Economic Questions of Waste Treatment

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***Abstract*— Strategies management of anthropic activities must, more than ever, take in account not only the environmental legislation corpus, but the concepts and principles that are used to build the public policies. Most of the times, it considers also economical and financial procedures (taxes and grants) and technical tools analysis (systemic analysis and flows balances). Agriculture is highly concerned because of its natural relations to environment and also because of its weight as a production /consumption chain. In most cases, spreading is used for soil restitution of nutrients but with unbalanced flows resulting in environmental impacts. It is obvious that territorial regulation of a « back to soil strategy » must be built on the aptitudes of soils to be amended; crops to be fertilized; farms to gain profit; neighbours to agree; natural areas and resources to be protected and exploited. What kind of natural cycle is pertinent for a specific flow? Where and how is it stored in nature?**

***Index Terms*— agriculture, economic strategies, environmental management, organic waste**

I. Introduction

Traditionally, management strategies of manufactured products cover the wide range of technical, economical and social considerations, which have learned to live together more or less quietly. The emergence of environmental considerations is relatively recent and leads to troubles. At this point of our knowledge and practices:

- new questions that have to be taken in account are identified
- their solutions are not always correctly implemented
- it is often difficult to organise them into a global problematic
- it is even more difficult to translate them into actions [1].

Applied to waste management, the level of difficulty increases of several points, because waste management is, more than other subjects, a conflict area. Further if you add "organic" to "waste", you again increase difficulty because of the complexity of the organic matter, of its reactive potential and of psychological considerations. A management strategy results of the answers to the following questions:

- What is ideally wishful? Considering the global context
- What is socially acceptable? Considering the present situation
- What is readily feasible? Considering my specific position [2].

These questions must be asked with a frequency depending on the speed of evolution of context, situation and position. However, this evolution is rather rapid because we actually live a period of construction under uncertainties. It means that the questions related to organic waste management must be answered through a prospective analysis, and with a proactive management policy as strategy means that you want to anticipate, to predetermine events and not to stay running after them [3].

The first point is to review the main environmental policies, to analyse their conception and development mechanisms in order to find how they can change in the next future. The second point is to detail the role of waste management policies and systems inside the range of environmental policies. The third point is to describe the possible strategies for organic wastes. We will conclude on the future of the "back to soil" strategy applied to all kind of wastes. And finally the fourth point is analyzes the management considerations for organic waste use in agriculture [4].

II. The Place and Role of Environment

The fact is that each state is building progressively its environmental policies through:

- the organisation of public services for control and incitation
- the development of a legislative corpus
- the modification of the existing economical rules

The role and respective weight of this different parts varies a lot from state to state resulting in more or less hard" or "soft" regulation policies. These policies answer to a social demand, as the public opinion has been aware of environmental impacts through scientific works. Aiming to modify our economical development conditions, basically responsible of environmental problems, it is not surprising that they use of financial mechanisms in order to change the value of things, activities and products [5].

If we look for details on environmental policies, we must consider on one hand the concepts, principles and tools on which they rely and on the other hand the different. If we look for details on environmental policies, we must consider on one hand the concepts, principles and tools on which they rely and on the other hand the different fields they cover and the way it is co-ordinated.

The concepts, principles and tools can be related to their rationale [6]:

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- economical changes to polluter/payer principle
- global public policies to sustainable development concept
- scientific approaches to systemic analysis
- engineering to best available technologies strategies
- ecological ideal to nature protection strategies

Environmental policies cover a wide range of problems. It results in specific thematic subpolicies, which can be gathered into groups:

- Natural Resources Quality Preservation (air, soils, water)
- "Wild" Nature Protection (biodiversity, protected areas, species in danger...)
- Production Activities Regulation (emissions regulation and waste treatment)

The third one is often the result of the others which give the background to assess the field and level of regulations. Agriculture is highly concerned with environmental policies, because of its natural relations to nature. It is surrounded by:

- elementary fluxes and geo/biocycles
- space occupation and landscapes
- quality of its own natural resources
- wild life versus its domestication processes: fauna and flora [7].

The main problems with agriculture are that:

1. Local impacts are the result of a collective behaviour. So the corrective actions must also be collective.
2. Agriculture covers a wide range of activities, and two main levels of production, e.g. vegetable growing and animal feeding, which have significant differences considering their respective environmental impacts.
3. Production systems for a specific activity are also widely different, depending on many parameters, a part of them are determined by the natural local context [8].

Agriculture is also involved, as a primary activity, in an important production/consumption chain: the food chain [9]. Specific tools have been developed to analyse the impacts of products through their production chain. Life Cycle Analysis. It considers that quality requirements and environmental production conditions are more and more imposed to producers as a feed-back requirement of consumer behaviours [10]. Applied to primary agriculture productions, the problem with such tools is to correctly integrate all the local impacts most of them depending of conditions or practices inside the system and then of the hypothesis that are used.

Another common specificity of the different production steps of this chain is the co-production of organic wastes:

- crops residues
- animal slurries and manure
- agro food organic wastes and by-products
- the organic wastes or fraction of wastes produced by shops, restaurants, and finally household
- at the far end, the organic wastes coming from sewage treatments

All these wastes are involved in a specific management system based on biological processes through animal feeding, biodegradation and new vegetable organic carbon fixation. Following this organic chain, we can notice that generally [11]:

- the production of organic wastes decreases from agriculture to food industries and then to household the organic purity decreases also, either by mixing with other wastes or by contamination
- the financial capacity increases

When trying to solve environmental local impacts, the first problem is to define the territorial system and its boundaries. For water pollution problems, it is relatively easy. But, for air pollution, it can be more difficult. Another problem is to determine the respective responsibilities and also to find the solidarity between activities on which can be built action plans. Concerning local space management, there are two main competitors involved in land uses responsibilities : agriculture (cropping) as an exploitation activity and municipalities as a public administrative regulation level. Manufactories and shops are more concerned with product exchanges (transport of goods, of energy, water resources, etc.) and then with territorial equipment and networks. The corresponding public administrative levels are regional or national [12].

To achieve this description of environmental problems and strategies, let's have a look on the systemic analysis method. As it comes from physical and chemical principles, it has been developed to assess the impacts of physical and chemical fluxes in and out of a specific system, a production system for instance. But, the reasons of the present situation are not physical or chemical.

It is more and more important to take in account for the same system:

- social and economical flows (employment, costs, added value), which can be easily done
- psychological and cultural flows, which is a little bit more difficult

It is important because the problem of environmental impacts of anthropic activities, which is as old as humanity, needs a negotiated political response and not only a scientific explanation. Maybe, we can find here the reasons of the troubles produced by environmental considerations when applied to social, economical and technical systems.

III. Waste Management Policies

Among the different specific environmental policies, one is dedicated to waste management. Its role is to develop an intermediate eco-industrial activity which avoids the direct contact between raw rejections (sewage, gases, solid wastes) and the environment. The waste management system takes in account:

- primary wastes from production/consumption chains including used packaging, by-products

- secondary wastes from treatment of rejections as sewage sludge, flying ashes

Any waste management system relies on:

- prevention including avoided productions and improved quality of wastes
- re-use and recycling of wastes
- storage in landfills or salt mines, with graduate levels of insulation depending on the wastes danger potential.

The system is limited and then determine by the two main points that are Prevention and Landfilling. The problem with prevention is to agree on what has to be prevented: pollution, costs, landfilling, and transport. The problem with landfilling depends on the role it plays in the system. It can be only a final storage equipment for treated wastes or a treatment step, something like an outdoor reactor [13].

The waste system is mainly defined by the pressure that is made on landfilling through its legal, technical and economical obligations, comparatively to the same kind of obligations on the other possibilities. The aim of waste re-uses is not only to avoid environmental damages from waste disposal, but also to decrease the exploitation of natural resources through recycling. As it is generally not economically profitable to recycle, taxes and financial mechanisms have been developed mainly to charge the consumer and not the citizen.

As the waste treatment activity can produce more pollution than avoided, the waste treatment system must be a clean one. Most of the time, specific emission levels are decided for wastes treatment plants and specific quality composition for waste derived products.

Re-use of waste can be done through three main strategies [14]:

- an industrial recycling/re-use strategy
- a "back to soil" strategy
- an energy production strategy.

Each waste strategy can be done by different ways. On one hand, it can integrate industrial cycles, as a "secondary raw" matter, for instance glass or cardboard recycling or industrial organic fertilisers production for organic wastes.

IV. Organic Waste Management

The recycling of organic wastes back to the food chain can be done at different steps of this chain. For instance, animal blood can be used for human food, for animal feeding or for crops fertilisation. It seems natural that organic wastes come back to the food chain, but only as far as it is acceptable, we mean safe and not shocking. But, organic matter can also be used for energy production through digestion or combustion or cogeneration, as a gaseous, liquid or solid fuel, which represent a lot of different possibilities. If lignocellulotic, it can also be used in material recycling, and so on [15].

The problem of the best solution with organic wastes management covers three main considerations.

First, the complex composition of organic matter, if we consider all the elements, leads to a lot of environmental questions about the most pertinent way to manage the corresponding fluxes. Is nitrogen better in air as ammonia than in water as nitrates? And what about soil accumulation of trace elements? Is phosphorus the best target element for organic wastes spreading?

Secondly, organic matter is generally very "reactive", We mean potentially source of reactions (as biodegradation, volatilisation, toxicity, ecotoxicity) depending on its environmental fate. It leads to two kinds of consequences: pollution problems, of course, but also treatment problems as whatever the process you choose, it has adverse effects.

Third, organic wastes can have a high content of water with and consequently, the fate of this water flow must be considered. But, the main point with this associate water is that the alternative strategy is not a solid waste one but a sewage treatment one.

Up to now, most of the territorial organic waste management systems include a "back to soil" basic strategy, through spreading of more or less treated (denitrified, digested, composted, limed) products. The limits of this basic option come from crops and soils needs and from environmental policies based on nitrogen or phosphorus loads. The adequate territorial level is the local agriculture area. It is relevant for the most aqueous organic wastes including a wide part of soluble elements. The solid wastes or the extracted solid part of wastes can also be managed with the same strategy but at a larger space scale. An energy strategy based on combustion or incineration in local supplying energy plants. It works pretty well for dry lignocellulotic wastes and can be used for the excess solid part of wet organic wastes. The good scale covers several municipal territories depending on the local activity pressure and the energy corresponding networks. Anaerobic digestion can supply energy but remains a biological strategy as the final digested products is mainly spread on lands. Finally, landfilling is still widely practised. But, the future of organic waste landfilling is under discussion and most of environmental policies aim to reduce or ban it. Direct organic wastes landfilling is needs methane recovery and, if profitable, utilisation.

V. The Management For Organic Waste Use in Agriculture

A. *The role of organic waste*

Organic wastes are utilized in agriculture mainly for improving the soil physical and chemical properties and for nutrient sources for growing crops. The major source of organic waste used in agriculture is animal manure, but small amounts of food processing and other industrial wastes (along with municipal wastes) are also applied to land. In the last 40 years, and especially in the last 15 years, there have been increasing environmental regulations affecting farms that have resulted in more animal manure treatment options, and thus affecting characteristics of residues that are subsequently applied to land. Farms are being assessed for nutrient balances, with the entire nutrient and manure management system evaluated for best management alternatives. Because of inadequate available land on the

animal farm in some cases, organic wastes must be treated and/or transported to other farms, or utilized for horticultural or other uses [16].

Organic wastes include animal manures, crop residues, food processing wastes, municipal biosolids and wastes from some industries. Organic wastes are typically by-products of farming, industrial or municipal activities, and are usually called "wastes" because they are not the primary product [17]. However the goal is to make the "waste" a resource that can be utilized and not just discarded. Possible uses of organic wastes include use as fertilizer and soil amendment, energy recovery (heat, liquid fuels, electricity), and production of chemicals (volatile organic acids, ammonium products, alcohols). Agriculture has traditionally used animal manures for fertilizer and improving soil physical and chemical properties, and to a much lesser degree has also utilized municipal biosolids and industrial organic wastes for this purpose [18].

Energy production from animal manures, crop residues, and/or other organic wastes has been utilized in agriculture to varying degrees in different parts of the world. Utilization of various organic wastes in agriculture depends on several factors, including the characteristics of the waste such as nutrient and heavy metal content, energy value, odor generated by the waste, availability and transportation costs, benefits to agriculture, and regulatory considerations. The importance of these factors can vary by type of organic wastes, but many of the considerations for utilizing organic wastes are similar for most organic wastes. We show some of the challenges affecting organic waste utilization in agriculture, main factors providing impetus for changing organic waste management strategies, how those changes may affect utilization of organic wastes, and management options and possible approaches to addressing challenges to utilizing organic wastes in agriculture.

B. Management of Energy Pollution

In some cases, energy recovery from anaerobic or aerobic digestion of organic wastes can be beneficial for certain objectives, but may have minimal benefit for nutrient management. Nutrient content generally remains unchanged, but nutrient availability may be increased and soluble organic matter reduced. Another benefit can be reduction of odor [19]. The type of farm and number of animals greatly affect whether the energy can be used on-farm, but the payment for selling the energy often determines whether this is a viable management scheme. Other possible energy recovery schemes are being researched, such as gasification of manure solids and conversion of gases to methanol or ethanol. This will require expensive processing plants, and likely some government subsidy to be developed. These energy recovery schemes offer opportunity to combine farm animal wastes and municipal or industrial organic wastes, however the transportation and hygiene factors present challenges. Generally, biogas recovery is considered potentially economical for only large farms and for regional facilities, and even then government subsidy and tipping or gate fees may be needed to be successful. If government energy policies were improved to support more "green energy" production, then more farms might consider anaerobic digestion for manure treatment and energy recovery.

C. Economics of waste treatment

Inherent in considering alternative management schemes for organic wastes are the costs and benefits. If regulations or environmental factors require additional treatment that increases costs of production and operation, then the farmer loses profit unless costs are shared with the government or other agencies. It is not easy to determine environmental costs and benefits of alternative waste management policies. The costs of additional waste treatment are more easily passed to the consumer for industrial waste treatment (or to taxpayers for municipal waste treatment) than for farm waste treatment [20]. As commodity producers, farmers cannot, for all practical purposes, pass on increased production costs to consumers. Government can offer incentives such as cost sharing of equipment or guarantee of not changing regulations for a period of time for improved waste treatment, but this is the exception more than the norm. Also, in the global trade environment, trade agreements between countries can restrict the use of government money to financially support farmers through cost-sharing arrangements. Economics may also suggest that a cooperative or regional facility is needed for certain waste management schemes. However, farmer and public acceptance of this is important because odor from large treatment plants and transportation of organic wastes on public roads may present more community concerns, and farmers may choose other alternatives if the regional treatment system is not clearly advantageous both economically and for management efficiency.

Utilization of organic wastes occurs more easily if there are clear economic incentives. However, the economic incentives are often marginal and sometimes negative. Better organization through farmer cooperatives, organic waste sellers, and government or other agencies could improve the economics. At least initially, more government subsidies may be needed to help distribute nutrients over a larger region by helping with transportation or costs of further processing.

D. Necessity of regulations in agriculture

Development of government policy and laws that consider environmental impacts, economic survival of agricultural producers of food, and food prices for consumers is difficult to formulate to satisfy the public. In some aspects, more regulation on organic waste products might be advantageous, such as setting specific but reasonable criteria for quality control, such as nutrient content and level of pathogen treatment [21]. Such criteria will likely be required for certification of organic farming enterprises, and having a uniform product that meets certain standards can lead to a more stable market. In order to determine regional policies and regulations, there needs to be more analyses done on watershed, and airshed, basis for nutrient distribution and environmental impacts [22]. With a regional analysis, it may be determined that additional treatment can reduce air emissions and result in value-added products that can be

successfully distributed to satisfy nutrient concerns. However, it may also become obvious that the concentration of animals or other organic waste sources is too great for a region, that processing and transportation costs are too high to transport the nutrients to other regions, and thus the number of animals in the region must be decreased. But if the number of animals must be decreased, who is going to pay the farmer for the loss of income? Farmers may have to absorb the costs, but possibly the government (or tax payers) will have to pay the bill. Also, large integrator companies that contract with growers may seek to move their business to other regions, thus affecting regional economies. Alternately, it might also be concluded that a regional composting plant or incineration plant might be economically feasible, with energy recovery and production of a mineral fertilizer from the ash. Development of strategies for using various mixes of agricultural (e.g., animal wastes) and industrial/municipal waste (e.g., food wastes) could enable a more economical solution, as well as a more balanced and consistent product.

E. Public acceptance

Better education of the public and the farmers of the benefits of proper management and utilization of organic wastes in agriculture are important to diminish fears and preconceived notions of nuisance problems, decrease in land values and environmental degradation. In the case of municipal and industrial organic wastes, utilization in agriculture can be presented as more sustainable than landfilling [23]. Examples of successful utilization with support of the farmer and neighbors can promote acceptance by others. However, one bad experience can be difficult to overcome. Therefore, it is important to have proper management to control flies, odors, and generally prevent degradation of air quality or water quality. Obtaining public acceptance also requires having adequate regulations that can protect the public from nuisances and air or water pollution. Education efforts can be national or regional, but must be effective at the local level where the organic wastes utilization is occurring. Education can be funded and conducted by a variety of organizations, including government agencies, cooperative extension service, farmer cooperatives, and commodity organizations. Regardless of the benefits of utilizing organic wastes in agriculture, public acceptance of the practices of organic waste utilization is critical to continuing this activity and developing expanded programs.

VI. Conclusions, Proposals

A. What Will Happen in the Next Future?

There is, nowadays, a great problem of acceptability of spreadings, for municipal sewage sludges because of health risks and of the bad image of the product, which applies also to animal slurries because of odour and excessive spreadings.

To be sure to forget nothing to describe the rules and laws of this strategy, seven "points of view" are needed:

a) Image, communication and social acceptability
b) legislation , contracts and standards
c) quality management and training
d) economical and financial conditions
e) processing, logistics and organisation
f) agricultural integration and results
g) environmental impacts assessment

The aim of this programme is to determine the future conditions of development of the "back to soil" recycling strategy, safety conditions of course but also and mainly its contribution to our future sustainable development.

Another key for future is our ability to develop integrated territorial strategies for all the different sources and kind of organic wastes. We know that the resulting systems will used more or less of each basic management possibilities, landfilling, energy production, fertilization, animal feeding, industrial recycling... depending on local and actual conditions. The co-treatment of different organic wastes is already possible and has been widely demonstrated. But, the genuine co-management has to face many resistance, and first the one which lays in minds reducing our point of view to what happens or not in our backyard.

B. Management Considerations for Agriculture

Some of the limitations for utilizing animal manure and other organic wastes are:

- public acceptance (nuisance or environmental concern),
- acceptable integration into agriculture,
- quality control of residues being applied,
- logistics and organization,
- satisfaction of environmental regulations,
- economic viability, and
- sustainability.

The environmental factors that appear to have the most potential impact on selecting management strategies in the next 10 years are nutrient management to minimize water pollution, air emissions of ammonia and odorants, and pathogens.

Management strategies for utilization of organic wastes start with the source, such as animal housing and corresponding manure handling and treatment, because this determines the nature of the organic residues and by-products to be utilized. Selection of manure management and treatment options increasingly depends on environmental regulations for preventing pollution of land, water and air. For example, regulated reductions in ammonia emissions could influence the housing management, the storage and treatment, and method of land application. To better utilize organic wastes other than animal manure, better organization and cooperation is needed between waste producers and waste users to schedule the appropriate application times and rates. More analysis needs to be conducted on a regional basis to develop regional management schemes to handle nutrients and protect the environment.

C. Requirements for regulation

Further development, validation and acceptance of expert systems and computer programs for regional analysis are

needed to assist in making policies and decisions. The validity of the models will depend not only on the model construction but also on the accuracy of the data input to the model. Thus, researchers should continue to attempt to do economic analysis of research projects and case studies to supply data to these models.

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