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ORIGINAL PAPER

Social Aspects of Livestock Waste Management in Cyprus

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Abstract This work examined the social perception of the population towards the management of livestock waste (LWM) in Cyprus. A questionnaire was designed based on major concerns of citizen extracted from literature reviews. These concerns were integrated into questions related to impact aspect of LWM, people perception on the subject, and to the management aspect. The questionnaire was sent to more than 100 individuals residing close to LWM facilities. A relation between risk perception and level of information was found. On a scale 1–5, the responses showed that the greatest problems as perceived by the population are odour issues (3.9), health issues and the adverse impact on property values (both 3.2). Although 81 % of the respondents stated that they have some information or are well informed about LWM in their area, they often tend to evaluate improperly functionality of the facility. Odour emissions are seen as an indication of improper operation of the facility; respondents usually agree on the fact that the current livestock waste treatment system is not adequate compared to the requirements. Finally, the participants in the survey believe that LWM activities cannot significantly improve the employment level in Cyprus. The job estimate for biogas power plant is 0.62 job-years/GWh, which is higher compared to other type of renewable energy installations.

Keywords Livestock waste management · Social impact assessment · Indicators · Questionnaire survey · Job creation

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Introduction

European economies have developed a 'take-make-consume and dispose' pattern of growth; this a linear model based on the assumption that resources are abundant, available, easy to source and cheap to dispose of. However, this pattern is not sustainable in the long run as it causes a significant depletion of resources which are not replenished. Moving towards a more circular economy is essential to deliver the resource efficiency agenda established under the Europe 2020 Strategy for smart, sustainable and inclusive growth [1]. Using smart policies to promote the transition to a more circular economy will significantly increase resource efficiency in Europe. While contributing significantly to the sustainability dimension of growth, increasing resource productivity by 30 % will also have a positive impact on job creation and growth of the gross domestic product (GDP) [2]. In Cyprus there is an

opportunity to recover materials/energy from biodegradable waste that, if properly managed, can result in two added value products: biogas and digestate [3]. The former represents a renewable energy source that can be used to reduce dependence from fossil fuels, while the latter is a potential fertilizer of higher quality compared to raw livestock manure [4]. Therefore, Cyprus represents a good example where the application of the European Commission guideline on circular economy can have a significant impact on the competitiveness of the country, bringing major benefits from an economic, environmental and social point of view.

In the European Union animal by-products (ABP) are defined in Article 3 of Regulation (EC) 1069/2009, which includes the health and surveillance rules applicable to the collection, transport, storage, handling, processing and use or disposal of animal by-products; as well as the placing on the market and, in certain specific cases, the export and transit of animal by-products and products not intended for human consumption [5]. The total livestock waste production in Cyprus in 2013 was approximately 1.6 million t/y. The large volumes of livestock waste produced cannot be applied on land, while many installations are close to residential areas. Although some cases of successful livestock waste management were reported in Cyprus [6], currently, the most frequently used processes for handling livestock waste in the country include the collection of slurry waste by scrubbers and its transportation to deep, anaerobic lagoons by open canals. Typically, the slurry is left in the lagoon until the liquid fraction evaporates. The manure left is then collected and applied as fertiliser. The Regulation has been directly applied into the Cypriot legislation which had replaced the Veterinary Sector Law of 2004 No 149. Animal by-products must be handled, identified, transported and used or disposed of in accordance with the requirements of the legislation by operators exercising under an approval of Cyprus Veterinary Service [6].

Treatment technologies can play a role in the management of livestock manure by providing a more flexible approach to land spreading and by resolving specific problems such as malodours or ammonia emissions. Such treatments are based on biological and physicochemical processes, with the possible use of chemical additives. The technologies already used by large farms are solid/liquid separation, composting, anaerobic and aerobic digestion. The challenge for many countries is how to implement such technologies both at a wider scale and economically [7]. Anaerobic treatment occurs at 5256 installations treating 88 million tonnes of livestock manure and other, equal to 6.4 % of the entire livestock manure production in EU. Measured by treated volume the most widely applied technology is mesophilic anaerobic digestion. In terms of the volume of processed manure and other products, anaerobic treatment is extensively applied in Germany, where there are 3800 installations, processing an amount equal to 29.0 % of the livestock manure production of the country [8].

Special treatment (except storage) of liquid manure/slurry is not practiced widely, apart from mixing before application: Spain (10 % of slurry), Italy (15 % of cattle and 40 % of pig slurry). Netherlands and the UK report that some slurry/liquid manure is separated and then treated in a nitrification–denitrification (NDN) processes. Some aerobic biological treatment of pig slurry was reported from France and Finland. Anaerobic digestion with biogas production is not a main technology applied, but some plants exist in many countries [9]. The improper management of livestock waste can result in several adverse environmental, social and economic impacts. Odour annoyance to inhabitants living close to livestock waste operations is a common source of discontent within communities and these concerns should be taken seriously into account. The so called NIMBY (Not In My Back Yard) syndrome often results in strong opposition of people against the construction of livestock waste treatment plants close to residential areas. These reactions can impact psychological health resulting in greater anger, confusion, tension, depression, and fatigue in populations living near intensive livestock operations [10].

The most common complaints associated with manure management are the odours produced. The odours emitted are a complex mixture of ammonia, hydrogen sulphide, and carbon dioxide, as well as volatile and semi-volatile organic compounds [11]. The anaerobic reaction that occurs when manure is stored in pits or lagoons for prolonged periods of time is the primary cause of odour nuisance. Odours from waste are carried away from farm areas on dust and other airborne particles. Depending on factors such as weather conditions and farming techniques, odours can be transmitted even 7 km away from the production site, although 5 km is a more usual distance [12].

Manure odours can cause severe lifestyle alterations for individuals in the neighbouring communities and can alter many daily activities. When odours are severe, people may choose to keep their windows closed. People also may choose not to allow their children to play outside. In general, people who live close to factory farms can develop odours-related post-traumatic stress disorder, including anxiety about declining quality of life [13]. Health issues from livestock waste management cover four main areas of impact: public health concerns, livestock health, farm staff health and food quality. Most studies that examine the health effects of manure air emissions focus on farm workers. There is evidence suggesting that factory farms increase asthma in neighbouring communities, as indicated by children having higher rates of asthma [14]. Other health effects of livestock waste air emissions can be

headaches, respiratory problems, eye irritation, nausea, weakness, and chest tightness [15].

There is evidence that the livestock sector affects property values and that the more likely it will be that the value of the property located in the vicinity livestock farming activities will drop. Studies have found differing results of rates of property value decrease. One study shows that property value declines can range from 6.6 % within a 5 km radius of a livestock farming to an 88 % decrease within 200 m from a livestock farming activities [16]. Another study found that property value decrease is negligible beyond 3 km from livestock farming [17]. A third study found that negative effects are higher for properties that are downwind and closest to livestock [18].

Social impact assessment (SIA) should be considered as being the process of managing the social issues of projects. Although the importance of SIA is now well-established and documented [19, 20], and several authors have studied social implications of livestock waste management systems (see "Profile of Respondents" section), there is a gap in the process of managing the social issues linked to the LWM sector. To the best of our knowledge this is the first study trying to systematically assess social aspects and repercussion of livestock waste management in Europe. Vanclay et al. [21] provided guidelines for SIA and social impact management processes, especially in relation to project development. Good practice SIA essentially involves the following main phases: (1) understanding of the issues, (2) predict, analyse and assess the likely impact pathways, (3) develop and implement strategies, and (4) design and implement monitoring programs. This study will focus on the last phase of an SIA.

This work was carried out in the framework of the EU LIFE^{+} LIVEWASTE project, which aims to develop, demonstrate and evaluate an innovative decentralized approach for sustainable management of livestock waste, achieving environmental protection and climate change mitigation in line with the requirements of the EU and National legislation through actions complementary to those of the Competitiveness and Innovation Framework Programme. Effective livestock waste management has several social, environmental and economic implications. The main objective of this work is to define and apply sustainable indicators and criteria in order to depict the social aspects of livestock waste management (LWM) in Cyprus.

Methodology

Adopted Indicators

To assess the social impact of LWM, population specific social indicators were specified. These indicators are useful to evaluate the current social impact of the livestock waste management on the country. Social indicators are numerical measures which describe the well-being of individuals or communities. The main criteria and target indicators used for the social assessment are selected based on scientific, functional and pragmatic criteria and are listed in Table 1 [8, 9, 22, 23]. Based on literature review [10, 24], the process of sustainability indicator development was the following:

Process of indicator development
+ Desired audience + Appropriate design
+ Relevant consultation/Participation.

The following list describes the major social indicators adopted in this study which were assessed based on a suitable questionnaire completed by the Cypriot population (48 individuals replied) residing close to LWM facilities.

Criterion: Quality of Life

Noise Exposure (Ordinal Scale) It considers the level of noise caused by the LWM plant, as well as by the transport of livestock waste to and from the plant (e.g. transportation of chemicals and/or waste).

Odour Exposure (Ordinal Scale) The indicator is based on the level of odour nuisance caused by the LWM, and/or manure disposal. Odour from waste treatment facilities is an important factor of the social acceptance of an LWM system.

Risk Perception (Ordinal Scale) This indicator is related to the citizens' fear of negative health effects due to normal operation of the LWM system. The resulting NIMBY attitude is very common concerning installations for the treatment or deposition of waste. The indicator quantifies the population risk perception towards waste pre-treatment and treatment plants by considering seven key factors affecting public risk perception: trust, voluntary versus involuntary, control, benefit/reward, understanding, gender and catastrophic potential.

Visual impact (Ordinal scale) This indicator measures the visual impact of the waste treatment plants, taking into account the visibility, fragility and contour quality.

Criterion: Impact on Employment

Direct Employment (person-years/GWh) It is measured as the average amount of labour in person-years per GWh of electric energy produced. Direct labour includes the labour required to build, operate and decommission the plant.

Indirect and Induced Employment (person-years/GWh): It is measured as the average amount of labour in person-years per GWh of electric energy produced. Indirect jobs

Table 1 Social indicators for livestock waste management (LWM) in Cyprus

Criterion	Indicator (current and/or future)	Unit	Estimation method
Quality of life	Noise exposure	Ordinal scale	Questionnaire
Quality of life	Odour exposure	Ordinal scale	Questionnaire
Quality of life	Risk perception in livestock waste management	Ordinal scale	Questionnaire
Quality of life	Visual impact	Ordinal scale	Questionnaire
Employment	Direct employment	person-years/GWh	Estimation and expert judgment
Employment	Indirect and induced employment	person-years/GWh	Estimation and expert judgment
Employment	Undergraduate and postgraduate student internship opportunities	person-years/plant	Estimation and expert judgment

include agriculture operator, soil analysis, environmental analysis, biomass transportation, component design, component fabrication, and component supply.

Undergraduate and Postgraduate Student Internship Opportunities (person-year/Waste Treatment Plant) It is measured as the number of students in person-years per livestock waste treatment plant. The process that is applied for the treatment of livestock waste is characterized by high and innovative technological level which can potentially provide internship opportunities.

Questionnaire Structure

The social aspects concerning livestock waste management and its impact on Cypriot population were evaluated by questionnaire survey using the methodology that is described in the above section (the questionnaire is available at the "Appendix"). Based on the literature review mentioned above, the questionnaire was designed to assess people's concerns and attitude to LWM facilities. It was made up of four parts as shown in Table 2.

The first three parts of the questionnaire were questions set in order to ascertain the degree of concern on various aspects of LWM, while the fourth part requested personal information of the respondents. Each question was identified with a number from Q1 to Q17. The first part (Q1–Q6) included questions to discover the extent of people's concern about impact or damage caused by a LWM facility. This part had two sub-groups of questions: (1) questions related to the risk of livestock waste management and (2) questions related to the problems associated with livestock waste identified during the literature review ("Methodology" section). The second part (Q7–Q8) consists of two questions regarding the level of information of the management of the livestock waste. People were asked also to indicate the source from where they received information on livestock waste management. The third part (Q9–Q12) consisted of questions regarding the management aspects of a livestock waste facility. Individuals were asked about the functionality of the LWM facility and whether it is properly working or not. Q12 refers to people's understanding on employment generation from the livestock waste management sector. Finally, personal information such as "proximity of individual to a LWM facility", age, sex, level of education and occupation were asked (Q13–Q17).

Profile of Respondents

A total of 48 respondents have at least partly answered the questionnaire. The respondents of the survey were equally distributed in terms of sex, while the age ranged between 20 and over 70 years old. Concerning the education level the following categories were identified: 58 % respondents with secondary school education, 25 % respondents with university education and 17 % with primary education. In terms of the employment level the respondents worked in public administration (33 %), service industry (25 %) and in the agricultural sector (17 %).

Results and Discussion

Risk Perception Related to LWM

Public's perception of the risk resulting from LWM is shown in Fig. 1a, b. The term risk perception was used to describe how people react to a specific risk. These reactions have a number of dimensions and are not simply reactions to any physical hazard itself. From a psychological perspective, the concept of perception is used to describe sensory phenomena with respect to light, sound, smell, and tactile sense. Perception in strict terms means the sorting out, interpretation, analysis and integration of stimuli involving our sense, organs and brain. However, the concept of risk perception does not refer to a sensory process, but to an individual's cognitive process of attribution of meaning.

Knowledge, or rather the absence of it, and lack of perceived benefits are important factors for public

Table 2 Structure of the questionnaire

Social aspect	Components	Question no.	Items
Concern	Impact related	Q1	General risk evaluation
		Q2	LWM risk evaluation
		Q3	Odour emissions from facility
		Q4	Noise from facility
		Q5	LWM traffic related
		Q6	LWM problem related evaluation
	Understanding of the topic	Q7	Level of information evaluation
		Q8	Source of information
	Management related	Q9	Functionality of facility
		Q10	Type of treatment identification
		Q11	Correctness of operation
		Q12	Employment generation
Personal information		Q13	Sex
		Q14	Age
		Q15	Level of education
		Q16	Occupation
		Q17	Distance from the facility

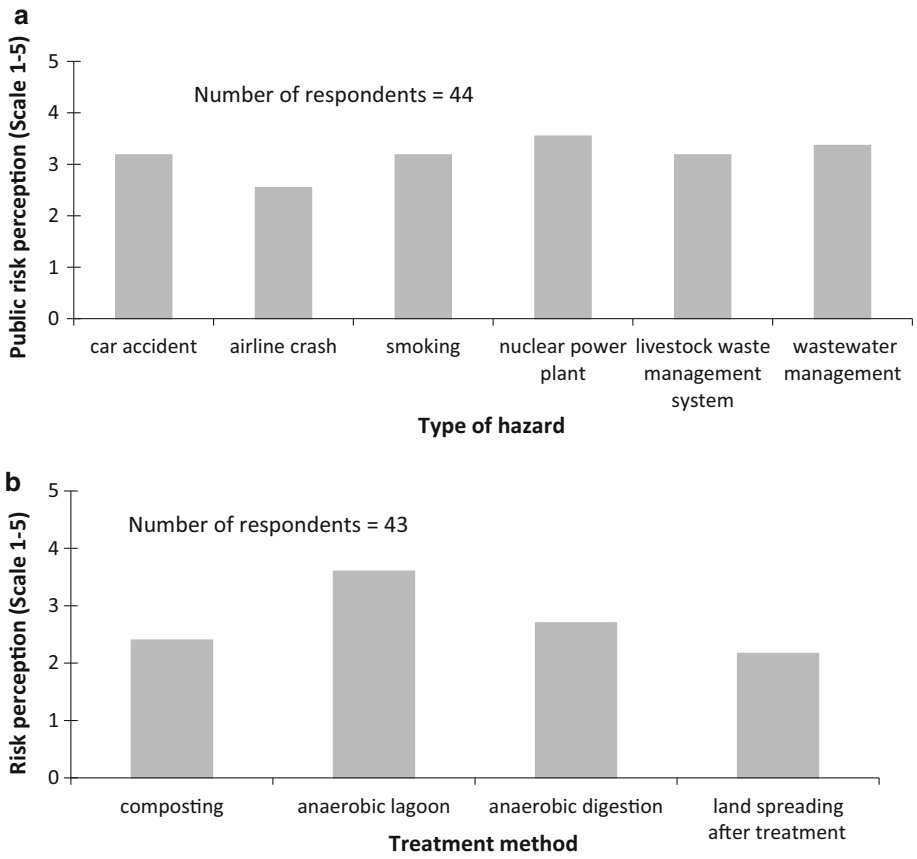

Fig. 1 Problems and risk perception related to LWM: **a** risk perception related to common problems; **b** risk perception of livestock waste treatment techniques

perception of risks. Risks from familiar things, which people feel they understand, control and make decisions about themselves, and risks from which people believe they derive a direct benefit, are perceived to be relatively low by the public. This is so even when there is common knowledge that the technology or activity results in a large

number of casualties. For example, although society may benefit from waste reduction, there is little perceived benefit from it. On the contrary, driving a car or smoking are voluntary risks. When the public was asked to rank different livestock waste treatment systems, people seem to underestimate the risk of land spreading after treatment, as the majority of the respondents indicate this option as the less risky when compared to the others. Generally, younger respondents show a lower level of risk associated with the livestock waste management, and their level of risk tends to be inversely proportional to the treatment intensity. This suggests that younger people correctly associate the livestock waste treatment to a potential reduction of the risk of the LWM, probably due to a better level of information and higher level of education. On the contrary, respondents having a lower level of education do not distinguish among the different types of treatment and they tend to indiscriminately associate the livestock treatment to a higher risk. In fact, most of these people also declared not to have received any information about LWM.

Adverse Effects of LWM

Livestock waste management has direct and indirect effects on human health and social impact of communities, such as odour emissions, noise or traffic. Odour emissions are considered as one of the most difficult problems in livestock waste management [25]. Odour becomes a problem when a given concentration of odorous substances is experienced as unpleasant. Odour emissions inevitably arise from livestock waste treatment facilities. For the above reasons, it is justified to incorporate odour from livestock waste as an important parameter of the social acceptability of a livestock waste management system. In Fig. 2 the results of the survey show the major problems perceived by public linked to LWM. The major problems indicated by respondents were odour emissions (score of 3.9 out of 5), followed by health issues and property value (scores of 3.2 out to 5). Those who participated in the survey assessed traffic and noise as minor problems, scoring 2.16 and 2 out to 5 respectively. When respondents were asked to rank the most frequently encountered problems related to LWM odour was ranked as the most frequent problem. It should be noted that only people that live within 4 km from the livestock facility experienced odour and noise problems, and 85 % of them living within 1 km (data not shown). These results confirm previously reported literature [17].

General Understanding of LWM

The responses to the questions regarding the level of understanding of the participants for LWM are shown in Fig. 3. People were asked how well informed they feel about the LWM system in their city and to indicate their source of information. Only few of the respondents declared not to be at all informed concerning LWM (19 %). The highest number indicated to be completely (46 %) or moderately informed (35 %). This reflects the efforts of the Cypriot relevant organizations to inform the public about livestock waste management issues. The majority of the respondents reported to have received information about livestock waste management from TV and brochures.

Opinion About Functionality and Operation of LWM

Figure 4 reports the public's perception concerning the various aspects of LWM: the treatment used for livestock waste (Fig. 4a); the functionality of LWM (Fig. 4b); whether the treatment systems are properly operated (Fig. 4c); whether the LWM results in employment generation (Fig. 4d). The majority of the respondents replied to the question of "how the livestock waste is treated in your city" that land spreading after treatment and composting are the most common treatment/disposal route. In general half of the respondents were not satisfied with the functionality of the management system (50 % reported that it was quite bad or very bad) and believe that the treatment facility in their area is not properly working (73 % reported that it is only working few times or never); this could be associated with the odours which the respondents have listed as the most frequent problem. On the contrary respondents that declared to live near a facility that treats livestock waste by anaerobic digestion (18 %) were in general satisfied with the functionality of the facility and reported that the treatment system was working well. Although 83 % of the participants in the survey stated to live far away from the livestock waste treatment facility (more than 2 km away), they normally agree about the fact that the treatment system is not adequate compared to the requirements. A general consensus was registered when people were asked to give their opinion on the possibility of the livestock waste management sector increasing the level of employment. In fact 73 % of the respondents declared that employment level has not increased at all, and only 27 % think that LWM provided some employment.

Employment Potential from LWM

Model assessments of employment development from renewable energy deployment are necessarily. The easiest and quickest method of assessing direct jobs resulting from renewables energy is the employment factor approach. Employment factor indicate the number of jobs (measured

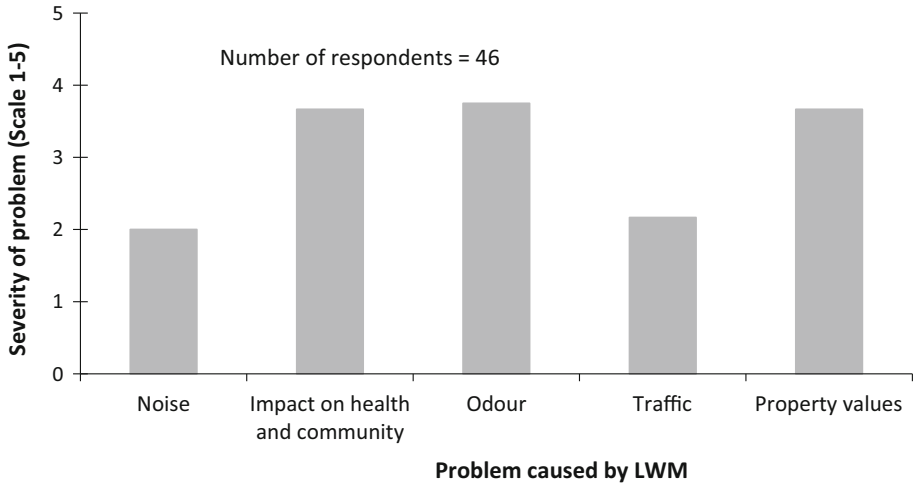

Fig. 2 Ranking of problems related to LWM

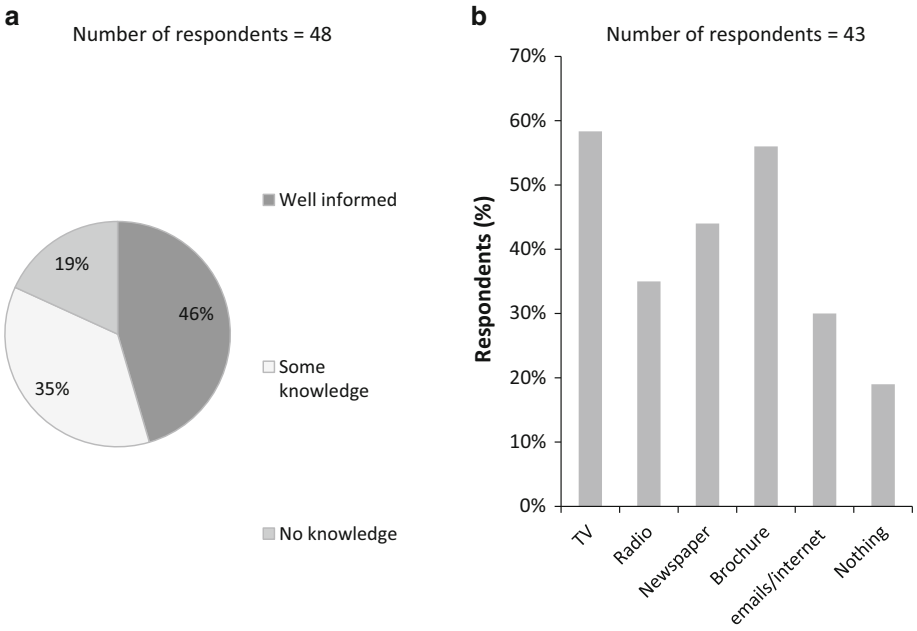

Fig. 3 **a** Awareness of people related to LWM and **b** sources of information

as full-time equivalents) created per physical unit, e.g. installed peak capacity or produced energy expressed as megawatts (MW) or megawatt-hours (MWh) for electricity generation [26]. To estimate the total number of direct jobs, employment factors are multiplied by a certain renewable energy capacity. This approach applies different employment factors for different phases of the life cycle, such as R&D, manufacturing, construction and installation and O&M [27]. Table 3 reflects those revised technologies to which coal, nuclear, natural gas and carbon capture alternatives were added in order to provide fossil fuel benchmarks and comparison.

Table 3 clearly points the way for countries with high solar exposure, while landfill biogas generation would appear to be a favourable technology where capacity exists. Offshore wind farms and biomass offer strong job creation prospects dependent only on resources. In general investing in biomass installations offers approximately 50 % more jobs than wind, solar thermal and geothermal installations.

The job estimate for biomass power plant is 0.62 job-years/GWh. Considering the total livestock waste production, the theoretical potential of direct utilisation of the livestock waste for the production of electrical energy in Cyprus has been estimated at 129.5 GWh/y [29, 30]. Accordingly, a potential of about 79 jobs-years on lifetime of 40 years is derived from the LWM sector. However, anaerobic digestion of livestock waste as a sole substrate results in relatively low biogas yields [31]. For this reason the anaerobic co-digestion of livestock waste with other fermentable organic waste has been set as common practice

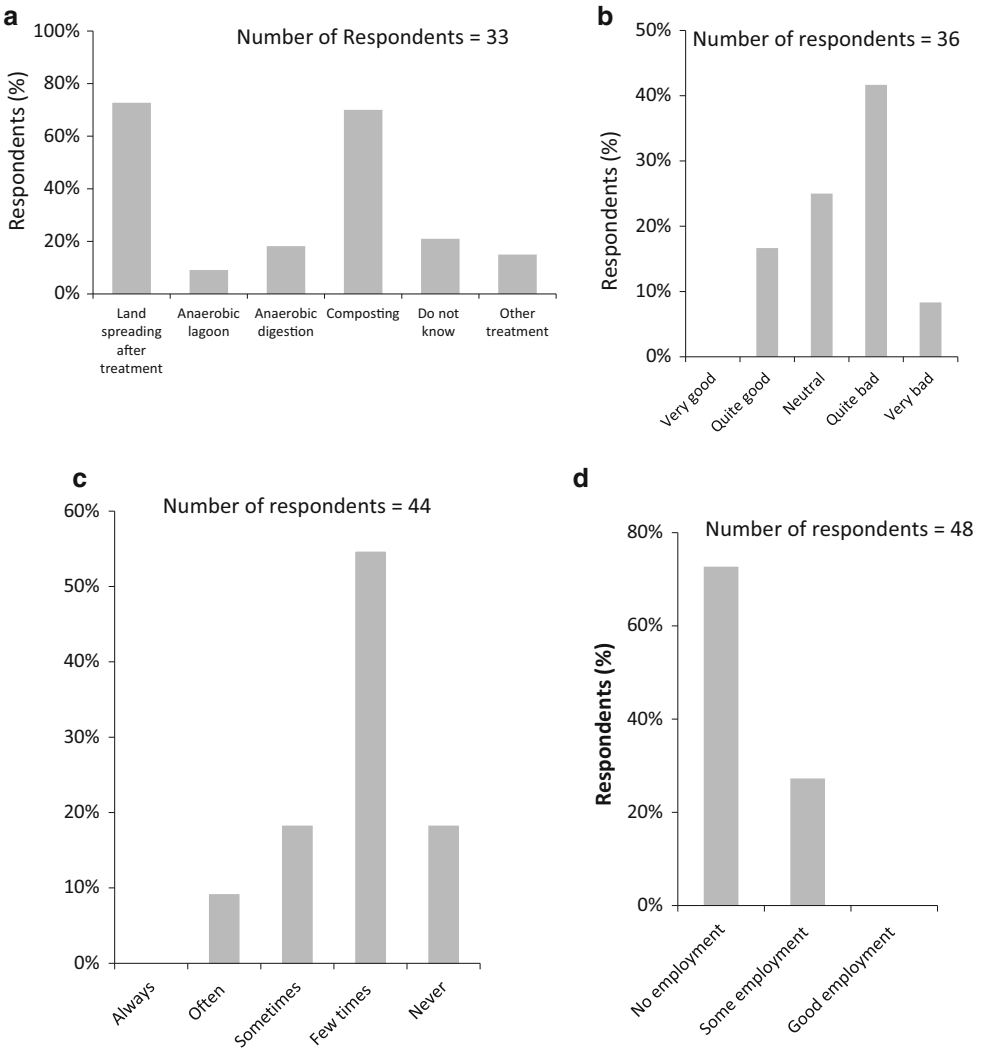

Fig. 4 Perception of public concerning: **a** the treatment methods applied for livestock waste; **b** the functionality of LWM; **c** whether the treatment systems are properly operated in your area; **d** whether the LWM sector has generated jobs

Table 3 Ranked job estimates (job-years/GWh) for renewable and sustainable energy technologies. Adapted from Tea [28]

Energy technology	Direct	Indirect	Induced jobs	Total
Solar PV	0.54	0.43	0.65	1.62
Hydroelectric	0.16	0.11	0.15	0.42
Landfill biogas	0.38	0.34	0.57	1.29
Offshore wind	0.17	0.17	0.26	0.60
Biomass	0.24	0.15	0.23	0.62
Geothermal	0.13	0.10	0.16	0.39
Solar thermal	0.12	0.11	0.18	0.41
Nuclear	0.07	0.07	0.11	0.25
Coal	0.06	0.05	0.09	0.20
Natural gas	0.06	0.05	0.09	0.20

[32]. Considering the total biodegradable wastes produced, including also solid biomass and the organic fraction of municipal solid waste, the theoretical electric energy production has been estimated at 15,995 GWh/y [33]. Consequently, a higher job creation potential would be obtained from the proper management of livestock waste in Cyprus and the potential co-digestion with other organic waste. Nevertheless, the Cypriot population has a low perception of this great potential for the economy. The participants in the survey believe that livestock waste management activities cannot significantly improve the employment level in Cyprus (Fig. 4d).

Conclusion

In this work, the Cypriot population concerns towards LWM facilities and their relation with attitudes to facilities were analysed. A questionnaire was designed based on the major concerns of citizens towards LWM practices as derived from literature reviews. These concerns were integrated into 12 questions: 6 were related to impact

aspect of the LWM, 2 were related to evaluate their understanding of the subject, and 4 were related to the management aspect. Five questions requested general and personal information. The main conclusions were the following:

- People who reported not to have received enough information tend to overestimate or have a distorted perception of risks linked to LWM. On the contrary, people who affirmed to have received enough information tend to associate LWM with a lower risk. This suggests that public information campaigns could be helpful in order to increase people's awareness on the topic.
- The main nuisance concerning livestock waste management is related to odour emissions. The impact on health and the decrease of property values were also important issues. Mitigation measures should be considered. Instead traffic and noise were seen as minor problems.
- Only a small part of the respondents (19 %) reported not to be at all informed concerning livestock waste management. Although 81 % of respondents affirmed to feel completely or reasonably well informed about LWM in their city, they often tend to evaluate improperly functionality of the facility. Odour emissions are seen as an indication of improper operation; respondents normally agree about the fact that the treatment system is not adequate compared to requirements.
- The participants in the survey believe that livestock waste management activities cannot significantly improve the employment level in Cyprus. The job estimate for biogas power plants is 0.62 job-years/GWh, which is not negligible. In general investing in biomass installations offers 50 % more jobs than wind, solar thermal and geothermal installations. Thus, a better communication of this aspect to the public could help people understand the true benefits of LWM with respect to job creation.

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Appendix: Questioner Survey

Questioner survey:

1 Please, could you rank the following problems in term of threat (risk or worry) they pose on human life in general in your opinion? (1=very low; 2=low; 3=medium; 4=high; 5=very high)

a) car accident	1	2	3	4	5
b) airline crash	1	2	3	4	5
c) smoking	1	2	3	4	5
d) nuclear power plant	1	2	3	4	5
e) livestock waste management system	1	2	3	4	5
f) wastewater management	1	2	3	4	5

2 Rank how high is the human risk associated with the following livestock waste treatment system (1=very low; 2=low; 3=medium; 4=high; 5=very high)

a) land spreading after any type of treatment	1	2	3	4	5
b) anaerobic lagoon	1	2	3	4	5
c) anaerobic digestion	1	2	3	4	5
d) composting	1	2	3	4	5
e) do not know	1	2	3	4	5

3 How often are the odours emitted from the livestock waste treatment plant a nuisance to you? (1=always; 2=often; 3=sometimes; 4=few times; 5=never)

	1	2	3	4	5

4 How often do you hear noise related to the livestock waste treatment plant of your area? (1=always; 2=often; 3=sometimes; 4=few times; 5=never)

	1	2	3	4	5

5 How often do you deal with traffic related to the livestock waste management? (1=always; 2=often; 3=sometimes; 4=few times; 5=never)

	1	2	3	4	5

6 Could you rank the following problems related to the livestock waste management? (1=lowest problem; 5=highest problem)

a) impact on health and community	1	2	3	4	5
b) noise	1	2	3	4	5
c) odour	1	2	3	4	5
d) traffic	1	2	3	4	5
e) property values	1	2	3	4	5

7 Could you tell us how well informed you feel about the livestock waste management system in you area? (1=well informed; 2=some knowledge; 3=no knowledge)

	1	2	3		

8 Have you received information about the livestock waste treatment of your area?

	Yes	No
a) TV		
b) radio		
c) newspaper		
d) brochure		
e) email/internet		
f) nothing		

9 What opinion do you have about the functionality of the livestock waste management system of your area? (1=very good; 2=quite good; 3=neutral; 4=quite bad; 5=very bad)

1	2	3	4	5

10 Could you tell us how the livestock waste is treated in your area?

	Yes	No
a) land spreading after any type of treatment		
b) anaerobic lagoon		
c) anaerobic digestion		
d) composting		
e) do not know		
f) other treatment		

11 Do you think that the livestock waste treatment plant of your area is working properly? (1=always; 2=often; 3=sometimes; 4=few times; 5=never)

1	2	3	4	5

12 Do you think that the livestock waste management in your area has contributed towards employment?

a) No employment	1
b) Some employment	2
c) Good level of employment	3

13 Sex

Male	1
Female	2

14 Age

<30	1
30-49	2
50-69	3
>70	4

15 What is your highest educational level attained?

a) primary school	1
b) secondary school	2
c) university	3

16 What is your occupation?

a) student	1
b) unemployed	2
c) agriculture	3
d) industry	4
e) service industry	5
f) public administration	6
g) others	7

17 How far away from your house is the livestock waste treatment plant located?

a) < 0.5 km	1
b) 0.5-1 km	2
c) 2-4 km	3
d) > 5km	4

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