blocks**
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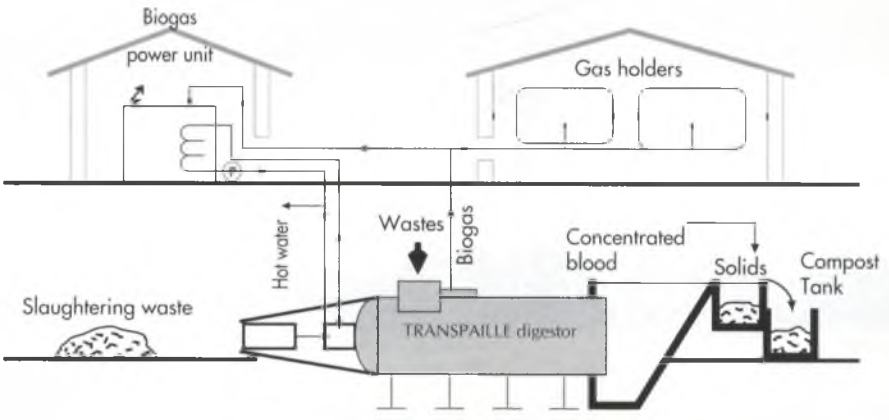
Transpaille: energy, fertilization, cleansing

J.-L. FARINET



Illustrated diagram of the Transpaille unit at Thiès (all rights reserved for all countries).

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The Transpaille procedure was designed by CIRAD and developed by Agriforce for organic waste recovery and processing using methane fermentation; gas and compost are produced.

The size of the digestor and peripheral equipment of the system can be modified according to needs. The setup at Thiès consists of a 40 m³ horizontal cylinder. The wastes are fed and the fermentation effluents are discharged mechanically. The system is controlled through a hydraulic station, and the digestor is heated by means of an internal circuit.

The nominal capacity of the Thiès slaughterhouse is 2 000 t per annum of carcass. This produces 480 t (tonnes) of waste which can be converted into 55 t per annum of compost, and 35.5 m³ per day of biogas at an average processing temperature of 31°C.

The biogas is stored in two 30 m³ PVC gas containers which fuel a biogas 20 kVA, 3 000 rpm power generating unit. This unit provides power for the slaughtering line in the morning and the refrigeration units in the afternoon. Moreover, the power unit is equipped with a heat recovery system which makes it possible to maintain the digestor temperature above 30°C year-round. Two concrete compost-ageing tanks are installed at one end of the digestor cylinder.

Development of Transpaille units

A Transpaille unit was installed at a slaughterhouse in N'Djamena (Chad) and became operational in June 1994. This 20 m³ capacity unit produces hot water compost, which is sold to market gardeners.

The Transpaille anaerobic digestion technique is used to process slaughterhouse wastes and was also developed for energy and compost production in rural African communities. In addition, a small-scale unit (3.5 m³) was designed to produce biogas for domestic use; this could provide a substitute for fuelwood in heavily deforested areas. Twelve of these small-scale units are currently being tested and showcased in three village in the Senegal River delta region.

In Mali, a 50 m³ capacity Transpaille unit is being built on an NGO experimental farm. The biogas produced will provide energy to pump about 9 000 m³ of water weekly to irrigate fruit orchards. The compost produced will be used to make a culture medium for plant nurseries.

More specific applications of the technique are also being investigated. For instance, studies are under way in Mexico on coffee pulp digestion in collaboration with a growers cooperative; in Brazil, a pilot research project should begin in 1995 to apply the technique for processing waste from a cassava industry.

From 1988 to 1989, this project in Senegal was jointly funded by:

– SERAS;

– GIE Agriforce;

– the French Agence de l'environnement et de la maîtrise de l'énergie (ADEME);

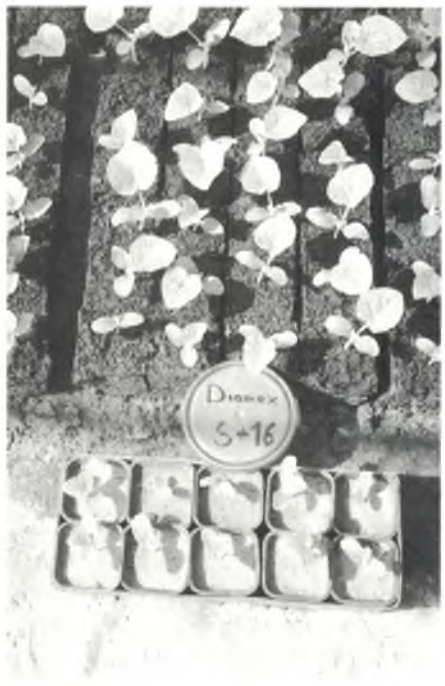
– the French ministère de l'environnement;

– the French ministère de la coopération et du développement (Fonds d'aide et de coopération).

Note: all prices quoted in CFA francs were before the devaluation.

Marketing compost as seedling nursery blocks

J.-L. FARINET



Melon plants in soil blocks after 16 days in the nursery.
Photo Y. Hurvois

In 1990, market gardening was carried out on an estimated 19 000 hectares (ha) of land in Senegal, mainly in the Niayes zone. There will probably be further vegetable crop extensions in the coming years because of recent crop diversification around the Senegal River and the planned Cayor Canal. Local markets will not be able to absorb this increased vegetable production, which could be cleared on world markets.

Senegalese market gardeners will therefore first have to solve several specific problems:

– controlling soil fertility through balanced inputs of organic matter and mineral fertilizers;

– introduction of high performance hybrid plant varieties;

– adapted techniques to make optimum use of the potentials of each plant variety.

It is always difficult to keep up chemical and biological fertility in cultivated soils, particularly in the tropics where organic matter mineralization is accelerated. Organic soil amendments are thus required. In Senegal, market gardeners traditionally use groundnut powder, fish waste, horse and donkey manure, and poultry manure which are high in nitrogen and phosphorus.

Groundnut powder is an oil mill by-product composed of degraded groundnut shells and haulms mixed with sand. Compost obtained by processing slaughterhouse wastes is a new high quality organic manure (Table 1), that is currently being tested.

Slaughterhouse compost

The Transpaille digestor installed at the Thiès slaughterhouse can process 480 t per annum of solid wastes, producing 13 000 kWh of electricity and 55 t of compost.

This compost is a good organic manure, as shown by the results of tests carried out at the Centre de développement horticole de Cambérène (Senegal) which highlighted its beneficial effects on soil fertility. However, the costs of producing this compost are higher (42 CFA francs/kg [gr.wt.]) than for other conventional manures. In addition, market gardeners prefer to buy groundnut powder at 15 CFA francs/kg (gr.wt.). A market survey in the vegetable growing region revealed that compost from Thiès could not be sold for higher than 30 CFA francs/kg (gr.wt.). In this price range, enhancement of raw compost is not cost-effective with the Transpaille system. It will thus be necessary to market this product in sectors where its qualities are suitable, such as nursery plant block propagation; enhancement and profits could then be discussed.

Table 1. Comparison of compost produced at the Thiès slaughterhouse with a French-type compost (an average of 43 unenriched organic manures; test n° 105 b, magazine *50 millions de consommateurs,* 1979).

Type	pH	OM (%)	N (%)	P_2O_5 (%)	K_2O (%)	CaO (%)	MgO (%)
Thiès compost	7.7	52.1	2.0	2.4	0.9	3.5	0.7
Average French compost	5 to 8	30.0	1.6	1.5	1.4	-	0.4

Elements compared: acidity (pH), levels (%) of organic matter (OM), nitrogen (N), phosphorus (P_2O_5), potassium (K_2O), calcium (CaO) and magnesium (MgO).

A new product

Soil blocks are widely used in European nurseries for propagating vegetable and flower plants. This block propagation technique provides protection for the germinating seed and then the seedling during the initial 4-week growth period. This is of agronomic interest since healthy and hardy plants can be produced with a high growth success after transplanting. This means that market gardeners can cut costs in their seed purchases, with a substantial labour reduction. The advantages of this technique considerably outweigh the increased price incurred by the indirect organic matter supplement in the soil blocks (approximately 2 t of dry matter/ha).

Production

A set of experiments was carried out to develop a high performance compost-based growth medium (Fig. 1). The goal was to determine a means of easily producing soil blocks that would stand up to watering and allow good seed germination and seedling development. The resulting formula is 75% compost/25% sand. Soil block performance was enhanced by the addition of a fungicide and water-retaining product. The technique involves moderately compressing the soil mixture manually or mechanically into small cubes. The size of these soil blocks varies according to the plant species to be propagated, e.g. 4 cm cubes for small-seed species (tomato, cabbage, pepper) and 6-7 cm for large-seed species (melon, cucumber).

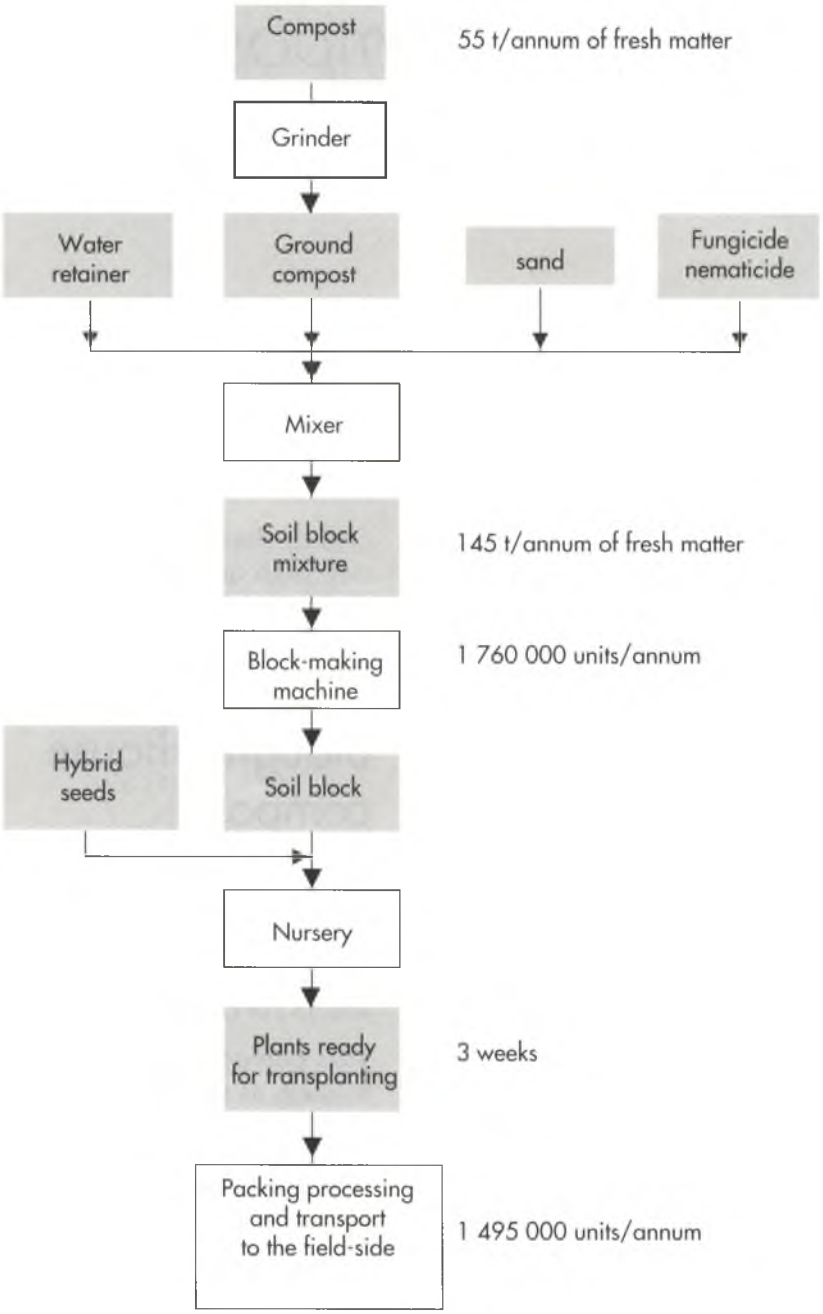


Figure 1. Schematic diagram of seedling nursery block production at the Thiès (Senegal) slaughterhouse.

Marketing

It is essential to first determine the features of the seedling nursery block market before developing a marketing strategy. The potential customers are primarily well-equipped market gardeners. Hybrid seeds are used for export crops and therefore the cropping techniques must be fully controlled. These soil block customers require a top quality product and service, involving plant protection, varietal purity, "field-side" delivery, and technical support until crop harvest in some cases.

From a competitive viewpoint, the only other nursery vegetable plants currently available in Senegal are grown on imported peat and the prices are prohibitive (150 CFA francs/kg [gr.wt.]).

The prospects are therefore quite promising for the development of block propagated plants, but SERAS (whose production is now animal-based) will have to diversify their activities.

Selling price

In 1990, in the Thiès region, competitors were selling selected,

Tomato plants in soil blocks after 20 days in the nursery.
Photos Y. Hurvois

non-hybrid varieties of "bare rooted" vegetable plants at about 15 CFA francs/plant. The cost of producing a vegetable plant in a soil block, with field-side delivery, is estimated to be 12 CFA francs, at an average seed price of 3 CFA francs. The growth medium price increases concomitantly with the seed price. The block propagation technique is therefore essentially used to grow high yielding hybrids. Such seedling nursery blocks can be sold for 20 CFA francs/plant for a net profit of 8 CFA francs.

When the Transpaille system at the Thiès slaughterhouse is operated at nominal capacity, 1.5 million plants per annum could be produced. They would be supplied to customers in three 500 000 plant batches to allow for compost ageing. Each transplanted batch could cover a 12-25 ha surface area, depending on the plant species.

At the Thiès site, SERAS is currently producing ready-to-plant vegetable seedlings that are just being sold to smallholders. However, large-scale vegetable producers offer another more profitable market which should be exploited.

5-6 million plants per annum could be produced by utilizing the results of the Thiès slaughterhouse study at a larger capacity slaughterhouse such as that of Dakar. The increased production could be sold to large private market gardeners.

Compost production cost analysis

Profits derived through treatment of solid slaughterhouse wastes depend on the extent to which the produced compost is refined. At the organic manure stage, processing costs are estimated to be 1% of the slaughtering fee charged by SERAS. The pollution problem can thus be solved quite cheaply at this recycling stage. SERAS could expect to generate profits by creating a seedling nursery block sector. Processing costs for this final stage in the profitable utilization of compost would correspond to 20.3% of the slaughtering fee. The slaughterhouse can also market the compost between these two stages as a bulk growth medium for a profit of around 6% of the slaughtering fee. Very little specialized equipment or skilled staff are required at this intermediate stage.

The head of the slaugterhouse can choose a compost production stage to meet his economic means and objectives. Regardless of the choice, the slaughterhouse environment will be markedly improved by this means of pollution and odour control.

Lagooning, a water purification technique for the tropics

J.-L. FARINET and Y. COPIN

A lagooning technique is used for water purification at a slaughterhouse in Thiès (Senegal). The unit meets two objectives:

– purification of liquid slaughterhouse wastes;

– testing the performances of different lagooning techniques in actual operational conditions.

The lagooning principle

Lagooning reproduces the process by which water purifies itself biologically, and accelerates and controls the phenomenon. The process often involves irrigating waste water and allowing it to stand in a sedimentation basin. Organic matter is decomposed by bacteria, producing water, carbon dioxide and mineral salts. These elements are then taken up by algae. The performance of this process is enhanced at high temperatures, and it can be combined with the Transpaille system in order to make optimal use of the biomass that develops in the basin. The technique is used with success in some European slaughterhouses and, since it is optimal at 25-35°C, could certainly be adapted to operate under tropical African conditions. The process is quite rustic and therefore should be in line with the budgetary constraints of slaughterhouse industries. Management and maintenance of the equipment and installations do not require skilled staff, the operating costs are low and, under anaerobic conditions, there is no energy consumption. In contrast, some lagooning techniques require mechanical aeration.

Slaughterhouses are often set up around urban centres on enough land to allow construction of lagoon basins (i.e. lagoons).

Pistia stratiotes plants from the lagoon with macrophytes.
Photo Y. Hurvois

Technical choices

There are several possible lagooning techniques for purification of polluted waters. Applications vary according to the waste water type and load, the physical and economic environment near the installation and the degree of waste refining. Lagooning can also be combined with conventional installations in order to limit land use and enhance microbial elimination.

The Thiès lagooning station

At Thiès, the blood and rumen contents can be collected immediately after animals are slaughtered. These wastes are then processed in a digestor by the Transpaille procedure to produce biogas and compost.

The liquid effluents are derived from washing the slaughtering areas and floors, hide processing, sewage (toilets, showers) and rainwater.

The average waste water output is 10 m^3/day. Considerable variations were noted in the pollution indicator results, e.g. suspended solids (SS), chemical oxygen demand (COD) and ammonia nitrogen ($N\text{-}NH_4$), concerning the slaughterhouse effluents (Table 1).

Agriforce and the French Centre de recherches de Mèze-Hérault (CEREMHER) are collaborating to develop a lagooning system for the Thiès slaughterhouse. The environmental conditions (especially climate), type of soil and performance specifications determined by SERAS and Agriforce were taken into consideration in developing the lagooning technique and deciding on the equipment design limitations. In this

project, several requirements have to be met: low investment, low energy consumption, and production of plant material from the lagoons to compensate for variations in the raw material supply for the digestor. Figure 1 shows a schematic diagram of the procedure, which includes pretreatment, a decanter/digester and three lagoons (L_1, L_2 and L_3). The features of the lagooning station and retention times in each equipment unit are given in Table 2.

The different units

Pretreatment retains the gross solids and floating matter. A degreasing/screening tank, divided into four compartments separated by screens and metal plates, has been added to the existing cesspool. Pretreatment reduces the SS and COD levels by 30%.

The decanter/digester is a simple cylindrical tank divided into two compartments that operate in parallel. Due to its small diameter, a thick crusty layer is formed on the surface which reduces odours. This primary anaerobic process can be upset by marked output variations, but works well with heavy loads. This step further reduces the COD by 60% and the SS by 80%.

The secondary waste water treatment takes place in three different lagoon basins: a natural lagoon with microphytes and two subsequent lagoons with macrophytes. Effluents from the decanter/digester flow by gravitation into the first lagoon (L_1). During the natural lagooning stage, microphytes (micro-algae) develop by assimilating the polluting elements. This leads to a drop in pollution to levels that are acceptable for macrophyte growth, i.e. N-NH_4 is reduced by more than 60%. The lagooning stage with macrophytes involves one main lagoon (L_2) and a secondary lagoon (L_3) in series. They are covered with *Pistia stratiotes* (water lettuce), a common rapidly and easily grown plant species in Senegal, which has the effect of concentrating the water pollution. These plants are then collected and used in the Transpaille system to produce energy and compost. The compost is enriched with minerals (particularly nitrogen) extracted from the waste waters.

Table 1. Elimination of pollution loads in waste waters from the Thiès slaughterhouse (February 1990).

Pollution indicators (mg/l)	Slaughterhouse outlet	Lagoon outlet	Elimination (%)
SS	6 000	350	94
Soluble COD	2 900	250	91
N-NH_4	300	5	98

SS : suspended solids; COD: chemical oxygen demand; N-NH_4: ammonia nitrogen

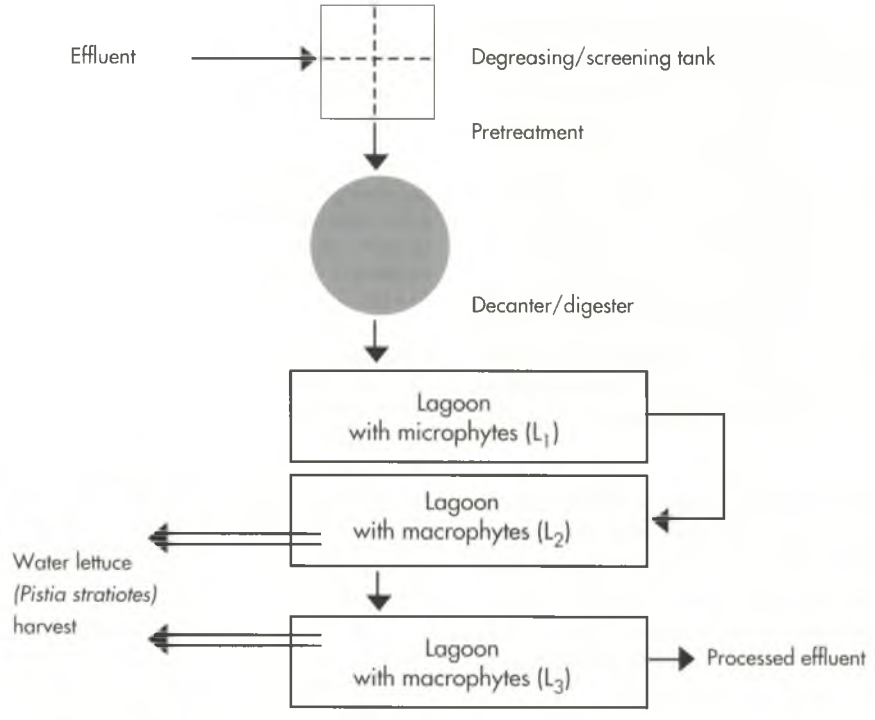


Figure 1. Schematic diagram of the waste water processing system at the Thiès slaughterhouse.

Practical adaptations

The Thiès lagooning station is the first water purification installation designed for a slaughterhouse in western Africa. It is based on European slaughterhouse waste water processing techniques, which were adapted to fit African conditions. Indeed, simple solutions were found for some technical problems caused by seasonal changes and load variations, etc.

A macrophyte-based aeration system enables the development of aerobic bacteria which help to decompose solids in waste overload situations, and during the cool rainy seasons when there is little sunlight. A biogas generator can be used as a power supply for this low-power aerator, thus reducing energy costs.

Mud buildup around the roots of macrophytes (*Pistia stratiotes*) near the lagoon outlets can kill these plants. The problem can be solved by concentrating the macrophyte crop in these parts of the lagoon to keep the biomass at the peak growth phase.

Maintenance

The lagoons are maintained by a quarter-time employee. There are regular duties to be done. On a daily basis, this worker removes all floating matter from the pre-processing tank, removes any accumulated grease from the L_1 lagoon, collects four-six wheelbarrows of water lettuce from the L_2 and L_3 lagoons and takes them to the Transpaille digestor. On a weekly basis, the pretreatment tank is cleaned and the crust is scraped off the top of the digester.

The main waste water inflow canal is cleaned monthly.

The lagoons have to be cleaned every 5 years and the sediments are then loaded into the Transpaille digestor.

Table 2. Features of the lagooning station and retention times.

	Pretreatment tank	Decanter digester	L_1 Lagoon	L_2 Lagoon	L_3 Lagoon
Volume (m^3)	5.5	4.0	225	79	37
Depth (m)	-	2	1.2	0.5	0.5
Surface area (m^2)	-	20	250	168	84
Retention times (h or d)	2.2 h	4 d	22 d	10-12 d	8-10 d

There is a hydraulic system of locks to adjust (in parallel or series) waste water levels in the lagoons from full to empty. Experiments and cleaning can thus be carried out without having to shut down the entire operation.

Economic aspects

The design of a lagooning station will depend on the site. Investment costs vary, and soil premeability is an important determining factor. The costs incurred at the Thiès installation (8.1 million CFA francs) cannot be simply extrapolated and applied to other slaughterhouses since it is only a small-scale experimental unit.

The constant effluent load variations at the small Thiès slaughterhouse could be the weak point of this small-scale lagooning system.

An installation built to handle maximum loads could, however, require considerable extra expenditures. An alternative would be to divert part of the effluents during high-load periods to an agricultural/water purification plot.

Annual depreciation charges for the lagooning unit is 400 000 CFA francs, over a term of 3 years for the stock, 10 years for the equipment and 25 years for civil engineering costs for all construction and development work.

Total lagooning expenses can be up to 550 000 CFA francs per annum, including 150 000 CFA francs for operations and maintenance. The water purification cost has been estimated at 735 CFA francs/t of carcass, or 2.4% of the slaughter fee charged by SERAS for an average overall slaughter rate of 750 t per annum of carcass.

Efficiency, prospects

The overall cleansing objectives can be met with this lagooning technique since the pollution indicator concentrations are reduced by at least 90% over 1.5 months. The water is purified enough to be used for the first hide washing, but it cannot be used to wash down the animal carcasses. This represents a substantial savings for the slaughterhouse since water costs are high in Senegal. Full water recycling will require further studies and expensive additional installations.

Moreover, the results with the lagooning system at Thiès showed a marked 50-60% decrease in the effluent load potential. This means a pollution reduction of more than 95%, which is taken into consideration in pollution tax calculations.

Agronomic studies could now be conducted on the cleansing capacities of cultivated soils, and it would also be interesting to assess water utilization in dry zones. The results of the experiments carried out at Thiès will be very useful for developing other processing units. However, if a new concept is developed which is as ecological, simple and inexpensive as lagooning, it should be kept in mind that different specific conditions are found at each slaughterhouse and they should be fully analysed to obtain the best performance.

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Abstract... Resumen... Résumé

J.-L. FARINET – **Transpaille: energy, fertilisation, cleansing.**

Designed by CIRAD (Centre de coopération internationale en recherche agronomique pour le développement) and developed by Agriforce, the Transpaille procedure is used for the recovery and processing of organic wastes using methane fermentation; gas and compost are produced. The system was installed at the slaughterhouse in Thiès, Senegal, in 1988-1989. It consists of a 40 cubic meter horizontal cylinder. The slaughterhouse produces 480 metric tonnes of waste per year which can be converted into 55 tonnes of compost per year and 35.5 cubic metres of biogas per day at a process temperature of 31°C.

Key words: energy, organic waste, recycling, Senegal.

J.-L. FARINET – **Transpaille : energia, fertilización, descontaminación.**

El procedimiento Transpaille, puesto a punto por el CIRAD (Centro de cooperación internacional en investigación agronómica para el desarrollo) y desarrollado por Agriforce, recupera y trata los residuos orgánicos por fermentación metánica, produciendo gas y abono compuestos. El dispositivo, que se instaló en el matadero de Thiès, Senegal, en 1988-1989, incluye una cuba cilindrica horizontal de 40 metros cúbicos. El matadero produce 480 toneladas de residuos al año, que pueden transformarse en 55 toneladas de abono compuesto al año y 35,5 metros cúbicos de biogas al dia para una temperatura de 31 °C.

Palabras clave : energia, residuos orgánicos, reciclaje, Senegal.

J.-L. FARINET – **Transpaille : énergie, fertilisation, dépollution.**

Mis au point par le CIRAD (Centre de coopération internationale en recherche agronomique pour le développement) et développé par Agriforce, le procédé Transpaille récupère et traite les déchets organiques par fermentation méthonique en produisant du gaz et du compost. Le dispositif a été mis en place à l'abattoir de Thiès au Sénégal, en 1988-1989. Il comprend une cuve cylindrique horizontale de 40 mètres cubes. L'abattoir produit 480 tonnes de déchets par an, ce qui peut être transformé en 55 tonnes de compost et 35,5 mètres cubes de biogaz pour une température de 31 °C.

Mots-clés : énergie, déchet organique, recyclage, Sénégal.

J.-L. FARINET – **Marketing compost as seedling nursery blocks.**

The Transpaille fermentor, installed at the Thiès slaughterhouse, Senegal, can process 480 tonnes of solid wastes per year to produce 55 tonnes of compost. As an organic manure compost, it has competition from the price of traditional fertilizers. Consideration is being given to the possibility of producing seedlings in nursery beds, as this could be a profitable market sector. The beds contain a mixture of 75% compost to 25% sand, plus a water-retaining product and a fungicide. Growing seedlings in nursery beds is an increasingly widespread practice in market gardening, due to its agronomic advantages, and there are plans for marketing the technique in major agricultural areas. Regardless of the degree of valorization of the compost, pollution is eliminated at the Thiès slaughterhouse . In the case of seedlings sold in nursery beds, profits will be made, although this type of utilization means that SERAS will have to diversify its operations.

Key words: compost, plants, nursery beds, market garden crops, environment, pollution, Senegal.

J.-L. FARINET – **Comercializacion de abono compuesto en forma de semilliones en terrones.**

El fermentador Transpaille, instalado en el matadero de Thiès, en Senegal, puede tratar 480 toneladas anuales de residuos sólidos para producir 55 toneladas de abono compusto. Como abono orgánico, el abono compuesto sufre la competencia de los fertilizantes tradicionales debido al precio. Se proyecta la fabricación de terrones para semillones, pues se ha revelado una actividad rentable. Los terrones están constituidos por una mezcla del 75% de abono compuesto y del 25% de arena, a la que se agrega un producto de retención de agua y un fungicida. El transplante de semilliones en terrones se utiliza cada vez más en los cultivos hortenses debido a sus ventajas agronómicas, por lo que la comercialización está prevista en los grandes perímetros agrícolas. Cualquiera que sea el grado de valorización del abono compuesto, la contaminación es eliminada en el matadero de Thiès. En caso de venderse semilliones en terrones, se realizará un beneficio, pero este tipo de valorización supone sin embargo la diversificación de las actividades de la SERAS.

Palabras clave : abono compuesto, semilliones en terrones, labores de huerta, matadero, medio ambiente, contaminación, Senegal.

J.-L. FARINET – **La commercialisation du compost sous forme de plants en mottes.**

Le fermenteur Transpaille installé à l'abattoir de Thiès est géré par la société d'exploitation des ressources animales au Sénégal (SERAS). Il peut traiter annuellement 480 tonnes de déchets solides pour produire 55 tonnes de compost. Comme amendement organique, le compost est concurrencé par le prix des engrais organiques traditionnels. La fabrication de plants en mottes est envisagée et se révèle être une filière rentable. Les mottes sont constituées d'un mélange de 75 % de compost et de 25 % de sable auquel on ajoute un produit de rétention d'eau et un fongicide. Le repiquage des plants en mottes est de plus en plus utilisé en cultures maraîchères du fait des avantages agronomiques et la commercialisation est envisagée dans les grands périmètres agricoles. Quel que soit le degré de valorisation du compost, la pollution est éliminée à l'abattoir de Thiès. Dans le cas de la vente de plants en mottes, un bénéfice sera réalisé. Ce type de valorisation suppose néanmoins une diversification des activités de la SERAS.

Mots-clés : compost, plant en motte, maraîchage, abattoir, environnement, pollution, Sénégal.

J.-L. FARINET, Y. COPIN – **Lagooning, a water purification technique for the tropics.**

Lagooning is used for the first time as a water purification technique at a slaughterhouse in western Africa. This technique reproduces the process by which water purifies itself biologically, and accelerates and controls the phenomenon. The procedure includes pretreatment, a decanter/digester and three lagoons. The organic matter is degraded by bacteria, producing water, carbon dioxide and mineral elements, which are then assimilated by micro-algae and macrophytes *(Pistia stratiotes)*. The tropical climate is suitable for this processing method, which is optimum at temperatures between 25 °C and 35 °C.

Key words: environment, pollution, purification, slaughterhouse, lagooning, Senegal.

J.-L. FARINET , Y. COPIN – **La depuración en laguna, una técnica para purificar las aguas en medio tropical.**

La depuración en laguna es utilizada por la primera vez para un matadero en Africa occidental. Esta técnica reproduce el fenómeno de autodepuración de las aguas por via biológica, acelerándolos y controlándolos. El principio incluye, en serie, un pretratamiento, un decantador/digestor y tres lagunas. La materia orgánica es degradada por las bacterias, que producen agua, gas carbónico y elementos minerales. Estos últimos son asimilados por las microalgas y los macrofitos (*Pistia stratiotes)*. El clima tropical es favorable a este modo de tratamiento, el cual es óptimo en temperaturas comprendidas entre 25 °C y 35 °C.

Palabras clave : medio ambiente, contaminación, depuración, matadero, depuración en laguna, Senegal.

J.-L. FARINET, Y. COPIN – **Le lagunage, une technique d'épuration des eaux en milieu tropical.**

Le lagunage est pour la première fois utilisé pour l'épuration des déchets d'un abattoir en Afrique occidentale. Cette technique reproduit les phénomènes d'auto-épuration des eaux par voie biologique en les accélérant et en les maîtrisant. Le principe comprend en série : un prétraitement, un décanteur/digesteur et trois lagunes. La matière organique est dégradée par les bactéries, ce qui produit de l'eau, du gaz carbonique et des éléments minéraux. Ceux-ci sont ensuite assimilés par les microalgues et les macrophytes (*Pistia stratiotes*). Le climat tropical est favorable à ce mode de traitement, qui est optimal pour les températures comprises entre 25 °C et 35 °C.

Mots-clés : environnement, pollution, épuration, abattoir, lagunage, Sénégal.