Small, low cost systems for agricultural waste management at field level -the case of pistachio waste at Aegina island, Greece

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1. Introduction

In Greece, pistachios are harvested between late August and early September. The nuts after harvest are transported to the processing facility where they are dehulled, and dried. Fresh water is used for the dehulling and from this process the main waste stream is produced, which apart from hulls contains also pistachios, shells and water. On average, during dehulling $2m^3$/h of water are required for 1 tn fresh nuts, which can be processed within an hour. Therefore, for 40 tn of fresh nuts (i.e. mean farm production), the anticipated water consumption is almost 80 m^3. For the entire Aegina island it is estimated that, for an average annual production of 1,500 tn of fresh nuts, almost 3,200 m^3 of water are used during dehulling. Moreover, considering that an average of 35-50% of the fresh nuts' weight will be recharged as waste, then almost 600 tn of hulls waste are produced, which in addition to the 3,200 m^3 of water, make an overall of almost 3,800 tn of waste. After the completion of the process, without separating solid waste from wastewater, farmers mainly dispose waste on soil, in sea or in wells and streams. Wastewater is dark colored, bad smelling, has high electrical conductivity and is rich in polyphenols and inorganics. The solid waste, which mainly consists of the nuts' pericarps, is very rich in organic matter, polyphenols, and other constituents. Its weight and quality depend mainly on cultivation practices which affect yield.

Pistachio waste cannot be considered as hazardous, by the classical mean of hazardous waste definition, since it contains no heavy metals or pathogens, however, due to its very high content in polyphenols and its very high electrical conductivity (i.e. salts content) may cause significant detrimental effects on soil quality. Therefore, the adoption and implementation of sustainable strategies for the management of this waste stream at farm level, especially in small and touristic islands or isolated areas, is of significant importance.

2. Materials and methods

In the framework of LIFE project "Sustainable strategies for the improvement of seriously degraded agricultural areas: The example of Pistachia vera L.-AgroStrat", a strategy for the reuse/application of solid wastes and wastewaters on soils was developed (Doula and Sarris, 2016; Doula et al., 2016) to assist local/regional authorities in managing non-hazardous and potentially hazardous/hazardous organic waste, which foresees a decision making procedure and implementation phases that are integrated into an 8-steps strategy. By considering pistachio waste as potentially hazardous for the environment (soil and aquatic), the appropriate steps for the management of this waste stream are shown in Table 1.

Table 1. The 8-step strategy for sustainable management of potentially hazardous/hazardous waste at local and regional level (Doula and Sarris, 2016; Doula et al., 2016).

Potentially-hazardous or hazardous wastes
Step 1: Development of regional action plans and establishment of quality criteria
Step 2: Physical, chemical, biological characterization of the organic materials
Step 3: Adoption of soil quality indicators and thresholds
Step 4: Development of Land Suitability Maps
Step 5: Assessment of risk level and development of remediation or landspreading plan
Step 6: Quantification of landspreading-Doses estimation
Step 7: Ensure safe reuse/disposal-Health protection and safe production
Step 8: Periodical monitoring and risk evaluation during and after landspreading

In this context, the strategy that was implemented at two pilot fields in Aegina island, Greece included:

a. Development and implementation of Steps 1-4 of Table 1.
b. Design and implementation of simple pretreatment methods at field level to separate solid waste from wastewater, and
c. Management and monitoring waste according to steps 5-8 of Table 1.

3. Results and discussion

Steps 1-4 (Table 1) were developed and implemented for the entire island, where the two pilot fields are located. Therefore, having all appropriate data available (i.e. quality criteria of the area, complete characterization of the waste streams, a set of soil quality indicators to assess effects on soil due to waste landspreading, and maps for the suitability of available areas on the island to accept waste, the next step was to implement simple waste pretreatment techniques at field level and then proceed to steps 5-8 in order to dispose the remaining part of the treated waste.

For waste pretreatment two small and low cost systems were developed and implemented. The first one by constructing three shallow evaporation ponds and the second one by re-constructing five existing sequential collection reservoirs.

- Shallow evaporation ponds (Photo 1a)
  Wastes are separated into solid and wastewater immediately after their production by using a simple separation equipment (metal grids). The solid part was collected and composted while wastewater was transferred into three shallow ponds (each of 5m x 5 m x 40 cm) and left to evaporate. Evaporation, given the climatic conditions of Aegina island, can be completed within 1-2 months. The system can be permanent or temporary. Protective media (geotextiles) were used to protect soil from infiltration of wastewater.
- Sequential Collection Reservoirs (Photo 1b)
  The system was constructed by exploiting a former, almost destroyed, pig breeding area, which had an initial inclination of 3% thus assisting transfer of wastewaters by gravity. The five stall places were reconstructed to form a sequential system of five reservoirs for waste collection. In this case, waste was not separated into solid and wastewater after production. Instead, the produced stream was directed into the five reservoirs; the transfer from the one to the next reservoir was accomplished through overflow. The solid part was left to precipitate and then used for composting while wastewater was left to evaporate.

(a) (b)

Photo 1. The two small and low cost waste pretreatment systems that were developed and implemented in Aegina island, Greece; (a) shallow evaporation ponds, (b) sequential collection reservoirs.

The compost produced was applied at pistachios orchards according to the steps 5-7 (Table 1) and instructions were given to the farmers and the authorities on monitoring soil quality in the short and long term by using also the monitoring tools developed by the project. The same procedure must by followed in case of landspreading of the remaining solid without prior composting.

4. Conclusions

An 8-steps strategy that was developed in the framework of the LIFE AgroStrat project was implemented for the management of pistachio waste at two pilot fields in Aegina island, Greece. Simple and low cost pretreatment practices that can be implemented at farm level were developed and integrated into the strategy with very positive results, as regards their effectiveness and farmers acceptance. The proposed systems protect the agricultural environment as well as water bodies from the uncontrolled disposal of waste generated during crops processing and, most importantly, can be considered as alternative scenarios to the expensive, collective systems usually implemented. They can be implemented and monitored at field level by the farmers themselves, have very low construction and operational cost, require no expertise, can be conformed to field characteristics (e.g. available space and materials) and agricultural practices during the cultivation period.

References

Doula, M.K., Sarris, A. 2016. Soil Environment. Environment and Development. S. Poulopoulos & V. Inglezakis (Eds) Elsevier, ISBN: 9780444627339. pp. 213-286.

Doula, M.K., Sarris, A., Hliaoutakis, A., Kydonakis, A., Papadopoulos, N.S., Argyriou, L. 2016. Building a Strategy for soil protection at local and regional scale-the case of agricultural wastes landsprading. Environmental Monitoring Assessment 188 (3): 1-14.

LIFE-AgroStrat. 2016. Sustainable strategies for the improvement of seriously degraded agricultural areas: the example of Pistachia vera L., 2016. http://www.agrostrat.gr (accessed December 2016).