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THE MANAGEMENT OF AGRICULTURAL PLASTIC PACKAGING WASTE: A PILOT EXPERIMENTATION IN SOUTHERN ITALY

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Abstract. In the early sixties started the "green revolution", a phenomenal increase in agricultural productivity worldwide; with it a wide and extensive diffusion of plastic material and a massive use of agrochemicals made their entrance in agriculture. The plastics used at farm level are many and different: film, hard sheet, net, string, tube and agrochemical container. All these plastics become waste and the problem of their disposal cannot be ignored since several studies indicate that most of them are disposed in an illegally way (by burning, burying, dispersion). When the waste are agrochemical containers the problem is more acute because they aren't often rinsed, resulting contaminated with chemical residues. In order to analyze the Italian current situation on this matter the Authors, in the framework of the "Agrochepack" Project, produced a mapping of Agricultural Plastic Packaging Waste (APPW) situation in an area of Southern Italy. This information was took as a basis for the design of a pilot plant that was realized in order to enable pilot tests of APPW disposal. The first indications, as a result of meetings with farmers, showed an increased attention towards the "environmental protection", as shown by the good results that were obtained within the Project.

Key words: *agricultural plastic packaging, waste management, pilot plant, sound disposal, environmental protection*

1. INTRODUCTION

In the early sixties started the “green revolution”, a term used to describe the phenomenal increase in agricultural productivity worldwide. With the green revolution new varieties of plants, called "hybrid", have been introduced, they were more receptive to the nutrients, faster maturation, and they can grow in every season, allowing more crops throughout the year. Besides, an increase in the use of heavy machinery, a wide and extensive diffusion of plastic materials and a massive use of agrochemicals made their entrance in agriculture. Since then, agricultural plastics have replaced traditional materials, such as glass and metal because they often are less costly, safer to use, and improve production efficiency; currently they still continue to have a great deal of attention.

The plastic material generated at farm level strictly depends on ruling of specific agricultural applications, such as films to cover greenhouses and tunnel, hard sheet for greenhouses, film for mulching, rope and strings to sustain crops and trees, harvesting nets or nets for tree protection, film for silage, tubes for different irrigation technique, agrochemical containers and so on [2, 5]. Although with different times, all these plastics become waste and the problem of their disposal cannot be ignored [9].

Several studies indicate that most agricultural plastics are disposed in an illegally way, by burning them on-farm, creating fire hazards, clogging water channels, releasing high levels of polluting emissions, and/or buried and dispersed across the rural landscape [9, 4, 3, 8]. When the agricultural plastics are agrochemical containers the problem is more acute because they aren’t often rinsed, resulting contaminated with chemical residues.

In Italy, as other Countries, an Agricultural Plastic Packaging Waste (APPW) management scheme has not been established yet, so it is necessary to develop appropriate environmentally friendly solutions [7, 6, 1]. In order to analyze the Italian current situation the Authors, in the framework of the “Agrochepack” Project, funded by the European Territorial Cooperation MED Programme (2G-MED09-015), produced a mapping of APPW situation in an area of Apulia Region (Southern Italy), collecting information on cultivations (main species, cultivated areas and their localizations), plastic material and agrochemical products used to estimate Agricultural Plastic Waste (APW) and APPW streams (quantity, temporal and spatial distribution, problems experienced with specific disposal solutions applied) and on farmers' knowledge about the environmental damage caused by poor waste management. This information was took as a basis for the design of a pilot plant that was realized in order to enable experimental tests of disposal of APPW in the Project area.

2. STATE OF THE ART

According to the Italian Law in force (Legislative Decree of the 3th April 2006, n. 152 "Roles on environment” - Annex D) [10], the agrochemical packaging (with residues after their use, or full with expired product) are currently classified as an hazardous waste. They are described by the CER code 15 01 10 - unwashed empty containers for plant protection or agrochemical products. This Law, however, includes in the list of

special non-hazardous waste also the agrochemical packaging after "decontamination", without specifying - yet -which is the way to "decontaminate" them.

In order to address this legal gap and satisfy the needs of farms in different Italian provinces, according to article 206 of the same Law n. 152/2006, special "Programme Agreement" between Local Authorities (Municipalities and/or Provinces) and the relevant stakeholders have "standardized" the decontamination procedures, according to the international experience. The guidelines are offered on the understanding that where local laws and regulations are already in place, these must take priority. The guidelines can and should, however, be used in dialogue with the relevant authorities to help shape new laws and regulations and revise existing ones.

The European Crop Protection Association - ECPA's policy on Container Management Strategies (CMS) consists, essentially, of a fundamental series of commitments to action at the Brussels level and recommendations for action at the national level [11]. These guidelines cover containers for liquid or solid products that are normally diluted with water. All other containers should be disposed according to the instructions on the product label or through agencies licensed for the purpose. These guidelines provide three different options for rinsing:

- Triple rinsing;
- Pressure rinsing;
- Integrated rinsing.

According to many studies, the quantity of dangerous substances that remains in the container after this process, either as residue after rinsing or as product migrated into the plastic, determines the classification of the empty container based on the process and limits described in the EWC. In 1993, the ECPA member companies generated extensive rinsability data on a wide range of packaging and formulations. These data were produced to provide evidence that primary crop protection product packs could be rinsed to leave behind less than 0.01% w/w of the original formulation in the pack. An analysis of data from n.180 rinsed primary crop protection product packs revealed that the average rinsing effectiveness achieved using either manual triple rinsing or integrated pressure rinsing was 0.008%. These findings are supported by other publications that show that crop protection product packs can be rinsed clean below 0.01%.

In 2002, ECPA member companies produced another set of data analyzing the total amount of active ingredient that remains in the container after triple rinsing or pressure rinsing. In addition to the findings that have been investigated in the rinsability study, this also took into account the amount of active ingredient that migrated into the plastic. The results of this study indicated that the total amount of active ingredient in correctly rinsed containers remains well under the threshold for very toxic substances of 0.1% set by the EWC. The amount of respective products sold in Europe is below 3%, with a clear decreasing tendency. For all other products a much larger safety factor exists.

These results clearly indicate that individual containers, even those that contained products with the most critical classification of very toxic, can be classified as non-hazardous after proper rinsing. In particular, triple rinsing is important for the Italian agriculture and it is precisely what the dissemination activities planned and promoted by the Agrochepack Project [12], in order to:

- underline the accountability and responsibility of farmers to have greater attention to the environment and living beings that inhabit it, promoting the reclamation of the containers with the triple rinse;

- give a strategic input to the institutional bodies to improve the systems for collection of empty and reclaimed containers; in this way, farmers wouldn't dispose APPW temporary collected in their farms, burning, burying leaving them in the environment, including water bodies (Fig. 1); contemporary, the traceability would be preserved in all steps.

Fig. 1: APPW abandoned close to water bodies.

3. Material and Method

The Province of Bari, included in the Apulia Region, co-ordinates n. 41 municipalities over an area of 3,821 km^2. Within it, there is the studied area (the so-called "ARO" territory) that includes n. 6 neighbouring Municipalities: Cellamare, Capurso, Noicattaro, Rutigliano, Triggiano and Valenzano.

The APPW management scheme, proposed by University of Basilicata and the Municipality of Cellamare, was concretized into a Pilot Station (Fig. 2) that was designed in order to:

-) enable the pilot tests performed under the Agrochepack Project;

-) enable demonstration activities directed towards politicians, technicians, waste companies, farmers and all the stakeholders interested into this issue.

Fig. 2: The Agrochepack Pilot Station at Cellamare.

In such a way, the Pilot Station conceived, designed and realized under the Agrochepack Project would be the prototypal benchmark to be followed by the Province of Bari for the realization of a full-scale plant for the check and disposal of APPW. In this way, the involvement of the entire ARO could reveal as a key factor for the optimal operation of the Pilot Station, together with the strategic involvement of several relevant local Authorities.

The site identified where the pilot plant was realized lies in the territory of the Municipality of Cellamare, inside a marginal area close to the town. This area is accessible by the provincial road n. SP98, connecting the town of Cellamare with the national highway n. SS100. The pilot plant is situated inside an existing ecological platform equipped for the collection and specific treatments of other special wastes. It works both as local collection station and central consolidation station for the pilot trials.

The collection station has been properly designed to store 100 l bags, until their transport to the final disposal. In particular, the collection station covers an area of about 140 m^2, including 65 m^2 covered with a roof. It is divided into three sub-areas, where different steps of the selection process are implemented. The paving is in concrete with a waterproofing membrane, with a slope suitable to avoid standing water. Galvanized iron net-grid walls of 2.00 m height close the station on three sides.

A cabinet for Personal Protective Equipment (PPE) for the operator (i.e. goggles, filter mask, overalls, gloves and boots for protection from hazardous chemicals belonging to the third category according with the Italian Law D. Lgs. 475/92) and first aid kit store are already present in an area close to the collection station.

The collection station has been concretized in an area very close to the platform for the weighing, in order to limit further movements of mechanical means within the ecological station. At the collection station the operator checks only the quality of the incoming APPW. In particular, the operator:

- chooses randomly the bags from which take containers;
- performs a visual inspection of bag: the bags used have be the ones provided by the scheme, safely closed with plastic straps, with a compiled label; no other material and/or colored-water should be present in the bags;
- takes the containers and checks if they are empty, rinsed and drained.

4. RESULTS AND DISCUSSION

The total considered Agricultural Used Surface is equal to 10,500 ha, of which Arable (cereals and vegetables) and Orchards (including vineyards and olive), respectively of about 1,500 ha (Tables 1-2) and about 9,000 ha (Table. 3).

Table 1: Used Agricultural Area (hectares), per municipalities.

MUNICIPALITY	Arable	Permanent crops	Permanent grassland and Pastures	Total
Capurso	128.85	662.04	3.61	794.50
Cellamare	27.12	300.03		327.15
Noicattaro	820.25	2,554.28	1.60	3.376.13
Rutigliano	410.69	3,672.45	0.40	4.083.54
Triggiano	99.20	1,298.60	0.85	1,398.65
Valenzano	26.66	624.18		650.84
TOTAL	1,512.77	10,624.35	6.46	10,630.81

SOURCE: ISTAT (ITALIAN NATIONAL INSTITUTE OF STATISTIC), THE 6TH AGRICULTURAL CENSUS (2011)

Table 2: Number of farms with arable surface (hectares) and main crops per municipality.

MUNICIPALITY	Total farms	CEREALS		VEGETABLES		ROTATED FODDER CROPS		OTHER HERBACEOUS
		Farm	Area	Farm	Area	Farm	Area	Area
Capurso	202	2	0.20	11	2.59			126.06
Cellamare	45	2	1.95	1	0.02			25.15
Noicattaro	687	18	96.72	59	73.87			649.66
Rutigliano	398	13	66.83	55	34.95	3	8.05	300.86
Triggiano	159	1	1.09	22	5.73			92.38
Valenzano	35	2	3.09	9	6.60			16.97
TOTAL	1,526	38	169.88	157	123.76	3	8.05	1,211.08

SOURCE: ISTAT (ITALIAN NATIONAL INSTITUTE OF STATISTIC), THE 6TH AGRICULTURAL CENSUS (2011)

Since the crops are many and different within the study area, it is possible to assume that the cultivation works are equally distributed throughout the year. Besides, considering that a crop (from establishment to harvest) is frequently subjected to agricultural activities, as pre and/or cover fertilizations, irrigations, pesticide treatments, cropping, etc., it has been very difficult to specify a temporal distribution of cultivation activities. Finally, the same species, but different varieties, were in the n. 6 territories so that the agricultural activities were also different (e.g. to a different time of fruit ripening corresponds, consequently, a different time of their harvesting).

Table 3: Number of farms and areas (hectares) with permanent crops per municipality.

MUNICIPALITY	Total farms	VINEYARD		OLIVE		CITRUS		ORCHARDS	
		Farm	Area	Farm	Area	Farm	Area	Farm	Area
Capurso	712	391	213.46	605	413.05	12	1.39	125	31.73
Cellamare	386	144	86.77	351	201.78	-		63	11.48
Noicattaro	1,403	1,210	2,048.26	490	406.05	5	14.10	147	84.97
Rutigliano	2,844	2,035	3,038.33	763	326.80	16	8.44	671	295.39
Triggiano	1,000	358	350.71	944	885.13	18	3.31	165	52.42
Valenzano	798	90	82.09	769	489.04	17	3.13	211	49.16
TOTAL	7,143	4,228	5,829.62	3,922	2,721.85	68	30.37	1,382	525.15

SOURCE: ISTAT (ITALIAN NATIONAL INSTITUTE OF STATISTIC), THE 6TH AGRICULTURAL CENSUS (2011)

The use of agrochemicals (fertilizers and pesticides) has been different because rain and hailstorm produced, during the testing period, some damages directed on the cultivation, as root rot and/or crack of the fruit, in two of the six municipalities (Noicattaro and Valenzano), promoting another serious damage, i.e. the creation of the access for other adversities, as molds and fungi. Generally, the agrochemical doses were determined on the basis of feelings and traditional experience of the farmer, rather than on the basis of precise information and a calculation rationally carried out. For all that, it has been very difficult to establish how much APPW were really originated and how much of them were management in uncontrolled way.

Regarding the results of the dissemination activities, a remarkable number of farmers coming from the six municipalities of the testing area delivered to the Pilot Station their APPW produced during about 4 months. One of the characteristics of the farming in this area is the quite small dimension of the farm (about 2.00 hectares), whose main crops are vegetables, vineyards and orchards. Moreover, another remarkable aspect of the local farming is the mean age of the farmers: most part of them were older than 60 years in age, so even the ability to cope with the rules of a new environmental procedure reveals quite limited. The farmers involved in the dissemination activities anyway were not able to report the exact amount of the agrochemicals they use.

At the Pilot station of Cellamare were collected and checked by visual inspection about 0.160 tons of APPW equal to n. 1,600 bottles (1 liter). All bags were clean, containing only APPW (no other material or dirty water). About 80 bottles (equal to 5%), taken randomly from the bags, were partially filled with clean water to check if after a quick rinse the water appeared clear. After this control it resulted that only two bottles were not well rinsed.

5. CONCLUSIONS

The first indications, emerged after the start of the Agrochepack Project during year 2011 as a result of the meetings with the farmers, pointed out that most of them didn't

consider as a good environmental practice both the correct recovery and disposal of empty agrochemical containers. The final results of the Project, including the connected training activities over some farmers within the study area, showed how the attention to the "environmental protection" is recently increased. Therefore, farmers would participate actively in the process of recovery of the plastic material and subsequent reuse, being involved in their collection and storage, so performing an active role that could pave the way for a more environmentally friendly Mediterranean agriculture.

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