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THE POTENTIAL USE OF SLUDGES FOR AGRICULTURAL PURPOSES IN ALBANIA

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Abstract

The use of sludge on agricultural land is widely considered to be the most sustainable sludge management option and is an important and well-established outlet for sludge in many countries. Sludge supplies nutrients and organic matter, and provides a partial or full replacement for animal manure and fertilizer. The application rate of sludge is usually determined by the nutrient requirements of the crop, in the range 5-10 t ds/ha per year. Regular applications of sludge gradually improve the organic matter status of soil with benefits to soil texture, and water holding capacity but for infertile soils, higher rates may be necessary to achieve early and sustained improvements to soil physical conditions. Extensive research and risk assessments carried out over the last 40 years or so continue to demonstrate that responsible and well-monitored use of sludge, in compliance with appropriate regulations, causes neither environmental damage nor endangers human health. Nevertheless, where there is limited experience of sludge use, farmers tend to be cautious about its use, at least initially. In Albania, sludge is a novel product and its use on land is not yet established. Concerns may be raised by the public over the acceptability of food grown on sludge treated land and in some countries the use of sludge on land has been made difficult due to the adverse perceptions of food retailers. Such issues can generally be overcome by providing appropriate information, marketing activities and through dialogue. It is important to recognize that the acceptance of sludge by farmers is voluntary and as a consequence, demand can be vulnerable to rapid changes in the attitudes of farmers to sludge. Demand for sludge will also be variable due to the seasonality of crop production. Consequently, understanding the ‘market’, the necessary conditions of supply and providing a high-quality product that meets farmers’ requirements are crucial to establishing and sustaining a sludge-to-land programme.

Keywords: Sludge, Agricultural, Animal Manure, Waste Treatment

Introduction

Agriculture represents a major sector of the Albanian economy. More than half of the Albanian population lives in rural areas and more than two-thirds of the rural population is employed in agriculture. Arable land constitutes approximately 24% (700,000 ha) of Albania's land area, pasture 15%(425,000 ha), and forest about 36% (1 million ha). Forty-four percent of the arable land lies in the coastal areas that are predominantly plains, and the remaining 37% and 19% are in the hill and mountainous areas, respectively. The three major agro-ecological zones in Albania based on climate and topography, are: (i) the lowlands consist of the coastal plains along the Adriatic/and Ionian Sea, with altitudes ranging from sea level to 200 m. The conditions allow production of a wide range of crops such as cereals, forages, vegetables and grapes, as well as citrus in the most southerly part; (ii) the transitional hilly (sub-mountainous) zone ranges from about 100 to 900 m, consisting primarily of hills stretching from north to south between the coastal plains and the mountains. Olives, grapes, temperate fruit trees, maize and wheat are grown, and there are extensive areas of low and shrub forest. The transitional zone includes the agriculturally significant Korca basin, located at over 800 m in the driest part of the country (average annual precipitation of 790 mm); (iii) the mountainous zone consists of intermountain valleys and high mountain peaks, with mild summers and cold winters. Crops such as maize, forages, summer vegetables and winter wheat may be grown in the valleys, with barley and potatoes at higher altitudes. Temperate fruit trees such as apples and plums are also grown. At high altitudes, the zone consists mostly of forests and pasture for livestock. Albania's transition to a market economy following the 1991 overthrow of Communism has been difficult, particularly for the agricultural sector with the breakup of the state-owned farms and the creation of more than 400,000 small family farms. Food production and agriculture continue to play an important role in Albania's economy, contributing about 19% of GDP(2006), compared with the average of 2% of GDP for EU27. While agriculture is improving in certain segments with international assistance, farming is essentially small-scale, fragmented and inefficient, characterized by poor access to markets, low prices and high wastage. As an accession candidate to the EU, Albania needs to make significant policy, institutional and economic reforms in the agricultural sector to adjust to the requirements of the Common Agricultural Policy. These factors are obstacles to the improvement of agricultural productivity and efficiency. Fragmentation causes a number of difficulties for the production and marketing of agricultural products and has prevented the wider use of agricultural machinery, which is

exacerbated by the high prices charged by owners of equipment. Furthermore, agriculture is dominated by elderly households (30% of farmers are over 65) as the demographic trend is for young people to move to urban areas or overseas in search of better economic prospects.

Results and Discussions

Albania's rural sector is beginning to see the emergence of community-based private groups and associations, many of which have received technical and financial assistance from government and donor financed programmes during their formation. The prospects for sludge use in agriculture are potentially high as low farm profitability, high input prices and a shortage of organic manure suggests there is a significant latent demand for sludge. The small size of farms in Albania makes the practicalities of supplying of sludge to farmers more difficult but these are not insurmountable. Critical to success will be effective marketing of sludge as a very large number of farms will be required in order to secure sufficient land for reliable disposal of the sludges generated by the WWTPs.

Agricultural Holdings

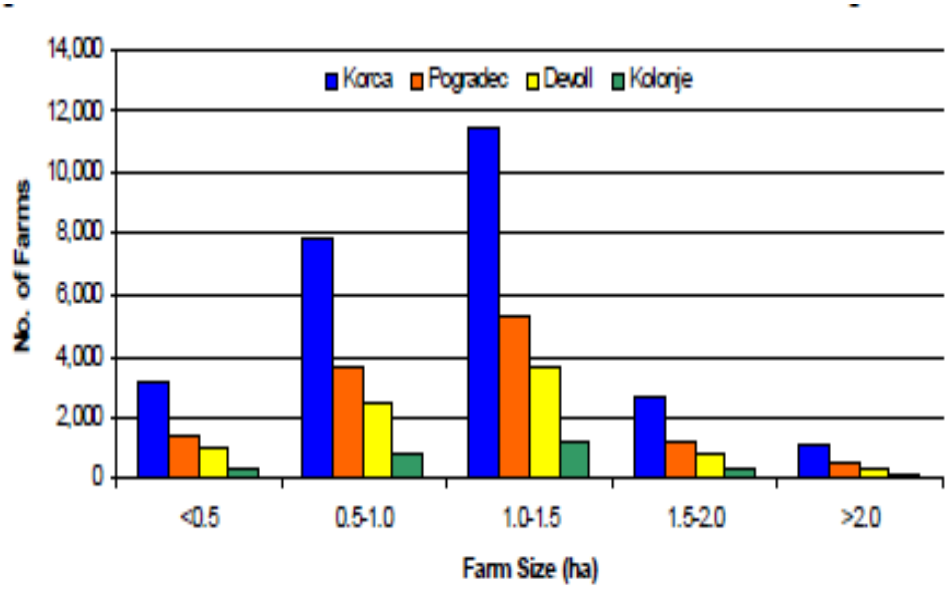
The consequences of the breakup of collective farms to small and fragmented family farms is shown by Table 1 which summarizes the average size of farms and plots in Tirana Region(includes Kavaja District), and Korca Region (includes Korca and Pogradec Districts)

Table 1. Numbers and Average Sizes of Farms and Plots

Region	No.ofFarms	AverageFarm Size(ha)	No.ofPlotsperFarm	AveragePlot Size(ha)
Tirana	33,186	1.09	4.1	0.26
Korea	30,943	1.13	6.4	0.17

Farm size distribution in the Districts of Korca Region is shown in Figure 1. Overall, 86% of farms have 1.5 ha or less, while only 4% of farms are larger than 2 ha. A similar distribution is expected in Kavaja District as the reallocation of land followed the same pattern throughout the country according to family size. Land ownership has remained static as there is little activity in buying and selling of land, and larger farms have not yet been created .The very small size of farms has significant implications for sludge management since the sludge producer would need to manage a very large number of 'customers' in order to secure sufficient land for use of sludge.

Figure 1: Farms size distribution and number of farms in Korca Region



Agricultural Area and Crop Types

Statistical information on agricultural production is published annually and provides a wealth of physical, social and economic data at the regional and district levels. Korca is one of the most important agricultural areas in Albania with an extensive area of farm land around the WWTP. Pogradec has a restricted area of farmland around the WWTP and the main agricultural area of the District is several kilometers to the south at a greater elevation on the northern end of the Korca basin. Kavaja WWTP is located in the agricultural area of the coastal plain, bounded by the sea to the west and uplands to the east. Table 2summarizes the areas of the principal crops grown in the Districts of Pogradec, Korca and Kavaja. Table 3 summarizes the crop areas in the Communes immediately surrounding the WWTPs as these areas are the most strategically important to the UKs. Fodder crops, wheat and maize are the most important crops by area in each district; all of these crops are suitable for liquid or solid sludge application. Vegetables are economically important crops but the areas involved are relatively small; 5.5% in Korca to 12.5% in Kavaja.

There are some important structural differences in production between the districts. In Korca, vegetables are mostly grown in open fields where sludge application would be practicable but in Pogradec and Kavaja, vegetables are predominantly grown in small plots adjacent to dwellings where sludge application would not be feasible or advisable in such proximity to houses. However, the use of sludge on vegetables is not permitted, and restrictions are applied on the period which must elapse between sludge application and the harvesting of subsequent vegetable crops if these are grown in rotation with permitted

crops.The numbers of fruit trees and areas of grapevines in the Districts of Pogradec, Korca and Kavaja are summarised in Table 28. A wide range of trees, particularly apples, are grown extensively in the Korca basin and in the coastal plain, where the climate is also suitable for olive and, to the south, citrus. Grapevines are grown in both regions. Korca is also a centre for the production of seedling trees.

Table 2. Fruit growing in districts of Pogradec, Korca and Kavaja

District	**Fruits** (no.)	**Olive** (no)	**Citrus** (no)	Other (no)	**Grapevine** ((ha)
Pogradec	259,000	0	0	49,000	227
Korca	1,145,000	0	0	97,000	498
Kavaja	356,000	173,000	24000	112,000	308

In the Communes immediately around the WWTPs, the areas of fruit growing are as follows: Bucimas Commune, (Pogradec District) 67 ha, Bulgarec and Voskop Communes, (Korca District) 308 ha, Synej and Golem Communes, (Kavaja District) 112 ha, Solid sludge (air-dried or from SRB) would be suitable for use on fruit trees, as the farmers are accustomed to apply manure, although the frequency of use is usually every four years. It is not practicable or appropriate to spread liquid sludge to fruit trees.

Table3 Areas of Crops Grown in Districts of Pograclec, Korca and Kavaja

District	Wheat	Maize	Rye	Barley	Oats	Vegetabl	Potato	Beans	Fodder	Tobacc	Total
AreaofCrops(ha)											
Korca	10,172	2,235	219	**1,165**	512	1,678	1,396	97	8,320	3	26,711
Pogradec	2,080	838	80	60	140	363	333	42	2,300	2	6,616
Kavaja	4,520	1,775		0	600	2,255	365	1,37	7,096	0	17,989
AreaofCropsasa%ofTotalCropArea											
Korea	38.1	8.4	0.	4.4	1.9	63	5.2	3.7	31.1	0.	100
Pogradec	31.4	12.7	1.	0.9	2.1	55	5.0	6.3	34.8	0	100
Kavaja	25.1	9.9	0	0	3.3	125	2.0	7.7	39.4	0	100

Table4: Areas of Crops Grown in the Communes immediately Around the WWfPs

Commune	**Wheat**	**Maize**	Rye	Barley	**Oats**	**Vegetable**	**Potato**	**Legume**	**Fodder**	Other	Total
BucimasCommune,PogradecOistrict											
Area(ha)	235	150	0	11	25	144	52	46	452	2	1,119
%oftotal	21.0	13.4	0	10	2.2	12.9	4.6	4.3	40.4	0.2	100
BulgarecandVoskopCommunes,KoreaDistrict											
Area(ha)	2,415	35	570	598	100	390	146	382	1,448	243	6,327
%oftotal	38.2	0.6	9.0	9.5	1.6	6.2	2.3	6.0	22.9	3.8	100
SynejandGolemCommunes,KavajaOistrict											
Area(ha)	920	0	0	430	220	90	393	506	2,329	0	4,888
%oftotal	18.8	0	0	8.8	4.5	1.8	8.0	10.4	47.6	0	100

Fertilizer Practices

For small farmers, animal manure is the primary source of nutrients for crop production; this is not only due to well-entrenched traditional practices but also from necessity due to the cost of chemical fertilizer and the low profitability of farming. The value of adding organic matter to local soils is well appreciated. Manure is invariably spread by hand from small piles distributed along the farmer's plot. Most farms keep a small number of livestock and these generally provide the only manure used on most farms. There is no active market in manure although farmers with a surplus may trade manure for other services from neighbours. Manure is rarely bought so establishing a reliable price is difficult, although €50 for a truck load (~7 t) appears average. Farmers generally would wish to apply more manure if there was a greater supply. The most commonly stated problem with importing manure is the introduction of weeds. Establishing a 'normal' rate of manure application is difficult due to the limitations of supply restricting actual practice. When asked what rate they would apply if manure was freely available, the farmers' aspirations were invariably excessive. The costs of fertilizers reflect international prices although farmers complain about the poorquality of the fertilizers available in Albania. Although there is a trend to using more urea as it is cheaper, diammonium phosphate is a commonly used compound fertilizer. This costs about 65 ALL/kg and an average application rate is around 200 kg/ha (13,000 ALL/ha).

Implications for Sludge Management

It is clear that there is a deficit in organic manure in Albania suggesting that there is a latent demand for an alternative organic fertilizer such as sewage sludge. The response by farmers to the concept of using sludge was predictably mixed, particularly to liquid sludge, but most would try solid sludge, particularly if it was free of charge. The most important issue raised by farmers is the physical quality of sludge as there is a strong preference for dry sludge as this is easy to store on the land and applied when the farmers wished in the same manner as animal manure. The concept of liquid sludge is novel to farmers in Albania as there is no experience of the equivalent animal slurry common in the intensive livestock areas elsewhere in Europe. This is confirmed by the slow uptake of liquid sludge application by farmers near to Kavaja WWTP. Marketing plays an important role in developing the use of sludge in agriculture, particularly in areas of small-scale traditional farming practices. Wheat is sown in the autumn and maize in the spring so there is a nominal period of about six months when sludge may be applied to the main arable crops. Sludge can be applied atany

time of year to fodder crops, normally before growth starts in the spring and after harvest or grazing. Liquid sludge is easily applied to fodder crops and rainfall quickly washes sludge residues into the soil but dry sludge should only be applied to fodder crops if the sludge particles are small so as not to leave large lumps on the surface. The maximum rate of sludge application is normally limited by its nitrogen content, assuming that heavy metals are not the rate-limiting factor. The analysis of sludge samples indicated widely different N contents (1.07 - 6.6% N ds) while sludge would normally be expected to contain on average 3% N on a dry solid's basis. Assuming sludge would be applied at the maximum rate of nitrogen addition (250 kg N/haper year), the rate of sludge application would be 8.3 t ds/ha for sludge containing 3% N ds. For liquid sludge typically containing 6% ds, the volumetric application rate would be140 m3/ha. These rates of application are adopted to evaluate the proportion of arable land that would be required to use all of the sludge produced by each of the WWTPs at their design capacities. The implications of this for each WWTP are summarized in Table 5. For assessing the area of available land for sludge application, only field crops in the immediately surrounding Communes are considered.

Table5. Agricultural Land required for Forecast Sludge production

WWTP	**Phase1**	**Phase2**	**Phase3**
Pogradec	2016	2026	**Future**
Sludgesolids(tds/y)	417	1,061	1,599
Liquidsludgevolume(m}/y)	6,942	17,678	26,645
Arearequredat140m1ha(ha)	So	127	192
Areaavailable(ha)	975	975	975
%ofavailablelandrequiredper	5.1	13.1	19.7
No.oftankertrips(6m'capacit	1,157	2,946	4,441
No.oftankertripsperd(156d/y	7	19	28
Korea	2016		
Sludgesolids(tds/y)	1,071		
Driedsludgeweight(t/y)	2,380		
Arearequiredat83tds/ha(ha)	129		
Areaavailable(ha)	5,937		
%ofavailablelandrequiredper	2.2		
No.oftrucktrips(5tcapacity)	476		
No.oftrucktripsperd(156d/y	3		
Kavaja	2014	2027	**future**
Sludgesolids(tds/y)	333	1,207	1,499
Liquidsludgevolume(m}/y)	5,545	25,126	31,653
Arearequredat140m1ha(ha)	40	145	180
Areaavailable(ha)	4,798	4,798	4,798
%ofavailablelandrequiredpe	0.8	3.0	3.7
No.oftankertrips(6m'capacit	416	1,884	2,374
No.oftankertripsperd(156d/y	3	12	15

Based on the above data there are some key constraints as the acceptance of liquid sludge by farmers and the logistics of supply by the UKs, the proportion of the potentially available farmland required to apply all of the sludge, conventional wisdom suggests that sustainable sludge management programme scan be established if only 5-10% of the potentially available land is required annually for sludge application. Critically, whether the soils in the proposed sludge use areas comply with the limit values for heavy metals in EC Directive 86/278/EEC. This is uncertain bearing in mind the prevalence of elevated concentrations of certain heavy metals in soils throughout Albania. The small size of farms will require to secure a large number of farmers willing to use sludge. This will require detailed planning in order to make the logistics of supply (and spreading) feasible within the period that the farmers are willing to accept sludge. Detailed land use maps of the areas around the WWTP should be used by the UKs in conjunction with the sludge management database.

Conclusions and Recommendations

Only about 5% of the arable land in Bucimas Commune around Pogradec WWTP would be required for the sludge generated by the existing plant at design capacity. This is considered practicable, provided the farmers are convinced to accept liquid sludge. Assuming that land is available for spreading for six months of the year, seven tanker loads of sludge would need to be spread daily (6 day week) over this period. This is logistically achievable given the proximity of the land to the WWTP but the work plan will require careful preparation to ensure continuity of the spreading operation bearing in mind the small size of plots and farms. The average plot size in Korca Region is 0.17 ha and this area would take a maximum of four tanker loads applied at 140 m3/ha. The expansion of Pogradec WWTP will double its treatment capacity but sludge production will increase by more than this due to the start of phosphorus removal at the WWTP. At design capacity, the proportion of land required for sludge spreading will increase to 13% of that potentially available; this should be feasible if farmers have become accustomed to liquid sludge and see benefit in its use. However, the average number of tanker loads will increase to 19 per day, and even if a second tractor-tanker unit was procured, this will become logistically challenging given that in practice it will not be possible to spread sludge every day due to adverse weather conditions over the winter period. A further factor to consider here is that, due to the proximity of this land to Lake Ohrid and the environmental sensitive nature of the area, it is

possible that the area may be designated a Nitrate Vulnerable Zone (NVZ). This would limit the maximum quantity of nitrogen that could be applied by sludge to 170 kg N/ha. The result of this would be to increase the proportion of land required annually for sludge spreading to 19% of the arable land. The introduction of NVZs may also impose closed periods of the year for sludge spreading to minimize the risks of nitrate leaching during the non-growing season. This would restrict the use of sludge in this area to such an extent as to make it untenable. There are potentially 2,000 ha of agricultural land in Dardhas and Cerave Communes, to the south of the WWTP on the northern edge of the Korca basin.

However, it is concluded that the spreading of liquid sludge to land will be limited by logistics and the SRBs on the WWTP should be used to balance sludge supply and demand. In this way, the period between emptying the SRBs will be extended if they are not utilised to their maximum capacity. It is important that the operation of the SRBs is staggered so that only a few are emptied each year as this will provide uniform continuity of supply of solid sludge to the local farmers.

From discussion with farmers around Korca WWTP, air-dried sludge is expected to be readily accepted. Only 2.2% of the arable land in the two Communes (Bulgarec and Voskop) around the WWTP would be required annually for full use of the sludge and this should be achieved easily. Nevertheless, the sludge should be marketed well to encourage early high demand. There is sufficient storage capacity for dried sludge to allow for the seasonality of demand from farmers. The use of the storage area should be maximized in order to ensure that the sludge removed from the drying beds after the winter drying cycle can dry further to ensure that it is sufficiently friable for the farmers to spread easily on the land by hand. Nevertheless, it would be sensible to encourage farmers to collect sludge with their own transport.

Based on supplying sludge to farmers in the surrounding Communes of Synej and Golem,the area of arable land required for spreading sludge is modest; about 1% for sludge production at the current design capacity of the WWTP, increasing to 3% of the land area atthe design capacity of the Phase 2 extension. For the current WWTP, if all of the sludge is used in agriculture, an average of three tanker loads per day would be required for spreading over the autumn-spring period. This is considered easily achievable due to the close proximity of suitable land to the WWTP.

The constraint on access to land for sludge spreading is that the farmers currently only accept sludge application to fodder crops. The farmers must be convinced to allow sludge

application for arable crops, particularly wheat and maize which is commonly grown on the land around the WWTP.

If it is necessary to use land further away, the time taken during road travel becomes an increasingly large proportion of the overall cycle time per load. Consequently, an additional tractor-tanker unit would be required or a road tanker used to transfer sludge from the WWTP to the field to increase spreading efficiency. In view of these constraints, it is recommended that the capacity of SRB treatment is increased because the sludge from SRBs will be much more readily accepted by the farmers who are accustomed to handling solid manure .If all of the sludge produced following the extension to the WWTP is treated by SRB, the quantity of sludge is estimated to reach about 1,000 m3/y at 30% ds. The proportion of the farmland required to use this quantity of sludge in the two neigh boring Communes will be about 2.5%; this is considered easily achievable. Kavaja UK would need to procure a trailer (to be towed by the existing tractor) for transporting the sludge to be tipped directly in the farmers' fields. This increases flexibility and simplifies the logistics.

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