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Environmental Impact Assessment of Small Industries in the West Bank with Emphasis on Olive Presses

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To whom I love, my mother, father,
sisters, brothers, and to my husband
For their stead fast confidence and encouragement

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ABBREVIATIONS

BOD_5: Biochemical Oxygen Demand

COD: Chemical Oxygen Demand

GDP: Gross Domestic Product

ICP: Inductively Coupled Plasma

OMW: Olive Mills Waste Water

SPSS: Statistical Package for Social Science

TOC: Total Organic Carbon

TSS: Total Suspended Solids

VSS: Volatile Suspended Solids

ABSTRACT

Environmental Impact Assessment of Small Industries in the West Bank with Emphasis on Olive Presses

The industrial sector in the West Bank consists mainly of small industries. The average annual contribution of the industrial sector to the Gross Domestic Product (GDP) in the West Bank is about 170 million US $, and the relative share in GDP is about 18.92%. These industries are considered as one of the main contributors to environmental pollution. Both of the liquid and solid industrial waste generation cause great environmental problems in Palestine. The reasons behind their environmental problems are the lack of pretreatment processes at the industrial sites, there is no separation system for collecting or disposing of the industrial waste, and the inexistence of proper treatment and disposal for municipal solid and liquid wastes.

Olive is considered as one of the important agricultural-industrial crops in Palestine. In 1998 the annual production of olive fruit and olive oil were 63187 tons and 14791 tons respectively. In 1998 season, out of 239 olive presses in the West Bank 218 presses were operating generating about 0.2 million cubic meters of OMW.

The main objective of this study was to conduct an environmental assessment of olive presses in the West Bank. As a parallel objective was to conduct two main surveys: (1) an overview of small industries and olive presses in Palestine, and (2) an overview and evaluation of olive mills wastewater treatment technologies. To achieve this purpose, 46 questionnaires were filled from 46 olive mills distributed in various villages and cities in the West Bank.

It was found that the olive mill solid waste was most often taken by villagers for heating. While, the olive mill wastewater (OMW) was either disposed to nearby cesspits or land, or to the sewer networks without any prior treatment at source.

The characteristics of OMW were experimentally analyzed and compared to Jordanian standards and regulations for the disposal of industrial wastewater to the environment and to the sewer system. OMW was found highly polluted and severly exceeding the permissible limits.

It was observed from field visits that ventilation, illumination and space are generally sufficient when the season is poor, but are poor in the productive seasons. However, the inevitable noise is a common environmental pollution in all of the olive presses surveyed.

It was also observed from field visits that few of the workers wear special customs for work or safety glasses or gloves, still, most of the olive presses contain first aid kits and fire extinguishers and the workers are trained on using them.

The poor working environment that was demonstrated above, may have physical and psycological impacts on the workers and on the customers, such as catching contageous diseases, nervousness, etc ... .

OMW treatment methods were also discussed. These methods include direct land application of OMW, composting of OMW using various techniqus and bulking agents, Azotobacter and nitrogen fixation in soils, anaerobic digestion, polyphenols and phenols reduction techniqus, heavy metals removal, electrolysis treatment systems, biological treatment techniques, decolorization techniqus. Other treatment techniqus, such as the use of solar collectors and combined treatment with other agricultural wastes were also briefly discussed.

Chapter One

Introduction

1. Introduction

1.1 Importance

Small industries in Palestine including the West Bank, is an important economic sector which contributes about 18.92% to the GDP (UNESCO, 1998). About 70 thousand employees or about half of the total labor force are enrolled in this sector in the West Bank (PCBS, 1999).

Olive oil production technology in Palestine is a link between agriculture and industry. Olive agriculture produces the edible olive fruit from which olive oil may be extracted. Also, the wood of the olive tree is valuable from which articrafts are made. Finally, the solid waste that result from olive oil processing is commonly used as a source of energy.

Agriculture has developed with time, but the development of olive tree plantation and farming is limited. In Palestine people are attatched to the traditional methods of olives plantation and farming.

In Palestine olive tree irrigation is not common. Also, the addoption of improved brands is not popular, since these brands generally produce olive fruits of big size, but with low oil procuction.

Olive oil processing results in large amounts of solid and liquid wastes. In Palestine, the solid waste that is produced from olive oil processing does not cause environmental problems, since most of it is used for heating in the rural areas, while small amounts are used as fuel in the traditional bakeries, some as animal food and some as a compost in farm lands.

However, the liquid wastes that are produced from olive oil processing (OMW), do cause environmental problems with a potential threat for soil and ground water pollution.

Environmental impact assessment of small industries in Palestine including olive presses was not considered before due to:

(1) the prolong military occupation of the Palestinian Territory,
(2) the lack of specialized institutions in the field,
(3) the poor economic development and the poor investment in the sector, and
(4) the lack of rules and regulations along with the mechanisms for monitoring and enforcement of these rules and regulations.

In Palestine the allowable water resources are inadequate, and the percentage of water that can be used for agriculture is very limited. The Palestinian water rights is estimated to be one billion cubic meters per year. Palestinians are allowed to use less than 25% of their water rights (Haddad, 1990). The remaining Palestinian water which is more than 75% is taken by the Israelis, from which they allow the Palestinians to use limited amounts with high prices. This makes the future of agricultural development questionable.

The scarcity of fresh water resources for all purposes, including irrigation drives more attention to dry - profitable agriculture such as olive tree and olive oil production.

However, olive agriculture is threatened recently by the Israeli settlers aggressive activities. The armed settelers forbid the olive trees owners from harvesting their trees that exist in the vicinity of the settelments. Also, the settlers supported by the Israeli army do not hesitate to eliminate olive trees whereever they want. Moreover, the continuous expansion of the Israeli settelments is a main cause for reducing the agricultural lands in which olive trees can be planted.

1.2 Objectives

The main objective of this study was to conduct an environmental assessment of olive presses in the West Bank. As a parallel objective was to conduct two main surveys: (1) an overview of small industries and olive presses in Palestine, and (2) an overview and evaluation of olive mills wastewater treatment technology.

1.3 Hypothesis

There is a direct relationship between the optimization of olive oil processing technique in Palestine and adhering to environmental protection measures. Broadly speaking, instead of the careless disposal of olive mills waste polluting the environment, these wastes may be wisely used after treatment, or even without treatment.

Chapter Two

Overview of Small Industries and Olive Presses in Palestine

2. Overview of Small Industries and Olive Presses in Palestine

2.1 Survey of Small Industries in the West Bank

There are about 5688 small industrial units in the West Bank employing about 69,357 workers. Hebron is the largest center for small industries in the West Bank, next comes Nablus. Out of the 5688 industrial units that exist in the West Bank, about 23% exist in Hebron and about 21% exist in Nablus (see Table 2.1). Textile, clothing and shoes industrial sector is the biggest small industry in the West Bank, constituting around 21% of small industries.

The average annual contribution of the industrial sector to the Gross Domestic Product (GDP) in the West Bank is about 170 million US $, and the relative share in GDP is about 18.92% (UNESCO, 1998).

Existing major industrial activities in the West Bank can be classified into two main categories: extractive industries and manufacturing industries. Extractive are those involving quarrying of limestone, marble stone, and crushed aggregates. Manufacturing industries include units for cutting and polishing stone, leather tanning, textile dyeing, food and beverage, textile, shoes and leather, metal processing, etc. The distribution of each type of industry in the West Bank is illustrated in Table 2.1.

Table 2.1: Distribution of Each Type of Industry in the West Bank

Type of Industry	Bethlehem	Hebron	Jenin	Jericho	Jerusalem	Nablus	Ramallah	Tulkarm	Total
Textile, Clothing, Shoes	95	348	89	23	85	287	143	131	1201
Metal working	96	237	56	13	84	205	181	82	954
Wood working	123	245	67	15	91	221	158	84	1004
Food, Beverage, Tobacco	109	223	88	35	83	187	207	132	1064
Nonmetallic & Construction	64	107	56	10	36	86	78	71	508
Stone processing	141	134	134	---	5	140	67	85	706
Balance	23	38	21	1	4	67	77	20	251
Total	651	1332	511	97	308	1193	911	605	5688

Source: Ministry of Industry (1998)

The industrial establishments in the West Bank were sited randomly without planning basis or regulations. The distribution of the industrial establishments in some districts in the West Bank could be among residential areas, commercial areas, agricultural areas or industrial areas as illustrated in the following table.

Table 2.2: Distribution of the Industrial Facilities in some Districts

District	Industrial Area	Residential Area	Commercial Area	Agricultural Area
Bethlehem	20%	70%	10%	---
Hebron	19%	31%	26%	24%
Ramallah	89.2%	8.6%	0.8%	1.4%
Nablus	45%	28%	27%	---
Jenin	20%	32.5%	12.5%	35%
Tulkarm	9.2%	39.2%	9.2%	42.1%

Source: MEnA (1999 a)

2.2 Environmental Aspects of Small Industries in the West Bank

Since there was no major industrial centers in the West Bank, small industries have traditionally been considered the main contributor to environmental pollution, and therefore, environmental protection values and control measures must be incorporated into industrial development projects. The misuse or contamination of water, air, land, and natural resources negatively affect the environment.

The industrial wastewater that is produced by most of the small industries in the West Bank is highly polluted, while the wastewater that is produced from leather tanning can be classified as hazardous. Stone processing industrial sector which constitutes around 12.4% of small industries in the West Bank is considered as a major contributor to air and water pollution especially in the neighboring areas.

Both of the liquid and solid industrial waste generation, cause great environmental problems in Palestine, because there is no separation system for collecting or disposing of the industrial waste; hazardous or non-hazardous. The common discharge methods of wastewater in each district in the West Bank are illustrated in Table 2.3. Also, the discharge methods of solid waste in each district in the West Bank are illustrated in Table 2.4.

Table 2.3: Distribution of Common Discharge Methods of Industrial Wastewater by District

District	Discharge to Network	Cesspit	Open Lands	Others (Reuse + Irrigation)
Bethlehem	18%	28%	5%	49%
Hebron	41%	38%	19.2%	1.8%
Ramallah	37%	46%	4.7%	12.3%
Nablus	33%	47%	12.4%	7.6%
Jenin	---	3.7%	92.6%	3.7%
Tulkarm	30.3%	2.3%	65.1%	2.3%

Source: MEnA (1999 a)

Table 2.4: Distribution of Common Disposal Methods of Industrial Solid Waste by District

District	Municipal waste Containers	Road side dumping	On-Site Burning	Others
Bethlehem	38%	16%	11%	35%
Hebron	35%	37%	9%	19%
Ramallah	41%	26%	19.1%	13.9%
Nablus	42%	9%	5%	44%
Jenin	19.3%	16.4%	21.3%	43%
Tulkarm	16.2%	9.5%	7.5%	66.8%

Source: MEnA (1999 a)

As shown in Table 2.3, the industrial wastewater is either discharged to the municipal collection system, affecting the quality of wastewater and raising the price of wastewater treatment if it is ever accomplished. The majority of the industrial establishments in Hebron governorate discharged their industrial wastewater to the municipal collection system.

In other cases, the industrial wastewater is discharged to the cesspits and later pumped and discharged to open lands, or it is directly discharged to open lands. In both cases the industrial wastewater affect soil and ground water. In the second case, direct discharge to open lands, the neighboring area and those who work at the factory themselves, are also affected by the industrial wastewater. In Jenin and Tulkarm governorates most of the industrial establishments dispose their wastewater to open lands, causing tremendous threat to the environment. Comparatively, in Nablus and Ramallah governorates the industrial establishments dispose their wastewater mostly to cesspits.

Some of the industrial wastewater, especially in Bethlehem governorate, is reused for irrigation. The crops that are irrigated with the industrial wastewater, that may contain chemical or toxic substances, are probably unsafe for human consumption.

As shown in Table 2.4, the industrial solid waste disposal methods are not satisfactory and lacking organization. Road side dumping of the industrial solid waste may cause serious environmental pollution. Also, uncontrolled on-site burning of the industrial solid waste causes air pollution, especially if it contains chemical or hazardous substances. Still, other disposal methods are followed in some industrial establishments that could be more serious.

After the establishment of Palestine National Authority (PNA) in 1995, environmental rules are starting to be applied and respected. Raw wastewater irrigation was forbidden and dumping solid waste in unauthorized areas was strictly controlled. New factories are now authorized only in industrial areas and after making sure that they fulfill certain conditions.

Since most of the small industrial establishments are situated within the municipal boundaries, their water supply, energy supply, wastewater and solid waste disposal services are mostly from municipal sources. The following paragraphs will emphasize on describing some of these elements and their environmental aspects.

a. Water Supply

The percentage of the industrial establishments whose main source of water is the public water supply network in the West Bank is about 62.3%, against 86.1% in Gaza strip. Therefore the percentage of the industrial establishments connected to the public water supply in Palestine is 69.1% (PCBS, 1998 a).

b. Solid Waste Management

About 93% of the West Bank industrial establishments do not treat the solid waste generated at their sites. About 7.0% of the West Bank industrial establishments treat the solid waste either by separation or by adding some additives. In Gaza strip this percentage is around 1.5%, and so the percentage of the establishments that treat its solid waste in the Palestinian territory is about 6% (PCBS, 1998 a).

Table 2.5 a: Percentage Distribution of Industrial Establishments by Region and Solid Waste Treatment before Disposal

Region	Solid Waste Treatment by separation or by adding materials
West Bank	7.2
Gaza Strip	1.5
Palestine	5.6

Source: PCBS (1998 a)

The local authorities (municipalities) collect about 35% of the industrial establishments' solid waste in the West Bank against 48.3% in Gaza strip (PCBS, 1998 a).

Table 2.5 b: Percentage Distribution of Industrial Establishments by Region and Solid Waste Disposal Part

Region	Solid Waste Disposal Part is the Local Authority
West Bank	34.8
Gaza Strip	48.3
Palestine	38.6

Source: PCBS (1998 a)

For the whole Palestine 46.9% of establishments dispose the solid waste by the establishment itself, and the local authority collects about 38.6% of establishments' solid waste. For the establishments that dispose of its solid wastes combined by itself and by the local authority the percentage is 14.5% (PCBS, 1998 a).

Table 2.5 c: Percentage Distribution of Industrial Establishments by Region and Solid Waste Disposal Part

Region	Solid Waste Disposal Part		
	The Establishment	Local Authority	Both
Palestine	46.9	38.6	14.5

Source: PCBS (1998 a)

The highest percentage of the establishments in the West Bank which dispose of the solid waste by themselves through throwing it into a dump site is about 41.3% while in Gaza strip it is about 36.2% and in the whole Palestinian territory it is about 40%. For the establishments that reuse the wastes, in the West Bank the percentage is 4.5%, in Gaza strip it is 10.5% and in the whole Palestinian territory it is 6% (PCBS, 1998 a).

Table 2.6: Percentage Distribution of Industrial Establishments Not Served by Waste Disposal by Region and by the First Method of Solid Waste Disposal

Region	Method of Solid Waste Disposal	
	Thrown into a dump	Reused
West Bank	41.3	4.5
Gaza Strip	36.2	10.5
Palestine	40.0	6.0

Source: PCBS (1998 a)

About 41.7% of the manufacturing establishments in the West Bank get rid of their wastes (by themselves or by the local authority) into a dump. In Gaza strip this percentage is around 40%. In the whole Palestinian territory 41.3% of the manufacturing establishments dispose the solid waste into a dump (PCBS, 1998 a).

Table 2.7: Percentage Distribution of Manufacturing Establishments Not Served by Waste Disposal by Region and by the First Method of Solid Waste Disposal

Region	Method of Solid Waste Disposal is Throwing into a dump
West Bank	41.7
Gaza Strip	39.8
Palestine	41.3

Source: PCBS (1998 a)

For the establishments who are served by the local authority with solid waste disposal service, about 11.5% of the establishments in the West Bank reported that the solid waste is collected once per week, while this percentage is about 2.7% in Gaza strip. About 30% of the establishments in the West Bank collect the solid wastes six times per week, and 39% in Gaza strip. For the whole Palestinian territory 8% of the establishments their solid wastes is collected once per week and 31% reported that the solid waste is collected six times per week (PCBS, 1998 a).

Table 2.8: Percentage Distribution of Industrial Establishments by Region and Periodicity of Solid Waste Collection by the Local Authority

Region	Collection Times Per Week	
	Once	Six Times
West Bank	11.4	25.9
Gaza Strip	2.7	38.9
Palestine	8.0	30.9

Source: PCBS (1998 a)

In the West Bank food wastes constitute the highest proportion of the solid waste component, which is around 18%, while in Gaza strip, the highest percentage is for the metals that is around 20.4% of the solid waste components. On the level of the whole Palestinian territory, food wastes constitute the highest percentage that is around 18%, while metals constitute 15.5% of the solid waste components (PCBS, 1998 a).

Table 2.9: Percentage Distribution of Industrial Establishments by Region and Most Important Component of Solid Waste

Region	Food Wastes	Metals
West Bank	17.7	13.6
Gaza Strip	17.7	20.4
Palestine	17.7	15.5

Source: PCBS (1998 a)

c. Waste Water Management

In general, 44.2% of the industrial establishments in the West Bank dispose their wastewater by sewage network, 47.8% by cesspit and about 6.1% use other ways of disposal. In Gaza strip 60.2% of the establishments dispose of their wastewater by sewage network, 34.4% by cesspit and about 5.2% use other ways of disposal (PCBS, 1998 a).

About 3.4% of the industrial establishments in the West Bank treat their wastewater, against 0.9% in Gaza strip, and so the overall percentage of the industrial establishments in Palestine that treat their wastewater is 2.7% (PCBS, 1998 a).

As indicated above, very few industrial establishments treat their wastewater at source prior to disposal in Palestine.

The industrial wastewater is generally discharged to the municipal network system without treatment, affecting the quality of wastewater leading to soil and ground water pollution and raising the price of later wastewater treatment if it is ever accomplished.

In other cases, the industrial wastewater is discharged from some industrial establishments to the cesspits and later pumped and discharged to open lands, or it is directly discharged to open lands. In both cases the industrial wastewater affect the underground water, while in the second case it also affects the neighboring area, and those who work at the factory themselves.

d. Summary

These facts assert that, for better future environment and less problems, an Environmental Impact Assessment (EIA) of the various industries must be conducted and the appropriate mitigation measures should be applied. Afterwards the government should act in the greening of industry by supporting green investments in industrial plants including the establishment of recycling and reprocessing plants. Such plants already exist like the used vehicle oil refining plants in Tulkarm city, and melting, reprocessing and shaping of aluminum waste plant in Qalqilya city.

The reduction of pollutants at source is essential. It is important to have local treatment units at each and every factory and to try to decrease the amount of the industrial waste by reusing and reprocessing. To achieve this goal monitoring and control of the industrial waste must be accomplished and followed up by environmental authorities. Acceptable limits with reference to local and international standards must be obtained and followed. Related institutions must play their role and coordinate with each other in monitoring and guiding the industrial establishments in accomplishing these tasks.

2.3 Survey of Olive Industry in the West Bank

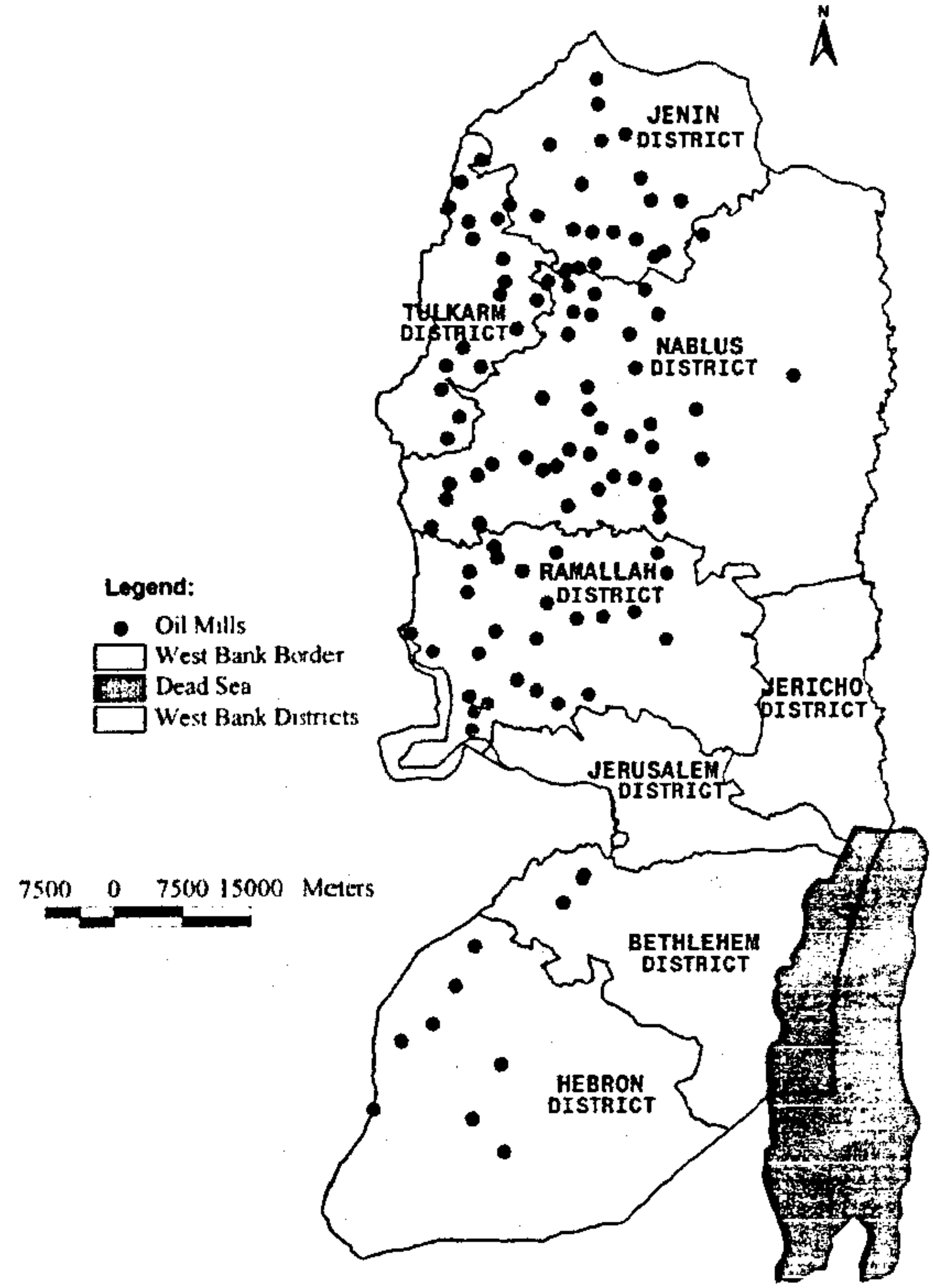
2.3.1 Olive Oil Production in the West Bank

Olive is considered as one of the important agricultural-industrial crops in the Palestinian Territory. Olive trees cover more than 12% of the total area of the West Bank accounting for more than 20% of the total agricultural production (Shu'un Tanmawiyyeh, 1992). In 1991 olive trees agricultural areas were around 755 thousand dunums constituting around 44% of the West Bank agricultural lands and around 75% of the West Bank agricultural lands planted with unirrigated fruitful trees. The agricultural areas invested in olive plantation and their percentages in the governorates of the West Bank are presented in Table (C-1) and Figure (C-2), Appendix C.

In 1996 the area planted with olive trees occupied 819 thousand dunums, which represented 45% of the cultivated area (PCBS, 1997). In 1998 the area planted with olive trees amounted to 837 thousand dunums, which represented 45.7% of the cultivated area (PCBS, 1999).

In 1996 the annual production of olive fruit and olive oil were 120000 tons and 24000 tons respectively (PCBS, 1997), while in 1998 the annual production of olive fruit and olive oil were 63187 tons and 14791 tons respectively (PCBS, 1999).

Locally, olive fruit is of different varieties. Some produce more oil than others, such as the Roman (old Nabali). While, others produce less oil such as the improved Nabali (big size fruit).



Source: ARIJ & MEnA (1999)

Figure 1 Distribution of Olive Mills in the West Bank

The percentage of oil production is also affected by the geographic location, even within the same governorate. As an example, the eastern villages of Nablus (such as Salem and Bet Dajan) are known to produce less percentages of oil in comparison with other villages of Nablus (such as Aseerah, Sabastyah, Qoseen, Jeet, etc ...).

The percentage of oil production is also affected by the season whether it is good or bad. If the season is good, then the olive product of each olive tree is high, but the percentage of oil produced from a specific amount of olives becomes less.

The percentage of oil production is also affected by the harvest time. If the olives are harvested before rainfall (since olives are generally not irrigated in Palestine) then, the percentage of oil produced from a specific amount of olives is less than that after rainfall. Also, the percentage of Olive Mills Wastewater produced from a specific amount of olives pressed is less before rainfall than that after rain-fall, however, this percentage also depends on the amount of water added for the extraction process.

The percentage of water consumption by olive presses is affected by the method of pressing; mainly full-automatic versus half-automatic. The full-automatic pressing technique needs high amounts of added water, compared to the half-automatic. For full-automatic presses, each ton of olives pressed needs approximately one cubic meter of water before rain-fall, and around one half cubic meter of water after rain-fall. For half-automatic presses only a small amount of water is added that does not exceed 100 liters per ton of olives and only before rainfall. This reflects the fact that the full-automatic presses produce much more Olive Mills Wastewater, with smaller concentration, in comparison with the half-automatic presses.

The approximate olive oil production output; average percentages and their ranges may be estimated as follows:

- Oil; constitutes around 25% with a variation between 15% and 30%,
- Solid Waste or olive cake (Jift); constitutes around 40% with a variation between 30% and 50%,
- Liquid Waste (Zeebar); constitutes around 40%, with a variation between 35% and 45%.

(Water added for the full-automatic presses is not included in these percentages).

Olive constitutes a link between agriculture and industry, since it constitutes the raw materials for (1) oil production, (2) olive canning, (3) olive cake (jift) manufacture that is used for heating, animal feeding and as fertilizer.

The percentage of local consumption for oil and olives and users of olive cake in Palestine are distributed as follows:

1. The percentage of local-consumption for oil in Palestine is 47.4%, while the percentage of oil sold in the local market is 39.1%. About 2.5% of oil was exported and 6.0% was sent out of Palestine as gifts (PCBS, 1999).

2. The percentage of local-consumption for olives (including the pickles) in Palestine is 3.1%. Most of olive quantity or production (92.2%) is pressed to extract oil (PCBS, 1999).

3. The percentage of holders who are using the olive cake as fertilizers is (0.8%), while (1.2%) of holders use it as fodder, and (62.7%) of holders use the olive cake for heating (PCBS, 1999).

Olive oil production is a major contributor to the national economy of the West Bank.

Oil and oil products contribute to the West Bank exports: 10% of the West Bank exports of oil industrial products such as soap, and 25% of the West Bank exports as total contribution of oil and oil industries (Shu'un Tanmawiyyeh, 1992). However the fluctuation of the productivity of the olive fruit restrain the people from relying on it as their sole income for living.

2.3.2 Olive Presses in the West Bank

Most of the West Bank olive presses exist in the northern region of the West Bank (Jenin and Tubas, Tulkarm, and Nablus governorates). Out of the 218 functioning olive presses that exist in the West Bank, 45 presses exist in Jenin and Tubas, 31 in Tulkarm, 46 in Nablus, 14 in Qalqilya, 24 in Salfit, 34 in Ramallah and Al-Bireh, 4 in Bethlehem and 20 in Hebron. Another 9 olive presses exist in Gaza Strip raising the number of the functioning olive presses in Palestine to 227 (PCBS, 1999) (see Table A-1, Appendix A for details).

The quality and quantity of olive presses have improved in Palestine over the last 30 years. The average increase was 5 a year between 1941 and 1965, but it decreased to a rate of only one every two years between 1966 and 1970. However, this average has increased to 6 new presses yearly between 1970 and 1990 (Shu'un Tanmawiyyeh, 1992).

In 1997 olive season, out of 248 olive presses (including traditional presses) in the West Bank 201 presses were in operation (PCBS, 1998 b) generating about 0.2 million cubic meters of OMW. Comparatively, in 1998 season, out of 239 olive presses in the West Bank 218 presses were in operation (PCBS, 1999) generating about the same amount of OMW.

Olive presses differ in their efficiency, characteristics, method of operation, advantages and disadvantages, and the number of each type in the different governorates of Palestine.

Olive presses are classified into three types according to their automation level (see Table A-2, Appendix *A* for details). These types are:

1. **Traditional (old) presses**. Traditional presses were established between the 1920s and the 1960s (see Table A-2, Appendix A). These presses consist of three main units; the stones, the piston, and the separator. These presses are run by a slow-rotating engine (around 180 rpm) from which the movement is transferred to the rest of the machinery by special belts.

The olive fruit is crushed by two cylindrical stones for half an hour, after which the olive paste is transferred from the container in which it was crushed into another container. The paste is then manually filled in thick textile containers fabricated from loofa or hair (kuffah). These containers (30-50 kuffahs) are stacked under a piston that works by liquid pressure (around 155-206 kg/cm^2) for half an hour. The applied pressure separates liquids (oil and water) from the solid constituents of the fruit that pile up in a special hole. The resulting liquids are then manually transferred to a special separator where oil is separated from other liquids by central diffusion technique.

In 1990 there were 100 operating traditional presses in the West Bank constituting 35.7% of the total number of presses. Out of the 100 traditional presses, there were 37 presses in Ramallah and 33 presses in Tulkarm.

2. **Half-Automatic.** In the half-automatic presses some of the operational stages are done mechanically and the others are done manually. Half-automatic presses started to be used in the early 1970s. Since these presses are run electrically, they are more efficient than the traditional type. These presses consist of three main units; the crusher (stones are used sometimes), the pistons (generally two), and the separators (one or two). Half-automatic presses include machines for washing olive fruits before they are crushed and mechanical risers. The efficiency of the piston may reach 310 kg/cm^2. Crushed olives are automatically distributed on the thick textile containers (kuffahs), which are moved on carriers. The separators of the half-automatic presses are highly efficient and can be washed from the inside without prior separation. In comparison with traditional presses, the construction and operational costs of half-automatic presses are higher.

In 1998 there were 104 operating traditional presses in the West Bank constituting 38.1% of the total number of presses. 48% of these presses existed in Tulkarm (see Table F and Figure F-2, Appendix F).

3. **Full- Automatic.** Full-automatic presses started to be used in the late 1970s. These presses are highly efficient and they may work with one or two production lines. Compared to other types of presses, full-automatic presses work automatically in all stages without any manual assistance. Full-automatic presses include machines for removing leaves and for washing olive fruits before they are crushed. In these presses, the oil and the other constituents of the olive fruit are being separated by central diffusion technique instead of the pressure that was used in the previous types. Full-automatic presses generally have two separators (not one). In one separator oil is separated, and in the other the other liquids are

separated. These presses have high operational cost since they consume a lot of electricity and water during operation.

In 1990 there were 74 operating full-automatic presses in the West Bank constituting 26.2% of the total number of presses. The majority of these presses existed in the northern region of the West Bank. Out of the 74 full-automatic presses 33 presses (11.7% of the full-automatic presses in the West Bank) had two production lines and 41 (14.5% of the full-automatic presses in the West Bank) had one production line (see Table F and Figure F-2, Appendix F).

In the traditional and half-automatic presses the cold pressing technique is adopted, resulting in a healthier oil type. In the full automatic presses hot pressing technique is adopted causing changes in the structure of olive oil and thus decreasing its storage period. Apparently, full automatic presses produce purer and cleaner oil because of their advanced refining process and because all of the automatic presses have machines for removing leaves and machines for washing olive fruits before they are crushed.

In the past most of olive presses were traditional and half-automatic. Although many villagers appreciate the value of the cold pressed olive oil, the majority of the presses that were established in the past 20 years were full-automatic. This is due to the fact that the full-automatic presses squeeze the olive fruit completely leaving very small traces of oil in the olive waste and still consuming much shorter time for the process. Also the full-automatic presses need fewer laborers with lower qualifications for operation. These factors make the full automatic presses more economical on the long run.

Another way of classifying olive presses is according to their operation technique. There are two types of operational techniques for producing olive oil:

1. Continuous

   &

2. Discontinuous.

In the discontinuous method, olives are washed and crushed in a mill (Crose et al., 1994). The crushed olives are then placed in a press, which squeezes the oil from the crushed olives. Then, the oil is pumped to a holding tank, which feeds a centrifuge. The centrifuge separates the oil from the waste effluent. The oil is then filtered to produce the final product. In the continuous method the whole process is done by one machine, to which hot water is added to improve centrifugation.

In the continuous method wastewater is generated from (1) the water contained in olive fruits, (2) the initial olive washing water, and (3) the water added for the separation of oil from paste by centrifugation. Because of the addition of water to the centrifuge, OMW that is generated by the continuous process is greater in quantity than that generated by the discontinuous process but is more dilute. It is estimated that 0.5-0.6 m^3 of OMW is generated per metric ton of olive pressed by discontinuous process, and 1.5-2.0 m^3 of OMW is generated per metric ton of olive pressed by continuous process (Balice et al., 1982 and Sanna, 1982).

2.3.3 Environmental Aspects of Olive Presses in the West Bank

The environmental conditions of olive presses include their method of disposal of solid, liquid and gaseous wastes, in addition to its location within the residential areas and possible noise and other environmental problems that might be of effect. The liquid waste that is produced by the olive presses usually causes environmental problems, and it is either:

- discharged to sewer networks (with partial or no treatment)
- discharged to cesspits around the press
- discharged to the nearby valleys
- discharged to the surrounding plants for irrigation

The solid waste is collected in nearby vacant areas not far from the industry itself causing air and soil pollution (MEnA, 1999 a). The quantities of solid waste produced are shown in Table 2.15. Still, some of the solid waste is used for various purposes.

Gaseous wastes and noise pollutants are considerably harmful when the olive presses are located in the vicinity of residential areas, which is probably the case in most of the Palestinian villages.

In 1998 the total number of olive presses in operation were 248 including the temporarily closed presses. 21 olive presses out of the 248 olive presses were temporarily closed and the other 227 were operating (PCBS, 1999).

Out of the 227 operating olive presses 181 presses discharged the OMW (zeebar) to the cesspits and 21 presses discharged the OMW (zeebar) to the sewer networks. The rest of the olive presses disposed their OMW in other ways (PCBS, 1999).

OMW usually contains a very high BOD and COD loads, acids and oil. This requires treatment at source before discharging and spreading out in order to minimize the danger of pollution.

In Palestine, the olive oil production output, i.e; (1) oil, (2) solid waste, and (3) liquid waste, differ according to olive type, geographic location, season condition (good or poor), harvest time (stage of maturity) and method of pressing (mainly full-automatic and half-automatic.

Olive mills wastewater is not treated in Palestine. However, olive mills solid waste is sometimes treated. These treatment techniques include: (1) de-oiling and fuel production, (2) treatment and addition to animal feed, and (3) transferring into compost.

Unpublished experiments were accomplished at An-Najah University for the utilization of olive mills solid waste. These include: (1) production of fuel from the solid waste that is water-free and oil-free, (2) the utilization of the solid waste that is water-free and oil-free, that has big surface area in water treatment, and the utilization of the solid waste in catalyst production.

Environmental impact assessment (EIA) and economical assessment for these utilizations were also accomplished.

2.3.4 Beneficial Use of Olive Presses Solid Waste in the West Bank

2.3.4.1 De-Oiling and Fuel Production from Olive Mills Solid Waste:

The solid waste that is produced by the half-automatic presses contains 6-8 % of oil (see Table 4.1 above). Seven de-oiling small factories existed in Palestine; five in Nablus, one in Ramallah and one in Hebron. These de-oiling factories used to extract oil from olive solid waste in order to use it for soap production. These factories worked efficiently in the past because of several reasons:

1. Most of the olive presses were half-automatic.
2. The people were more interested in the local soap that was produced from olive oil.
3. Most of the local factories, nowadays, produce soap from industrial oil fatty acids that is imported mainly from Italy. This industrial oil is much more economical than olive oil.

In the year 2000 none of these factories operated, because of the fact that, the liquid (SBPP) used in oil separation doubled in price.

The de-oiling process is done as follows:

1. Water is removed from the solid waste by evaporation, where the vapor is kept for later use.

2. The dry solid waste is moved to three containers. There are five containers, but only three of them work simultaneously. The five containers are connected by pipes and valves, through which the Special Boiling Point Petrol (SBPP) separator is added and stopped.

3. The SBPP is then applied to three solid waste containers. The color of the SBPP is white, while the color of oil extracted from the solid waste is green, and the liquid that consists of both the SBPP and the oil is white-greenish. The liquid that results from the extraction process is transferred to another container for separating the oil from the SBPP. The SBPP application is stopped when the liquid turn into white-greenish, indicating that oil extraction is completed.

4. The solid waste from which oil was extracted is now ready to be released. The solid waste container is opened from the bottom, and the solid waste is forced to move out by the steam pressure that was kept earlier.

5. The resulting solid waste that is, approximately, moist free and oil free is used as fuel for the evaporation process (step 1, above). The solid waste that result from combustion is called Dukk (similar to coal in structure). It is then packed and sold as fuel for heating.

6. Finally, the oil that result from the extraction process is sent for soap manufacturing.

2.3.4.2 Sheep Feed production from Olive Mills Solid Waste:

In 1993 experiments were made on the utilization of olive mills solid waste for sheep nutrition. These experiments proved to be successful and economically feasible because of the following reasons: (MARAYA, 1993)

1. The high price of animal feed.
2. The lack of local source of animal feed, due to the Israeli confiscation of Palestinians farmlands, prohibiting the animals belonging to the Palestinians from grazing in these lands.
3. Olive mills solid waste is produced in big amounts in Palestine, and it is more economical to be used for feeding sheep than for heating.
4. According to laboratory tests, olive mills solid waste is a good energy source, when added to sheep feed. It may also be chemically treated in order to raise its nutritional value as follows:
   a. Ammonia addition (as urea) in order to increase its Nitrogen content, and hence its protein content.
   b. Treatment with caustic soda in order to increase the degree of fibers digestion.

The sheep feed production experiment was done as follows:

1. Amounts of solid waste were taken from an olive press three months after olive pressing.

2. The solid waste was exposed to the surrounding natural environmental conditions (temperature, pressure, etc) in order to get it dry by solar energy. It was laid on a concrete surface and was stirred once a day.
3. After making sure that the solid waste was dry, it was stored for another three months before its use in the experiment.
4. Before using the solid waste, a sample was sent for laboratory analysis.
5. The solid waste was used in two forms:
   a. Dry solid waste as it is.
   b. Dry solid waste after removing its seeds by sieving using a 2mm sieve (each opening length = 2mm).
6. Thirty male sheep (Himlan Elawasi type) were bought from sheep vendors, and were left in the shadow all day long.
7. The feed of the experiment was served gradually to the sheep for ten days.
8. Feeding was accompanied by sheep vaccination against abdominal (bellies) toxicities, and they were given dozes of Oromic medicine that expel out interior and exterior microorganisms.
9. The sheep were arbitrarily distributed into five groups, each containing six sheep. In each of the five groups, the average weight of a sheep ranged between 22.3 kg and 23.3 kg per head.
10. For each of the five groups, a different nutritional mixture was served, as demonstrated in Table 2.10. Each group was served in a group-like manner by self-feeding system for 77 days.
11. The observation period was divided into two periods:
    a. During the first 56 days the experimental feed mixtures were used without vetch addition.

b. During the following 21 days the experimental feed mixtures were used with vetch addition with an average of 250 gm/head/day.

12. All the sheep were weighed at the beginning and at the end of the experiment, and were weighed every week. The experimental feed mixtures were abundant all the time. The remaining feed was taken away and weighed at the end of each week.

13. In the first period of the experiment (without vetch), best results among all, were for the sheep that ate 16% solid waste without seeds, showing an average growth rate of 198gm/head/day. While the worst were for the sheep that ate 8% solid waste as it is, showing an average growth rate of 139gm/head/day (see Table 2.13).

14. In the second period of the experiment (with vetch), best results among all, were for the sheep that ate standard feed without solid waste addition, showing an average growth rate of 214gm/head/day. While for the sheep that ate standard feed with solid waste addition, the best results were for the sheep that ate 16% solid waste without seeds, showing an average growth rate of 178gm/head/day (see Table 2.13).

15. For the first period, it was found that, the group of the highest feed consumption was the fifth group (16% solid waste without seeds), with an average consumption of 932 gm/head/day. While the group of the lowest feed consumption was the second group (8% solid waste as it is), with an average of 855 gm/head/day (see Table 2.13).

16. For the second period (with vetch), it was found that, the group of the highest feed consumption was the fourth group (8% solid waste without seeds), with an average consumption of 929 gm/head/day. While the group of the lowest feed consumption was the third group (16% solid waste as it is), with an average of 767 gm/head/day (see Table 2.13).

17. For the first period (without vetch utilization), it was found that the economical feasibility was best for the third group (16% solid waste as it is); expressed in terms of kg feed/kg living weight equals (4.5:1). While, the worst was for the second group (8% solid waste as it is); equals (6.2:1) (see Table 2.13).

18. For the second period (with vetch utilization), it was found that the economical feasibility was best for the first group (without solid waste addition); expressed in terms of kg feed/kg living weight equals (3.9:1). While, the worst was for the third group (16% solid waste as it is); equals (6.7:1) (see Table 2.13).

Table 2.10: Type of Nutritional Treatment for the Experiment

Group No.	Treatment for the first period (first 56 days)	Treatment for the second period (last 21 days)
1	100% Control Mixture	100% Control Mixture + 250 gm vetch/head/day
2	8% solid waste as it is + 92% Control Mixture	8% solid waste as it is + 92% Control Mixture + 250 gm vetch/head/day
3	16% solid waste as it is + 84% Control Mixture	16% solid waste as it is + 84% Control Mixture + 250 gm vetch/head/day
4	8% solid waste without seeds + 92% Control Mixture	8% solid waste without seeds + 92% Control Mixture + 250 gm vetch/head/day
5	16% solid waste without seeds + 84% Control Mixture	16% solid waste without seeds + 84% Control Mixture + 250 gm vetch/head/day

Source: MARAYA (1993)

Table 2.11: Chemical Structure of the Control Mixture (according to manufacturer

Element	Percentage
Protein	18 %
Digestible Energy	2700 Kilo Joule / Kilo gram
Fats	3 – 4 %
Fibers	5 %
Salt	1 %
Calcium	0.8 %
Phosphorous	0.3 %

Source: MARAYA (1993)

Table 2.12: Chemical Structure for Olives Solid Waste

	% DM	% DM	% DM	% DM	% DM
	Dry Material	Ash	Protein	Fibers	Fats
Olives Solid Waste	75 - 80	3 - 4	5 - 10	35 - 50	8 - 15
Olives Solid Waste (without Seeds)	80 - 90	6 - 7	9 - 12	20 - 30	15 - 30
Olives Solid Waste (oil free)	85 - 90	7 - 10	8 - 10	35 - 40	4 - 6
Olives Solid Waste (without Seeds and oil free)	85 - 90	6 - 8	9 - 14	15 - 35	4 - 6

Source: MARAYA (1993)

Table 2.13: Results of the Sheep Fattening Experiment

Observation No.	1		2		3		4		5	
No. of Observation days	56	21	56	21	56	21	56	21	56	21
Average of Sheep Initial Weight (kg/head)	22.8	32.8	23.1	30.9	22.5	33.5	23.3	32.1	22.3	33.4
Average of Sheep Final Weight (kg/head)	32.8	37.3	30.9	33.7	33.5	35.9	32.1	35.3	33.4	35.3
Average Daily Growth (gm/head/day)	179	214	139	133	196	114	157	152	198	178
Average Feed Daily Consumption (gm/head/day)	905	843	855	776	877	767	909	929	932	862
Economical Feasibility (kg Feed/ kg Living Weight)	5.1	3.9	6.2	5.8	4.5	6.7	5.8	5.5	4.7	4.8

Source: MARAYA (1993)

Table 2.14: Costs of the Experiment (Feed Cost), in US $

Observation No.	Cost of 1kg of feed consumed in the first 56 days	Cost of 1kg of feed consumed in the last 21 days	Cost of 1kg of increment in sheep wt. in the first 56 days	Cost of 1kg of increment in sheep wt. in the last 21 days
1	0.24	0.24	1.22	0.94
2	0.23	0.23	1.43	1.33
3	0.22	0.23	0.99	1.45
4	0.24	0.24	1.39	1.32
5	0.24	0.24	1.13	1.15

Source: MARAYA (1993)

Other experiments were conducted on utilizing olive mills solid waste for sheep nutrition, and proved to be successful. Abo Omar, (1996) reported that the substitution of 20%-30% of sheep feed (such as corn and barley) by olive mills solid waste causes no negative effects on sheep. He also reported that the olive mills solid waste may substitute the filler feed up to 40%. The utilization of olive mills solid waste resulted in sheep fattening at a rate of 190-240 gm/day, which is similar to the rate obtained by regular feed.

Also, some experiments were conducted on utilizing olive mills solid waste for broiler chicks' nutrition. The experiment showed that it was most successful to utilize 7.5% of seedless olive mills solid (olive pulp) in broiler chicks feed.

2.3.4.3 Compost Production from Olive Mills Solid Waste:

According to field interviews, some farmers use the untreated olive mills solid waste as compost for crops. However, they may face the potential risk of the solid waste rottening and the growth of microorganisms and rodents.

Recently, there are plans to establish a factory for compost production from olive mills solid waste in Bala'a – Tulkarm.

2.4 Status of Olive Mills Wastewater Management in Palestine

Most areas in the West Bank have olive pressing industries, using new and old technologies. There are 278 mills olive mills (OM) in the West Bank (MEnA, 1999 a). The percentage distribution of these mills and the quantities of discharged wastewater are presented in Table 2.15.

Table 2.15: Distribution & quantities of wastewater & solid waste from olive mill

District	No. Of O.M	% of O. M	Quantity of wastewater CM Yr	Quantity of solid waste Ton/Yr
Hebron	15	5.4	20250	2913
Jenin	52	18.7	70200	10098.4
Nablus	51	18.4	68850	9912.2
Ramallah & Bethlehenm	52	18.7	70200	10098.4
Tulkarm	108	38.8	145800	20978
Total	278	100%	375300	54000

Source: MEnA Survey & ARIJ (1998)

Olive mill wastewater produced is either disposed into the public sewage networks or dumped in nearby cesspits (MEnA, 1999 a). The majority of the olive mills that are available in Palestine exist in the villages that do not have sewerage network systems. The collected data through questionnaires show that OMW is not treated at source and is usually transported and disposed to the valleys in the village, or disposed to the sewerage network systems in the cities.

Chapter Three

Research Methodology

3. Research Methodology

To fulfill the objectives of this study (see page 4), an olive EIA questionnaire was developed and conducted. Questionnaire development, data collection and processing and the difficulties encountered in conducting the study are described in the following paragraphs.

3.1 Olive presses EIA questionnaire (see Appendix G for detailed Tables).

The questionnaire covers three main elements:

1. General information about the presses (name, ownership, location, year of establishment, level of automation, machinery description, etc ...) .

2. Environmental related issues (water source, power source, materials storage, solid, liquid, and gaseous wastes generation and disposal practices, application of environmental rules and sanitation practices, working environment including ventilation, lighting and space, workers health and environmental awareness, workers safety, etc ...).

3. Economic information about the presses (capital invested, operational and maintenance costs, workers salaries and expenses, transport expenses, guests' expenses, and others.

3.2 Data Collection and Processing:

3.2.1 Data Collection:

The data on olive presses were collected via a special questionnaire covering the items mentioned above and via visual field observation. Taking into consideration the geographic distribution of the olive presses in the West Bank (see Appendix A-1), the information were collected from 46 olive presses (about 20% of olive presses that exist in the West Bank) via detailed questionnaires (see Appendix G).

3.2.2 Data Entry and Processing:

After collection of data from the field, questionnaires underwent manual sorting and logical revision. Micro-Soft Excel software was used in data entry and processing.

Certain statistical variables were calculated for data analysis. These variables include averages, standard deviations and percentages. SPSS was used for statistical analysis, and relations between certain variables were also analyzed.

3.2.3 Data Quality:

In this round of olive presses survey, data were collected via direct questioning of owners or managers of olive presses. While collecting data, some questions were asked in different ways in order to obtain the required data. Also, some figures were roughly estimated since the olive presses owners could not give exact answers, such as: the quantity of solid waste and liquid waste produced. However, these figures were corrected afterwards regarding the presses automation level and type.

In general, there was good response from olive presses owners as they did cooperate in order to complete (fill out) the questionnaires.

3.2.4 Chemical Analysis of OMW (Zeebar) :

Olive mill wastewater chemical quality was conducted at Chemical and Biological Analysis Unit at Al-Quds University. A grab sample was collected in a two - liter polyethylene container from Ar-Rantisi press – Ramallah and was transported to the laboratory for analysis. Chemical parameters of BOD, COD, TSS were analyzed according to Standards Methods for examining water and wastewater (APHA, 1996). ICP run was conducted on the sample in order to determine its content of Al, B, Ba, Ca, Cr, Cu, Fe, K, Li, Mg, Mn, Na, Ni, Pb, Si, and Sr.

3.2.5 Difficulties Encountered While Collecting Data:

Collecting data was done in the years 1998 and 1999. Unfortunately, the olive season during these two years was not good. As a result, not all of the presses were operating during these two years, and even those that were operating did not work at their full capacity. Notably, most of the presses that were operating during these two years were the full automatic presses and a smaller number of half-automatic presses and it was rare to see any of the traditional presses operating.

Since the season was poor in the years 1998 and 1999, I could fill only 46 questionnaires, taking into account the geographic distribution of the olive presses in the West Bank. These questionnaires include: (11 in Nablus, 8 in Jenin, 7 in Ramallah & Al-Bireh, 6 in Tulkarm, 5 in Salfit, 3 in Hebron, 4 in Qalqilyah and 2 in Bethlehem).

Due to the fact that the olive season was poor in these two years, some presses were visited twice or three times in order to see them operating.

Chapter Four

Overview of Olive Mills Wastewater (OMW) Treatment Technology

4. Overview of Olive Mills Wastewater (OMW) Treatment Technology

4.1 General

4.1.1 Characteristics of Olive Mill Wastewater

OMW is a strong pollutant; resistant to degradation and presents a severe environmental problem related to its high organic content made up largely of simple phenolic compounds, which are both anti-microbial and phytotoxic. The presence of phenolic compounds in OMWs makes them highly toxic and ecologically noxious to the waterways into which they are dumped unprocessed, as is usually the case in many Mediterranean countries. In addition, OMW contains a very high BOD load, acids and oil. Consequently, OMW requires treatment at source before discharging and spreading out in order to minimize the danger of pollution.

Furthermore, chemical pollution should be avoided or reduced. Attention should be paid that no germicides will be utilized after the harvest when finally purifying the ground that could be harmful to the biology of the municipal sewerage plant (Municipality of Nablus - Sewerage Project, 1998).

Measurements from four, and observations of operation from 10 olive mills in Greece show that: 0.0007-0.19546 m^3 wastewater/ton olive.day are produced and the wastewaters found to have suspended solids 0.05-0.39 g/l, dissolved solids 2.31-71.44 g/l, BOD_5 0.24-5.44 g/l, COD 0.76-16.46 g/l, chloride 0.11-43.78 g/l and sodium chloride 0.17-72.21 g/l. The large fluctuations in these data are caused by variations in the olive purchase and sale rates, olive preparation stages among the various periods, olive preparation conditions among the various factories and the purity, ripeness and size of olive (Kopsidas, 1994).

The pollution abatement due to olive mills effluents is a complex problem, which has different optimal solutions according to local factors in Italy, such as; the oil extraction process, the possibility to store the wastes, and the ratio between the load due to the mills, and the one related to the local population (Rozzi and Malpei, 1996). The variability in OMW characteristics was found to be high depending on various factors (see Table 4.2.a).

4.1.2 Overview of Technical, Environmental, Economic and Social Aspects of OMW Management

Both olive tree culture and olive oil industry produce large amounts of by-products. It has been estimated that pruning produces 25 kg of by-products (twigs and leaves) per tree per year. Leaves represent 5% of the weight of olives in oil extraction. Moreover, the olive oil industry produces 35 kg of solid waste (crude olive cake) and 100 liters of liquid waste (oil mill wastewaters) per 100 kg of treated olives. Such substantial amounts of by-products may have harmful effects on the environment (Alcaide and Nefzaoui, 1996).

In the Mediterranean countries vast amounts of OMW are produced, where their treatment and disposal is becoming a serious environmental problem. Increasing attention has been paid to discovering a use for OMW and a wide range of technological treatments are available nowadays for reducing their pollution effects and for their transformation into variable products. The most suitable methods being found to involve recycling rather than the detoxification of these wastes (Cegarra et al., 1996). Among these methods: Direct land application of OMW, composting of OMW prior to land application and the utilization of OMW by Azotobacter leading to Nitrogen fixation in soils. Other technological treatment methods include: Toxicity reduction by OMW anaerobic digestion, polyphenols and phenols reduction, heavy metals reduction and removal, OMW treatment by means of an electrolysis system, OMW treatment by ozone and UV radiation, biological purification of OMW and the decolorization of OMW. There are other treatment methods that are not widely used and/or still under study which are briefly discussed in section 2. 11.

4.1.3 Waste Resulting from Olive Oil Production

The half-automatic presses that are used for olive oil extraction, and which are operated discontinuously, result in about 400 kg of liquid waste per ton of processed olives.

Depending on its size the capacity of such an oil mill is about 10 to 20 tons of olives per day. With a capacity of 20 tons of olives per day and a process-specific wastewater volume of 0.4 m^3 per ton of olives, the daily wastewater volume is up to 8 m^3 per day.

Compared to the half-automatic presses, twice the quantity of wastewater (about 750 l per ton of olives) is produced with the three-phase decanting method (full automatic).

Depending on their size, the capacities of these oil mills are also between 10 to 20 tons of olives per day. With a capacity of 20 tons of olives per day and a process-specific wastewater volume of about 0.75 m^3 per ton of olives, the daily wastewater volume from a continuous process is up to 15 m^3 per day.

The concentration of the constituents in wastewater from the half-automatic presses is therefore twice as high as in the wastewater resulting from three-phase decanting.

Quality and quantity of the waste are influenced by the following factors: (IMPROLIVE, 2000)

* type of production process,
* type of olives,
* area under cultivation or arable soil,

* use of pesticides and fertilizers,
* climatic conditions,
* harvest time, stage of maturity.

Olive oil mills waste only constituents come either from olive itself, or from outside due to the production process. Auxiliary agents are hardly used in the production process, moreover, their application can be influenced and controlled by the process management. Therefore they are not important for the composition of the wastewater. However, the composition of the olive cannot be influenced, hence, olives constituents are decisive for the pollution load to be expected. The following Table shows an input-output analysis of material and energy flows of the production processes, related to one ton of processed olives.

Table 4.1: Input-Output Analysis of Material and Energy Flows of the Olive Oil Production Processes, Related to One Ton of Processed Olives

Production process	Input	Amount of input	Output	Amount of Output
Traditional(1) pressing process	Olives	1 t	oil	ca. 200 kg
	washing water	0.1 – 0.12 m^3	solid waste (c. 25 % water + 6% oil)	ca. 400 kg
	Energy	40 –63 k Wh	wastewater (c. 88 % water)	ca. 600 l
Three-phase(2) decanter	Olives	1 t	Oil	ca. 200 kg
	washing water	0.1 – 0.12 m^3	solid waste (c. 50 % water + 4% oil)	ca. 500 – 600 kg
	fresh water for decanter	0.5 – 1 m^3		
	water to polish the impure oil	ca. 10 l	wastewater (c. 94 % water + 1% oil)	ca. 1000– 1200 l
	Energy	90 –117 k Wh		
Two-phase(3) decanter	Olives	1 t	oil	200 kg
	washing water	0.1 – 0.12 m^3	solid waste (c. 60 % water + 3% oil)	800 - 950 kg
	Energy	< 90 –117 k Wh		

Source: IMPROLIVE (2000)

Notes:
(1) Traditional pressing process = half – automatic presses in Palestine.
(2) Three-phase decanter = full – automatic presses in Palestine.
(3) Two-phase decanter
(4) ca = approximately, c = contains

The Table below summarizes some literature data concerning the constituents of olive oil wastewater.

Table 4.2 a: Literature Data Concerning the Constituents of Olive Oil Wastewater

Parameter	Unit	Pompei (1974)	Fiesteas (1981)	Steegmans (1992)	Hamadi (1993)	Andreozzi (1998)
PH	[g/l]	-	4.7	5.3	3 - 5.9	5.09
Chemical oxygen demand (COD)	[g/l]	195	-	108.6	40 - 220	121.8
Biochemical oxygen demand] in 5 days (BOD_5)	[g/l]	38.44	-	41.3	23-100	-
Total solids (TS)	[g/l]	-	1 - 3	19.2	1-20	102.5
Organic total solids (oTS)	[g/l]	-	-	16.7	-	81.6
Fats	[g/l]	-	-	2.33	1-23	9.6
Polyphenols	[g/l]	17.5	3-8	0.002	5-80	6.2
Volatile organic acids	[g/l]	-	5- 10	0.78	0.8-10	0.96
Total nitrogen	[g/l]	0.81	0.3–0.6	0.6	0.3–1.2	0.95

Sources: Andreozzi et al., (1998), Pompei & Codovilli (1974), Steegmans & Fragemann (1992), Fiestas et al., (1981) & Hamdi (1993)

Table 4.2 b: Literature Data Concerning the Constituents of Olive Oil Wastewater.

	Unit	Hamadi (1993)
Conductivity	[mS/cm]	12.500 - 22.500
Total phosphorus	[mg/l]	1 -900
reduced sugar	[g/l]	3 - 24
Fats	[g/l]	1 - 23
Calcium	[g/l]	0.2 – 0.9
Magnesium	[g/l]	0.1 – 0.7
Sodium	[g/l]	0.1 – 0.5
Potassium	[g/l]	2.8 – 11.6
Chloride	[g]	1.1 – 5.7
Zinc	[mg/l]	5 – 8
Copper	[mg/l]	1 - 19

Source: Hamdi (1993)

The wastewater from olive oil production is characterized by the following special features and components:
(IMPROLIVE, 2000)

- intensive violet-dark brown up to black color,
- strong specific olive oil smell,
- high degree of organic pollution (COD values up to 220 g/l) at a COD/BOD_5 ratio between 2.5 and 5 (hardly degradable),
- pH between 3 and 5.9 (slightly acid),
- high content of polyphenols (up to 80 g/l),
- high content of solid matter (total solids up to 20 g/l).

From the components mentioned the phenols and the organic substances, which are responsible for the high COD value, have to be considered as problematic for the treatment of this wastewater (IMPROLIVE, 2000).

The terms for the waste resulting from the different oil extraction processes are neither standardized nor country-specific. The following Table shows the definitions found in the Mediterranean area.

Table 4.3: Definitions of the Waste Resulting from the Different Oil Extraction Processes in the Mediterranean Area.

	Pressing	**Three-phase decanting**	**Two-phase decantion**
Solids	Trester Stone Orujo Pirina (greek/turk.) Hask (ital./tun.) Grignons	Orujo Grignons Pirina (greek/turk.) Hask (ital./tun.) Orujillo (after de-oiling of solid waste)	Alpeorujo (in 2-phase decanting mainly alpeorujo is produced)
Wastewater	Alpechin Katsigaros Margine	Alpechin Katsigaros Margine	Alpechin
Oil *(from de- oiling of solid waste)*	----	Orujooil	Orujooil

Source: Geissen (1995)

Starting from a medium-sized oil mill processing about 10 tons of olives per day, differing waste volumes result from the classical and from the continuous process.

From pressing of olives results a waste water volume of approx. 600 liters per ton of olives, thus a waste water flow rate of 6 m^3/d. Assuming a BOD_5 concentration of 95 g/l, the resulting BOD load is 570 kg BOD_5/d.

The wastewater volume from three-phase decanting is twice as high as from the pressing process, therefore the concentrations are cut by half. Assuming the same production volume, the wastewater volume is 1000 l per ton of olives with a BOD_5 concentration of about 42 g BOD_5/l. The resulting load is about 420 kg BOD_5/d, which corresponds to a population equivalent of approx. 7000 PE.

The amount of alpeorujo amount from two-phase decanting is about 9 tons per day.

4.2 Olive Mill Wastewater Treatment

An overview of olive mill wastewater treatment technologies is presented in the following section.

The overview involves direct land application of OMW, composting of OMW using various techniques and bulking agents, Azotobacter and nitrogen fixation in soils, anaerobic digestion, polyphenolsand phenols reduction techniques, heavy metals removal, electrolysis treatment systems, biological treatment techniques, decolorization techniques. The overview also involves other treatment techniques, such as the use of solar collectors and combined treatment with other agricultural wastes.

This section includes the advantages and benefits that can be gained from OMW.

4.2.1 Direct Land Application of OMW

a) Introduction

Direct application of OMW to soil has been considered as an inexpensive method of disposal and recovery of their mineral and organic components but, because of their organic acid content and phenolic compounds that are both antimicrobial and phytotoxic, OMW are also a source of pollution (Cegarra et al., 1996).

In order to reduce the polluting effects of OMW on soil, it is advisable to compost OMW prior to its application to soil. Various composting methods may be used (see section 2.2).

b) Technical Assessment and Planning

Direct application of OMW to soil should be accompanied by irrigation (water addition) so as to obtain the beneficial effects of its application. The amount of water added determines the concentrations of OMW doses. OMW may be applied to the soil at high or low doses and it could be still beneficial to the soil, depending on the soil type, the soil layer thickness and the period of OMW application to the soil. However, continuous monitoring and testing of soil characteristics have to be done in order to avoid sodium salinization of the soil and the watertable.

In general OMW application to soil increases the concentrations of soil organic matter, Kjeldahl N, soluble N, soluble NO_3 and available P enhancing soil fertility.

Also, OMW application to soil affects its porosity by reducing large pores ($r > 10\ \mu m$) and increasing small pores ($r < 0.1\ \mu m$). This effect is advantageous while using herbicides. The increase of non-conducting pores by OMW amendment results in a reduction of herbicide leaching due to an increase of herbicide interaction with soil matrix enhancing the adsorption and degradation processes.

c) Experiences with Various Land Application Techniques

c.1) Experiments Using High Doses of OMW

The irrigation of soil with high doses of OMW, may be advantageous. In Sevilla-Spain, OMW spreading caused an increase of soil fertility that could allow agronomic use of the soil. After three years of irrigation only minor changes in soil organic-C, Kjeldahl-N, nitrate-N, exchangeable-K and E.C. were detected below 50 cm depth. However, special attention must be made to hydrogeological characteristics of soil in order to avoid sodium salinization of the watertable (Lopez et al., 1996).

Another experiment in Sevilla-Spain show that land treatment with high loading rates of OMW results in quantitative increase of the lipidic fraction of the soil upper layer and in significative alterations in the lipid compositions of both the soil upper layer and the subsoil. GC-MS analysis of the lipidic fractions before and after the treatments showed the preferential accumulation of some hydrophobic components of the wastewater. These compounds were also retained by the humic acid (HA) fractions as seen by Pyrolysis-GC-MS (Gonzalez-Vila et al., 1995).

c.2) Experiments Using Limited Doses of OMW

Other experiments in Sevilla-Spain show that if OMW was applied in limited doses to the soil, it might not be harmful. Experiments carried out in lysimeters filled with two calcareous clayey soils (ca 40% $CaCO_3$; ca 40% clay), showed that a 2m layer of soil almost completely removed the organic and inorganic components of OMW when it was applied in doses of 5000 - 10000 m^3 ha^{-1} $year^{-1}$. This efficiency was maintained for at least 2 years. In field experiments, the application of OMW to one of these soils during 3 successive years at an annual rate of up to 6000 m^3 ha^{-1} caused changes in some chemical properties of the soil, especially in the upper layer (0-50 cm). Concentrations of soil organic matter, Kjeldahl N, soluble N, soluble NO_3 and available P increased enhancing soil fertility. On the other hand, soil electrical conductivity and sodium adsorption ratio also increased but below the levels representing salinization or sodification hazard for the soil. Furthermore, leaching of Na^+ and NO_3^- below the 1m layer was also detected (Cabrera et al., 1996).

c.3) Experiments Using Various Doses of OMW

In order to compare the effect of applying various doses of OMW to soil a laboratory experiment was performed during a 40-day incubation period in order to evaluate changes in organic and inorganic compounds of soil amended with two doses of OMW. Differences between the amounts of organic components of the amended soil and those of the control, although related to doses and sampling time, disappeared at the end of the experimental period. On the contrary, the inorganic anion contents were still different for the various treatments, which suggest, especially for NO_3^- and SO_4^{2-}, a transition inhibition in the soil sludge system. A germination test carried out on the soil amended with different doses of sludge, indicates that after about 20 days even the soil containing the highest dose of sludge did not show toxicity any longer (Riffaldi et al., 1993).

c.4) Experiments on the Effect of OMW Amendment on Leaching of Herbicides

The effect of OMW amendment on leaching of the herbicide clopyralid (3,6-dichloropicolinic acid) in soil columns has been investigated. OMW amendment increased organic carbon content of a soil and affected its porosity by reducing large pores ($r > 10$ μ m) and increasing small pores ($r < 0.1$ μ m). This increase of non-conducting pores by OMW amendment resulted in a reduction of herbicide leaching due to an increase of herbicide interaction with soil matrix enhancing the adsorption and degradation processes (Cox et al., 1996).

4.2.2 Composting of OMW Using Various Techniques & Bulking Agents

a) Introduction

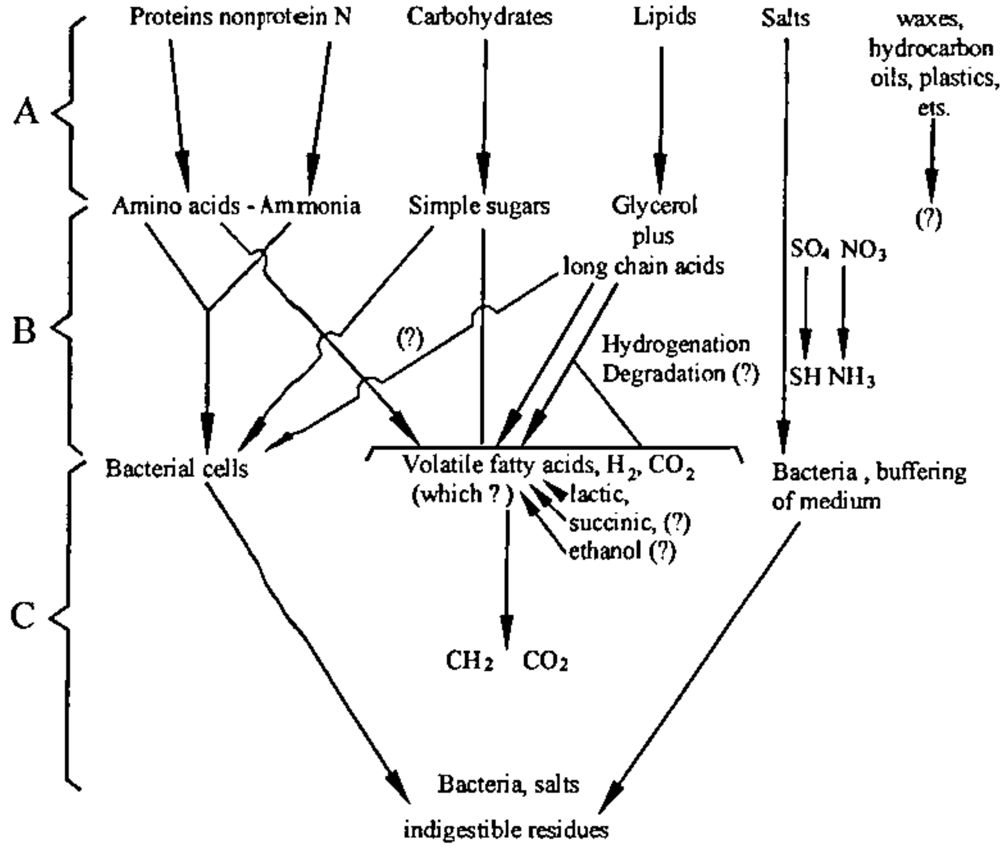
The direct applications of OMW to the soil (especially if it is not accompanied by irrigation) could lead to more adverse than beneficial effects, for which reason it would be necessary to carry out a previous composting process in order to utilize it (Negro and Solano, 1996).

By using composting technologies, it is possible to transform either fresh OMW or sludge from pond-stored OMW mixed with appropriate plant waste materials (carriers) into organic fertilizers (composts) with no phytotoxicity to improve soil fertility and plant production, the process involving the microbial degradation of the polluting load of the wastes (Cegarra et al., 1996).

Composting using other techniques such as aerobic and anaerobic digestion is briefly discussed below.

The following figure clarifies the reaction occurring in the anaerobic digestion, including the following processes:

1. Hydrolysis,
2. Fermentation, and
3. Methanogenesis.



A: hydrolysis; B: fermentation; C: methanogenesis

Source: Hobson et al., (1974)

Figure 2 General Scheme of the Reaction Occurring in Anaerobic Digestion

b) Technical Assessment and Planning

OMW application to soil as fertilizers increases the organic matter content of soils and the availability of some nutrients like N, K, Fe, Mn and Zn. However, the content of these residues tends to increase the electrical conductivity of the calcareous soil (Sierra et al., 1994).

Results of field and plot experiments using OMW- composts to cultivate horticultural and other crops have shown that yields obtained with organic fertilization are similar, and sometimes higher, to those obtained with a balanced mineral fertilizer. However, the bio-availability of iron and manganese may be linked to the soil humic complexes originated by the OMW organic fertilizers (Cegarra et al., 1996).

b.1) Technical Assessment and Planning of OMW Composting Using Various Bulking Agents

The composting process was experimented using various bulking agents in order to determine the most suitable bulking agent. A decline in phytotoxicity or a total disappearance of phytotoxicity were encountered in raw materials in the following composting processes, and most of the resulting composts can therefore be satisfactorily used as fertilizers for agricultural crops.

A mixture of extracted olive press cake and olive tree leaves was used as the solid substrate for composting of OMW. The salinity of the compost was the factor restricting the treatment of OMW by the process

A mixture of crude olive husks, OMW and fresh olive tree leaves inoculated with cow manure. The composting process brought about a total disappearance of phytotoxicity encountered in raw materials. The development of enzymatic activities was positive and no pathogen was found. The compost can therefore be satisfactorily used as amendment for agricultural crops.

Composting of OMW-wheat straw mixture enhanced diazotrophic microflora as indicated by nitrogenase activity. The experiment shows that the compost can be satisfactorily used as a fertilizer for agricultural crops.
OMW containing about 7% solids was composted with wheat straw in a forced aeration static pile. No phytotoxicity was recorded on the end product, the chemical and physical properties of which suggest its possible use as a fertilizer.

The solid residue resulting from the flocculation of OMW was composted using different lignocellulosic residues. Important degradation of organic matter as well as cellulose was observed. In addition, a decline in phytotoxicity which was the initial product presented was observed. The experiment shows that the compost can be used as a fertilizer.

b.2) Technical Assessment and Planning of OMW Composting Using Aerobic and Anaerobic Bioremediation

The aerobic bioremediation of OMW produces high quality compost, characterized by a considerable presence of nutrients, mainly organically-bound nitrogen (1.5-3%), a good level of humification (degree of humification=78%; humification index=0.28), and absence of phytotoxicity. Field experiments performed on maize, rye grass and horticultural plants showed that the application of this compost to these plants reduces the need for chemical fertilization. The compost supply also enhanced both soil oxygen consumption and nitrogen fixation in the open field (Tomati et al., 1996).

The organic and inorganic component levels of the soil amended with anaerobically digested OMW (ADVW) does not differ markedly from those of the untreated (UVW). Both amended soils show increment in the concentrations of soil organic matter, Kjeldahl N, soluble N, soluble NO_3 and available P enhancing soil fertility. On the other hand, the soil amended with ADVW does not show any toxicity, while the toxicity disappears from the soil amended with UVW after approximately 30 days. For detailed information on toxicity reduction by OMW anaerobic digestion see (section 4.2.4).

c) Experiences of OMW Composting Using Various Techniques

c.1) Experiences of OMW Composting Using Various Bulking Agents

1) The co-composting of the solid residue and OMW has been studied as a new method for the treatment of wastewaters containing high organic and toxic pollutants. The solid residue was used as bulking material and OMW was continuously fed in the experimental plant. Composting temperature was controlled between 45 and 65°C by air supply and the wastewater addition was fed mainly in order to keep the moisture in the range of 45 to 60% and secondly to replace the carbon substrate. During 23 days of operation in the

thermophilic region, the system was fed with 263 m^3 wastewater in total, which means an average rate of 11.4 m^3/day wastewater or 2.9 kg wastewater per kg solid residue. The total bioenergy production was estimated to be about 90 000 000 kcal. Then followed a 3 months stabilization period in the mesophilic region until the final product reached ambient temperature (Vlyssides et al., 1996).

2) In another composting study, a mixture of extracted olive press cake and olive tree leaves was used as the solid substrate for composting of OMW. OMW was added to the composting mass to replenish the water loss during processing in a pilot -scale topless static container reactor. The salinity of the compost was the factor restricting the treatment of OMW by the process. The rate of OMW treatment achieved in this study was 2.1 l/kg starting solid substrate (dry weight -d.w). The cumulative moisture and volatile solids content reduction during the temperature-induced aeration period of the process was 19 and 45%, respectively (Papadimitriou et al., 1997).

3) Also, a study to evaluate the quality of cured compost obtained by a mixture of crude olive husks, OMW and fresh olive tree leaves inoculated with cow manure, after 6 months of composting, has been conducted. Biological activities (ATP, DHA, DNA contents and enzyme activities), several microbial groups (including pathogenic bacteria, E. coli and Samonellae) and microflora composition were determined. Phytotoxicity tests were also carried out. The composting process brought about a total disappearance of phytotoxicity encountered in raw materials. The development of enzymatic activities was positive and no pathogen was found. The compost can therefore be satisfactorily used as amendment for agricultural crops (Sciancalepore et al., 1996).

4) In a study for the composting of OMW-wheat straw mixture during which oxygen consumption, microbial growth, lignin and phenol degradation, urease,

were prepared by mixing OMW and OMW sludge with the two bulking agents mentioned above (maize straw and cotton waste) and two organic wastes with high content of nitrogen (sewage sludge and poultry manure), which were composted by the Rutgers static pile composting system in a pilot plant. The aim of this work was to study the evolution of total nitrogen and different forms of organic matter and evaluate the variation in the aerobic bacterial microbiota present and the biotoxicity during the composting process. In piles prepared with OMW, the use of maize straw as a bulking agent reduced the nitrogen losses whereas the use of sewage sludge instead of poultry manure, with cotton waste originated the highest degradation of organic matter. In piles prepared with OMW sludge a similar evolution of the composting process was observed. There were not great variations during composting in the aerobic bacterial microbiota present in mixtures. However, the pile prepared with OMW sludge and maize straw was only one to present bacteria capable of growing in OMW, and the toxicity study showed that this was only present in the starting mixtures (Monteoliva-Sanchez et al., 1996).

c.2) Experiences of OMW Composting by Aerobic and Anaerobic Digestion

1) In an experiment the agronomic value of a compost obtained from the aerobic bioremediation of OMW was tested both by the 'crop test' and following the plant-soil system as influenced by compost supply. The aerobic bioremediation of OMW produces a high quality compost, characterized by a considerable presence of nutrients, mainly organically-bound nitrogen (1.5-3%), a good level of humification (degree of humification=78%; humification index=0.28), and by the absence of phytotoxicity. Field experiments performed on maize showed that compost, when supplied before sowing in amounts of 60-90 Mg ha-1 (equivalent to manuring on the basis of organic matter) is able to reduce the need for chemical fertilization. The same quantity supported the nutritional need of rye grass and horticultural plants. A good

rest-effect was also recorded. Compost supply enhanced both soil oxygen consumption and nitrogen fixation in the open field. An improvement of activities in the plant-soil system was made evident by pot trials (Tomati et al., 1996).

2) A laboratory experiment was performed during a 120-day incubation period in order to evaluate changes in the properties of soil amended with the same waste water from olive-oil processing, either untreated (UVW) or anaerobically digested (ADVW). The experiment shows that, during a 120-day incubation period, the organic and inorganic component levels of the soil amended with anaerobically digested OMW (ADVW) do not differ markedly from those amended with untreated OMW (UVW). However, the contents of the same components for the soil amended with UVW resulted much higher, especially in the first days after the addition and sometimes also at the end of the experimental period. A germination test carried out on the soil amended with ADVW did not show any toxicity, while the soil amended with UVW still showed an inhibitory effect after thirty days, after which the toxicity disappeared completely (Levi-Minzi et al., 1995).

4.2.3 Azotobacter & Nitrogen Fixation in Soils

a) Introduction

The bacterial strain A can grow in OMW showing significant nitrogen fixing capacity for soils (Papadelli et al., 1996). Because of the low content of OMW in nitrogenous organic components and its richness in carbon sources, OMW offer a highly favorable environment for the growth of free-living dinitrogen fixing microorganisms. This property is manifested both in natural environments and in axenic cultures (Balis and Flouri, 1996).

b) Technical Assessment and Planning

Repetitive addition of OMW to soil under aerobic conditions leads progressively to its enrichment with dinitrogen fixers. This activity consequently increases the soil fertility. The microbial consortium that develops in soil due to OMW amendment, is dominated mostly by members of Azotobacter (Balis and Flouri, 1996). The experimental results show that OMW supports the growth of the Azotobacter strain A and strain H23 and that OMW could be utilized as a carbon source for the Azotobacter.

c) Experiences of Azotobacter & Nitrogen Fixation in Soils

c.1) In an experiment OMW was Repetitively added to soil under aerobic conditions. This leads progressively to soil enrichment with dinitrogen fixers, the activity of which is beneficial to soil fertility. The microbial consortium that develops in soil is dominated mostly by members of Azotobacter. A very efficient N_2-fixing and slime producing strain of Azotobacter vinelandii (strain A) was isolated from such an enriched soil sample. The isolate was deposited in the culture collection of the laboratory and its biochemical and molecular characteristics were investigated. The strain proved to be effective in bio-remediation processes of OMW both in a laboratory-scale fermenter unit and a field pilot plant of approximately $5m^3$ capacity. The inhibitory growth-limiting components of the principal OMW constituents and their impact on the duration of the lag period of N_2-fixing activity recovery was examined. The design of a multi-stream two-stage process was described which provides a stable N_2-fixing system suitable for the bio-transformation of OMW into an agrobiological product and/or for the production of extracellular polysaccharide 'slime' in high yields (Balis et al., 1996).

c.2) Another experiment investigates the effect of 1, 5, 10, 15, and 20% (v/v) of OMW on cells of Azotobacter chroococcum grown in chemically defined media (N-free or with $NH4^+$) and dialyzed-soil media. OMW concentrations of

1 to 20% (v/v) significantly reduced dinitrogen fixation and growth of Azotobacter chroococcum in chemically defined N-free medium, whereas the presence of 1 to 15% had a stimulatory effect on dinitrogen fixation and growth of Azotobacter in dialyzed-soil medium. Azotobacter chroococcum grew on $NH4^+$ media (without glucose) amended with OMW, suggesting that these wastes were utilized by Azotobacter as a carbon source (Garcia-Barrionuevo et al., 1993).

c.3) In another experiment large amounts of homo- and copolymers of polyhydroxyalkanoates (PHAs) were produced by Azotobacter chroococcum strain H23 when growing in culture media amended with OMW. Azotobacter chroococcum grown on $NH4^+$ medium supplemented with OMW formed PHAs up to 50% of the cell dry weight after 24h. The results show that OMW supports the growth of strain H23 and also that this waste could be utilized as a carbon source. Production of PHAs by using OMW looks promising, since the use of inexpensive feed-stocks for PHAs is essential if bioplastics are to become competitive products (Gonzalez-Lopez et al., 1996).

4.2.4 Reducing the Toxicity of OMW by Anaerobic Digestion

a) Introduction

Anaerobic digestion of OMW yields methane with an average content of $37m^3/m^3$ of vegetation water and an energetic yield of 325 KwH, of which 30% can be converted into electrical energy and 63% into calorific energy by the use of cogeneration processes. This is sufficient to cover the energy needs of both an olive oil production plant and an anaerobic reactor for the integral purification of wastewater. From an economic point of view, and taking into account the costs of electricity (15 points Kw/h) and calorific energy (3.2 points/therm), the intrinsic value of olive vegetation water would be 2148 pts/m^3.

The maximum BOD_5 concentration of OMW can reach 100 kg/m^3 and the maximum COD, 220 kg/m^3. Anaerobic digestion is a satisfactory method for detoxified OMW treatment. Using simple techniques for anaerobic digestion approximately reduces the total COD by 67% and the soluble COD by 68%. Other more sophisticated techniques reduce soluble COD more than 77% and total COD more than 94%. The use of an anaerobic filter performs the double role of physical retention and anaerobic mineralization and reduces the TSS. The black color of the OMW is weakly reduced by the anaerobic treatment.

b) Technical Assessment and Planning

The anaerobic digestion of OMW can be accomplished by means of various systems. Some of these systems are discussed below:

b.1) The anaerobic digestion of OMW by the use of a two-stage pilot-plant with reactors connected in series; an up-flow type (digester) for the first stage and a fixed-bed type for the second stage.

This system is among the best for biogass production, COD reduction and loading rate, especially for the up-flow digester. Experimental data shows total COD reduction during the anaerobic digestion process in both digesters exceeded 83%. Phenols were also greatly reduced with a concentration reduction that exceeded 75%.

b.2) The anaerobic digestion of OMW by the use of two different types of anaerobic digesters; a fixed-bed type for the supernatant and a plug-flow type for the sludge.

In both digesters, biogass production and COD reduction exceeds the rates mentioned in literature for diluted raw OMW. Experimental data shows that this system resulted in an overall biogas production of 2.28 liters/ liter working volume and in an overall COD reduction of 94.02%.

b.3) In order to compare, anaerobic treatability using different types of OMW, including raw waste (concentrated or dilute) and pretreated waste containing soluble organics only, are evaluated.

Experimental data shows that the removals resulting from anaerobic treatment of concentrated raw waste in draw and fill digesters was found in the range 68-74% mean for soluble BOD_5 and 78-81% mean for soluble COD, while treatment of diluted raw waste in the same type digesters resulted in 83-84% mean BOD_5 and 75-77% mean COD removals.

b.4) The anaerobic treatability of OMW using a laboratory scale up-flow anaerobic sludge blanket reactor (UASBR) was also investigated.
Soluble COD removal was around 75%. Methane conversion rate of 0.35 m^3 per kg COD removed may also be achieved during the study.

b.5) Anaerobic co-treatment of OMW and piggery effluent (PE) was evaluated. Increases in organic load and feed OMW content resulted in reduced biogas methane contents but higher overall methane production rates. Total COD removal efficiencies of 70-77% were achieved consistently, while the methane yield of 0.341-0.349/m^3/kg total COD removed indicated stable operation even at the highest feed OMW content.

c) Experiences on Reducing the Toxicity of OMW by Anaerobic Digestion

c.1) Case Studies on Anaerobic Digestion of OMW

1) A study was undertaken to evaluate the anaerobic digestion of total raw OMW in a two-stage pilot-plant with reactors connected in series. Two different types of anaerobic digesters were used, an up-flow type and a fixed-bed type. The main purpose of the study was to evaluate the performance of an up-flow type reactor working in series with a fixed-bed type reactor, which was used as complementary treatment. The pilot-plant system operated in the

mesophilic range (35± 1°C) during approximately 390 days, and with organic matter loading levels that ranged between 2.8 and 12.7 g COD/liter.day. Concentrated aqueous ammonia was added to the total raw wastewater to adjust the C/N ratio to the optimum value of 20/1, and this also achieved stabilization of the pH values in the digesters within a range about neutrality. In a series of seven consecutive experiments, for the first stage (upflow digester) optimum values of specific biogas production rate established at a value of 2.1 liters/liter digester.day with a very satisfactory COD reduction of 83% (with a volumetric load of 11 g COD/liter.day). For the second stage (fixed-bed digester), the biogas production rate established at a value of 0.22 liters/liter digester.day with a COD reduction of 8% (with a volumetric load of 0.19 g COD/l. day). These results show that this system is among the best for biogass production, COD reduction and loading rate, especially for the up-flow digester. Phenols were greatly reduced during the anaerobic digestion process in both digesters, with a concentration reduction reached 75% in the up-flow digester; with the use of the second stage (fixed-bed reactor) a further reduction of 45% was obtained (Dalis et al., 1996).

2) Another study was undertaken in Greece to investigate controlled mesophilic anaerobic digestion of both the supernatant and the sludge from settled OMW. Two different types of anaerobic digesters were used, a fixed-bed type for the supernatant and a plug-flow type for the sludge. Concentrated aqueous ammonia and sodium carbonate were added to adjust the C/N ratio and the pH values of the solution in each digester. In both digesters, biogass production and COD reduction exceeded the rates mentioned in literature for diluted raw OMW. In the digester fed with the supernatant, biogass production rate was established at a value of 1.86 liters/ liter working volume (average of 24 biogas values) with a COD reduction of 90.91%. In the digester fed with the settled sludge, biogas production rate established at a mean value of 2.75 liters/ liter working volume (average of 12 biogas values) with a COD

reduction of 94.95%. These values resulted in an overall biogas production of 2.28 liters/ liter working volume and in an overall COD reduction of 94.02% with a final COD concentration of 4000 mg/l OMW (Georgacakis and Dalis, 1993).

3) In order to evaluate the anaerobic treatability of different types of OMW, including raw waste (concentrated or dilute) and pretreated waste containing soluble organics only, another study was undertaken in Greece. Anaerobic treatment of concentrated raw waste in draw and fill digesters operating at organic loading levels up to 4 kg COD/m^3/d affected 68-74% mean BOD_5 and 78-81% mean COD removals, while treatment of diluted raw waste in the same type digesters fed at hydraulic detention time of 8 d and organic loading levels up to 3.7 kg COD/m^3/d resulted in 83-84% mean BOD_5 and 75-77% mean COD removals. Anaerobic treatment of soluble organics contained in OMW in draw and fill digesters operating under simulated steady state conditions at hydraulic detention times 8-20 d and an organic loading level of 0.8 kg COD/m^3/d achieved 72-88% mean BOD_5 and 56-70% mean COD removals. The maximum attainable soluble organics removal was found in the range 77-79% for soluble COD and 92-95% for soluble BOD_5 (Tsonis and Grigoropoulos, 1993).

4) A study was undertaken in Turkey to investigate the anaerobic treatability of OMW using a laboratory scale up-flow anaerobic sludge blanket reactor (UASBR) operated for about 6 months.

In the first part of the study, the reactor was operated with feed COD concentrations from 5000 to 19,000 mg/l and a retention time of 1 day, giving organic loading rates from 5 to 18 kg COD/m^{3}d. Soluble COD removal was around 75% under these conditions. In the second part of the study, feed CODs were varied from 15,000 to 22,600 mg/l while retention times ranged from 0.83 to 2 days; soluble COD removal was around 70%. A methane conversion rate of 0.35 m^3 per kg COD removed was achieved during the study. The average volatile solids concentration in the reactor had increased from 12.75 g/l to 60 g/l by the end of the study. The settleability of the anaerobic sludge in the reactor was excellent. Sludge granules ranging from 3 to 8 mm in diameter were produced in the reactor (Ubay and Oeztuerk, 1997).

5) Anaerobic co-treatment of OMW and piggery effluent (PE) was performed to evaluate the operational conditions required to develop a feasible method of OMW treatment. The effect of influent concentration and composition on the performance of an up-flow anaerobic filter treating a mixture of these wastes was investigated by gradually increasing the proportion of OMW in the feed from 8% to 83% by volume. Organic loads ranged from 3 to 10 kg COD/m^3 d, with substrate organic load ratio (OMW COD/PE COD) varying from approximately 6 to around 30. Hydraulic retention times of 6-7 days were employed throughout. Increases in organic load and feed OMW content resulted in reduced biogas methane contents but higher overall methane production rates. Total COD removal efficiencies of 70-77% were achieved consistently, while the methane yield of 0.341-0.349/m^3/kg total COD removed indicated stable operation even at the highest feed OMW content (Marques et al., 1997).

c.2) Interaction Between Acidogenesis and Methanogenesis in the Anaerobic Treatment of OMW

Interaction between the two successive stages occurring in the anaerobic digestion, the acidogenesis and the methanogenesis was investigated. Most of the lipids were degraded both in acidogenesis and methanogenesis tests. Polyphenol-like substances were not degraded at all in acidogenesis conditions, whereas they were partially removed in methanogenesis conditions. Oleic acid was degraded both in acidogenesis and methanogenesis tests, provided that an easily biodegradable substrate (glucose) was added to the solution. The presence of glucose was also required for the degradation of p-hydroxybenzoic acid in the methanogenesis conditions. This acid was not degraded at all in acidogenesis conditions, thus confirming the results obtained in the tests on OME (olive mill effluents). This result shows that a two-phase anaerobic digestion is suitable for optimizing OMW degradation (Beccari et al., 1996).

c.3) The Effects of the Most Important Polyphenolic Constituents of OMW on Batch Anaerobic Methanogenesis

A major limitation of the anaerobic digestion of OMW is inhibition of methanogenesis bacteria by simple Phenolic compounds, certain organic acids and Polyphenols. Pretreatment methods that modify or remove these natural inhibitors improve digestion of OMW (Hamdi, 1995).

In an experiment aiming to evaluate the effects of the most important Polyphenolic constituents of OMW (which are: tyrosol, oleuropein and caffeic, p-hydroxybenzoic and protocatechuic acids) on batch anaerobic methanogenesis, these constituents were added at various concentrations to aliquots of domestic anaerobic sludge in Hungate serum bottles and these were incubated at 35 °C. The concentration of methane in the headspace gas was monitored to determine if the Phenolics were fermented to methane or if they inhibited the anaerobic process. Only tyrosol and p-hydroxybenzoic acid were fermented to methane. At 600 mg/l (but not at 400 mg/l) oleuropein reduced the rate and the amount of methane produced. The ortho-diphenols (caffeic and protocatechuic acids) were inhibitory at 1000 mg/l but not at 500 mg/l. In cultures supplemented with acitic and propionic acids (VFA), and in unsupplemented cultures, tyrosol at concentrations up to 600 mg/l was fermented to methane. Between 900 and 1300 mg/l tyrosol, methane production was neither enhanced nor inhibited relative to control cultures containing no tyrosol. Inhibition of methane production was evident when tyrosol was present at greater than or equal to 2000 mg/l. In similar experiments with p-hydroxybenzoic acid enhanced methane production was observed at concentrations of less than or equal to 500 mg / l; no enhancement or inhibition was observed at 700 mg / l; and inhibition was noted when p-hydroxybenzoic acid was present at greater than or equal to 1000 mg / l (Borja et al., 1996).

c.4) Comparison Between Anaerobic and Aerobic Treatment of OMW

The maximum BOD_5 concentration of OMW can reach 100 kg/m^3 and the maximum COD, 220 kg/m^3. An anaerobic filter (AF) was compared with an aerobic fluidized bed fermentor (AFBF) for treating detoxified OMW by Aspergillus niger. The AF performed better than the AFBF in treating the wastewater. The AFBF removed 57% of total COD after elimination of total suspended solids that correspond to sludge. The treatment of detoxified OMW by AF reduced the total COD by 67% and the soluble COD by 68.1%. The AF performed the double role of physical retention and anaerobic mineralization and reduced the TSS by 62.9%. The AFBF was less economic than AF because it consumed more aeration energy and produced high amounts of secondary sludge. The AF produced biogas at 80% methane. The black color of the OMW was weakly reduced only by the AF (Hamdi and Ellouz, 1993).

4.2.5 Polyphenols and Phenols Pollution by OMW & their Reduction

a) Introduction

OMW is a powerful pollutant, resistant to degradation and presents a severe environmental problem related to high organic content made up largely of simple phenolic compounds, that are both antimicrobial and phytotoxic. The presence of phenolic compounds in OMWs makes them highly toxic and ecologically noxious to the waterways into which they are dumped unprocessed, as is usually the case in many Mediterranean countries. In addition, direct unloading onto the ground may result in phytotoxic effects on the soil and the groundwater. Because OMW contains the aforementioned toxic compounds and of the peculiar production habits of olive oil manufacturers, OMW calls for rather specific purification procedures in order to avoid agro-industrial pollution.

b) Technical Assessment and Planning

b.1) The Impact of the Main Phenolic Compounds of OMW on Batch Anaerobic Methanogenesis.

The most important phenolic constituents of OMW are tyrosol, oleuropein and caffeic, p-hydroxybenzoic and protocatechuic acids. Only tyrosol and p-hydroxybenzoic acid are fermented to methane in the anaerobic batch reactor. The concentration of methane in the headspace determines if the phenolics are fermented to methane or if they inhibite the anaerobic process. At 600 mg/l (but not at 400 mg/l) oleuropein reduces the rate and the amount of methane produced. The ortho-diphenols (caffeic and protocatechuic acids) are inhibitory at 1000 mg/l but not at 500 mg/l. In cultures supplemented with acetic and propionic acids (VFA), and in unsupplemented cultures, tyrosol at concentrations up to 600 mg/l is fermented to methane. Between 900 and 1300 mg/l tyrosol methane production is neither enhanced nor inhibited relative to control cultures containing no tyrosol. Inhibition of methane production is evident when tyrosol is present at greater than or equal to 2000 mg/l.

b.2) The Antimicrobial Activity of OMW and Biotransformed OMW.

i) The micro organisms (Bacillus pumilus) is capable of reducing the phenol content of OMW. However, the biotransformation also depends on the dilution (v/v) of the OMW. The bacterium has most effect in reducing the phenol content of OMW at concentrations of between 40 and 100%. At concentrations of 80%, in addition to a slight further reduction in total phenols, new phenolic compounds, not present in the original OMW, are generated.

ii) In comparison of the capability of the Bacillus pumilus and Arthrobacter of fermenting tyrosol experiments show that: Arthrobacter is capable of completely transforming added tyrosol to the corresponding 4-hydroxyphenylacetic acid (that is available in untreated OMW) and after 139h of fermentation no traces of tyrosol can be identified. In contrast, only traces of phenylacetic acid are produced by Bacillus pumilus after 139h of fermentation of tyrosol.

b.3) Reduction of Phenol Content and Toxicity in OMW with the Ligninolytic Fungus Pleurotus Ostreatus.

The toxicity of the phenolic compounds present in OMW can be assimilated to lignin components. Only few microorganisms, mainly "white-rot" basidiomycete, are able to degrade lignin by means of oxidative reactions catalysed by phenol oxidases and peroxidases. Ligninolytic organisms and their enzymes are evaluated for the treatment of these kinds of substrates. In specific,"white-rot" basidiomycete Pleurotus ostreatus and particularly the phenol oxidases it produces is evaluated for its capablity of the detoxification of OMW phenol compounds. Experiments show that the treatment of OMW with purified phenol oxidase showed a significant reduction of its phenolic content, but no decrease of its toxicity was observed when tested on Bacillus cereus. Otherwise, the effect of processing OMW with the entire microorganism resulted in a noticeable detoxification of the waste with concomitant abatement of the phenol content.

c) Experiences on Polyphenols and Phenols Pollution by OMW and Their Reduction

c.1) Experiences on Polyphenols and Phenols Pollution Due to OMW

Groundwater pollution caused by OMW spreading on soil was tested. The study area included several olive mills. The chemical and hydro-geological characteristics of the aquifer system were studied. Particular attention was given to the presence of phenols in water samples because of their high content in these wastewaters. A connection between the wastewater spreading areas and local high concentrations of phenolic compounds in groundwater was found and OMW were recognized as being the source of local groundwater pollution by polyphenols (Spandre and Dellomonaco, 1996).

c.2) Experiences on the Impact of the Main Phenolic Compounds of OMW on the Kinetics of Acetoclastic Methanogenesis.

Bench-scale tests were conducted to assess the impact of the most representative phenolic compounds present in OMW, two cinnamic acid derivatives (p-coumaric and caffeic acids) and two benzoic acid derivatives (p-hydroxybenzoic and protocatechuic acids), on the kinetics of acetoclastic methanogenesis. Phenolic compounds were added to cultures transferred from an acetate-enriched seed culture reactor. A control without phenolic compound was included as a basis for comparison. Unacclimated cultures were used to minimize the biodegradation of the toxic organic chemicals during the test. A finite-difference, non-linear, least-squares algorithm was used to estimate kinetic parameters by obtaining a best fit of the experimental data to the classical Monod growth and substrate utilization model. Resulting kinetic coefficients revealed substantial changes in both the maximum rate of acetate conversion, k, and the half-velocity coefficient, K_s, when both cinnamic and benzoic acid derivatives were used. The relative effect of the phenolic compound was manifested in a decrease in the value of k or an increase in the value of Ks as the phenolic compound concentration increased. Therefore, mixed inhibition was occurring. In addition, the toxic effects were clearly related to the molecular structure of the phenolic compound in each pair of toxicants studied, the inhibitory impact being greater for the ortho-diphenols (caffeic and protocatechuic acids) in relation to their corresponding monophenolic compounds (p-coumaric and p-hydroxybenzoic acids, respectively) (Borja et al., 1997).

c.3) Experiences on the Impact of the Main Phenolic Compounds of OMW on Batch Anaerobic Methanogenesis.

The most important phenolic constituents of OMW, i.e. tyrosol, oleuropein and caffeic, p-hydroxybenzoic and protocatechuic acids, were added at various concentrations to aliquots of domestic anaerobic sludge in Hungate serum bottles and these were incubated at 35°C. The concentration of methane in the headspace gas was monitored to determine if the phenolics were fermented to methane or if they inhibited the anaerobic process. Only tyrosol and p-hydroxybenzoic acid were fermented to methane. At 600 mg/l (but not at 400 mg/l) oleuropein reduced the rate and the amount of methane produced. The ortho-diphenols (caffeic and protocatechuic acids) were inhibitory at 1000 mg/l but not at 500 mg/l. In cultures supplemented with acetic and propionic acids (VFA), and in unsupplemented cultures, tyrosol at concentrations up to 600 mg/l was fermented to methane. Between 900 and 1300 mg/l tyrosol methane production was neither enhanced nor inhibited relative to control cultures containing no tyrosol. Inhibition of methane production was evident when tyrosol was present at greater than or equal to 2000 mg/l.

In similar experiments with p-hydroxybenzoic acid enhanced methane production was observed at concentrations of less than or equal to 500 mg/l; no enhancement or inhibition was observed at 700 mg/l; and inhibition was noted when p-hydroxybenzoic acid was present at greater than or equal to 1000 mg/l (Borja et al., 1996).

c.4) Experiences on the Antimicrobial Activity of OMW and Biotransformed OMW.

1) The capability of the microorganisms (Bacillus pumilus) to reduce the phenol content of OMW was studied. The study shows that the biotransformation depends on the dilution (v/v) of the OMW. Furthermore, a real evaluation of the extent of OMW biotransformation was sought. This was achieved by means of an internal reference, i.e. in relative terms, the phenol content resulting from the biotransformation process. The phenol content was measured using HPLC techniques, and results were obtained showing that the bacterium had most effect in reducing the phenol content of OMW at concentrations of between 40 and 100%. It was also observed that at concentrations of 80%, in addition to a slight reduction in total phenols, new phenolic compounds, not present in the original OMW, were generated (Ramos-Cormenzana et al., 1996).

2) The main objectives of the presented Spanish-German collaboration are the purification of OMW by biodegrading phenolic compounds and the investigation of metabolites during fermentation prior to its safe disposal. In addition to 12 well-known compounds, 3,4-dihydroxyphenylglycol was also identified in untreated Spanish and Italian OMW samples using a GC/MS method. The qualitative composition of the Italian and Spanish smaples differ.

First results of degradation tests of reference substances are reported: Arthrobacter is capable of completely transforming added tyrosol to the corresponding 4-hydroxyphenylacetic acid and after 139h of fermentation no traces of tyrosol can be identified. In contrast, only traces of phenylacetic acid are produced by Bacillus pumilus after 139h of fermentation of tyrosol (Knupp et al., 1996).

c.5) Experiences on Reduction of Total Polyphenols in OMW by Physico-Chemical Purification.

The influence of the physico-chemical purification was analyzed. The results obtained show that the physico-chemical technique is satisfactory in the reduction of total polyphenols both on the laboratory scale and at two OMW purifying plants dealing with various wastes of this kind (Gonzalez et al., 1994).

c.6) Experiences on Reduction of Phenol Content and Toxicity in OMW with the Ligninolytic Fungus Pleurotus Ostreatus.

OMW constitute a major environmental problem because of the large amount produced and the toxicity of the phenolic compounds present. Several of these aromatic compounds can be assimilated to many of the components of lignin. Only few microorganisms, mainly "white-rot" basidiomycete, are able to degrade lignin by means of oxidative reactions catalysed by phenol oxidases and peroxidases. Both the low degree of specificity which characterizes these enzymes, and the structural relationships of many aromatic pollutants with the natural substrates of the enzymes, have suggested the use of ligninolytic organisms and of their enzymes for the treatment of these kinds of substrates. The paper investigates the ability of the "white-rot" basidiomycete Pleurotus ostreatus and particularly of the phenol oxidases it produces in the detoxification of OMW phenol compounds. Treatment of OMW with purified phenol oxidase showed a significant reduction of phenolic content, but no decrease of its toxicity was observed when tested on Bacillus cereus. Otherwise, the effect of processing OMW with the entire microorganism resulted in a noticeable detoxification of the waste with concomitant abatement of the phenol content (Martirani et al., 1996).

4.2.6 Heavy Metals from OMW Pollution and Removal

a) Introduction

OMW contains heavy metals in varying concentrations. These heavy metals include: Ni, Cd, Zn, Cu, Pb, Fe and Mn. In this section the effect of OMW solutions on the solubilization of heavy metals at various pH values was studied.

Furthermore, the potential use of processed solid residue of olive mill products (SROOMP) to treat drinking water containing several heavy metals in trace concentrations was studied.

Heavy metal recovery by the use of Azotobacter vinelandii biomass production from OMW was also evaluated. Moreover, heavy metal removal by solar collectors was discussed.

b) Technical Assessment and Planning

b.1) OMW solutions affect the solubilization of heavy metals. However, pH of these solutions has the dominant effect on the solubilization of many heavy metals such as Ni, Cd, Zn, Cu, Pb with the exception of Fe and Mn. OMW solutions causes mobilisation of most metals mentioned above at pH 5 except Cd and Zn and this effect is progressively less marked as pH decreases, so that at pH 4 less mobilisation is detected for Ni, Cu, Mn and Pb, and at pH 3 only is noticeable for Ni and Mn.

b.2) The processed solid residue of olive mill products (SROOMP) has the potential to treat drinking water containing some heavy metals in trace concentrations, namely Pb(II) and Zn(II) by adsorption.

b.3) Azotobacter vinelandii biomass production from OMW was also evaluated for heavy metal recovery from a liquid stream. Azotobacter vinelandii proved to be successful in adsorbing cadmium and lead ions from the liquid stream.

b.4) By solar collectors, the photocatalysis allows the oxidation / reduction of the heavy metals by the chemical action of light, in the presence of a catalyst agent such as Titanium dioxide (TiO_2). Although the process is natural and fully understood, practical and economic solar detoxification systems are not available yet.

c) Experiences on Heavy Metals Pollution and Removal

c.1) The effect of OMW solutions on the solubilization of Ni, Cd, Zn, Cu, Mn, Pb and Fe in a sediment from Agrio river (Seville, Spain) at pH 3, 4 and 5 was studied. Metal solubilized by OMW solutions was compared with data from different fractions of metal speciation of the sediment. The data shows that the dominant effect is pH for all metals with the exception of Fe and Mn. Within a given pH, it is shown that the presence of OMW solutions causes mobilisation of most metals studied at pH 5 except Cd and Zn and this effect is progressively less marked as pH decreases, so that at pH 4 mobilisation is detected for Ni, Cu, Mn and Pb, and at pH 3 only is noticeable for Ni and Mn. The joint effect of pH and of the presence of OMW is the release of amounts of metals which are comparable to those metal fractions attributed to exchangeable and bound to carbonates (Berjarano and Madrid, 1996).

c.2) Complexing parameters in aqueous systems containing heavy metals and OMW have been estimated using a cation exchange resin method. The parameters estimated were the maximum complexing ability (MCA), the stability constant (K_c) and a parameter indicating the stoichiometrical characteristics of the complex (a). MCA of OMW for Cu, Zn, Pb and Mn was 0.470, 0.314, 0.068 and 0.300 mmol /g OMW respectively, and was related with the ionic radii of the various metal ions. The log K_c values followed the sequence: Cu>Pb>Zn>Mn in agreement with their respective electronegativities. In the case of Cu and Pb, data obtained here was compared with that determined in other work (Berjarano and Madrid, 1996).

c.3) The potential use of processed solid residue of olive mill products (SROOMP) to treat drinking water containing several heavy metals in trace concentrations, namely Cr(III), Ni(II), Pb(II), Cd(II), and Zn(II), was explored. Different experimental approaches including equilibrium batch mode experiments, scanning electron microscopy (SEM), and X-ray fluorescence (XRF) were used to explore the feasibility of this material as an adsorbent for the removal of these heavy metals from aqueous solutions. Results indicate that SROOMP can be used to remove Pb(II) and Zn(II) from aqueous solutions by adsorption (data best fit Fruenlich isotherm) but does not remove the other heavy metals investigated in this study (Gharaibeh et al., 1998).

c.4) Other experiments were conducted for heavy metal recovery by the use of Azotobacter vinelandii biomass production from OMW. Sixteen litres of OMW diluted to 5% organic matter (d.w.) were inoculated in a fermentor (T = 30°C, air flow = 161/m, stirring = 100 rpm) with a strain of Azotobacter vinelandii. After 2 weeks the bacterial biomass was separated by centrifugation and capsular polysaccharide (CPS) and exopolysaccharides were extracted. The apparent molecular weight of CPS was determined by gel filtration. The CPS was entrapped in polyvinyl alcohol membranes that were used to adsorb cadmium and lead ions from a liquid stream (Pasetti et al., 1996).

4.2.7 OMW Treatment by Means of an Electrolysis System

a) Introduction

OMW treatment by means of an electrolysis system may be done by several methods. These methods include total oxidation and indirect oxidation. Both of these methods are discussed in this section.

b) Technical Assessment and Planning

b.1) Technical Assessment of the Electrolytic Method of Total Oxidation

Experiments indicate that the electrolytic method of total oxidation of OMW is not feasible. However, it could be used as an oxidation pretreatment stage for detoxification of the wastewater. After 10 h of electrolysis at 0.26 A/cm^2, total COD may be reduced by 93%, total TOC may be reduced by 80.4%, VSS may be reduced by 98.7%, and total phenolic compounds may be reduced by 99.4%. On the other hand, the mean energy consumption may reach 12.3 kwh per kg of COD removed for the 10 h period.

b.2) Technical Assessment of the Electrolytic Method of Indirect Oxidation

The electrolytic method of indirect oxidation is highly efficient and consumes only short times. This leads to the optimization of experimental conditions to obtain significant decoloration of the effluent associated to reduction of toxicity and organic content.

c) Experiences on OMW Treatment by Means of Electrolysis

c.1) OMW was treated by an electrochemical method using Ti/Pt as anode and Stainless Steel 304 as cathode. In this technique, sodium chloride 4% (w/v) as an electrolyte was added to the wastewater and the mixture was passed through an electrolytic cell. Due to the strong oxidizing potential of the chemicals produced (chlorine, oxygen, hydroxyl radicals and other oxidants) the organic pollutants were wet oxidized to carbon dioxide and water. A number of experiments were run in a batch, laboratory-scale, pilot-plant, and the results are reported here. After 1 and 10 h of electrolysis at 0.26 A/cm^2, total COD was reduced by 41 and 93%, respectively, total TOC was reduced by 20 and 80.4%, VSS were reduced by 1 and 98.7%, and total phenolic compounds were reduced by 50 and 99.4%, while the mean anode efficiency was 1960 g h^{-1} A^{-1} m^{-2} and 340 g h^{-1} A^{-1} m^{-2}. Also, the mean energy consumption was 1.273 kwh per kg of COD removed and 12.3 kwh per kg of COD removed for 1 and 10 h, respectively. These results strongly indicate that this electrolytic method of total oxidation of OMW is not feasible. However, it could be used as an oxidation pretreatment stage for detoxification of the wastewater (Israilides et al., 1997).

c.2) Another attempt to reduce the toxicity and the organic content of OMW was demonstrated. The high efficiency together with short times of electrolysis, for indirect oxidation, lead to the optimisation of experimental conditions to obtain significant decolouration of the effluent associated to reduction of toxicity and organic content (Urmal et al., 1996).

4.2.8 OMW Treatment by Ozone & UV Radiation

a) Introduction

OMW treatment by oxidizing the protocatechuic and Vanillic acids (which are phenolic and polyphenolic compounds, respectively) present in OMW, have been done by ozonation and UV radiation. The oxidation processes may be done through several techniques: (1) the combination of ozone and UV radiation, (2) the combination of hydrogen peroxide and UV radiation, (3) UV radiation, or (4) ozonation separately. These methods are discussed in this section.

b) Technical Assessment and Planning

Through the study of ozonation and UV radiation for protocatechuic and Vanillic acids removal from OMW, special attention was paid to kinetics. The kinetic parameters were determined and correlated as a function of pH and temperature.

b.1) In the study of the oxidation process by the combination of ozone and UV radiation, for the chemical degradation of protocatechuic acid, the kinetic study was carried out by taking into account the contributions of the single ozonation and the photochemical reaction and applying the film theory model. The apparent kinetic constants and reaction orders for the combined reaction are deduced and correlated as a function of pH and temperature.

b.2) In the study of the oxidation process by the combination of hydrogen peroxide and UV radiation, for the chemical degradation of protocatechuic acid, an empirical reaction rate expression that considers the contribution of both oxidants, UV radiation and hydrogen peroxide, is proposed. The kinetic rate constants for this combined reaction are also obtained and correlated as a function of temperature and pH.

b.3) In the study of the oxidation process by UV radiation and by the combination of ozone and UV radiation, for the chemical oxidation of Vanillic acids, the operating variables considered were the temperature, pH, and initial Vanillic acid concentration, plus ozone concentration in the combined experiments. In both processes, the specific kinetic parameters were determined and correlated as a function of the temperature: the quantum yields for the photochemical oxidation, and the apparent kinetic constants for the combined oxidation.

b.4) In the study of the oxidation process by ozonation for the oxidation of Vanillic acids, the experiments were conducted modifying the temperature, pH, ozone concentration in the gas stream and initial contaminant concentration. The stoichiometric ratio for the reaction, the influence of the operating variables and the ozonation yields in the process were determined. A model based on the film theory was used to develop the kinetic study of the degradation process, the kinetic rate constants obtained being correlated as a function of pH and temperature.

In another study of the oxidation process by ozonation for the oxidation of Protocatechuic acid, the influence of the operating variables (temperature, pH, ozone partial pressure and initial acid concentration) was established and the kinetic regime of ozone absorption was shown to be fast and pseudo m-order with respect to ozone, except at pH 2, when the reaction developed in the moderate kinetic regime. The reaction orders were deduced and the kinetic rate constants determined as a function of pH and temperature. A modified Arrhenius expression was proposed to correlate them.

c) Experiences on OMW Treatment by Ozone & UV Radiation

c.1) OMW Treatment (a) by the Combination of Ozone and UV Radiation and (b) by Hydrogen Peroxide and UV Radiation

Two advanced oxidation processes: the combination of ozone and UV radiation, and hydrogen peroxide and UV radiation, have been used in the chemical degradation of protocatechuic acid, a phenolic pollutant present in OMW. In the first case, the kinetic study is carried out by taking into account the contributions of the single ozonation and the photochemical reaction and applying the film theory model. The apparent kinetic constants and reaction orders for the combined reaction are deduced and correlated as a function of pH and temperature. In the second case, an empirical reaction rate expression which considers the contribution of both oxidants, UV radiation and hydrogen peroxide, is proposed. The kinetic rate constants for this combined reaction are also obtained and correlated as a function of temperature and pH (Benitez et al., 1996).

c.2) OMW Treatment (a) by UV Radiation and (b) by the Combination of Ozone and UV Radiation

The chemical oxidation of Vanillic acids, a polyphenolic compound present in OMW, is studied by the action of UV radiation and the combination of ozone and UV radiation. The operating variables considered were the temperature, pH, and initial Vanillic acid concentration, plus ozone concentration in the combined experiments. In both processes, the specific kinetic parameters were determined and correlated as a function of the temperature: the quantum yields for the photochemical oxidation, and the apparent kinetic constants for the combined oxidation (Benitez et al., 1995).

c.3) OMW Treatment by Ozonation

The oxidation of Vanillic acid, an important pollutant in OMW, by ozone is investigated in a semi-continuous reactor. The experiments were conducted modifying the temperature, pH, ozone concentration in the gas stream and initial contaminant concentration. The stoichiometric ratio for the reaction, the influence of the operating variables and the ozonation yields in the process are determined. A model based in the film theory is used to develop the kinetic study of the degradation process, the kinetic rate constants obtained being correlated as a function of pH and temperature (Benitez et al., 1994).

Protocatechuic acid constitutes one of the most important pollutants in OMW. The oxidation of protocatechuic acid with ozone in aqueous solution has been studied varying the temperature, pH, ozone partial pressure and initial acid concentration to determine the main kinetic parameters of the degradation process which must be known to design a contactor where the ozonation will be carried out. A stoichiometric ratio of 2 mol of ozone consumed per mol of protocatechuic acid reacted is deduced from homogeneous experiments in a discontinuous tank reactor. In the ozonation experiments, the influence of the operating variables was established and the kinetic regime of ozone absorption was shown to be fast and pseudo m-order with respect to ozone, except at pH 2, when the reaction developed in the moderate kinetic regime. After applying a mass transfer with chemical reaction model, the reaction orders were deduced and the kinetic rate constants determined as a function of pH and temperature. A modified Arrhenius expression is proposed to correlate them (Benitez et al., 1993).

4.2.9 Biological Purification of OMW

a) Introduction

Biological purification of OMW is done by the microorganisms such as aspergillus terreus and Bacillus pumilus. However, the concentration of OMW and the duration of the biological purification process greatly affect the final degradation results.

b) Technical Assessment and Planning

Among the micro organisms aspergillus terreus showed greater efficiency in degrading the OMW. Still, the biological purification of OMW depends on the concentration of OMW. Experiments show that:

b.1) **Aspergillus Terreus** gave the best results in the biological purification of OMW at approximately 80% concentration, degrading organic material by 53%, expressed as COD, and 67%, expressed as BOD. Degradation of the total phenol content, which included the great majority of phenolic compounds, reached 69%.

b.2) **Bacillus Pumilus** had most effect in reducing the phenol content of OMW at concentrations of between 40 and 100%. However, at concentrations of 80%, in addition to a slight reduction in total phenols, new phenolic compounds, not present in the original OMW, were generated.

b.3) After 48 hours of biodegradation, Bacillus pumilus began to produce new phenolic compounds , while this phenomenon occurred with Aspergillus only after six days; thus four days was taken to be the maximum fermentation period to give optimum degradation.

b.4) OMW cannot be conveniently treated by biological processes as they contain phenol compounds that are toxic and recalcitrant to biodegradation. Wet air oxidation treatment allows a complete decolorization of OMW and a

77% COD reduction; the remaining COD is mainly low molecular weight carboxylic acids (chiefly acetic) easy for a biological post-treatment.

c) Experiences on Biological Purification of OMW

c.1) Biological Purification of OMW by Aspergillus Terreus

Aspergillus terreus gave the overall best results in the biological purification of OMW at approximately 80% concentration, degrading organic material by 53%, expressed as COD, and 67%, expressed as BOD. Degradation of the total phenol content, which included the great majority of phenolic compounds, reached 69% (Nieto et al., 1993).

c.2) Comparison Between the Biological Purification of OMW by Bacillus Pumilus & Aspergillus Terreus

The biodegradation of the organic content of OMW was investigated by comparing the results of Bacillus pumilus with those of Aspergillus terreus in an initial 20% OMW solution under aerobic conditions. Samples were drawn from the final centrifugation step into sterile flasks and diluted to concentrations of between 20% and 80%. Aspergillus terreus showed a greater efficiency in degrading the OMW. The fungus was most effective at concentrations of about 80%. After 48 hours, Bacillus pumilus began to produce new phenolic compounds and thereby raised the chemical oxygen demand. This phenomenon occurred with Aspergillus only after six days; thus four days was taken to be the maximum fermentation period to give optimum degradation. This degradation process might have an industrial application since, with the reduction in the concentration of a large number of phenolic compounds, the remaining effluent would have less antimicrobial capacity. Thus, the time needed in anaerobic digesters for the production of methane would be reduced. The biomass obtained could then be used either as a fertilizer or, in concentrated form, as a supplementary feed additive (Brunone-PTT) (Martinez-Nieto et al., 1993).

Micro organisms (Bacillus pumilus) has the potential to reduce the phenol content of OMW. The biotransformation of OMW depends on the dilution (v/v) of OMW. OMW biotransformation was evaluated by means of an internal reference, i.e. in relative terms, the phenol content resulting from the biotransformation process. The phenol content was measured using HPLC techniques, and results were obtained showing that the bacterium had most effect in reducing the phenol content of OMW at concentrations of between 40 and 100%. It was also observed that at concentrations of 80%, in addition to a slight reduction in total phenols, new phenolic compounds, not present in the original OMW, were generated (Ramos-Cormenzana et al., 1996).

c.3) Complete Treatment of OMW by Biological Processes Coupled with a Wet Air Oxidation Process

OMW cannot be conveniently treated by biological processes as they contain important amounts of phenol-like compounds, toxic and recalcitrant to biodegradation. Wet air oxidation (WAO) process catalysed by hydrogen peroxide coupled with bioxidation for the treatment of OMW was investigated. Oxidation was conducted according to the "hydrogen peroxide promoted wet air oxidation" process between 180 and 200 degree C. It consists of injecting continuously hydrogen peroxide at a low dosage (10% on a COD basis) into a WAO reactor in order to promote the radical reactions and then lowering the temperature and pressure constraints. WAO treatment allows a complete decolorization of the solution, a 77% chemical oxygen demand (COD) reduction; the remaining COD is mainly low molecular weight carboxylic acids (chiefly acetic) easy for a biological post-treatment. Compared to the various processes reported in the literature, this two step process offers a good opportunity for OMW depollution (Chakchouk et al., 1994).

4.2.10 Decolorization of OMW

a) Introduction

Decolorization of OMW is done by **chemical and biological means.** In general, the treatment of OMW is always accompanied by decolorization or color reduction of OMW. However the following techniques are conducted especially for the purpose of OMW decolorization.

b) Technical Assessment and Planning

b.1) Decolorization of OMW by Chemical Means:

i) Aluminium sulphate, lime and hydrogen peroxide exert decolorizing effect when applied to strains of Pleurotus, yet the most effective is hydrogen peroxide, followed by lime and alumina. Among the Pleurotus species under test P. cornucopiae (ATCC 38547) and P. ostreatus (ATCC 34675) were the most efficient.

ii) lignin peroxidase (LiP) and manganese peroxidase (MnP) also exert decolorizing effect on decolorizing OMW by Phanerochaete chrysosporium. 25% of OMW decolorization was found with P. chrysosporium which was grown in a medium with a high Mn(II) concentration and in which a high level of MnP (0.65 μ m) was produced. In contrast, more than 70% of OMW decolorization was observed with P. chrysosporium which was grown in a medium with a low Mn(II) concentration but which resulted in a high level of LiP activity (0.3 μ m). In this culture medium, increasing the Mn(II) concentration resulted in decreased levels of OMW decolorization and LiP activity. Decolorization by reconstituted cultures of P. chrysosporium was found to be more enhanced by the addition of isolated LiP than by the addition of isolated MnP. The highest OMW decolorization levels were obtained at low initial chemical oxygen demands combined with high levels of extracellular LiP. These data indicate that culture conditions which yield high levels of LiP activity lead to high levels of OMW decolorization.

b.2) Decolorization of OMW by Chemical and Biological Means

Wet air oxidation (WAO) process catalysed by hydrogen peroxide coupled with bioxidation for the treatment of OMW allows a complete decolorization of the OMW.

b.3) Decolorization of OMW by Biological Means

Experiments show that the white rot fungus Funalia trogii showed 31% and 38% color removal during the aerobic digestion of OMW in static and agitated cultures. 77% and 72% phenol removal in static and agitated cultures was also obtained, in addition to 40% chemical oxygen demand (COD) reduction.

c) Experiences on Decolorization of OMW

c.1) Experiences on Decolorization of OMW by Chemical Means

The removal of color from OMW using aluminium sulphate $[Al_2(SO_4)_3x18H_2O]$, lime (CaO) and hydrogen peroxide (H_2O_2) was investigated, along with the decolorizing effect of sixteen strains of Pleurotus. In general terms all chemical substances exerted a clear decolorizing effect, yet the most effective was hydrogen peroxide, followed by lime and alumina. The tests with Pleurotus isolates were carried out on plates using different concentrations (25%, 50%, 75%, 100%) of sterilized OMW solidified with 1.5% agar. For all strains tested, decolorization proceeded more slowly than radial growth. Among the six Pleurotus species P. cornucopiae (ATCC 38547) and P. ostreatus (ATCC 34675) were the most efficient (Flouri et al., 1996). The relative contributions of lignin peroxidase (LiP) and manganese peroxidase (MnP) to the decolorization of OMW by Phanerochaete chrysosporium were investigated.

A relatively low level (25%) of OMW decolorization was found with P. chrysosporium which was grown in a medium with a high Mn(II) concentration and in which a high level of MnP (0.65 μ m) was produced. In contrast, a high degree of OMW decolorization (more than 70%) was observed with P. chrysosporium which was grown in a medium with low a Mn(II) concentration but which resulted in a high level of LiP activity (0.3 μ m). In this culture medium, increasing the Mn(II) concentration resulted in decreased levels of OMW decolorization and LiP activity. Decolorization by reconstituted cultures of P. chrysosporium was found to be more enhanced by the addition of isolated LiP than by the addition of isolated MnP. The highest OMW decolorization levels were obtained at low initial chemical oxygen demands combined with high levels of extracellular LiP. These data, plus the positive effect of veratryl alcohol on OMW decolorization and LiP activity, indicate that culture conditions which yield high levels of LiP activity lead to high levels of OMW decolorization (Sayadi and Ellouz, 1995).

c.2) Experience on Complete Decolorization of OMW by Chemical and Biological Means

Wet air oxidation (WAO) process catalysed by hydrogen peroxide coupled with bioxidation for the treatment of OMW was investigated. Oxidation was conducted according to the "hydrogen peroxide promoted wet air oxidation" process between 180 and 200 °C. It consists of injecting continuously hydrogen peroxide at a low dosage (10% on a COD basis) into a WAO reactor in order to promote the radical reactions and then lowering the temperature and pressure constraints. WAO treatment allows a complete decolorization of the solution, a 77% chemical oxygen demand (COD) reduction; the remaining COD is mainly low molecular weight carboxylic acids (chiefly acetic) easy for a biological post-treatment. Compared to the various processes reported in the literature, this two step process offers a good opportunity for OMW depollution (Chakchouk et al., 1994).

c.3) Experience on Decolorization of OMW by Biological Means

During the aerobic digestion of OMW in static and agitated cultures was studied, the white rot fungus Funalia trogii showed 31% and 38% color removal and 77% and 72% phenol removal in static and agitated cultures. 40% chemical oxygen demand (COD) reduction was also obtained (Yesilada et al., 1995).

4.2.11 Other Treatments and Considerations

4.2.11.1 Detoxification of OMW with Solar Collectors

a) Introduction

The photocatalysis allows the degradation of organic compounds and/or the oxidation/reduction of inorganic compounds (heavy-metal) by the chemical action of the light, in the presence of a catalyst agent. Although the process is natural and fully understood, practical and economic solar detoxification systems are not available yet. With its development, two goals may be achieved:

1) to contribute to a cleaner environment
2) to save conventional energy.

b) Technical Assessment and Planning

Using the process of photocatalysis for the detoxification of industrial wastewater (including OMW) is still new and uneconomical. Still the use of this method is promising in the future because it is natural and environmentally friendly. Titanium dioxide (TiO_2) can be used as a catalyst for the chemical action of this process.

c) Experience on Detoxification of OMW with Solar Collectors

The photocatalytic destruction of organic and inorganic compounds by the use of the near UV of the solar spectrum, captured by solar concentrator collectors of the focusing (Hellioman collectors, from PSA, Spain) and non-focusing (CPC, from the USA and Portugal) type was studied. According to recent studies, non-concentrating collectors can be more interesting for this purpose than concentrating ones, given the higher fraction of diffuse radiation, containing a greater percentage of UV, which can be collected by the previous. However, low concentration (C<2) CPC type collectors can also collect direct and diffuse radiation, being stationary like the flat plate ones and they can be envisaged as an optimized solution for the solar UV collection. An optimization study has been held in order to compare the efficiency and capacity of the pollutants (atrazine, dichloroacetic acid, olive mill wastewater, phenol and Cr(VI)) decontamination of the three systems and we have also studied the layout of the collector field, bearing in mind the involved flow-rates and time exposure. Titanium dioxide (TiO_2) was the chosen catalyst. In this work, the effect of the photocatalysis on the detoxification of aqueous solutions containing organic and/or inorganic compounds as atrazine, dichloroacetic acid, phenol, Cr(VI) and wastewater from a Portuguese olive oil industry, was studied. The results obtained were examined in terms of destruction efficiency and/or oxidation-reduction of the contaminants vs. hydraulic load, concentration and pH effect, and they showed that this process can be used for the detoxification of industrial wastewater (Marques et al., 1997).

4.2.11.2 Co-digestion of OMW with Manure, Household Waste or Sewage Sludge

a) Introduction

Combined anaerobic digestion of OMW together with manure, household waste (HHW) or sewage sludge makes it possible to get rid of more than one pollutant simultaneously. The proper wastes to be combined are determined by the type of waste that is available and causing pollution to the environment.

b) Technical Assessment and Planning

Experiments show that the high buffering capacity contained in manure, together with the content of several essential nutrients, make it possible to degrade OMW without previous dilution, without addition of external alkalinity and without addition of external nitrogen source. However, in co-digestion of OMW with HHW or sewage sludge, OMW dilution with water (1:5) was required in order to degrade it. Experimental data indicates that co-digestion of OMW with manure (50:50 and 75:25 OMW to manure ratios) was successful with a theoretical OMW utilization of 75% and with approx. 87% reduction of the lipids content in OMW. An OMW utilization of approx. 55%, and lipid reduction of 73% was reached in co-digestion with HHW (50:50 and 75:25 OMW to HHW ratios).

c) Experience on Co-digestion of OMW with Manure, Household Waste or Sewage Sludge

Combined anaerobic digestion of OMW together with manure, household waste (HHW) or sewage sludge was investigated. In batch experiments it was shown that OMW could be degraded into biogas when co-digested with manure. In co-digestion with HHW or sewage sludge, OMW dilution with water (1:5) was required in order to degrade it. Using continuously stirred lab-scale reactors it was shown that co-digestion of OMW with manure (50:50 and 75:25 OMW to manure ratios) was successful with a theoretical OMW utilization of 75% and with approx. 87% reduction of the lipids content in OMW. An OMW utilization of approx. 55%, and lipid reduction of 73% was reached in co-digestion with HHW (50:50 and 75:25 OMW to HHW ratios). The results showed that the high buffering capacity contained in manure, together with the content of several essential nutrients, make it possible to degrade OMW without previous dilution, without addition of external alkalinity and without addition of external nitrogen source (Angelidaki and Ahring, 1997).

4.2.11.3. OMW Treatment by Immobilized Cells of Aspergillus Niger and its Enrichment with Soluble Phosphate

a) Introduction

OMW treatment by immobilized cells of Aspergillus niger may be supplemented or not supplemented with ammonium sulphate (N) and rock phosphate (RP).

b) Technical Assessment and Planning

Experiments show that, during OMW treatment by immobilized cells of Aspergillus niger, when the OMW was enriched with RP and ammonium sulphate (N) significant reduction of the total phenols was achieved. The treated OMW that was produced can be used for various purposes.

c) Experience on OMW Treatment by Immobilized Cells of Aspergillus Niger

OMW, supplemented or not with ammonium sulphate and rock phosphate (RP), was applied as a medium in a shake-flask repeated-batch fermentation with Aspergillus niger immobilized on polyurethane sponge. Compared to other treatments, the results showed higher growth of the immobilized mycelium and significant reduction of the total phenols when the OMW was enriched with RP and ammonium sulphate (N). The immobilized fungus solubilized the RP with a maximum level of soluble P ranging from 0 to 58 g/litre reached during the fourth batch cycle of the OMW + RP treatment. Depending on the medium composition, three types of treated OMW were produced which could be further used for various purposes (Vassilev et al., 1997).

4.2.11.4. The Use of Yarrowia Lipolytica to Reduce Pollution in OMW

a) Introduction

The yeast Yarrowia lipolytica may be used to reduce pollution in OMW.

b) Technical Assessment and Planning

Experiments show that Yarrowia lipolytica is capable of reducing the COD level in OMW by 80% in 24 h, when grown in a 3.5 litre fermenter. Furthermore, most of the organic and inorganic substances are consumed during this process.

c) Experience on OMW Treatment by the Use of Yarrowia Lipolytica

The practical results of this study show that the yeast Yarrowia lipolytica is capable of reducing the COD level in OMW by 80% in 24 h, when grown in a 3.5 litre fermenter. This produces a useful biomass of 22.45 g/litre and the enzyme lipase. During this process, most of the organic and inorganic substances are consumed (Scioli and Vollaro, 1997).

4.2.11.5. Ultra-Filtration Plant for OMW by Polymeric Membrane Batteries

a) Introduction

The ultrafiltration plant that will treat OMW is based on the following steps:

1) Dirty water storage, 2) oil removal system, 3) Settling of suspended solids,

4) Tangential filtration on polymeric membrane, 5) Eluate treatment by means of polymeric membranes in a double-step biological process complying with Italian standards.

b) Technical Assessment and Planning

Experimental data is not ready yet. The nominal capacity of the ultra-filtration plant will be 300m^3/d flowing from olive-oil mills.

c) Experience on OMW Treatment by the Use of Yarrowia Lipolytica

Within the re-conversion activities of the industrial complex of S. Eufemia Lamezia (Cz, Italy) into an environmental service plant system, a vegetation water treatment plant was started in November 1995 suitable to treat a nominal capacity of 300 m^3/d flowing from olive-oil mills. The treatment plant is based on the following steps:

(1) Dirty water storage,

(2) Oil removal system,

(3) Settling of suspended solids,

(4) Tangential filtration on polymeric membrane, and

(5) Eluate treatment by means of polymeric membranes in a double-step biological process complying with Italian standards.

The final reconversion of the industrial complex into an environmental service plant system will be composed of a sewage treatment line, an oil vegetation treatment line, a solid waste incineration line, and a compost solid waste line (Borsani and Ferrando, 1997).

4.2.12 Advantages and Benefits from OMW

a) Characterization and Utilization of a New Activated Carbon Obtained from Moroccan Olive Wastes

Through experiments, activated carbon was obtained by the utilization of Moroccan olive wastes. This new carbon proved to be as satisfactory as the commercial carbon used by sugar mills in Morocco for the discolourisation of sugar syrup.

A comparative study of the adsorption of some organic compounds (methylene blue, iodine, phenol, atrazine, diuron and sodium dodecysulphate (DSS)) was carried out using activated carbon obtained by the utilization of Moroccan olive wastes and commercial carbon from wood, coal and black plant. This new carbon was prepared by physical activation in the presence of steam. Our results show that the prepared carbon performs very well; it has a specific surface determined by adsorption of nitrogen (N_2) and isotherm BET, of 1200 m^2/g. The maximum capacities of its adsorption according to the Langmuir model are 1.26 mmol/g (403 mg/g) for methylene blue, 4.46 mmol/g (1131 mg/g) for iodine, 1.95 mmol/g for phenol, 1.56 mmol/g for atrazine, 1.98 mmol/g for diuron and 0.82 mol/g for DSS superior to those obtained with commercial carbon. Tests on the dicolorization of sugar syrup have shown that it is as satisfactory as the commercial carbon used by sugar mills in Morocco (Bacaoui et al., 1998).

b) Edible Mushrooms from Olive Oil Mill Wastes

The cultivation of edible mushrooms of the genus Pleurotus by olive oil mill wastes was examined. Two Pleurotus species (P. eryngii and P. pulmonarius) were tested for their ability to colonize an olive press-cake substrate supplemented with various dilutions of raw OMW. Results show that P. pulmonarius strain showed better earliness in production, while P. eryngii produced basidiomata in high yields and of a very good quality.

The present investigation was aiming at examining whether olive oil mill wastes could be exploited for the cultivation of mushrooms of the genus Pleurotus. At a preliminary stage, two Pleurotus species, i.e. P. eryngii and P. pulmonarius, were tested for their ability to colonize an olive press-cake (OPC) substrate supplemented with various dilutions of raw OMW. Some important cultural characters related to mushroom production (earliness, yield, biological efficiencies and quality of basidiomata) were estimated. The outcome revealed different cultural responses for each Pleurotus species examined; the P. pulmonarius strain showed better earliness values and P. eryngii, although it was a slow growing fungus, produced basidiomata in high yields and of a very good quality.

On the other hand, the OPC substrate supplemented with low concentrations of OMW (12.5% v/w) behaved satisfactorily as regards the fungal colonization rates and mushroom yield, but when the addition of higher rates of raw, untreated OMW (75-100% v/w) was attempted then the Pleurotus strains were completely unable to grow. The optimal concentration of OMW for Pleurotus mycelial growth was assessed through measurements of the biomass produced in liquid nutrient media and was found to lie within the 25-90% range, depending on the Pleurotus species and on the properties of the substrates examined. Furthermore, the phytotoxic effects that the spent liquid medium possessed were examined in comparison with the phytotoxicity of the raw liquid waste. The prospects of exploiting olive oil mills wastes for mushroom cultivation is discussed (Zervakis et al., 1996).

c) Olive Oil Mill Wastewater as Carbon Source in Post-Anoxic Denitrification.

OMW can be used as carbon source in the second anoxic stage modified Bardenpho system for nutrients removal in order to assure consistently very low concentrations of total nitrogen (well below 3 mg/l) in the treated effluent.

The required dosage of OMW was found to be in the range 4.6-5.4 mg COD/mg N-NO_3 removed.

A study was undertaken to evaluate the efficiency of applying OMW as a non-nitrogenous external carbon source in the second anoxic stage modified Bardenpho system for nutrients removal in order to assure consistently very low concentrations of total nitrogen (well below 3 mg/l) in the treated effluent. Addition of OMW was found acceptable only up to 50 mg COD of mill waste/l of wastewater fed to the system because at higher additions color problems in the treated effluent were encountered. The required dosage of OMW was found to be in the range 4.6-5.4 mg COD/mg N-NO_3 removed. Operation with OMW effects at the same time higher removal of phosphorus. Addition of physicochemically pretreated OMW with lime to the second anoxic tank at a rate of 22-45 mg COD/l of municipal type wastewater fed (ratio of volume of the mill waste added to the volume of the municipal type wastewater fed 1:1000-1:2000) resulted in a treated effluent with total nitrogen below 3 mg/l and soluble phosphorus well below 1 mg/l (Tsonis, 1997).

d) Xanthan Production from Olive-Mill Wastewaters.

OMW is proposed as a low-cost substrate for xanthan production. The maximal xanthan production of 4.4g/l was found at 30-40% OMW concentration. Addition of nitrogen and/or salts led to significantly increased xanthan yields with a maximum of 7.7g/l. The N/salts supplements also allowed an increase in the optimal OMW concentration.

OMW is a by-product from olive oil manufacture that causes environmental pollution. These wastes have been used as substrate for the production of the extracellular polysaccharide xanthan by Xanthomonas campestris NRRL B1459-S4L41. Growth and xanthan production on dilute OMW as a sole source of nutrients were obtained at OMW concentrations below 60%, yielding a maximal xanthan production of 4.4g/l at 30-40% OMW concentration. Addition of nitrogen and/or salts led to significantly increased xanthan yields with a maximum of 7.7g/l. The N/salts supplements also allowed an increase in the optimal OMW concentration. Inocula pre-grown on OMW can be used. Results suggest that an improved xanthan yield could be obtained with adequate balance between waste concentration and nitrogen or salt supplementation. OMW is proposed as a low-cost substrate for xanthan production with the additional environmental benefit of this use (Lopez and Ramos-Cormenzana, 1996).

e) Recycling of Olive Oil By-Products: Possibilities of Utilization in Animal Nutrition.

Olive tree culture and olive oil industry by-products could play a crucial role as sources of local feeds for small ruminants. They may also contribute to the development of efficient and environmentally conservative extensive animal production systems within Mediterranean semi-arid ecosystems.

Alternative utilizations of the by-products, that are produced by olive oil industry, have been considered. One important alternative from the quantitative point of view is their utilization as a source of nutrients for animals. Information concerning chemical and nutritional characteristics of the various types of olive tree culture by-products and, particularly, of those by-products resulting from the new industrial procedures applied to olive oil extraction must be generated in order to achieve efficient uses of such by-products in animal feeding. The possibilities of different chemical and biological methods for the nutritive evaluation of olive tree culture and olive oil industry by-products have also to be investigated (Alcaide and Nefzaoui, 1996).

f) Biomethanization.

Phenolic compounds are responsible for the inhibition of the biomethanization process. Thus, the development of a biological process for the biodegradation of the phenolic compounds accelertates the biomethanization process. Anaerobic digestion of OMW produces methane that can be used to produce electrical energy. So the development of OMW treatment plan, that combines more than one OMW treatment method may result in satisfactory and economical benefits.

Vegetation water in the olive constitutes 45-50% of the fruit, with a total content of 170 kg m^3, of which 150 kg m^3 are organic compounds (80% of these can be directly converted to methane). Anaerobic digestion of this waste yields methane with an average content of 37 m^3/m^3 of vegetation water and an energetic yield of 325 KwH, of which 30% can be converted into electrical energy and 63% into calorific energy by the use of cogeneration processes. This is sufficient to cover the energy needs of both an olive oil production plant and an anaerobic reactor for the integral purification of wastewater. From an economic point of view, and taking into account the costs of electric (15 pts Kw/H) and calorific energy (3.2 pts/therm), the intrinsic value of olive vegetation water would be 2148 pts/m^3. For the optimization of this process, the following lines of research were investigated:

(i) development of a biological process for the biodegradation of the phenolic compounds responsible for the inhibition of the biomethanization process;

(ii) selection of the nature and the characteristics of an appropriate support for the immobilization of anaerobic bacteria; and

(iii) development of a system and high density cellular reactor to obtain optimum conditions - hydraulic residence time, methane yield and efficiency for the purification process (Fiestas-Ros-de-Ursinos and Borja-Padilla, 1996).

4.3 Summary

There are a wide range of treatment and recycling methods that can be used for OMW. These methods include: Direct land application, composting using various bulking agents or using other techniques, anaerobic digestion, the utilization of OMW by Azotobacter leading to Nitrogen fixation in soils, polyphenols and phenols reduction, heavy metals reduction and removal, electrolysis, ozone and UV radiation, biological purification, decolorization and others. Some of these treatment techniques can be combined together in order to get a completely treated OMW. Also, treatment techniques can be followed by land application for fertilizing crops and plants, since the direct land application of OMW may be harmful to the soil and the watertable.

In order to choose a suitable and appropriate treatment and recycling method, several variables need to be considered, including those related to socio-economic, technical and agricultural aspects and conditions.

Olive preparation stages and conditions, purity and ripeness of olives, size and type of olive produced and quantities to be processed are among the agricultural variables to be considered.

Development level of the community and its economic growth will determine the level of technology to be used and recycling type and method.

The availability of OMW could be considered advantageous from which one may get some benefits. Activated carbon was obtained by the utilization of OMW. This new carbon proved to be as satisfactory as the commercial carbon used by sugar mills for the discolorization of sugar syrup. Also, edible mushrooms of the genus Pleurotus were cultivated by OMW. Two Pleurotus species (P. eryngii and P. pulmonarius) were able to colonize an olive press-cake substrate supplemented with various dilutions of raw OMW. Mushrooms showed better earliness in production, and a very good quality.

Olive oil industry by-products can also be used as a source of local feeds for small ruminants. They may also contribute to the development of efficient and environmentally conservative extensive animal production systems within Mediterranean semi-arid ecosystems.

In Palestine the most feasible and economical method is composting, using a suitable bulking agent (such as wheat straw) followed by land application. It is also important not to apply this compost at the same land continuously year after year. The application of the compost to the same land should not exceed three years, because otherwise it will be harmful to the soil. It may cause complications related to humidity, salinity, acidity,............etc. Also the soil layer on which the compost is applied should not be thin (more than 50 cm thick) in order to allow the compost digestion in soil.

Other treatment methods may be feasible according to the specific situation. For example, where energy can be extracted, OMW anaerobic digestion yields large amounts of methane that may be used to generate energy, of which 30% can be converted into electrical energy and 63% into calorific energy by the use of cogeneration processes. This energy could be sufficient to cover the energy needs of both an olive oil production plant and an anaerobic reactor for the integral purification of wastewater.

The tendency to dump OMW in the nearby valleys without considering the hazards of soil pollution or groundwater pollution, as is the case in Palestine, will severely pollute the environment, and consequently threaten our lives due to the increasing scarcity of natural resources.

In order to control the hazards of pollution, the specialized institutions should monitor waste disposal and enforce the application of environmental rules and regulations according to specific standards.

Chapter Five

Survey Results & Discussion

5. Survey Results & Discussion

5.1 Results:

The questionnaires of the olive presses in the West Bank were sorted in detailed columns presented in Appendix G. Tables 5.1 A, 5.1 B and 5.1 C include a summary of the main findings of the survey. These findings are presented and discussed in the following sections.

Table 5.1 A: Summary of Physical Aspects of Olive Presses

Reference	Description	%
Column 1.4 App. G	a. Year of Establishment	
	$1940 \le a < 1960$	17%
	$1960 \le a < 1980$	17%
	$1980 \le a < 2000$	65%
Column 1.5 App. G	b. Type of Ownership	
	Partnership	43%
	Personal	50%
	Cooperative Committee	7%
Column 1.6 App. G	c.1Construction Area (m^2)	
	$100 \le a < 300$	54%
	$300 \le a < 600$	37%
	$600 \le a < 900$	9%
Column 1.8 App. G	c.2 Area of Land (m^2) on which the Press is Constructed	
	$100 \le a < 1000$	54%
	$1000 \le a < 2000$	22%
	$a \ge 2000$	24%
Column 1.7 App. G	d. Type of Building Construction	
	Reinforced Concrete	94%
	Barracks	4%
	Old Stone	2%
Column 1.9 App. G	e. Distance from Nearest Residential Area	
	$0 \le a \le 10$	72%
	$10 < a \le 50$	24%
	$50 < a \le 100$	4%
Column 2 App. G	f.1 Automation Level	
	Full-Automatic	65%
	Half-Automatic	35%
	Traditional	0%
Columns 2.1 a & b App. G	f.2 Process of Pressing:	
	Available machines for removing leaves	87%
	Available machines for washing	91%

Reference	Description		%
Column 2.2 App. G	f.3 Automatic Risers:		
	Available Automatic Risers		100%
Column 2.3 App. G	f.4 Automatic Grinder		
	Automatic Grinder		65%
	Cutter		22%
	Stone Grinder		11%
	Cutter & Stone Grinder		2%
Column 2.5 b App. G	f.5 Number of Final Separators	1	28%
		2	68%
		3	2%
		4	2%
Column 2.6 a App. G	f.6 Total Capacity (ton olive/hr)		
	$0.8 \leq a \leq 1$		50%
	$1 < a \leq 2$		41%
	$2 < a \leq 2.5$		9%

Table 5.1 B: Summary of Environmental Impacts & Assessment

Reference	Description	%
Column 3 a App. G	a.1 Main Water Sources	
	Municipality Water	76.1%
	Territorial (Jewish colonies) Water	15.2%
	Transported Water Tanks	6.5%
	Artesian Well	2.2%
	a.2 Water Uses:	
	Available Water Cistern	95.7%
	Average Size of Water Cistern	$61.8 m^3$
Column 3 b App. G	b. Main Power Electric Source	
	Private Motor	35%
	Municipality	37%
	Territorial (Jewish colonies)	17%
	Jerusalem Electricity Company	11%
Column 9.3 App. G	c. Method of OMW Disposal	
	Cesspits/pumped/transported to valleys	78%
	To sewer systems	13%
	By pipe directly to valley	7%
	To natural openings underground	2%
Column 8.3 App. G	d. Method of Solid Waste Disposal	
	Everyone Takes His Own	65%
	Others	35%
Column 7.2 App. G	e. Workers Health & Training	
	In Good Health	100%
	Trained	65%
Columns 13, 14,15 App. G	f. Acceptable Working Environment	
	Ventilation	100%
	Lighting	100%
	Space	100%

Reference	Description		%
Column 11 App. G	g. No Application of Environmental Rules		
	OMW (Zeebar)		100%
	Solid Waste		100%
	Noise		100%

Table 5.1 C: Summary of Economic Data

Reference	Description		%
Column 25 App. G	a. Profitability of Olive Press		
	Not Profitable		61%
	Profitable		28%
	Not Sure		4%
Column 23 a App. G	b.1 Number of Other O.P. in the Same Town	0	28%
		1	17.5%
		2	30.5%
		3	9%
		4	4%
		5	11%
Column 23 b App. G	b.2 Distance from Other O.P.		
	<5 Km		72%
Column 12 App. G	c. Payment Methodology		
	Mostly Oil		89%
	Mostly Cash		11%
Column 12.1 App. G	c.1 For Oil Payment		
	10-13:1		44%
	13.5-16:1		27%
	17-20:1		12%
Column 12.2 App. G	c.2 For Cash Payment (NIS/Ton of olives)		
	200≤a≤300		40%
	300<a≤400		60%
Column 16 App. G	d. Number of Operational Years	1	2%
		2	11%
		3	6.5%
		4	11%
		5	69.5%
Column 6.T1 App. G	e.1 Total Capital Investment (JD)		
	For 1998:		
	1000≤a≤20,000		89%
	20,000<a≤60,000		11%
Column 6.T2 App. G	e.2 Total Capital Investment (JD)		
	For 1999:		
	0≤a≤6,000		83%
	6,000<a≤12,000		17%

5.2 Discussion:

5.2.1 Physical Aspects of Olive Presses:

a. Year of Establishment

Most of the olive presses surveyed were established within the last two decades (see Column 1.4, Appendix G and Figure 5.2.1 a). This indicates that newer equipment is in operation and people invest in this sector encouraged by its economic feasibility.

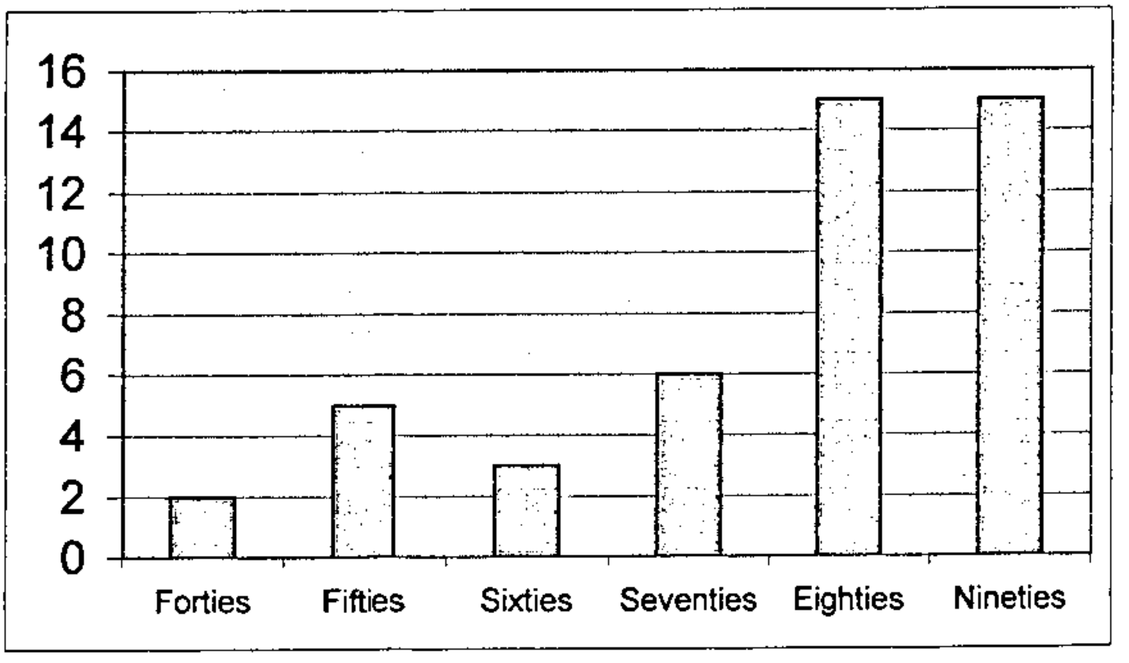


Figure 3: Year of Establishment

b. Type of Ownership

There are three types of olive press ownership in the West Bank. These are personal (private), partnership, and committee ownership (see Column 1.5, Appendix G).

Table 5.2.1 b: Types of Ownership & their Percentages

Type of Ownership	No. of Olive Presses	Percentage (%)
Personal	23	50 %
Partnership	20	43.5%
Committee	3	6.5 %
Total	46	100%

The data demonstrated in Table 5.2.1 b above show that the majority of the olive presses ownership are of personal and partnership type. Very few olive presses are owned by cooperative committees. This reflects the fact that (1) the cooperative work and activities in rural communities in Palestine is weak and small, and that (2) the aim of olive presses establishment is based on economic feasibility.

The Chi-Square test was applied on the data of Column 1.5, Appendix G. It shows that there is significant difference between the three categories. This means that, if the survey was repeated, then the probability of getting different result from that of this survey is very low, since the P-value equals 0.001 which is less than 0.05. This means that the survey figures are satisfactory.

c. Construction and Land Area of Olive Presses:

Construction areas of the olive presses that are covered in the survey range from 115 to 800 m^2 (see Columns 1.6 and 1.8, Appendix G). The mean value of the construction area is 302.1 m^2 and the standard deviation is 145.8. The big deviation in the construction areas is generally attributed to financial reasons. The availability of adequate space within the olive press construction does not only facilitate the workers movement and provide them with a healthier environment, but also, provide adequate space for materials storage. Although the related PNA ministries do not request a specific size for the area of the presses, they do request that the construction area is compatible with the production line and size of work by visual inspection (see Column 1.6, Appendix G).

The areas of land on which the olive presses surveyed are constructed range from 120 to 8000 m^2. The mean value of the areas of land on which the olive presses are constructed is 1567.0 m^2 and the standard deviation is 1942.4. The big deviation in the areas of land on which the olive presses are constructed may be attributed to various reasons. These reasons may be financial reasons or it may be the lack of the surrounding land, since many olive presses are close or adjacent to the residential areas (see Column 1.8, Appendix G).

It is clear from Table (5.2.1 c) that 76% of the surveyed presses were constructed on a land area less than 2000 m^2 and about 55% of those presses were constructed on a land area less than 1000 m^2. If we relate these percentages to the constructed or construction area, it is clear that the area remaining for solid waste disposal, for parking of farmers transporting vehicles and for olive oil containers storage (empty stock) is not sufficient for more than half of the surveyed presses.

The availability of adequate space around the olive press construction is important, since the effluent solid and liquid wastes are not immediately disposed; transported and moved away from the olive press in most of the cases (see Columns 8.3 and 9.3, Appendix G).

Table 5.2.1 c: Area of Land on which the Olive Press is Constructed

Area of Land on which the Press is Constructed	No. of Olive Presses	Percentage (%)
$A < 500$ m^2	16	34.8 %
$500 \leq A < 1000$ m^2	9	19.6 %
$1000 \leq A < 2000$ m^2	10	21.7 %
≥ 2000 m^2	11	23.9 %
Total	46	100%

d. Type of Building Construction:

There are two types of olive press construction in the West Bank. These are Barracks type and reinforced concrete building type (see Column 1.7, Appendix G).

Table 5.2.1 d: Construction Type

Construction Type	No. of Olive Presses	Percentage (%)
Reinforced Concrete	42	91.5 %
Barracks	3	6.5 %
Old Stone	1	2 %
Total	46	100%

The data demonstrated shows that the majority of the olive presses construction type is reinforced concrete. Very few olive presses are of Barracks construction type. This is due to the fact that most of the press owners prefer the reinforced concrete construction, although it is much more expensive, in order to provide protection for their costly equipment. But in some cases the necessity calls for Barracks construction especially when the Israeli Authority does not allow or give permits to construct reinforced concrete structure.

The binomial test (normal distribution), based on Z approximation, was applied on the data of Column 1.7, Appendix G. The test shows that if the survey was repeated, then the probability of getting different result from that of this survey is very low, since the P-value which is equal to 0.000 is less than 0.05. This means that the survey figures are satisfactory.

e. Distance Between the Olive Press and the Nearest Residential Area:

The distances between the surveyed olive presses and the nearest residential areas range from 0 to 100 meters. The mean value of the distances between the olive presses and the nearest residential areas is 14.1 meters and the standard deviation is 23.1 (see Column 1.9, Appendix G).

Some of the olive presses were initially constructed faraway from the residential areas, but later became within the residential areas due to extension of building areas.

The olive presses that are cited within the residential areas do cause environmental problems because of solid and liquid wastes generation, in addition to the air and noise pollution.

f. Olive Presses Operation:

Automation level

The surveyed olive presses were either full or half-automated. About 65% of the olive presses in operation that were covered in the survey were full-automatic and 35% were half-automatic (see Table 5.2.1 f.1). The preference of the full-automatic presses is due to their higher capacity and higher rates of oil production in comparison with the half-automated and traditional presses. In this round of olive presses survey none of the traditional olive presses were found in operation (see Column 2, Appendix G). This indicates that the traditional presses are not economic or feasible in poor olive yield seasons where the olive oil production is low and profits are low.

Table 5.2.1 f.1: Automation Level of Olive Presses

Automation Level	No. of Olive Presses	Percentage (%)
Full-automatic	30	65 %
Half-automatic	16	35 %
Total	46	100%

The binomial test, based on Z approximation, was applied on the data of Column 2, Appendix G, related to automation level. The test shows that if the survey was repeated, then the probability of getting similar result to that of this survey is low, since the P-value which is equal to 0.055 is more than 0.05.

Process of Pressing

Some of the olive presses contain machines for removing leaves and machines for washing olives and others do not. Automatic presses contain machines for removing leaves and machines for washing olives. Comparatively, the inclusion of those machines in the half-automatic and the traditional presses is optional. Since most of the presses surveyed were full-automatic, this indicates the preference for inclusion of those machines in the equipment (see Columns 2.1 (a & b), Appendix G).

Table 5.2.1 f.2: Process of Pressing

Equipment	Available	Percentage (%)
Machines for removing leaves	40	87 %
Machines for Washing	42	91 %
Total	46	100%

The binomial test, based on Z approximation, was applied on the data of Columns (2.1a and 2.1b, Appendix G). The test shows that if the survey was repeated, then the probability of getting different result from that of this survey is very low, since the P-value which is equal to 0.000 is less than 0.05. This means that the survey figures are satisfactory.

Automatic Risers

All of the modern olive presses, full-automatic and half-automatic contain automatic risers. Since all of the presses that were covered in the questionnaires were full-automatic and half-automatic presses, all of them did contain automatic risers between the different pressing stages (see Column 2.2, Appendix G).

Methods of Grinding

All of the full-automatic presses have automatic grinders with central diffusers. Half-automatic presses may have stone grinders or cutters with pistons. Also, the full-automatic presses do not have thick textile containers (kuffah). Only the half-automatic presses with pistons have kuffah (see Columns 2.3, 2.4 (a & b), Appendix G).

Table 5.2.1 f.3: Method of Grinding

Automation Level	No. of Olive Presses	Percentage (%)
Full-automatic press with automatic grinders and central diffusers	30	72 %
Half-automatic press with stone grinders	5	11 %
Half-automatic press with cutters	7	15 %
Half-automatic press with stone grinders & cutters	1	2 %
Total	46	100 %

Note: Compare this table with the table of section 5.2.1 f1 above.

The Chi-Square test was applied on the data of Column 2.3, Appendix G. The test indicates that, if the survey was repeated, then the probability of getting different results from that of this survey is very low, since the P-value which is equal to 0.000 is less than 0.05. This means that the survey figures are satisfactory.

Also the binomial test, based on Z approximation, was applied on the data of Column 2.4 a , Appendix G. The test indicates that, if the survey was repeated, then the probability of getting different results from that of this survey is very low, since the P-value which is equal to 0.012 is less than 0.05. This means that the survey figures are satisfactory.

Methods of Final Separation

All of the presses that were covered in the survey contain at least one final separator. In general, full-automatic presses contain two or more final separators, while half-automatic presses may contain one or two final separators.

In this survey, the number of final separators in the olive presses ranges from 1 to 4 separators. The mean value of the number of final separators in the olive presses is 1.8 separators and the standard deviation is 0.6 (see Column 2.5 b, Appendix G).

Total Capacity of Olive Press

In general, full-automatic olive presses have much higher capacity for olives processing and for oil production than the half-automatic and traditional presses.

In this survey, the total capacity of the olive presses for processing olives ranges from 0.8 to 2.5 tons per hour. The mean value of the total capacity of the olive presses is 1.3 tons per hour and the standard deviation is 0.5. Also, the total capacity of the olive presses for producing oil ranges from 200 to 700 Kilo grams per hour. The mean value of the total capacity of the olive presses is 344.1 Kilo grams per hour and the standard deviation is 134.3 (see Columns 2.6 (a & b), Appendix G). The high standard deviation reflects the high variability in presses total capacity. A variable that is not properly planned and depends on the olive season.

The maximum total capacity of the full-automatic olive presses for processing olives reaches 2.5 tons per hour, while the maximum total capacity of the half-automatic olive presses reaches only 1.5 tons per hour.

However, the maximum total capacity of the full-automatic and the half-automatic olive presses for producing oil, depend on the type of olive pressed. In general, the weight of oil produced approximately equals one fourth of the weight of the olive crushed.

It was indicated by the owners of the olive presses during the survey, that the issue of capacity depend mainly on the olive season and olive quantities reaching the press. In poor seasons, the presses operate under their capacities and under their economic feasibility.

5.2.2 Environmental Impacts and Assessment

a. Water Sources and Uses

Around 52% of the presses that were covered in the questionnaire contained concrete water cisterns with an average storage volume of 61.8 m^3. Despite this fact, the survey indicated that press owners are still in need of another source of water such as territorial (mainly from the nearby Jewish colonies) or municipality water. The following Tables include the water source for olive presses and the availability of water cisterns at the olive presses (see Column 3 a, Appendix G).

Table 5.2.2 a1: Water Source

Water Source	No. of Olive Presses	Percentage (%)
Municipality Water	35	76.1 %
Territorial (Jewish colonies) Water	7	15.2 %
Transported Water Tanks	3*	6.5 %
Transported Water Tanks & Artesian Well	1	2.2 %
Municipality & Transported Water Tanks	4**	8.7
Total	46	100%

*: Some of the water tanks are transported from Beit Eba well and others from the colonies well.

**: These four presses are common with the first row above.

Table 5.2.2 a2: Availability of Water Cistern

Availability of Water Cistern	No. of Olive Presses	Percentage (%)
Available Water Cistern	44	95.7 %
Not Available Water Cistern	2	4.3 %
Total	46	100 %

The binomial test, based on Z approximation, was applied on the data of Column 3, Appendix G. related to the availability water cisterns for the olive presses. The test show that if the survey was repeated, then the probability of getting different result from that of this survey is very low, since the P-value which is equal to 0.000 is less than 0.05. This means that the survey figures are satisfactory.

b. Electric Power Source

50 % of the surveyed presses had private motors for generating electricity. 35% of the surveyed presses rely on private motors and may use municipality electricity only for lighting. While, about 15% of the surveyed presses have private electric generating motors and use these motors only when the main power source was weak or cut (see Column 3 b, Appendix G).

Table 5.2.2 b: Power Source

Power Source	**No. of Olive Presses**	**Percentage (%)**
Available Private Motor	23*	50 %
Only Private Motor	8	17.4 %
Municipality & Private Motor	11	23.9 %
Municipality only	11	23.9 %
Territorial & Private Motor	3	6.5 %
Territorial only	6	13 %
Municipality & Territorial	2	4.4 %
Jerusalem Electricity Company	4	8.7 %
Jerusalem Electricity Company & Private Motor	1	2.2 %
Total	46	100%

*: These 23 are common with other rows below.

Territorial = Jewish colonies

The Chi-Square test was applied on the data of Column 3 b, Appendix G. The test indicates that if the survey was repeated, then the probability of getting different results from that of this survey is very low, since the P-value is equal to 0.015 which is less than 0.05. This means that the survey figures are satisfactory.

c. Impacts of Presses Liquid Waste Disposal

All of the presses that were covered in the questionnaire did not treat OMW at source prior to disposal. About 78% of the surveyed olive presses dispose the OMW to the cesspits, pump it, transport it and dispose it in the valleys. While, about 7% dispose the OMW by pipes from cesspits to the valleys, and about 2% dispose the OMW to natural opening underground. Those presses that are located within municipal area, and constitute around 13% of the surveyed olive presses, dispose the OMW to the sewer systems (see Column 9.2 & 9.3, Appendix G).

Table 5.2.2 c: Method of OMW Disposal

Method of OMW Disposal	No. of Olive Presses	Percentage (%)
Pumped Transported and Thrown in the Valleys	36	78 %
Disposed by Pipes from Cesspits to the Valleys	3	7 %
Disposed to Natural Opening	1	2 %
Disposed to the Sewer System	6	13 %
Total	46	100 %

The Chi-Square test was applied on the data of Column 9.3, Appendix G. The test indicates that if the survey was repeated, then the probability of getting different result from that of this survey is very low, since the P-value which is equal to 0.000 is less than 0.05. This means that the survey figures are satisfactory.

d. Impacts of Presses Solid Waste Disposal

The questionnaire results reveal that the average quantity of solid waste produced from the olive press is around 0.6 tons per hour, with a minimum of 0.4 and a maximum of 1.25 tons per hour. Still, around 65% of the villagers take there own solid waste for heating, around 5% is taken by local - traditional bakeries for incineration and around 15% is thrown in agricultural lands or in the valleys.

In the past the solid waste that resulted from olive pressing did not cause any environmental problem since it was used by villagers for heating, or it was taken by soap factories for further extraction of olive oil to be used in manufacturing soap.

Recently this solid waste is starting to cause an environmental problem since villagers are losing interest in the solid waste as a heating source and so are the soap factory owners. The solid waste that result from the modern full-automatic presses contains no or trivial amounts of olive oil that makes it unprofitable for soap factory owners to use.

When solid waste was applied to the soil in excessive amounts it will inevitably pollute the soil due to its high organic and acidic compounds. This polluting effect may extend to the underground water along the years depending on the soil layer thickness and soil type (see Columns 8.2 & 8.3, Appendix G).

Table 5.2.2 d: Method of Solid Waste Disposal

Method of Solid Waste Disposal	**No. of Olive Presses**	**Percentage (%)**
Taken by Clients or Bakery Owners	39	85 %
Thrown Causing Environmental Problems	7	15 %
Total	46	100%

e. Impacts on Workers Health and of Their Training and Awareness

The average number of workers in the olive press ranges from 2 to 30 workers, with an average of 5.3 workers and a standard deviation of 4.5. Most of the workers are trained by practice along the years. New workers get their training by observation and practice under the supervision of the experienced workers. In general, the experienced workers themselves take hold of the most sensitive tasks.

The binomial test, based on Z approximation, was applied on the data of Column 7.2, Appendix G. The test shows that if the survey was repeated, then the probability of getting deferent result to that of this survey is high, since the P-value which is equal to 0.055 is more than 0.05.

The questionnaire responses show that all of the workers take care of cleaning equipment and of facility, and that they understand the hazard of waste. Unfortunately, few of them wear special customs for work or safety glasses or gloves.

The questionnaire figures also show that most of the olive presses contain first aid kits and fire extinguishers and the workers are trained on using them.

The binomial test, based on Z approximation, was applied on the data of Columns 7.4 (c & d), Appendix G. The test shows that if the survey was repeated, then the probability of getting different results from that of this survey is very low, since the P-values which are equal to 0.000 and 0.002 successively are less than 0.05. This means that the survey figures are satisfactory.

f. Impacts of Working Environment

The working environment, as reported by press owners or managers, is fairly acceptable by the Ministry of Health – the Environmental Department, in all of the surveyed olive presses. However, the following conditions were observed:

- In general, there are sufficient openings (windows and doors) for ventilation; however, these openings become hardly sufficient in the productive seasons since the place becomes more crowded with customers.

- Aulthough most of the olive presses are not sufficiently illuminated by sun light, electricity lights generally make up this deficiency.

- In general, the working space is adequate when the season is poor, but is hardly acceptable in the productive seasons. In the productive seasons the place becomes more crowded with customers, and the textiles containing olives pile up reducing the space.

- The inevitable noise is a common environmental pollution in all of the olive presses surveyed. However, in the productive seasons the continuously working machines cause continuous noise pollution.

The reasons behind the fair acceptance of such working conditions by the Ministry of Health or Environment were:

(1) the poor economic conditions of the farmers and press owners,

(2) that most areas where presses situated are still under Israeli military control,

(3) that the PNA institutions are still without proper staff and laboratories needed to make such judgment and decision.

The poor working environment that was demonstrated above, may have physical and psychological impacts on the workers and on the customers, such as catching contagious diseases, nervousness, etc ... .

g. Impacts of Materials Storage

There are several environmental elements that need to be considered, which are related to storing of materials at presses and to disposing solid and liquid wastes produced. These elements include, solid waste (Jift), olives, diesel, water, domestic wastewater, OMW, cooling water, etc.... . In the following paragraphs the current practices used for specific materials storage are summarized and their environmental assessment is discussed.

i. Impacts of Solid Waste Storage:

The portion of the solid waste that is left at the press is sometimes stored in the olive press (within the press construction area) for the coming season, in order to be used as fuel for electric generators. However, about one third of the presses surveyed store their solid waste in the press. Questionnaire data show that the quantity of solid waste stored range from 0 to 200 sacks (sack = shwal=50 Kg), with an average of 45.4 sack and a standard deviation of 69. Most often, the solid waste is stored in plastic sacks (shwal), and sometimes it is left unpacked. When the solid waste is left unpacked it will cause environmental problems, since it might attract insects and rodents polluting the place, in addition to the bad smell it produces (see Columns 10.1 (a, b & c), Appendix G).

Table 5.2.2 g i: Solid Waste Storage Material

Solid Waste Storage Material	No. of Olive Presses	Percentage (%)
Plastic Sacks (Shwal)	8	47 %
Thrown Unpacked (causing environmental problems)	7	41 %
Silo (Metal Containers)	2	12 %
Total	17	100%

The Chi-Square test was applied on the data of Column 10.1 b, Appendix G. The test shows that if the survey was repeated, then the probability of getting similar result to that of this survey is very low, since the P-value which is equal to 0.161 is more than 0.05.

ii. Impacts of Olives Storage:

Pickled olives is sometimes stored in the olive press for a few weeks or even a few months, before sale or consumption. However, only 2% of the surveyed olive presses practice this storage. Olives to be sold are generally stored in metal containers (see Columns 10.2 a, b & c, Appendix G).

iii. Impacts of Diesel Storage:

Diesel is usually stored in the olive press for sometime for the coming season in order to be used as fuel for electric generators or for heating water. However, only about 30% of the surveyed presses tend to store this material. Questionnaire data show that diesel amounts stored range from 0 to 8 m^3, with an average of 0.556 m^3 and a standard deviation of 1.351. Sometimes the diesel is stored in plastic, metal or reinforced concrete containers (see Columns 10.3 (a, b & c), Appendix G).

Table 5.2.2 g iii: Diesel Storage Material

Diesel Storage Material	No. of Olive Presses	Percentage (%)
Plastic Containers	5	31.2 %
Metal Container	10	62.5 %
Reinforced Concrete & Metal	1	6.3
Total	16	100%

The Chi-Square test was applied on the data of Column 10.3 b, Appendix G. The test shows if the survey was repeated, then the probability of getting different results from that of this survey is low, since the P-value which is equal to 0.022 is less than 0.05. This means that the survey figures are satisfactory.

iv. Impacts of Water Storage:

Water is usually stored in the olive press since most of the olive presses do not completely rely on municipality or territorial water. Questionnaire figures show that water amounts stored range from 0 to 400 m^3, with an average of 38.8 m^3 and a standard deviation of 65.9. Sometimes the water is stored in plastic, metal or reinforced concrete containers or traditional cisterns (cement plastered wells). See Columns 10.4 (a, b & c), Appendix G. Water storage was discussed in section 5.2.1 above.

The large variation in the size of water storage facility indicates that these facilities were not properly planned and were constructed upon needs.

The Chi-Square test was applied on the data of Column 10.4 b related to water storage material (containers). The test shows that if the survey was repeated, then the probability of getting different results from that of this survey is very low, since the P-value which is equal to 0.001 is less than 0.05. This means that the survey figures are satisfactory.

v. Impacts of Wastewater Storage:

Wastewater is usually disposed to reinforced concrete or traditional cesspits. These disposal containers may receive only wastewater, or they may receive wastewater and OMW (olive mill wastewater). Questionnaire data show that wastewater amounts stored range from 2.5 to 240 m^3, with an average of $42.3m^3$ and a standard deviation of 45.8. However, some olive presses dispose their wastewater directly to the sewer network and have no cesspits (see Columns 10.5 a, b & c, Appendix G).

Table 5.2.2 g 1 v: Wastewater Storage Material

Wastewater Storage Material	No. of Olive Presses	Percentage (%)
Unplastered Cesspit	16	34.7 %
Reinforced Concrete Cesspit	8	17.4 %
Common Unplastered Cesspit	10	21.7 %
Reinforced Concrete Common Cesspit	1	2.2 %
Concrete Cesspit with Reinforced Top	1	2.2 %
Concrete Plastered Cesspit with Reinforced Concrete Top	1	2.2 %
Unplastered Cesspit Disposing Directly to Valley	1	2.2 %
Common Unplastered Cesspit Disposing Directly to Valley	1	2.2 %
Natural Underground Opening	1	2.2 %
None	6	13 %
Total	42	100%

Note: Common = Common for wastewater & OMW

The Chi-Square test was applied on the data of Column 10.5 b, Appendix G, related to wastewater storage material. The test shows that if the survey was repeated, then the probability of getting different result from that of this survey is very low, since the P-value which is equal to 0.000 is less than 0.05. This means that the survey figures are satisfactory.

Table 5.2.2 g 2 v: Wastewater Leakage Probability

Wastewater Leakage Probability	No. of Olive Presses	Percentage %
Leaking	31	77.5 %
Not Leaking	9	22.5 %
Total	40	100 %

vi. Impacts of OMW (Olive Mill Wastewater) Storage:

OMW is usually disposed to reinforced concrete or traditional cesspits. These disposal containers may receive only OMW, or they may receive OMW and domestic wastewater. Questionnaire data show that OMW amounts stored range from 4 to 400 m^3, with an average of 89.8 m^3 and a standard deviation of 92.7 (see Columns 10.6 a, b & c, Appendix G).

Table 5.2.2 g1 vi: OMW Storage Material

Wastewater Storage Material	No. of Olive Presses	Percentage (%)
Unplastered Cesspit	12	26.1 %
Common Unplastered Cesspit	10	21.75 %
Reinforced Concrete Cesspit	10	21.75 %
Reinforced Concrete Common Cesspit	1	2.17 %
Unplastered Cesspit with Reinforced Conc.Top	1	2.17 %
Concrete Plastered Cesspit with Reinforced Concrete Top	1	2.17 %
Reinforced Concrete Cesspit & Unplastered Cesspit	1	2.17 %
Unplastered Cesspit Disposing Directly to Valley	1	2.17 %
Common Unplastered Cesspit Disposing Directly to Valley	1	2.17 %
Direct Hole to the Valley	1	2.17 %
Natural Underground Opening	1	2.17 %
None	6	13.04 %
Total	46	100%

Note: Common = Common for wastewater & OMW

The binomial test, based on Z approximation, was applied on the data of Column 10.6 b, related to related to OMW storage material. The test shows that there if the survey was repeated, then the probability of getting different result from that of this survey is very low, since the P-value which is equal to 0.000 is less than 0.05. This means that the survey figures are satisfactory.

Table 5.2.2 g2 vi: OMW Leakage Probability

OMW Leakage Probability	No. of Olive Presses	Percentage %
Leaking	17	42.5 %
Not Leaking	23	57.5 %
Total	40	100 %

5.2.3 Assessment of Economic data

a. Profitability of the Olive Press:

The establishment of olive presses projects are not only profit generating, but they also serve the villagers and the whole Palestinian community at large.

Most of the olive presses owners who participated in filling the questionnaires did not believe that the projects of olive presses establishment are profitable (see Column 25, Appendix G). This is due to the various difficulties they face for a working season of two or three months a year. Among these difficulties: (1) maintenance of the equipment, (2) securing the labor needed, and (3) securing empty olive sacks and transport means for farmers to encourage them to bring their olives to the press.

Table 5.2.3 a: Presses Owners Opinion of Economic Value of the Press

Presses Owners Opinion of Economic value of the Press	No. of Olive Presses	Percentage (%)
Profitable	13	28 %
Not Profitable	28	61 %
Not Sure	2	4 %
Yes, But Not for All Years	3	7 %
Total	46	100%

The Chi-Square test was applied on the data of Column 25, Appendix G, related to the profitability of the olive presses. The test shows that if the survey was repeated, then the probability of getting different result from that of this survey is very low, since the P-value which is equal to 0.000 is less than 0.05. This means that the survey figures are satisfactory.

b. Availability of Olive Presses:

There is satisfactory number of olive presses in Palestine. Most of the Palestinian villages that grow olives contain one or more olive presses. The villages that were covered in the survey had one or more olive presses. The number of olive presses in the visited villages (in addition to the visited press) ranges from 0 to 5 olive presses, with an average of 1.8 olive presses and a standard deviation of 1.6 (see Column 23 a, Appendix G).

Also, the olive presses in the same village are close to each other. The distances among the olive presses in the villages that were covered in the survey, within the same village, are less than 5 Km. Generally, if there is more than one olive press in the village, it is very probable that they belong to other families (see Column 23 b, Appendix G).

The binomial test, based on Z approximation, was applied on the data of Column 23 c, Appendix G, related to the differentiating between families. The test shows that if the survey was repeated, then the probability of getting similar result to that of this survey is very low, since the P-value which is equal to 0.302 is more than 0.05.

Table 5.2.3 b: Differentiating Between Families

Differentiating Between Families	No. of Olive Presses	Percentage %
Exists	18	39 %
Does Not Exist	28	61 %
Total	46	100

c. Payment Methodology:

Most of the olive presses owners take oil rather than cash as payment (see Column 12, Appendix G).

The binomial test, based on Z approximation, was applied on the data of Column 12.1, Appendix G, related to payment methodology. The test shows that if the survey was repeated, then the probability of getting different result from that of this survey is very low, since the P-value which is equal to 0.000 is less than 0.05. This means that the survey figures are satisfactory.

Table 5.2.3 c1:Method of Payment to Presses Owners

Payment to Presses Owners	No. of Olive Presses	Percentage (%)
Oil	41	89 %
Cash	5	11 %
Total	46	100%

When the clients pay in the form of oil, the average payment is 14 : 1 in volume and the standard deviation is 3. The maximum payment is 10 : 1 and the minimum is 20 : 1 in volume (see Column 12.2, Appendix G). The frequency of each payment is demonstrated in the following table:

Table 5.2.3 c2: Method of Payment to Presses Owners Frequency

Payment to Presses Owners	Frequency	Percent %	Commulative Percent
10 : 1	3	7.3	7.3
11 : 1	3	7.3	14.6
12 : 1	10	24.4	39
13 : 1	2	4.9	43.9
13.5 : 1	1	2.4	46.3
14 : 1	3	7.3	53.6
15 : 1	7	17.1	70.7
17 : 1	7	17.1	87.8
18 : 1	1	2.4	90.2
20 : 1	4	9.8	100.0
Total	41	100.0	

d. Operation Years:

About 70% of the olive presses that were covered in the questionnaires operated in the past 5 years with an average of 4.4 years and a standard deviation of 1.1. The minimum number of years of operation was one and the maximum was five (see Column 16, Appendix G).

Table 5.2.3 d1: Number of Years of Operation (in the Past 5 Years)

No. of Years of Operation (in the Past 5 Years)	No. of Olive Presses	Percentage (%)
5	32	69.5 %
4	5	10.9 %
3	3	6.5 %
2	5	10.9 %
1	1	2.2 %
Total	46	100%

Table 5.2.3 d2: Frequency of Years of Operation (in the Past Years)

No. of Years of Operation (in the Past 5 Years)	Frequency	Percent %	Commutative Percent
1	1	2.2	2.2
2	5	10.9	13.1
3	3	6.5	19.6
4	5	10.9	30.5
5	32	69.5	100.0
Total	46	100.0	

e. Capital Invested in the Olive Press:

The average capital cost, invested in the olive presses, that was collected from the questionnaires data was 146,804 JDs and the standard deviation is 80,037. The minimum capital cost that is invested in the olive presses is 45,000 JDs and the maximum is 345,000 JDs.

In general, the capital cost invested in the establishment of an olive press in Palestine is high regarding the long period of time until the investor starts to gain profit. Especially, it is common that the olive season makes good profit every other year.

This capital cost includes the price of land, construction and machinery.

The average capital cost that is invested in land is 32,826 JDs and the standard deviation is 32,343. The minimum capital cost that is invested in land is 6000 JDs and the maximum is 150,000 JDs.

The average capital cost that is invested in construction is 23,163 JDs and the standard deviation is 15,167. The minimum capital cost that is invested in construction is 4,500 JDs and the maximum is 80,000 JDs.

The average capital cost that is invested in machinery is 90,815 JDs and the standard deviation is 59,505. The minimum capital cost that is invested in machinery is 20,000 JDs and the maximum is 250,000 JDs.

Frequency Tables and Figures for Columns 5 (a, b, c & d), related to capital invested in olive presses, are demonstrated in Appendix G.

f. Operation Related Expenses:

In this survey the olive presses working expenses for the years 1998 and 1999 were investigated. These working expenses include workers wages, maintenance, fuel, water, electricity and other expenses (see Columns 6 (a, b, c, d, e, f, g & t), Appendix G).

It was observed that many olive presses were run by the olive presses owners or their relatives in order to reduce the working expenses of the olive presses.

During the years 1998 and 1999, most of the olive presses did not work to their full capacity and the working days were few due to poor olive production. For the year 1998, the minimum number of working days was 8 days and the maximum was around 3 months. While in the year 1999, the minimum number of working days was 0 days and the maximum was around one month (see Columns 6 (a1 & a2), Appendix G). Also, the number of workers was less than usual since the olive presses did not work to their full capacity.

For the year 1998, the average number of workers, at the same shift, was 4.2 workers with a standard deviation of 1.9. The minimum number of workers was one and the maximum was twelve workers.

For the year 1999, the average number of workers, at the same shift, was 2.6 workers with a standard deviation of 1.5. The maximum number of workers was 5 workers (see Columns 6 (b1 & b2), Appendix G).

For the year 1998, the average number for workers salaries per season was 3,458 JDs, with a standard deviation of 3,468. The maximum number of workers salaries was 19,200 JDs.

For the year 1999, the average number of workers salaries was 947 JDs, with a standard deviation of 1,250. The maximum number of workers salaries was 6,000 JDs (see Columns 6 (d1 & d2), Appendix G).

For the year 1998, the average maintenance expenses were 3599 JDs with a standard deviation of 4078. The maximum maintenance expenses were 24,000 JDs.

For the year 1999, the average maintenance expenses were 1,541 JDs with a standard deviation of 1,696. The maximum maintenance expenses were 6,000 JDs (see Columns 6 (c1 & c2), Appendix G).

For the year 1998, the average fuel (diesel) expenses were 1475 JDs with a standard deviation of 1854. The maximum fuel expenses were 10000 JDs.

For the year 1999, the average fuel expenses were 352 JDs with a standard deviation of 481. The maximum fuel expenses were 2,500 JDs (see Columns 6 (e1 & e2), Appendix G).

For the year 1998, the average water and electricity expenses were 1,309 JDs with a standard deviation of 1,382. The minimum water and electricity expenses were 20 JDs and the maximum were 5,000 JDs.

For the year 1999, the average water and electricity expenses were 473 JDs with a standard deviation of 533. The maximum water and electricity expenses were 2,000 JDs (see Columns 6 (f1 & f2), Appendix G).

Some olive presses have other expenses. These expenses include: guests, transport, kuffeh (rubber containers).

For the year 1998, the average other expenses were 1,624 JDs with a standard deviation of 2,309. The maximum other expenses were 10,200 JDs.

For the year 1999, the average other expenses were 393 JDs with a standard deviation of 735. The maximum other expenses were 4,000 JDs (see Columns 6 (g1 & g2), Appendix G).

For the year 1998, the average total expenses were 11,981 JDs with a standard deviation of 10,276. The minimum total expenses were 1,750 JDs and the maximum were 52,000 JDs.

For the year 1999, the average total expenses were 3,605 JDs with a standard deviation of 2,761. The maximum total expenses were 11,400 JDs (see Columns 6 (T1 & T2), Appendix G).

Frequency Tables and Figures for Columns 6 b (1&2), c (1&2), d (1&2), e(1&2), f (1&2), g (1&2), T (1&2) are demonstrated in Appendix G.

5.2.4 Evaluation of Institutional Options

In general, the institutions which are involved in the monitoring and supervision of the olive presses are (1) the Ministry of health – the environmental department, and (2) the Ministry of Agriculture. Members from these institutions make frequent visits to the presses before and during the olive season. While, (3) the Ministry of Industry is supposed to issue the presses working permits.

Olive presses are considered and counted as small industries following to the rating of the Ministry of Industry. The Ministry of Industry, however, does not yet oblige the presses owners to get the working permits. The permit requests that are applied by the presses owners to the Ministry of Industry, are mainly rejected or accepted by the Ministry of health and the Ministry of Environment that has started to function. The Ministry of Industry members visit only the presses that had previously applied for a working permit.

The Ministry of Health – the Environment Department and the Ministry of Agriculture request the presses owners to satisfy and maintain the following conditions in order to get a working license:

1. The construction of walls and ceiling should be from reinforced concrete or made in a way that is acceptable by the Ministry of health – the environmental department.

2. Interior plaster for all the walls and ceiling inside the press should be made without exception. Plaster should be thorough, clean and is acceptable by the Ministry of health – the environmental department.

3. All the doors, windows and woodworks should be painted well with oil paint. All the doors, windows and other openings should be supplied with special metal mesh.

4. Dustbins with suitable covers should be available.

5. Trash and liquid waste should not be disposed around causing environmental problem.

6. Clean water supply network, a basin and soap, and sewer disposal system should be available for workers and customers usage.

7. Olive washing water should be kept continuously clean. Also, the temperature of the hot water in the full-automatic presses should not go below 60°C while pressing.

8. The construction floor should be from fine concrete or terrazzo tiles with a suitable slope in order to facilitate its washing.

9. The olive storage containers floor and walls should be made to a height of 1.5 m. Crushed olives receiving containers should be totally tiled with white porcelain tiles.

10. Barriers should be installed around the machinery for protection and in order to prevent accidents.

11. Suitable and clean containers for receiving and storing oil should be available. Also, the hard textile container should be sufficient, clean and in good condition.

12. OMW disposal container should be big enough and does not allow OMW to leak or to be discharged anywhere else.

13. A toilet and a basin should be available for workers and customers usage.

14. Separate store for olive solid waste should be available and acceptable by the Ministry of health – the environment department and the Ministry of agriculture.

15. Each worker should be medically examined and vaccinated against smallpox and typhoid. Also, two personal photos should be available for each worker.

16. Obtaining working license before starting work.

17. Piston pressure should not go below 250 lb (lb = Libra = 4.45 N) in traditional presses, and not below 350 lb in half-automatic presses while pressing.

18. No change or transfer in the press machinery without informing the Ministry of agriculture.

19. Every press owner should keep records including the following information: (farmer's name, village, quantity of olives, quantity of oil, date of bringing olive and date of pressing). These information should be confidential and for statistics only.

20. Any violation for these conditions during the olive season gives the right for the authorized parties to withdraw the working license.

21. All the conditions that are mentioned above, may be renewed or changed by the Ministry of health – the environment department and the Ministry of agriculture.

22. In order to check the execution of the conditions that are mentioned above, a member from the Ministry of health and an agricultural engineer (from the Ministry of Agriculture) check upon the presses continuously during the olive season, each in his region, for guidance and control.

23. The Ministry of Agriculture members request the presses owners to start olive pressing at a specific time of the year; not before the 15th of October.

Still these conditions do not include satisfactory measures for olive presses liquid or solid waste treatment. Hence, the role of the Ministry of Health and the Ministry of Agriculture, is not efficient in controlling the hazards of olive presses waste on the environment.

Despite the fact that the conditions mentioned above are not complicated or hard to apply, still the presses owners and workers do not comply with them. Many complaints were submitted to the Ministry of Health – the Environmental Department by the local communities and the village councils. Some of these complaints include that wastewater and the OMW is spilling to the streets and to the neighboring areas. Others leave the OMW cesspits open and may spill anytime to the neighboring areas.

Notably, all of the olive presses that were covered in the survey, were visited by members from the Ministry of health and the Ministry of Agriculture, at least once during the olive pressing season (see column 21, Appendix G).

5.3 Olive Mills Waste Water Characteristics in Palestine

Table 5.3 includes the chemical analysis of OMW collected from Ramallah area, Ar-Rantisy press. The analysis of OMW indicates notably high concentration of BOD_5, COD and TSS, in addition to other chemical constituents. It also indicates high concentration of Boron and Potassium.

Table 5.3: Comparison Between Olive Mills Wastewater Characteristics & the Requirements of Jordanian Standards and Regulations

Parameter	Units	OMW Characteristics	Jordanian Standards & Regulations (Maximum Allowable Limit)		
			Disposal to Wadis & Rivers	Reuse for Irrigation	Discharge to Sanitary Sewer System
BOD_5	mg/l	13 000	50 M	---	800
COD	mg/l	115 000	150 M	---	2100
TSS	mg/l	29 800	50	100	1100
ICP run					
Al	mg/l	0.8	5	5	NA
B	mg/l	21	1	1(5)	5
Ba	mg/l	<0.01	NA	NA	10
Ca	mg/l	670	---	---	NA
Cr	mg/l	---	0.1	0.1	T-Cr=5
Cu	mg/l	0.1	2	0.2	4.5
Fe	mg/l	3.9	1	5	50
K	mg/l	670	NA	NA	NA
Li	mg/l	<0.01	NA	NA	NA
Mg	mg/l	863	---	---	NA
Mn	mg/l	<0.01	0.2	0.2	10
Na	mg/l	110	---	400	NA
Ni	mg/l	<0.01	0.2	0.2	4
Pb	mg/l	<0.01	0.1	1	0.6
Si	mg/l	---	NA	NA	NA
Sr	mg/l	0.3	NA	NA	NA

NA = not available

M: monthly average

In comparing these results with the maximum permissible levels in the Jordanian standards, it indicates that BOD_5, COD, TSS and B are of critical need for treatment before disposal to water, wastewater, or soil.

It is also noticeable that the Potassium content is very high. A result that indicates either an error in the measurements occurred, or an unknown source of Potassium has entered to the waste of the sample.

Boron is also higher than the permissible level to be disposed to wadis or sanitary sewer system and needs pretreatment before disposal.

Olive mill wastewater has a high level of acid, which will disturb the wastewater treatment units or pollute groundwater. The total quantity of wastewater produced as estimated by MEnA, (2000) is about 375,300 m^3/yr. The effluent is extremely concentrated of about 42,000 mg/l as BOD_5, and 65,000 mg/l as TSS (ARIJ survey).

As shown, pretreatment of OMW by using various known treatments (see Chapter 4 for details) is required before any disposal process takes place.

Chapter Six

Conclusions

6. Conclusions

In summary the following are the main conclusions and recommendations found during the course of this study. This summary includes the physical aspects, environmental impacts and assessment, economic aspects and institutional options related to olive presses, as one of the main small industries in the West Bank.

Physical Aspects

There are three types of olive press ownerships in the West Bank. These are personal (private), partnership, and committee ownership. The main physical aspects of these olive presses may be summariezed as follows:

- The mean size of the construction area is around 315 m^2.
- The mean value of the areas of land on which the olive presses are constructed is 1567.0 m^2.
- The majority of the olive presses construction type is reinforced concrete.
- The mean value of the distances between the olive presses and the nearest residential areas is 14.1 m.
- The surveyed olive presses were either full or half-automated. About 65% of the olive presses in operation were full-automatic and 35% were half- automatic.
- All the olive presses that were covered in the survey contain at least one final separator.

- The total capacity of the olive presses for processing olives ranges from 0.8 to 2.5 tons per hour. The mean value of the total capacity of the olive presses is 1.3 tons per hour.

Environmental and Health Aspects

The main environmental impacts of the olive presses in the West Bank may be summariezed as follows:

Around 52% of the olive presses that were covered in the survey contained concrete water cisterns with an average storage volume of 61.8 m^3.

About 50% of the olive presses that were covered in the survey had private motors for generating electricity. 35% of the surveyed presses rely on private motors, While, 30% of the surveyed presses have private electric generating motors and use these motors when the main power source (municipality, territorial or Jerusalem electricity company) was weak or cut.

All of the olive presses that were covered in the survey did not treat OMW at source prior to disposal. About 78% of the surveyed olive presses dispose the OMW to cesspits, pump it, transport it and dispose it in the valleys.

OMW chemical analysis shows that BOD_5, COD, TSS, in addition to other chemical constituents are higher than the permissable limits. This indicates that pretreatment of OMW is required before any disposal process takes place.

The questionnaire results also reveal that the average quantity of solid waste produced from the olive press is 0.6 tons per hour, with a minimum of 0.4 and a maximum of 1.25 tons per hour.

The average number of workers in the olive press ranges from 2 to 30 workers.

The questionnaire responses show that all of the workers take care of cleaning of equipment and of facility, and that they understand the hazard of waste. Unfortunately, few of them wear special customs for work or safety glasses or gloves.

The poor working environment that was demonstrated above, may have physical and psychological impacts on the workers and the customers, such as catching contageous diseases, nervousness, etc ... .

The portion of the solid waste that is left at the press, is sometimes stored in the olive press (within the press construction area) for the coming season, in order to be used as fuel for electric generators. However, about one third of the presses surveyed store their solid waste in the press. Questionnaire data show that the quantity of solid waste stored range from 0 to 200 sack (sack = shwal=50 Kg).

Pickled olives are is sometimes stored in the olive press for a few weeks or even a few months, before sale or consumption. However, only 2% of the surveyed olive presses practise this storage.

Only about 30% of the surveyed presses tend to store diesel in their presses. Water is usually stored in the olive press since most of the olive presses do not completely rely on municipality or territorial water. Questionnaire figures show that water amounts stored range from 0 to 400 m^3.

Wastewater is usually disposed to reinforced concrete or traditional cesspits. These disposal containers may receive only wastewater, or they may receive wastewater and OMW (olive mill wastewater). Questionnaire data show that wastewater amounts stored range from 2.5 to 240 m^3.

OMW is usually disposed to reinforced concrete or traditional cesspits. These disposal containers may receive only OMW, or they may receive OMW and domestic wastewater. Questionnaire data show that OMW amounts stored range from 4 to 400 m^3.

Financial Aspects

The main economic aspects of the olive presses in the West Bank may be summariezed as follows:

Most of the olive presses owners who participated in filling the questionnaires did not believe that the projects of olive presses establishment are profitable. This is due to the various difficulties they face for a working season of two or three months a year. Among these difficulties: (1) maintenance of the equipment, (2) securing the labor needed, and (3) securing empty olive sacks and transport means for farmers to encourage them to bring their olives to the press.

The number of olive presses in the visited villages (in addition to the visited press) ranges from 0 to 5 olive presses (see Column 23 a, Appendix G).

Most of the olive presses owners take oil rather than cash as payment.

In this survey the olive presses working expenses for the years 1998 and 1999 were investigated. These working expenses include workers wages, maintenance, fuel, water, electricity and other expenses.

It was observed that many olive presses were run by the olive presses owners or their relatives in order to reduce the working expenses of the olive presses.

During the years 1998 and 1999, most of the olive presses did not work to their full capacity and the working days were few due to poor olive production. For the year 1998, the minimum number of working days was 8 days and the maximum was around 3 months. While in the year 1999, the minimum number of working days was 0 days and the maximum was around one month. Also, the number of workers was less than usual since the olive presses did not work to their full capacity.

For the year 1998, the average number of workers, at the same shift, was 4.2 workers with a standard deviation of 1.9. The minimum number of workers was one and the maximum was twelve workers.

For the year 1999, the average number of workers, at the same shift, was 2.6 workers with a standard deviation of 1.5. The minimum number of workers was 0 and the maximum was 5 workers.

For the year 1998, the average number of total salaries for workers per season was 3,534 JDs, with a standard deviation of 3,468. The minimum number of workers salaries was 0 and the maximum was 19,200 JDs.

For the year 1999, the average number of workers salaries was 968 JDs, with a standard deviation of 1,256. The minimum number of workers salaries was 0 and the maximum was 6,000 JDs.

For the year 1998, the average total expenses were 11,981 JDs with a standard deviation of 10,276. The minimum total expenses were 1,750 JDs and the maximum were 52,000 JDs.

For the year 1999, the average total expenses were 3,605 JDs with a standard deviation of 2,761. The minimum total expenses were 0 JD and the maximum were 11,400 JDs.

Institutional Options:

In general, the institutions which are involved in the monitoring and supervision of the olive presses in the West Bank are (1) the Ministry of health – the environmental department, and (2) the Ministry of Agriculture. Members from these institutions make frequent visits to the presses before and during the olive season. While, (3) the Ministry of Industry which is supposed to issue the presses working permits, does not yet oblige the presses owners to get the working permits.

The Ministry of Health – the Environmental Department and the Ministry of Agriculture, request the presses owners to satisfy and maintain certain conditions in order to get a working license.

Still these conditions do not include satisfactory measures for olive presses liquid or solid waste treatment. Hence, the role of the Ministry of Health and the Ministry of Agriculture is not efficient in controlling the hazards of olive presses waste on the environment.

Despite the fact that the conditions mentioned above are not complicated or hard to apply, still the presses owners and workers do not comply with them. Many complaints were submitted to the Ministry of Health – the Environment Department by local communities and village councils. Some of these complaints include that wastewater and the OMW is spilling to the streets and to the neighboring areas. Others leave the OMW cesspits open and may spill anytime to the neighboring areas.

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Appendices

Appendix (A-1): Number of Olive Presses by Operational Status and Governorate, 1998

Governorate	Operational Status الحالة العملية			المحافظة
	Total المجموع	Operating عاملة	Temporarily Closed مغلقة مؤقتا	
Jenin & Tubas	46	45	1	جنين وطوباس
Tulkarm	36	31	5	طولكرم
Nablus	50	46	4	نابلس
Qalqilya	15	14	1	قلقيلية
Salfit	26	24	2	سلفيت
Ramallah & Al-Bireh	41	34	7	رام الله والبيرة
Bethlehem	4	4	0	بيت لحم
Hebron	21	20	1	الخليل
West Bank	**239**	**218**	**21**	**الضفة الغربية**
Gaza city & Deir Albalah	5	5	0	مدينة غزة ودير البلح
Khanyounis & Rafah	4	4	0	خانيونس ورفح
Gaza Strip	**9**	**9**	**0**	**قطاع غزة**
Palestinian Territory	**248**	**227**	**21**	**الأراضي الفلسطينية**

Appendix (A-2) : Number of Operating Olive Presses by Automation Level and Year of Establishment, 1998

Automation Level of Olive Presses	الاجمالي Total	Number of Olive Presses by Year of Establishment				عدد المعاصر العاملة حسب سنة الانشاء		مستوى الأتمتة للمعاصر
		1998-1991	1990-1981	1980-1971	1970-1961	1960-1951	1950 Before قبل	
Traditional Presses	4	0	0	0	0	1	3	معاصر قديمة
Half Automatic	104	24	25	25	4	14	12	معاصرنصف اوتوماتيك
Full Automatic	119	49	40	13	10	5	2	معاصر اوتوماتيك
Total	**227**	**73**	**65**	**38**	**14**	**20**	**17**	المجموع

Appendix (A-3) : Number of Olive Presses by Methods of Waste Disposal, 1998

Governorate	Olive Cake الجفت			Waste Water المياه العادمة			Disposal Liquids (Zebar) الزيبار			عدد المعاصر العاملة Num. Of Operating Presses	المحافظة
	أخرى Others	المصانع Factories	المزارع Farmers	أخرى Others	شبكة مجاري Sewer System	حفرة امتصاصية Cesspool	أخرى Others	شبكة مجاري Sewer System	حفرة امتصاصية Cesspool		
Jenin & Tubas	0	1	44	8	0	37	8	0	37	45	جنين وطوباس
Tulkarm	0	1	30	1	2	28	1	3	27	31	طولكرم
Nablus	0	0	46	8	7	31	7	7	32	46	نابلس
Qalqilya	0	0	14	0	0	14	0	0	14	14	قلقيلية
Salfit	0	0	24	2	0	22	2	0	22	24	سلفيت
Ramallah & Al-Bireh	1	0	33	2	2	30	7	2	25	34	رام الله والبيرة
Bethlehem	3	0	1	0	1	3	0	1	3	4	بيت لحم
Hebron	0	0	20	0	3	17	0	3	17	20	الخليل
West Bank	4	2	212	21	15	182	25	16	177	218	**الضفة الغربية**
Gaza city & Deir Albalah	5	0	0	1	4	0	0	4	1	5	مدينة غزة ودير البلح
Khanyounis & Rafah	4	0	0	0	1	3	0	1	3	4	خانيونس ورفح
Gaza Strip	9	0	0	1	5	3	0	5	4	9	**قطاع غزة**
Palestinian Territory	13	2	212	22	20	185	25	21	181	227	**الأراضي الفلسطينية**

Appendix (B-1): Jordan Standards 202/1991
Requirements for Discharge of Industrial Effluents

Parameter	*Unit*	*Disposal to Wadis and Rivers*	*Groundwater** Recharge*	*Reuse for Irrigation*
BOD5	mg/L	50 M	50 M	-
COD	mg/L	150 M	150 M	-
DO	mg/L	1 *	1 *	1 *
TDS	mg/L	3000(1)	3000(1)	2000(2)
TSS	mg/L	50	50	100(3)
PH	SU	6.5-9.0	6.5-9.0	6.5-8.4
Color	Unit	15	15	-
FOG	mg/L	5	5	5
Phenol	mg/L	0.002	0.002	0.002
MBAS	mg/L	25	25	-
NO3-N	mg/L	12(4)	12(4)	30
Nh3	mg/L	5	5	5
T-N	mg/L	-	-	50
PO4-P	mg/L	15	15	-
Cl	mg/L	500	500	350(3)
So4	mg/L	500	500	400
F	mg/L	1.5	1.5	-
HCO3	mg/L	-	-	500
Na	mg/L	-	-	-
Mg	mg/L	-	-	-
Ca	mg/L	-	-	-
SAR	mg/L	-	-	9
Al	mg/L	5	5	5
As	mg/L	0.05	0.05	0.1
B	mg/L	1	1	1(5)
Cr	mg/L	0.1	0.1	0.1
Cu	mg/L	2	2	0.2
Fe	mg/L	1	1	5
Mn	mg/L	0.2	0.2	0.2
Ni	mg/L	0.2	0.2	0.2
Pb	mg/L	0.1	0.1	1
Se	mg/L	0.02	0.02	0.02
Cd	mg/L	0.01	0.01	0.01
Zn	mg/L	15	15	2
Sn	mg/L	0.1	0.1	0.1
Hg	mg/L	0.001	0.001	0.001
TCC	MPN/100ml	-	-	-
TFCC	MPN/100ml	1000(6)	1000(6)	1000(6)
Nematodes	(Egg/l)	<1	<1	<1

*: Minimum Value

**: Depends upon, type and quantity of crops, irrigation methods, soil type, climate and groundwater in the area concerned.

-: Undetermined

M: monthly average

Notes:

(1) TDS allowable limit is subject to the TDS concentration in the water supply and the water basin affected.

(2) Allowable limits of wastewater reuse determine the degree of restriction (none, slight to moderate, or service).

(3) Method of irrigation is determined by wastewater quality being used.

(4) Nitrate concentrations allowed are determined by its concentrations in the affected water basin.

(5) Could reach 3 mg/L.

(6) Geometric mean.

Appendix (B-2) Summary of the Water Authority of Jordan Regulations No. 18/1988 for the Discharge of Industrial and Commercial Wastwater into the Sanitary Sewer System.

Parameter	Unit	Maximum Allowable Limit
PH	SU	5.5-9.5
BOD5	mg/L	800
COD	mg/L	2100
TSS	mg/L	1100
P	mg/L	50
FOG	mg/L	50
ABS	mg/L	26
Phenol	mg/L	10
T-Cr*	mg/L	5
Cu*	mg/L	4.5
Zn*	mg/L	15
Sn	mg/L	10
Be	mg/L	5
Ni*	mg/L	4
Cd*	mg/L	1
As	mg/L	5
Ba	mg/L	10
Pb*	mg/L	0.6
Mn	mg/L	10
Ag*	mg/L	1
B	mg/L	5
Hg*	mg/L	0.5
Fe	mg/L	50
S (as H2S)	mg/L	10
Temp	C	65
Chlorinated Solvents	mg/L	0

* The total concentration of the asterisked parameter should not exceed 10 mg/L.

a. It is not permitted to dispose any cyanides containing liquid materials which can produce 1 mg/L HCN or more.

b. It is not permitted to dispose any radioative material without a written approval from WAJ.

Appendix (B-3): Palestinian Standard PS 227/1998
Requirements for Discharge of Industrial Effluents

Parameter	Unit	Disposal to Wadis and Rivers	Groundwater ** Recharge	Reuse for Irrigation
COD	mg/L	150 M	150 M	-
DO	mg/L	1 *	1 *	1 *
TDS	mg/L	3000	1500	2000
TSS	mg/L	50	-	100
FOG	mg/L	15	-	5
Phenol	mg/L	0.002	0.002	0.002
MBAS	mg/L	25	15	-
NO3-N	mg/L	12	12	50
Nh3	mg/L	5	5	5
T-N	mg/L	-	-	50
PO4-P	mg/L	15	-	-
Cl	mg/L	500	500	300
So4	mg/L	500	500	400
F	mg/L	1.5	1.5	-
HCO3	mg/L	-	-	500
Na	mg/L	-	400	-
Mg	mg/L	-	-	-
Ca	mg/L	-	-	-
SAR	mg/L	-	-	9
Al	mg/L	5	0.3	5
As	mg/L	0.05	0.05	0.1
B	mg/L	1	1	1
Cu	mg/L	2	2	0.2
Fe	mg/L	1	1	5
Mn	mg/L	0.2	0.2	0.2

*: Minimum Value

**: Depends upon, type and quantity of crops, irrigation methods, soil type, climate and groundwater in the area concerned.

-: Undetermined. Its allowable limit depends on the general requirements and the test results of the industrial wastewater.

M: monthly average

Notes:

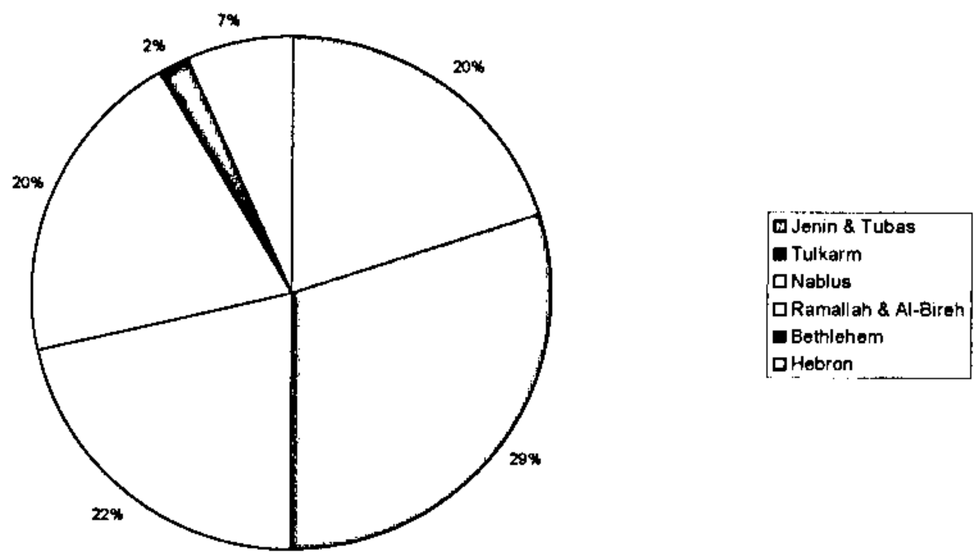
1. TDS allowable limit is subject to the TDS concentration in the water supply and the water basin affected.
2. Allowable limits of wastewater reuse determine the degree of restriction (none, slight to moderate, or service).
3. Method of irrigation is determined by wastewater quality being used.

Appendix (C-1): Olive Trees Agricultural Areas and their distribution in the West Bank Governorates

Governorate	Area (Thousand Dunum)	%
Jenin & Tubas	150	19.9
Tulkarm	227	30.1
Nablus	163	21.6
Ramallah & Al-Bireh	149	19.7
Bethlehem	16	2.1
Hebron	50	6.6
West Bank	755	100

Shu'un Tanmawiiyyeh, 1992

Appendix (C-2): Olive Trees Agricultural Areas and their distribution in the West Bank Governorates

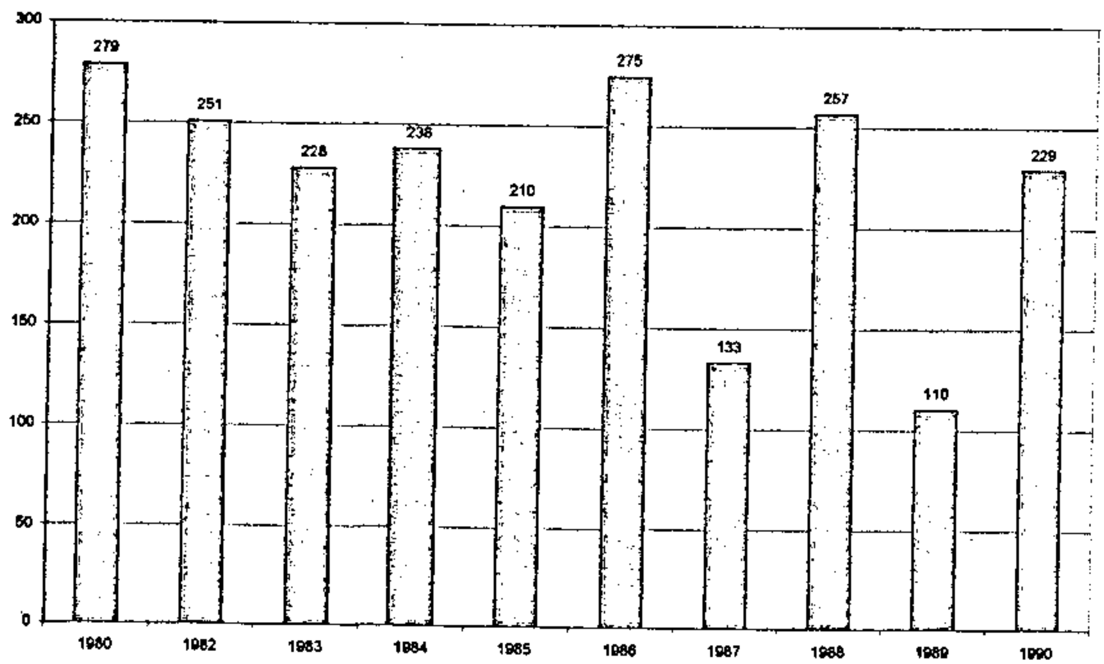


Appendix (D): Basic Changes for the Olive Presses Activity in the Palestinian Territory 1980-1990

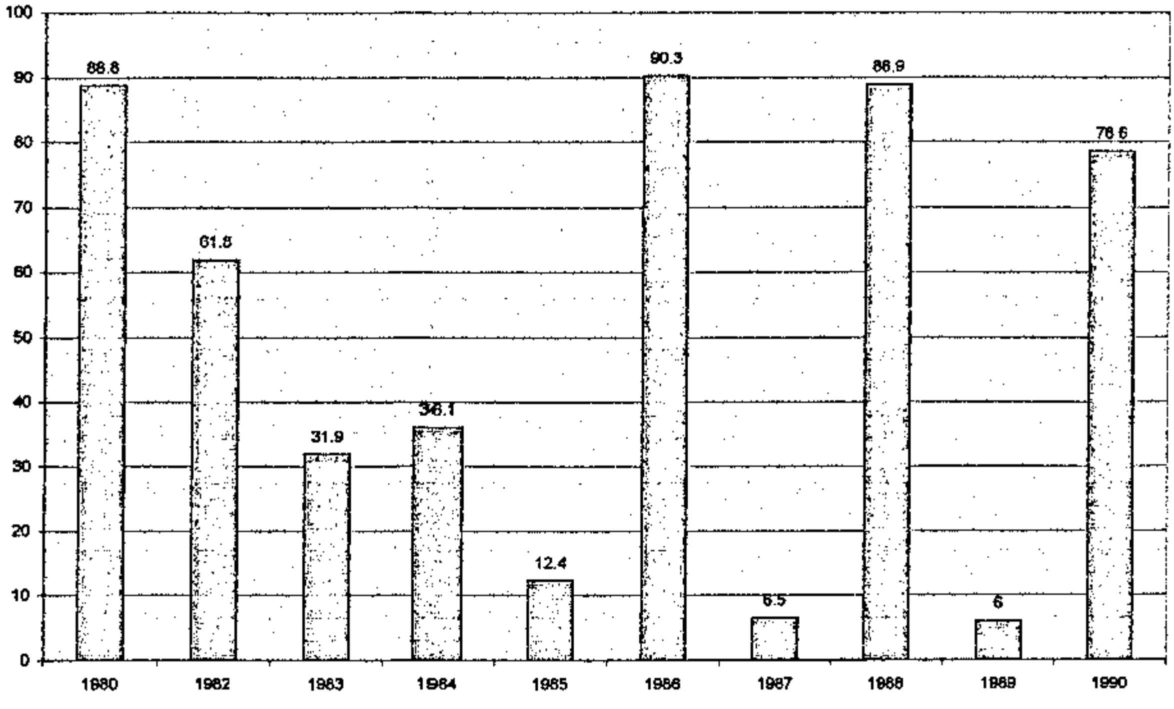
Year	Number of Operating Olive Presses	Quantity of Olive Pressed (Tons)
1980	279	88.8
1982	251	61.8
1983	228	31.9
1984	238	36.1
1985	210	12.4
1986	275	90.3
1987	133	6.5
1988	257	88.9
1989	110	6.0
1990	229	78.6

Shu'un Tanmawiiyyeh, 1992

Appendix (D-1): Basic Changes for the Number of Operating Olive Presses in the Palestinian Territory 1980-1990



Appendix (D-2): Basic Changes for the Quantity of Olive Pressed (Tons) in the Palestinian Territory 1980-1990

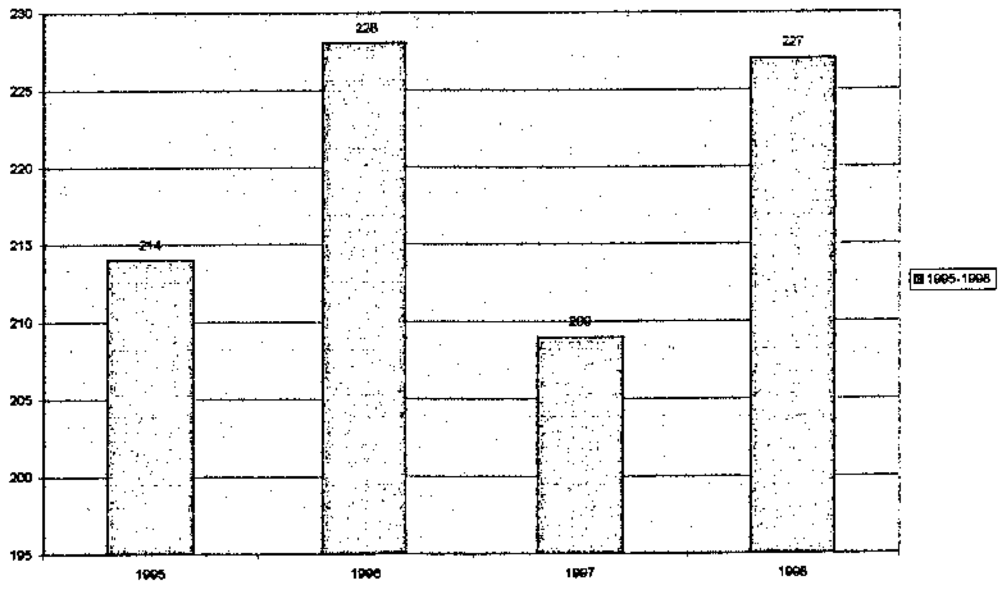


Appendix (E): Basic Changes for the Olive Presses Activity in the Palestinian Territory 1995-1998

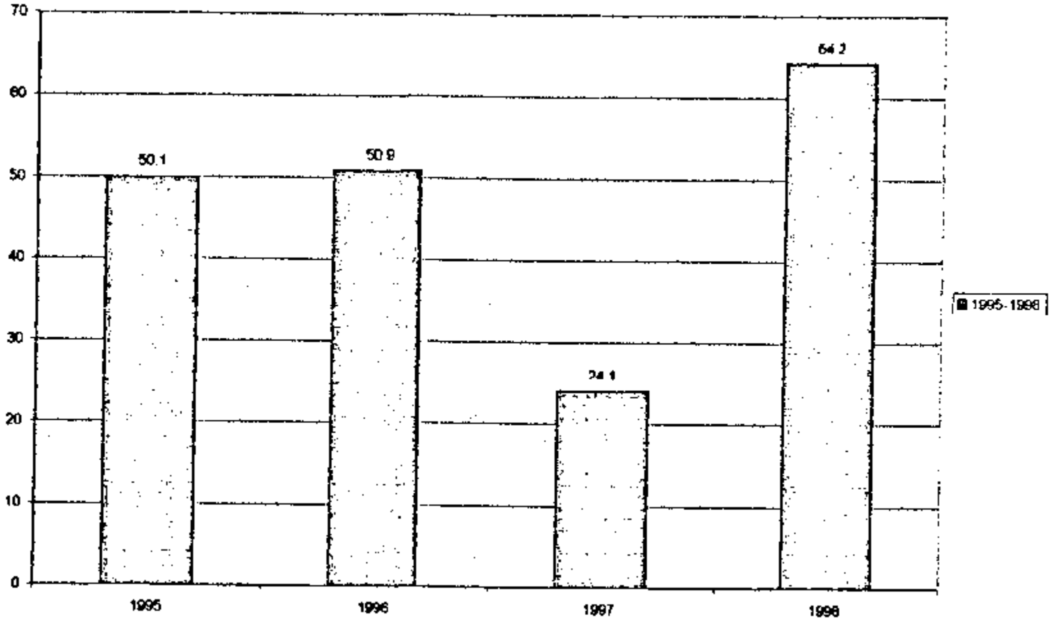
Year	Number of Operating Olive Presses	Quantity of Olive Pressed (Tons)
1995	214	50.1
1996	228	50.9
1997	209	24.1
1998	227	64.2

Palestinian Central Bureau of Statistics, 1998

Appendix (E-1): Basic Changes for the Number of Operating Olive Presses in the Palestinian Territory 1995-1998



Appendix (E-2): Basic Changes for the Quantity of Olive Pressed (Tons) in the Palestinian Territory 1995-1998

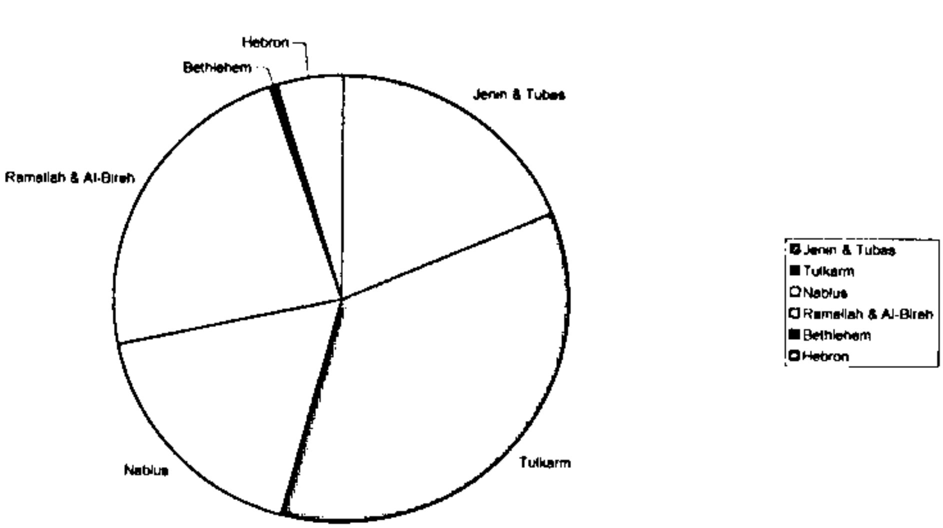


Appendix (F): Number of Olive Presses by Automation Level and Governorate in the West Bank, 1990

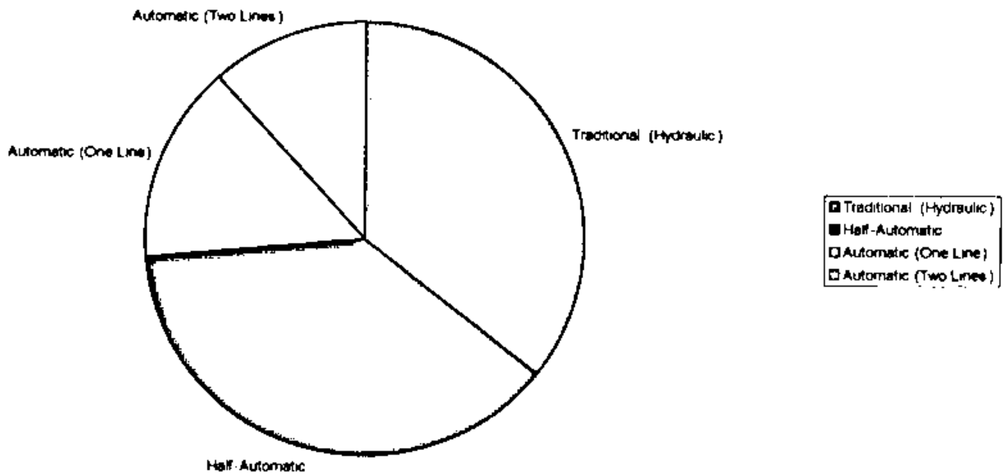
Governorate	Traditional (Hydraulic)	Half-Automatic	Automatic (1 Line)	Automatic (2 Lines)	Total	%
Jenin & Tubas	12	25	12	3	52	18.5
Tulkarm	32	51	10	7	100	35.6
Nablus	19	20	4	6	49	17.5
Ramallah & Al-Bireh	37	9	6	13	65	23.1
Bethlehem	-	-	1	1	2	0.7
Hebron	-	2	8	3	13	4.6
West Bank	100	107	41	33	281	100%
%	35.6	38.1	14.6	11.7	100%	

Shu'un Tanmawiiyyeh, 1992

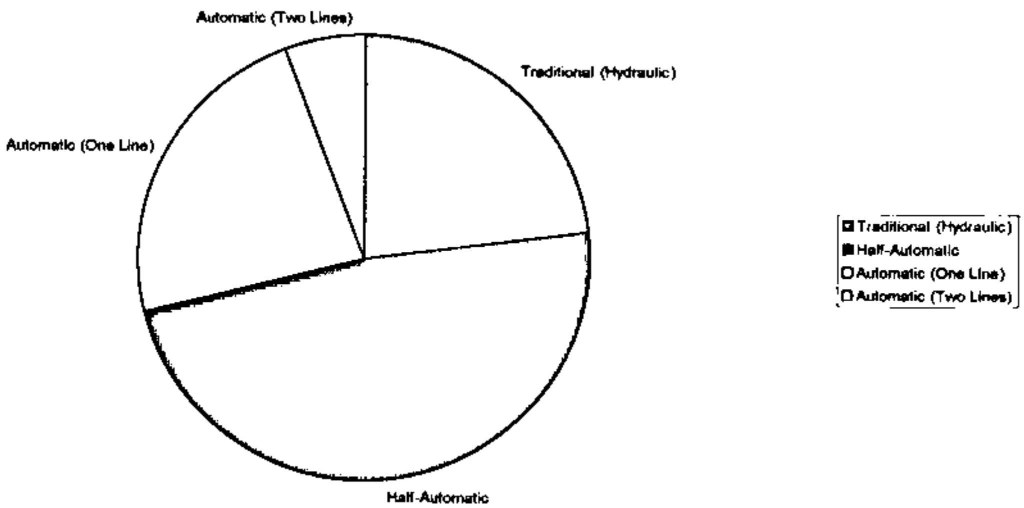
Appendix (F-1): Number of Olive Presses by Governorate in the West Bank, 1990



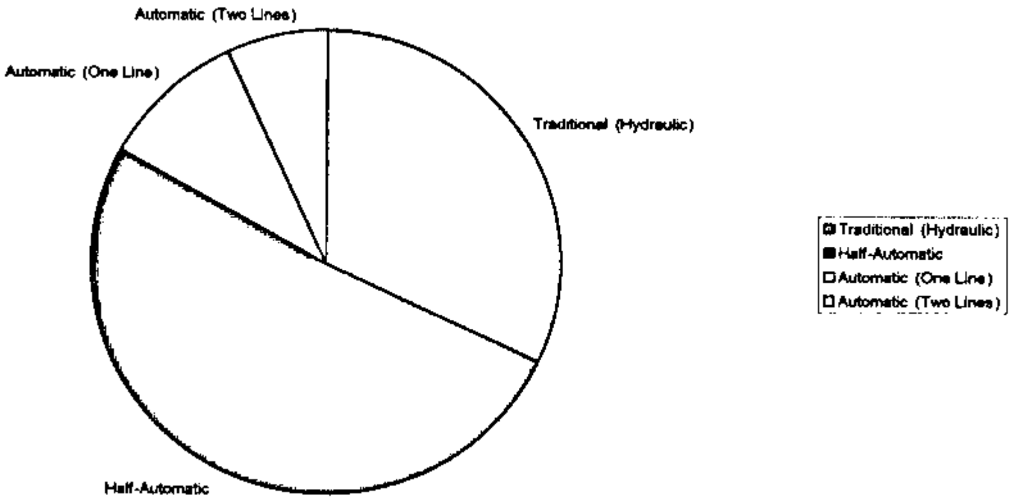
Appendix (F-2): Number of Olive Presses by Automation Level in the West Bank, 1990



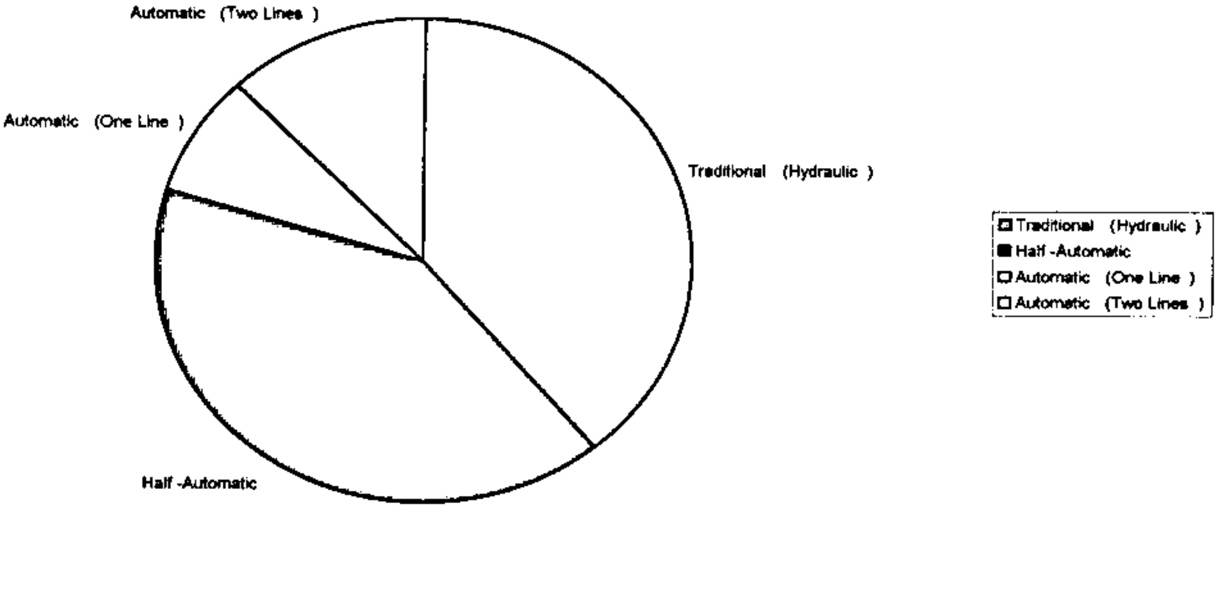
Appendix (F-2-1): Number of Olive Presses by Automation Level in Jenin & Tubas, 1990



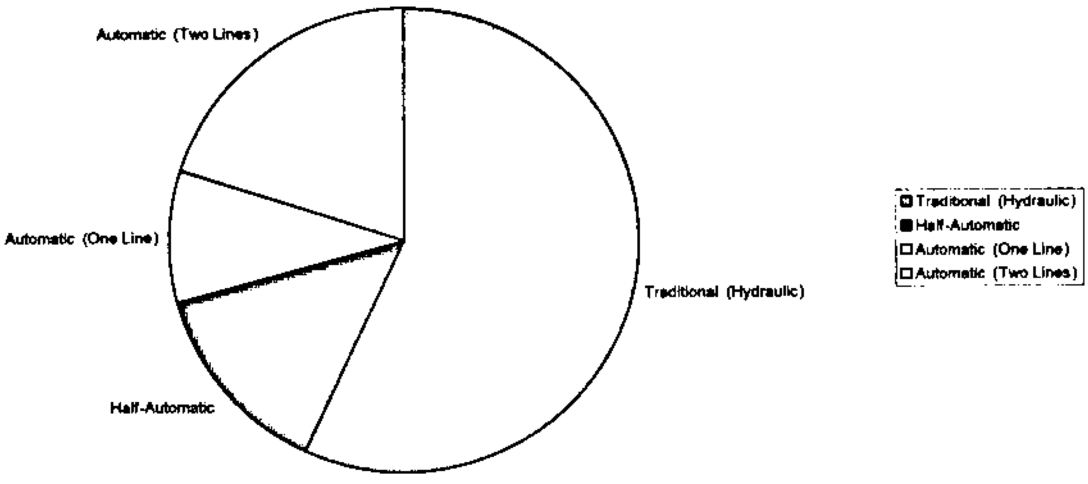
Appendix (F-2-2): Number of Olive Presses by Automation Level in Tulkarm, 1990



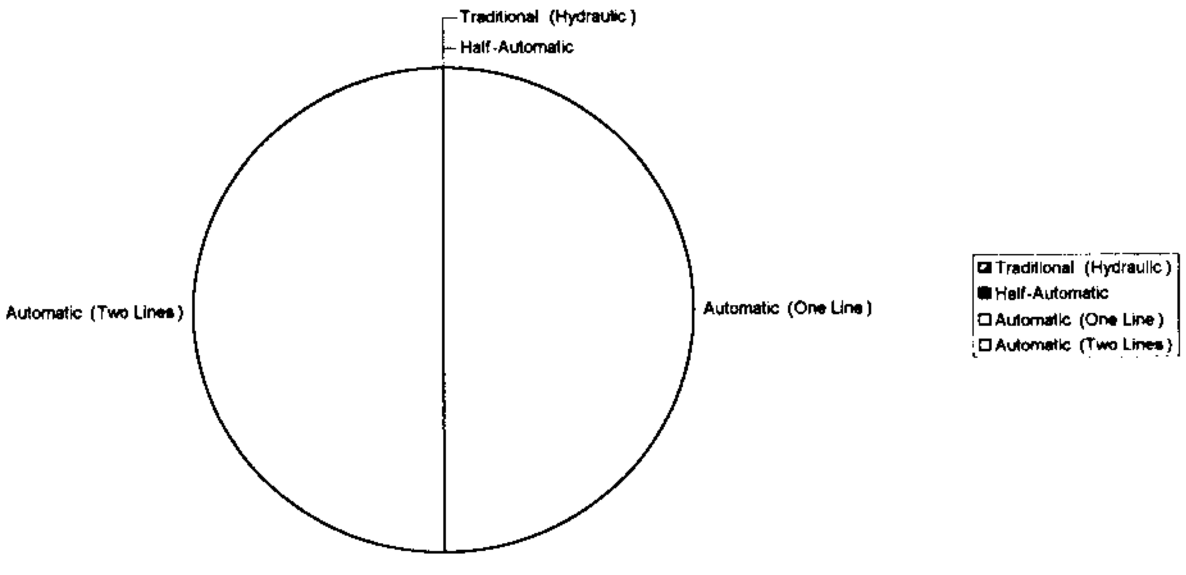
Appendix (F-2-3): Number of Olive Presses by Automation Level in Nablus, 1990



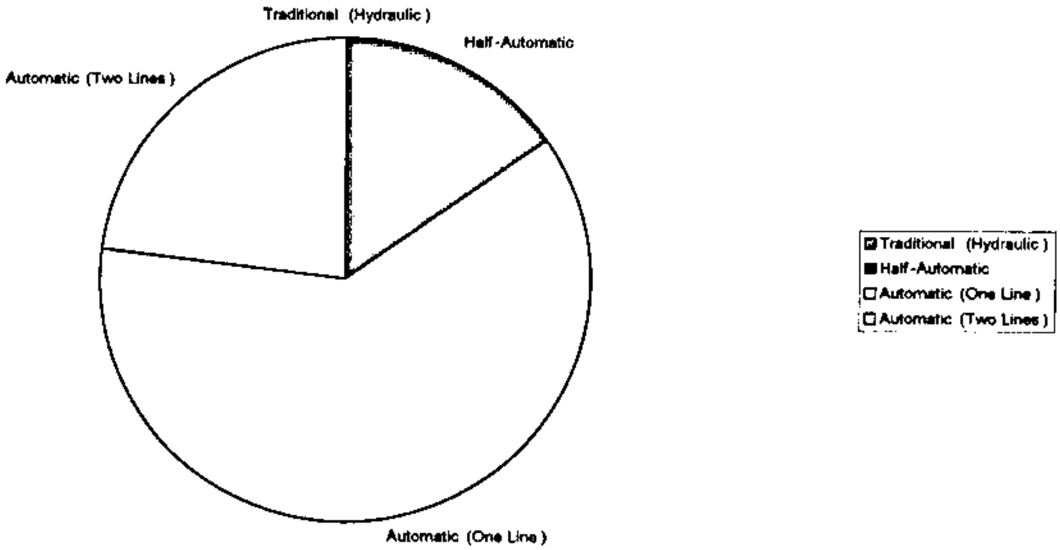
Appendix (F-2-4): Number of Olive Presses by Automation Level in Ramallah & Al-Bereh, 1990



Appendix (F-2-5): Number of Olive Presses by Automation Level in Bethlehem, 1990



Appendix (F-2-6): Number of Olive Presses by Automation Level in Hebron, 1990



Appendix G

Listing of Appendix (G) Content

Description	Col. No.
General Information about the Press	1
Name of Press	1.1
Name of Press Owner or Manager	1.2
Name of Village and Location	1.3
Year of Establishment	1.4
Type of Ownership (Partnership, Committee, Private)	1.5
Construction Area (meter Square)	1.6
Construction Type	1.7
Area of Land (meter Square) on which the Press is Constructed	1.8
Distance between the Press and the Populated Area (meters)	1.9
Machinery Description	2
Machine Brand : Old Fashion / Half Automatic / Full Automatic	
Machine Source and Agent Name	
Year of Purchase of Recent Machinery	
Maintenance Time	
Methods of Washing and Preparing Olives for Pressing	2.1
Machine for Removing Leaves : Available / Not Available	2.1a
Machine for Washing : Available / Not Available	2.1b
If there is a Washing Machine :	
Mashine Capacity (meter cube)	
Frequency of Renewing Water	
Automatic Risers between Squeesing Stages : Available / Not Available	2.2
Grinding	2.3
Method of Grinding : Stone Grinder / Cutter / Automatic Grinder	
Separation	2.4
Method of Separation : Pistons / Central Diffusion /Turbines	2.4a
If there are Pistons :	2.4b
1- Number of Pistons	
2- Automatic Spreader : Available / Not Available	
3- Kuffeh (Rubber Container) Type :	
If Central Diffusion is used : Number of Lines	2.4c
Final Separation :	2.5
Type of Separators	2.5a
Number of Separators	2.5b
Total Capacity :	2.6
Tons of Olives - hourly	2.6a
Kilo Grams of Oil - Hourly	2.6b
What are the Causes that Decrease theTotal Capacity ?	2.6c
Water and Power	3
Water Source :	3a
Is there a Water Cistern (Yes /No)	
If there is a Water Cistern, What is its Volume and any other details	
Power Source	3b
Private Motor	
Municipality	
Territorial	
Others	
The Modifications that was carried out During the Last 5 Years	4

Listing of Appendix (G) Content

Description	Col. No.
Capital Invested	5
Land (JD)	5a
Building (JD)	5b
Machinery (JD)	5c
Total (JD)	5d
Sponsor (Source of Financing)	5e
Working Expenses	6
Number of Working Days (Each Day = 8 Hours)	6(a)
Number of Wokers at the Same Shift	6(b)
Maintenance (Construction, Machinery) (JD)	6(C)
Management and Workers Salaries (JD)	6(d)
Petroleum (JD)	6(e)
Electricity & Water (JD)	6(f)
Other Expenses (Geusts + Transport + Kuffeh (Rubber Containers) + Plastic Bags (JD	6(g)
Total Expenses (JD)	6(T)
Workers	7
Number of Workers	7.1
Is there any training for the Workers	7.2
Workers Health and Environmental Awareness	7.3
Do they take care of Cleaning	
Do they understand the Hazards of Waste?	
Workers Safety	7.4
Special Costumes	
Awareness / Education	
First Aid Kit / Fire Extinguisher	
Workers Training on First Aid	
Workers General Health	7.5
Jift (Solid Waste)	8
Quantity of Jift Produced (Tons/ Hour) (While Working to Full Capacity)	8.1
Is there Treatment for Jift (Yes / No)	8.2
How is it Dealt with	8.3
Zeebar (Liquid Waste)	9
Quantity of Zeebar Produced (meter cube/Hour) (While Working to Full Capacity)	9.1
Is there Treatment for Zeebar (Yes / No)	9.2
Method of Disposal	9.3
Related Problems	9.4
Materials Storage	10
Jift	10.1
Jift Volume (Plastic Bags ie Shwals) 1 Shwal = 50 Kg	10.1a
Storage Material for Jift	10.1b
Leakage Probability for Jift	10.1c
Olives	10.2
Olives Volume (Plastic Bags ie Shwals) 1 Shwal = 50 Kg	10.2a
Storage Material for Olives	10.2b
Leakage Probability for Olives	10.2c

Listing of Appendix (G) Content

Description	Col. No.
Petroleum	10.3
Petroleum Volume (Liter)	10.3a
Storage Material for Petroleum	10.3b
Leakage Probability for Petroleum	10.3c
Pure Water	10.4
Pure Water Volume (meter cube)	10.4a
Storage Material for Pure Water	10.4b
Leakage Probability for Pure Water	10.4c
Waste Water	10.5
Waste Water Volume (meter cube)	10.5a
Storage Material for Waste Water	10.5b
Leakage Probability for Waste Water	10.5c
Zeebar	10.6
Zeebar Volume (meter cube)	10.6a
Storage Material for Zeebar	10.6b
Leakage Probability for Zeebar	10.6c
Cooling Water	10.7
Cooling Water Volume	10.7a
Storage Material for Cooling Water	10.7b
Leakage Probability for Cooling Water	10.7c
Others	10.8
Are the Environmental Rules Applied?	11
* Liquid Waste (Zeebar and Others)	
* Solid Waste (Jift and Others)	
* Gaseous Waste (Turbine Smoke and Others)	
* Noise (Noise from Motors and Others)	
* Poisonous and Hazardous Materials	
How do the Farmers Pay?	12
Olives / Percentage	12.1
Oil / Percentage	12.2
Cash / Average (New Israeli Sheikel per Ton of olives)	12.3
Is there Good Ventilation?	13
Is there Good Lighting?	14
Is there enough space?	15
Number of Seasons that the Press Worked During the Last 5 Years	16
Number of Accidents that Occurred During the Last 5 Years	17
Number of Violations During the Last 5 Years	18
Number of Complaints During the Last 5 Years	19

Listing of Appendix (G) Content	
Description	**Col. No.**
The Problems that Faces the Press Work	20
a) with respect to Machinery	
b) with respect to Dealing with Farmers	
c) with respect to Partnership	
d) with respect to the Quality of Oil Produced	
e) Other Problems	
Are there Formal Authorities that Monitors the Press, and What do they request ?	
	21
What are the Needs that are Necessary to Develop the Press and their Costs?	
	22
Number of Other Presses in the Area :	
a) In the Same Town	23
b) 5 KM Away Or Less	
c) Is there Descrimination Regarding Families	
Do You Think There Is Need For Other Presses In Your Area/Town ?	
Yes / No / Not Sure	24
Please Give More Details	24.1
	24.2
Do You Think that This Press is Profitable ?	
Yes / No / Not Sure	25
a) If Your Press is Modern, What is its Advantages Compared to Other Presses ?	
b) Do You Think that the Farmers Appreciate these Advantages ?	
Appreciate it Very Much / Do Not Appreciate it / Fairly Appreciate it / Not Sure	
General Notes	26

Col.: Column

No.	Column 1.1
1	Ahmad Al-Theeb Press
2	Albarakah Press
3	Kufur Raii Press
4	Modern Kufur Raii Press
5	Al-Haj Sadeq Najeeb Press
6	Northern Jaba' Press
7	Silet Adaher Modern Press
8	Silet Adaher Typical Press
9	Sa'id Ali Mahmoud Press
10	Partnership Press
11	Farhan & Adnan Husni Sulaiman Press
12	Baf'a Modern Press
13	Mohamad Taher Hannoon Press
14	Anabta Modern Press
15	Azzoon Automatic Modern Press
16	Azzoon Typical Press
17	Al-Beik Modern Press
18	Ma'zooz Eisa Khader Press
19	Husein Dawood & Brothers Press
20	Moosa Eisa & Brothers Press
21	The Typical Press
22	Azzawiyah Press
23	Masha Press
24	Fayez Keewan Press
25	Nitham Azem Press
26	Qosin Automatic Modern Press
27	Huwwarah Press
28	Oreef Modern Press
29	Berqoza Press
30	Mohamad Wahid El-Jabali Press
31	Mutee' El-Jaghoob & Brothers Press
32	Aseerah Shamaliyah Press
33	Asharakeh Press
34	Al-Adham Press
35	Arrantisy Press
36	Der Ibzeih Press
37	Kober Modern Press
38	Al-Mazra'a El-Kibliyeh Press
39	Birzeit Press
40	Abood Modern Press
41	Bani Zaid Modern Press
42	Al-Amana Company for Olive Pressing
43	Tarqumya Committee for Olive Pressing
44	Abu Sakur Abu Esheh Modern Automatic Press
45	The Cooperation Committee for Olive Pressing, Manufacture & its Products Marketing
46	The Cooperation Committee for Olive Pressing, Manufacture & its Products Marketing
	AVERAGE
	STANDARD DEVIATION
	MINIMUM
	MAXIMUM

Col: Column

/: Not available

Column 1.2	Column 1.3	Col. 1.4
Ahmad Al-Theeb	Arrabeh - Jenin	1995
Najeeb Mohamad Ameen &Partners	Arrabeh - Jenin	1996
Nabeel Jameel Fareed Sbeih	Southern Kufur Raii - Jenin	1986
Mahmood Sa'id Diab	Kufur Raii - Jenin	1986
Al-Haj Sadeq Najeeb	Eastern Kufur Raii - Jenin	1986
Ahmad Husein AbdulGhani & Partners	Jaba' - Jenin	1987/88
Mohamad Mujahed Abu Qayyas	Silet Adaher - Jenin	1995/96
Mohamad Mujahed Abu Qayyas	Silet Adaher - Jenin	1991/92
Sa'id Ali Mahmoud & Partners	Der El-Ghsoon - Toulkarm	1952
Mahmood Yousef Asa'ad	Der El-Ghsoon - Toulkarm	1956
Farhan & Adnan Husni Sulaiman	Bal'a - Toulkarm	1996
Ahmad Hasan Umayr	Bal'a - Toulkarm	1984
Mohamad Taher Hannoon	Kufr El-labad - Toulkarm	1986
Partnership run by Committee	Anabta - Toulkarm	1982
Ameen Abdu salam El-Azzooni	Azzoon - Qalqilyah	1976
Sudqi Shbeitah	Azzoon - Qalqilyah	1992
Abdul Haleem Ahmad Sa'id & Brothers	Jayyoos - Qalqilyah	1997
Ma'zooz Eisa Khader	Jeet- Qalqilyah	1963
Husein Dawood & Brothers	Bidyah - Silfeet	1981
Moosa Eisa & Brothers	Bidyah - Silfeet	1974
Shhadeh Abdullah Rayyan & Brothers	Karawat Bani Hassan - Silfeet	1995
Abdul Rahman Fares Yousuf	Azzawiyah - Silfeet	1951
Ibrahim Sabri Amer	Masha - Silfeet	1991
Fayez Keewan	Sabastyah - Nablus	1986
Nitham Azem	Sabastyah - Nablus	1994
Mohamad Fareed & Saleh Mohamad Khalili	Qosin - Nablus	1998
Nidal Jihad El-Huwari & Brothers	Huwwarah - Nablus	1985
Najeh Ahmad Sabah	Oreef - Nablus	1985
Bahjat El-Aqtash & Brothers	Beita - Nablus	1982
Mohamad & Hamid El-Jabali & Sons	Beita - Nablus	Fifties
Mutee' El-Jaghoob & Brothers	Beita - Nablus	Forties
Mohammad Taher Abdallah Yaseen & Sons	Aseerah Shamaliyah - Nablus	1996
Saleh Ragheb Abdul-Rahman Jawabreh	Aseerah Shamaliyah - Nablus	1975
Naji Al-Adham & Brothers	Nablus City	1940
Fuad & Saleem Arrantisy	Ramallah City	1952
Salameh Abdullah Salameh Awwad	Der Ibzeih - Ramallah	1998
Partnership	Kober - Ramallah	1982
Mohamad El-HaJ Sulaiman & Familly	Al-Mazra'a El-Kibliyeh - Ramallah	1984
Harb Jaser & Dawood Shaheen	Birzeit - Ramallah	1990
Khateeb Thabet Uthman	Abood - Ramallah	1972
Partnership	Der Ghssaneh - Ramallah	1975
Jamil Khaleel Mohamad Abu Hadid	Industrial Zone - Hebron	1998
Cooperative Committee	Tarqumya - Hebron	1975
Ishaq Khaleel Ismail Abu Esheh	Dura - Hebron	1987
Cooperative Committee/Shawkat E-Shomaly	Bet Jala	1965
Cooperative Committee/Shawkat E-Shomaly	Bet Jala	1965

Column 1.5	Column 1.6	Column 1.7	Column 1.8	Column 1.9
Partnership	200	Barracks	1000	20
Personal	350	Barracks	570	50
Personal	500	Reinforced Concrete	8000	4
Personal	300	Reinforced Concrete	2000	0
Personal	250	Reinforced Concrete	1000	5
Partnership	400	Reinforced Concrete	1000	20
Personal	115	Reinforced Concrete	5000	0
Personal	200	Reinforced Concrete	5000	0
Partnership	200	Reinforced Concrete	500	3
Partnership	750	Reinforced Concrete	750	0
Personal	300	Reinforced Concrete	300	0
Personal	200	Reinforced Concrete	1500	10
Personal	270	Reinforced Concrete	270	0
Partnership	120	Reinforced Concrete	120	2
Partnership	800	Reinforced Concrete	4000	50
Partnership	220	Reinforced Concrete	500	5
Partnership	250	Reinforced Concrete	500	10
Personal	240	Reinforced Concrete	900	100
Personal (Brothers)	500	Reinforced Concrete	1500	0
Personal (Brothers)	217	Reinforced Concrete	320	0
Partnership	120	Reinforced Concrete	500	0
Partnership	150	Reinforced Concrete	250	10
Partnership	300	Reinforced Concrete	7000	5
Personal	350	Reinforced Concrete	500	0
Personal	230	Reinforced Concrete	270	7
Partnership	200	Reinforced Concrete	400	15
Personal (Brothers)	260	Reinforced Concrete	260	0
Personal	120	Reinforced Concrete	1500	0
Partnership	200	Reinforced Concrete	200	5
Partnership	400	Reinforced Concrete	400	0
Personal (Brothers)	250	Old Stone	250	0
Personal (Brothers)	350	Reinforced Concrete	1500	40
Partnership	240	Reinforced Concrete	300	0
Personal (Brothers)	400	Reinforced Concrete	400	3
Personal	250	Reinforced Concrete	270	0
Personal	200	Reinforced Concrete	200	80
Partnership	260	Reinforced Concrete	1000	50
Partnership	500	Reinforced Concrete	4500	30
Partnership	450	Reinforced Concrete	2000	50
Partnership	380	Reinforced Concrete	600	10
Partnership	400	Reinforced Concrete	2000	15
Personal	154	Reinforced Concrete	350	0
Cooperation Committee	450	Reinforced Concrete	1600	50
Personal	300	Reinforced Concrete	1100	0
Cooperation Committee	300	Barracks	5000	0
Cooperation Committee	300	Reinforced Concrete	5000	0
Personal : 50 %	302.0869565	Reinforced Concrete: 91.5 %	1566.956522	14.10869565
Partnership : 43.5 %	145.7493779	Barracks : 6.5 %	1942.345512	23.13268804
Coop. Committee : 6.5%	115	Old Stone : 2	120	0
	800		8000	100

Column 2
Pieralizi / Automatic / Italy by Ibraheem Salameh / 1994 / 1 Month Before Season
Pieralizi / Automatic / Italy by Ibraheem Salameh / 1995 & 1196 / 1 Month Before Season
Pieralizi / Automatic / Italy by Rif'at Al-Huwari / 1986 / In October (Before Season)
Pieralizi / Automatic / Italy by Tahseen El-Fares / 1986 / Before & After Season
Pieralizi / Automatic / Italy by Rif'at Al-Huwari / 1986 / Before & After Season
Pieralizi / Automatic / Italy by Rif'at Al-Huwari / 1987 / Before & After Season
Pieralizi / Automatic / Italy by Rif'at Al-Huwari / 1996 / Before Season (In July)
Rapanelli / Half Automatic / Italy by Rif'at Al-Huwari / 1991 / Before Season (In July)
Rapanelli / Half Automatic / Italy by Rif'at Al-Huwari / 1975 / Before and after Season
Rapanelli / Half Automatic / Italy by Rif'at Al-Huwari / 1982 / Before and after Season
Pieralizi / Automatic / Italy by Khaled Jnaidy / 1996 / Before and after Season
Rapanelli / Automatic / Italy by Rif'at Al-Huwari / 1984 / Before and after Season
Pieralizi / Half Automatic / Italy by Tahseen El-Fares / 1987 / Before & After Season
Pieralizi / Half Automatic / Italy by Tahseen El-Fares / 1982 / Before & After Season
Pieralizi / Automatic / Italy by Sheikh Abu Hamed & Directly / 1988 & 1992 / Before & After Season
Rapanelli / Half Automatic / Italy by Rif'at Al-Huwari / 1989 / Before and after Season
Pieralizi / Automatic / Italy by Israeli Agent / 1997 / Before & After Season
Pieralizi / Automatic / Italy by Husein Moosa / 1996 / Before & After Season
Pieralizi / Automatic / Italy by Tahseen El-Fares / 1981 / Before & After Season
Pieralizi / Half Automatic / Italy by Bahjat Odeh / 1974 / Before & After Season
Pieralizi / Automatic / Italy by Bahjat Odeh / 1998 / Before & After Season
Pieralizi / Half Automatic / Italy by Bahjat Odeh&Tahseen El-Fares/1985&1988/Before & After Season
Pieralizi / Half Automatic / Italy by Tahseen El-Fares / 1991 / Before & After Season
Pieralizi / Automatic / Italy by Rif'at Al-Huwari / 1995 / Before & After Season
Pieralizi / Automatic / Italy by Bahjat Odeh / 1994 / Before & After Season
Pieralizi / Automatic / Italy by Bahjat Odeh / 1998 / Before & After Season
Rapanelli / Automatic / Italy by Rif'at Al-Huwari / 1985 / Before and after Season
Pieralizi / Half Automatic / Italy by Tahseen El-Fares / 1985 / Before & After Season
Pieralizi / Automatic / Italy by Tahseen El-Fares / 1982 / Before & After Season
Pieralizi / Half Automatic / Italy by Bahjat Odeh / 1972 / Before & After Season
Tuskana / Half Automatic / Ibrahim Abu Hijleh / 1998 / Before & After Season
Pieralizi / Half Automatic / Italy / 1996 / Before Season & After Season
Rapanelli / Half Automatic / Italy by Basem Abdul-Hadi / 1975 / Before and after Season
Futtege / Automatic / Germany Directly / 1985 / Before & After Season
Pieralizi / Automatic / Italy Directly / 1995 / Before, Through & After Season
Pieralizi / Automatic / Italy by Bahjat Odeh / 1998 / Before & After Season
Pieralizi / Automatic / Italy by Tahseen El-Fares / 1982 / Before & After Season
Pieralizi / Automatic / Italy by Bahjat Odeh / 1986 / Before & After Season
Pieralizi / Half Automatic / Italy by Bahjat Odeh / 1990 / Before & After Season
Pieralizi / Half Automatic / Italy by Bahjat Odeh / 1972 / Before & After Season
Pieralizi / Automatic / Italy by Bahjat Odeh / 1975 / Before & After Season
Pieralizi / Automatic / Italy Directly / 1998 / Before Season
Pieralizi / Automatic / Italy by Rif'at Al-Huwari / 1989 / Before & After Season
Pieralizi / Automatic / Italy Directly by Rif'at Al-Huwari / 1987 / Before & After Season
Pieralizi / Automatic / Italy by Ibrahim Salameh / 1982 / Before & After Season
Rapanelli / Automatic / Italy by Haj Atwan / 1993 / Before & After Season

Pieralizi / Automatic : 56.5 %	Automatic : 65 %
Pieralizi / Half Automatic : 22 %	Half Automatic : 35 %
Rapanelli / Automatic : 6.5 %	
Rapanelli / Half Automatic: 11 %	Maintenance Before & After Season : 87 %
Futtege / Automatic : 2 %	Maintenance Before Season : 13 %
Tuskana / Half Automatic : 2 %	

Column 2.1 (a)	Column 2.1 (b)	Column 2.2
Available	Available /4 / Daily	Available
Available	Available /2 / Daily	Available
Available	Available / Running Water / Every 4 Days	Available
Available	Available / 2 / Every Other Day	Available
Available	Available / 1 / Daily	Available
Available	Available / Running Water / Daily	Available
Available	Available / 1.5 / 3-4 Times Per Day	Available
Available	Available / 1 / 3-4 Times Per Day	Available
Not Available	Not Available	Available
Not Available	Not Available	Available
Available	Available / 2 / Daily	Available
Available	Available / 1.5 / Every Other Day	Available
Not Available	Not Available	Available
Available	Available / 1 / Every 6 Hours	Available
Available	Available / 6 / Every 12 Hours	Available
Available	Available / 2 / Daily	Available
Available	Available / 4 / Daily	Available
Available	Available / 2 / Every 6 Hours	Available
Available	Available / 2 / Daily	Available
Available	Available / 2.5 / Daily	Available
Available	Available / 2 / Daily	Available
Available(Not Used)	Available / 2 / -	Available
Available	Available / 2 / Every Other Day	Available
Available	Available / 2 / Every 12 Hours	Available
Available	Available / 2 / Every 3-4 Hours	Available
Available	Available / 1.5 / Daily	Available
Available	Available / 1.5 / Daily	Available
Available	Available / 2 / Every 12 Hours	Available
Available	Available / 1.5 / Every Other Day	Available
Available	Available / 1.5 / 3-4 Times Daily	Available
Not Available	Not Available	Available
Available	Available / 2 / Every 4-10 Hours	Available
Available	Available / 1 / Every 4 Hours	Available
Available	Available / 3 / Every 4 Hours	Available
Available	Available / 4 / Every 12 -24 Hours	Available
Available	Available / 1.5 / Every 12 Hours	Available
Available	Available / 1.5 / Every 12 -24 Hours	Available
Available	Available / 2 / Every 12 -24 Hours	Available
Available	Available / 2 / 2-3 Times Daily	Available
Not Available	Available / 3 / 2 Times Daily	Available
Available	Available / 0.5 / Every 48 Hours	Available
Available	Available / 2 / Every 24 Hours	Available
Available	Available / 2 / Every 4-10 Hours	Available
Available	Available / 2 / Every 24 Hours	Available
Available	Available / 1.5 / Every 3.5 Hours	Available
Available	Available / 1.5 / Every 3.5 Hours	Available
Available : 87 %	Available : 91 %	Available : 100 %
Available(Not Used) : 2 %	Not Available : 9 %	
Not Available : 11 %		

Column 2.3	Column 2.4 (a)
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Stone Grinder	Pistons
Stone Grinder	Pistons
Stone Grinder	Pistons
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Stone Grinder	Pistons
Cutter	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Pistons
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Cutter	Pistons
Automatic Grinder	Central Diffuser
Automatic Grinder	Pistons
Automatic Grinder	Pistons
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Cutter	Pistons
Automatic Grinder	Central Diffuser
Cutter	Pistons
Stone Grinder	Pistons
Stone Grinder & Cutter	Pistons
Cutter	Pistons
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Cutter	Pistons
Cutter	Pistons
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder	Central Diffuser
Automatic Grinder : 72 %	Central Diffuser : 0.65 %
Cutter : 15 %	Pistons : 0.35 %
Stone Grinder : 11 %	
Stone Grinder & Cutter : 2%	

Column 2.4 (b)	Column 2.4 (c)
/	2
/	2
/	1
/	2
/	1
/	1
/	2
2/Available/Plastic	/
2/Available/Plastic	/
2/Available/Plastic	/
/	2
/	2
2/Available/Plastic	/
/	2
/	3
2/Available/Shader	/
/	2
/	2
/	2
2/Available/Plastic	/
/	1
2/Available/Plastic	/
2/Available/Plastic	/
/	2
/	1
/	1
/	1
2/Available/Plastic	/
/	2
4/Available/Plastic	/
2/Available/Plastic	/
3/Available/Plastic	/
2/Available/Plastic	/
/	1
/	2
/	1
/	2
/	1
2/Available/Plastic	/
2/Available/Plastic	/
/	1
/	2
/	1
/	1
/	1
/	1
For Pistons : 100% Automatic Spreader Available	For Central Diffuser # of Lines =1 : 48.4 %
	For Central Diffuser # of Lines =2 : 48.4 %
	For Central Diffuser # of Lines =3 : 3.2 %

Column 2.5 (a)	Column 2.5 (b)	Col. 2.6 (a)	Column 2.6 (b)	Col. 2.6 (c)
Pieralizi	3	2.5	680	/
Pieralizi	2	2.25	610	/
Rapanelli	1	0.8	210	/
Pieralizi	2	1.5	400	/
Rapanelli	2	1	270	/
Pieralizi	2	1.2	330	/
Pieralizi	2	1.5	400	/
Rapanelli	1	1	270	/
Rapanelli	1	1	270	/
Pieralizi	1	1	270	/
Pieralizi	2	2	550	/
Rapanelli	2	2	550	/
Pieralizi	1	1	270	/
Pieralizi	2	1.5	400	/
Pieralizi	2	0.8	210	/
Pieralizi	1	1	270	/
Pieralizi	2	2	550	/
Pieralizi	2	2.5	680	/
Pieralizi	4	1.5	380	/
Pieralizi	2	1	250	/
Pieralizi	2	1.2	300	/
Pieralizi	1	1	250	/
Pieralizi	2	1	250	/
Pieralizi	2	1.5	400	/
Pieralizi	1	1	270	/
Pieralizi	2	1.2	300	/
Rapanelli	1	1	250	/
Pieralizi	1	1	250	/
Pieralizi	2	1.5	380	/
Pieralizi	1	1	250	/
Tuskana	2	1	250	/
Pieralizi	1	1.5	400	/
Rapanelli	2	1	270	/
Pieralizi	2	1.25	290	/
Pieralizi	2	1.5	380	/
Pieralizi	2	0.8	200	/
Pieralizi	2	1.5	390	/
Pieralizi	2	1.2	300	/
Pieralizi	2	1	250	/
Pieralizi & Rapanelli	2	1	250	/
Rapanelli	1	1	250	/
Pieralizi	2	2	440	/
Rapanelli	2	1	220	/
Pieralizi	2	1.2	300	/
Pieralizi	2	1.5	450	/
Rapanelli	2	1.5	450	/
Pieralizi : 74 %	1.782608696	1.313043478	343.6956522	
Rapanelli : 22 %	0.593035261	0.439372631	124.0315138	
Pieralizi & Rapanelli : 2 %	1	0.8	200	
Tuskana : 2 %	4	2.5	680	

Column 3 (a)
Arrabeh Municipality & Water Containers from Qabatyah / Yes / 12 & 25
Arrabeh Municipality / Yes / 50
Jaba' Municipality / Yes / 15
Kufur Ra'i Municipality / Yes / 100
Kufur Ra'i Municipality / Yes / 500 & 400
Jaba' Municipality / Yes / 80 & 4
Silet Adaher Municipality / Yes / 50
Silet Adaher Municipality / Yes / 50
Der El-Ghsoon Municipality / Yes / 1
Der El-Ghsoon Municipality / Yes / 2
Bal'a Municipality / Yes / 16 & 8
Bal'a Municipality / Yes / 70
Municipaity Water / Yes / 12
Municipality Water / Yes / 1& 1
Azzoon Municipality / Yes / 64
Azzoon Municipality / Yes / 1 &1 &1
Azzoon Municipality / Yes / 13.5
Territorial / Yes / 45 (not used)
Bidyah Municipality / Yes / 5
Bidyah Municipality / Yes / 20 & 1
Territorial / Yes / 8
Territorial / No
Territorial / Yes / 1&1
Water Tanks Transported from Beit Eeba Well / Yes / 60
Water Tanks Transported from Beit Eeba Well / Yes / 150
Territorial / Yes / 4
Territorial / No
Territorial / Yes / 130
Beita Municipality / Yes / 7
Beita Municipality / Yes / 100
Beita Municipality / Yes / 4
Water Tanks (Bought) & Municipality Water / Yes / 20
Water Tanks (Bought) & Municipality Water / Yes / 20
Water Tanks (Bought) & (Nablus Municipality for Drinking) / Yes / 40
Ramalla Municipality / Yes / 9
Water Tanks Bought from the Settlement Well / Yes / 40
Ramalla Municipality / Yes / 40
Ramalla Municipality / Yes / 130
Bir Zeit Municipality / Yes / 8
Ramalla Municipality / Yes / 6
Western Bani Zaid Municipality / Yes / 36
Municipality Water / Yes / 100
Municipality Water / Yes / 7
Water Tanks (Bought) & Artesian Well / Yes / 12
Municipality Water / Yes / 20
Municipality Water / Yes / 20
Municipality Water : 76 %
Territorial : 15 %
Others : 9 %

Territorial: Jewish Collonies

Column 3 (b)	Column 4
Private Motor	/
Arrabeh Municipality	/
Private Motor	/
Private Motor	/
Private Motor	/
Private Motor	/
Private Motor	/
Private Motor	/
Der El-Ghsoon Municipality / Territorial	/
Der El-Ghsoon Municipality / Territorial	/
Bal'a Municipality	/
Bal'a Municipality	/
Municipality / Private Motor	/
Municipality / Private Motor	/
Private Motor (spare) / Territorial	/
Azzoon Municipality	/
Private Motor	/
Private Motor / Territorial	/
Bidyah Municipality	/
Bidyah Municipality	1 Automatic Separater & 1 Grinder
Territorial	Modernized from Half to Full Automatic
Territorial	Renovated After Burning / 4000 JD
Private Motor (Spare) / Territorial	Half Automatic Separater & Belt
Municipality (Spare) / Private Motor	Modernized from Half to Full Automatic in 1994
Territorial	Turbine was Developed in 1999
Territorial	/
Nablus Municipality	/
Municipality (for Lights Only) / Private Motor	/
Territorial	/
Municipality	/
Municipality / Private Motor (Spare)	/
Municipality (for lighting) & Private Motor	/
Municipality & Private Motor	/
Nablus Municipality	/
Ramalla Municipality	Second Turbine was Bought in 1998
Territorial	/
Jerusalem Municipality / Private Motor (Spare)	Second Turbine was Bought
Jerusalem Municipality	/
Bir Zeit Municipality / Private Motor (Spare)	/
Jerusalem Municipality	/
Bani Zaid Municipalty / Private Motor (Spare)	/
Municipality & Private Motor	/
Municipality (for lighting) & Private Motor	/
Municipality	/
Territorial	/
Territorial	/

Col. 5(a)	Col. 5(b)	Col. 5(c)	Col. 5(d)	Column 5(e)	Col. 6(a1)
40000	4500	250000	294500	Personal	3 Months
20000	12000	120000	152000	Personal	1 Month
15000	33000	65000	113000	Personal	40 Days
40000	30000	100000	170000	Personal	1 Month
30000	15000	79000	124000	Personal	21 Days
15000	24000	103000	142000	Personal	25 Days
50000	6000	110000	166000	Personal	20 Days
50000	15000	40000	105000	Personal	17 Days
15000	20000	30000	65000	Partnership	40 Days
10000	10000	25000	45000	Partnership	20 Days
30000	20000	110000	160000	Personal	45 Days
30000	10000	105000	145000	Personal	50 Days
9000	17000	33500	59500	Personal	35 Days
15000	30000	80000	125000	Partnership	45 Days
15000	80000	250000	345000	Personal & Loan	10 Days
17000	8000	32000	57000	Personal	1 Month
20000	10000	70000	100000	Personal	1 Month
20000	20000	135000	175000	Personal	1 Month
40000	20000	150000	210000	Personal	15 Days
15000	10000	20000	45000	Personal	18 Days
24000	10000	100000	134000	Personal	40 Days
10000	10000	30000	50000	Personal	8 Days
12000	20000	30000	62000	Personal	14 Days
10000	30000	150000	190000	Personal	1 Month
10000	30000	64000	104000	Personal	17 Days
10000	30000	90000	130000	Personal	25 Days
20000	20000	70000	110000	Personal	25 Days
20000	20000	60000	100000	Personal	22 Days
10000	20000	100000	130000	Partnership	27 Days
10000	40000	70000	120000	Personal	1 Month
10000	20000	25000	55000	Personal	2 Months
40000	20000	20000	80000	Personal	30 Days
6000	20000	26000	52000	Partnership	35 Days
80000	20000	200000	300000	Personal	20 Days
150000	30000	150000	330000	Personal	65 Days
25000	20000	85000	130000	Personal	40 Days
17000	20000	110000	147000	Partnership	37 Days
20000	30000	70000	120000	Partnership	28 Days
60000	40000	20000	120000	Partnership	50 Days
20000	20000	20000	60000	Partnership	25 Days
40000	25000	180000	245000	Partnership	29 Days
20000	40000	200000	260000	Personal	25 Days
70000	30000	70000	170000	Partnership	20 Days
70000	80000	100000	250000	Personal	25 Days
125000	13000	150000	288000	Personal & Loan	40 Days
125000	13000	80000	218000	Personal & Loan	40 Days
32826.08696	23163.04348	90815.21739	146804.3478	Personal : 70 %	
32342.81947	15166.50342	59504.93525	80036.8997	Partnership : 24 %	
6000	4500	20000	45000	Personal & Loan : 6 %	
150000	80000	250000	345000		

Col. 6(a2)	Col. 6(b1)	Col. 6(b2)	Col. 6(c1)	Col. 6(c2)	Col. 6(d1)
1 Month	4	4	24000	4000	19200
6-7 Hours	3	3	500	500	4000
15 Days	2	1	3500	4000	3000
7 Days	4	2	4000	4000	350
8 Days	1	1	6000	3000	2500
5 Days	4	4	2000	1000	3000
7 Days	2	2	1500	2300	1200
0	6	0	700	0	2500
20 Days	12	5	1500	350	0
20 Days	5	5	1000	1000	3500
14 Days	4	3	5000	1000	2000
15 Days	4	3	6000	2000	4500
60 Hours	4	3	1000	0	3800
14 Days	4	3	3000	700	5000
8 Days	4	2	150	700	2500
3 Weeks	3	3	2000	700	1800
2 Weeks	2	2	1200	200	200
12 Days	2	2	2000	2000	1200
5 Days	3	1	1500	0	0
7 Days	4	4	300	100	1400
20 Days	3	3	Guarantee	Guarantee	1200
5 Days	3	3	600	1400	400
11 Days	5	5	300	300	200
14 Days	4	1	10000	1000	3000
20 Days	3	2	1500	5000	2000
6 Days	3	2	10000	4000	400
7 Days	3	4	7000	1000	3000
10 Days	7	5	2500	800	4000
10 Days	3	3	7000	3000	4700
0	4	0	6000	0	4000
0	6	0	2000	0	5000
0	6	0	2000	0	10000
12 Days	3	3	6000	0	6300
10 Days	1	1	4000	6000	200
12 Days	4	4	3500	3500	2000
15 Days	4	2	Guarantee	Guarantee	1000
4 Days	7	2	2400	0	7000
12 Hours	3	3	8000	6000	3000
0	6	0	2000	0	6000
7 Days	8	5	3000	500	3000
40 Days	5	5	1000	1000	2000
20 Days	5	3	Guarantee	Guarantee	12000
15 Days	4	4	3000	2000	1000
20 Hours	5	2	1000	1000	5000
15 Days	6	3	2700	1200	6000
15 Days	5	2	2400	1000	5000
	4.195652174	2.608695652	3598.837209	1540.697674	3457.608696
	1.927803185	1.482913961	4077.763281	1695.521265	3468.14019
	1	0	150	0	0
	12	5	24000	6000	19200

Col. 6(d2)	Col. 6(e1)	Col. 6(e2)	Col. 6(f1)	Col. 6(f2)	Col. 6(g1)
4800	4000	1200	4000	1200	500
2000	1000	500	4000	2000	1500
500	3000	300	1500	300	750
0	2500	500	350	100	0
800	3000	1000	350	100	400
1000	1900	600	500	100	1200
420	150	150	100	100	6500
0	2500	0	200	0	10000
0	0	0	200	100	550
3500	0	0	1000	1000	300
1000	1100	300	3000	1000	1000
1000	100	0	1700	1200	2000
400	300	100	20	10	800
2000	200	80	200	100	0
1500	500	300	400	300	150
400	300	180	90	50	1600
100	1500	1000	400	200	3000
480	3000	1200	5000	2000	5000
0	0	0	500	250	0
600	0	0	400	200	520
800	0	0	1500	1000	6000
400	0	0	250	200	500
150	0	0	500	400	1500
0	1500	300	1400	300	10200
100	1000	250	600	100	1000
300	0	0	4000	1000	1800
320	400	100	2400	600	500
2000	1000	400	80	40	1600
1500	2300	800	3400	1100	180
0	2500	0	600	0	1700
0	400	0	200	0	2000
0	10000	0	2000	0	2000
2150	2000	0	2600	800	550
100	350	200	650	400	50
500	450	200	4000	1100	1000
500	2000	700	1000	350	1000
1000	3000	500	500	100	0
200	3000	1000	1000	200	350
0	100	0	700	0	700
750	4500	200	90	20	800
2000	200	300	850	1000	2100
6000	5000	2500	3000	1500	1000
700	1300	900	500	350	400
0	1000	50	3500	70	200
2000	400	200	600	500	1200
1600	400	200	400	300	600
947.173913	1475	352.3913043	1309.347826	472.6086957	1623.913043
1250.051844	1854.356732	481.2954038	1381.81427	532.5512382	2309.263931
0	0	0	20	0	0
6000	10000	2500	5000	2000	10200

Col. 6(g2)	Col. 6(T1)	Col. 6(T2)	Col. 7.1	Col. 7.2	Col. 7.3(a)	Col. 7.3(b)
200	51700	11400	4	Yes	Yes	Yes
700	11000	5700	3	No	Yes	Yes
250	11750	5350	2	Yes	Yes	Yes
0	7200	4600	2	Yes	Yes	Yes
150	12250	5050	2	Yes	Yes	Yes
600	8600	3300	4	Yes	Yes	Yes
4000	9450	6970	2	Yes	Yes	Yes
0	15900	0	6	Yes	Yes	Yes
0	2250	450	12	No	Yes	Yes
300	5800	5800	5	Yes	Yes	Yes
500	12100	3800	4	No	Yes	Yes
600	14300	4800	4	Yes	Yes	Yes
20	5920	530	4	No	Yes	Yes
0	8400	2880	4	Yes	Yes	Yes
100	3700	2900	2	Yes(In Italy)	Yes	Yes
180	5790	1510	3	No	Yes	Yes
0	6300	1500	2	No	Yes	Yes
2000	16200	7680	4	Yes	Yes	Yes
0	2000	250	3	No	Yes	Yes
60	2620	960	4	No	Yes	Yes
300	8700	2100	3	Yes	Yes	Yes
300	1750	2300	3	No	Yes	Yes
1200	2500	2050	5	Yes	Yes	Yes
500	26100	2100	4	No	Yes	Yes
200	6100	5650	5	Yes	Yes	Yes
300	16200	5600	3	No	Yes	Yes
100	13300	2120	6	No	Yes	Yes
800	9180	4040	7	No	Yes	Yes
80	17580	6480	6	Yes	Yes	Yes
0	14800	0	12	No	Yes	Yes
0	9600	0	6	No	Yes	Yes
0	26000	0	10	Yes	Yes	Yes
50	52000	3000	12	Yes	Yes	Yes
50	5250	6750	2	Yes	Yes	Yes
100	10950	5400	6	Yes	Yes	Yes
200	5000	1750	4	No	Yes	Yes
0	12900	1600	7	Yes	Yes	Yes
50	15350	7450	3	Yes	Yes	Yes
0	9500	0	6	Yes	Yes	Yes
20	11390	1490	5	Yes	Yes	Yes
2500	6150	6800	5	Yes	Yes	Yes
500	21000	10500	30	Yes	Yes	Yes
300	6200	4250	4	Yes	Yes	Yes
50	10700	1170	5	Yes	Yes	Yes
600	10900	4500	3	Yes	Yes	Yes
200	8800	3300	2	Yes	Yes	Yes
392.6086957	11981.08696	3605	5.217391304	Yes : 65 %	Yes : 100 %	Yes : 100 %
735.4165404	10276.15562	2791.747959	4.530945663	No : 35 %		
0	1750	0	2			
4000	52000	11400	30			

Column 7.4(a)	Col. 7.4(b)	Col. 7.4(c)	Col. 7.4(d)	Col. 7.5	Column 8.1
No	Yes	Yes	Yes	Good	1.25
No	Yes	Yes	Yes	Good	1.15
No	Yes	Yes	Yes	Good	0.4
No	Yes	Yes	Yes	Good	0.75
Yes	Yes	Yes	Yes	Good	0.5
No	Yes	Yes	Yes	Good	0.6
No(Only One Does)	Yes	Yes	Yes	Good	0.75
No(Only Two Do)	Yes	Yes	Yes	Good	0.4
No	Yes	No	No	Good	0.4
No	Yes	Yes	Yes	Good	0.4
No	Yes	No	No	Good	1
Yes(Over Whole)	Yes	Yes	Yes	Good	1
No	Yes	Yes	Yes	Good	0.4
No	Yes	Yes	Yes	Good	0.75
No	Yes	Yes	Yes	Good	0.4
Yes	Yes	Yes	Yes	Good	0.4
No	Yes	Yes	Yes	Good	1
No	Yes	Yes	Yes	Good	1.25
No	Yes	Yes	Yes	Good	0.75
Yes(In Long Seasons)	Yes	Yes	Yes	Good	0.4
No	Yes	No	No	Good	0.6
No	Yes	No	No	Good	0.4
No	Yes	Yes	Yes	Good	0.4
No	Yes	No	No	Good	0.75
No	Yes	Yes	Yes	Good	0.5
No	Yes	Yes	Yes	Good	0.6
No	Yes	Yes	Yes	Good	0.5
No	Yes	No	No	Good	0.4
No	Yes	Yes	Yes	Good	0.75
No	Yes	Yes	Yes	Good	0.4
No	Yes	Yes	Yes	Good	0.4
No	Yes	No	No	Good	0.6
No	Yes	No	No	Good	0.4
No	Yes	Yes	Yes	Good	0.63
No	Yes	Yes	Yes	Good	0.75
No	Yes	No	No	Good	0.4
No	Yes	Yes	Yes	Good	0.75
No	Yes	No	No	Good	0.6
No	Yes	Yes	Yes	Good	0.4
No	Yes	Yes	Yes	Good	0.4
No	Yes	Yes	Yes	Good	0.5
No	Yes	Yes	Yes	Good	1
Yes	Yes	Yes	Yes	Good	0.5
Yes	Yes	Yes	Yes	Good	0.6
No	Yes	Yes	No	Good	0.75
No	Yes	Yes	No	Good	0.75
Yes : 11 %	Yes : 100 %	Yes : 78 %	Yes : 74 %	Good : 100 %	0.623478261
No : 89 %		No : 22 %	No : 26 %		0.24576608
					0.4
					1.25

Column 8.2	Column 8.3
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own, Otherwise Thrown in Agricultural Lands
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Some People Take It. The Rest is Sold to Shariket Azuyut in Nablus & to Bakeries
No	Everyone Takes His Own
No	Thrown Away In the Valleys
No	Thrown Away In the Valleys
No	Everyone Takes His Own
No	Taken by Bakeries for Free
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own, Otherwise Thrown in the Vallies
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Thrown Away In the Valleys & People Take it from There
No	Some People Take It. The Rest is Taken by Other People for Heating
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Some People Take It. The Rest isTaken by Bakeries
No	Burnt in City Cinerator After Ramallah Munic. Permits. Since 2 Years None Takes It
No	Everyone Takes His Own
No	Most People Take It. The Rest is Stored in the Press.
No	Villagers Take Their Own. City People Leave Theirs and Villagers Take It.
No	Villagers Take Their Own. City People Leave Theirs and Villagers Take It.
No	Everyone Takes His Own
No	Some People Take It. The Rest is Distributed to Bakeries on Bakeries Expense
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own
No	Everyone Takes His Own, Otherwise Thrown Away
No	Everyone Takes His Own, Otherwise Thrown Away
No : 100 %	Everyone Takes His Own : 65 %
	Other : 35 %

Column 9.1	Column 9.2	Column 9.3
2.5	No	Pumped / Transported / Thrown in Valley
2.25	No	Pumped / Transported / Thrown in Valley
0.8	No	Pumped / Transported / Thrown near Village Entrance
1.5	No	Pumped / Transported / Thrown in Valley
1	No	Pumped / Transported / Thrown near Village Entrance
1.2	No	Pumped / Transported / Thrown in Valley
1.5	No	Most of OMWW is Disposed by pipe from Cesspit Directly to Vally
0.4	No	Most of OMWW is Disposed by pipe from Cesspit Directly to Vally
0.4	No	Pumped / Transported / Thrown in Valley
0.4	No	Pumped / Transported / Thrown in Valley
2	No	Pumped / Transported / Thrown in Valley
2	No	Pumped / Transported / Thrown in Valley
0.4	No	Pumped / Transported / Thrown in Valley
1.5	No	Disposed to Sewer System
0.8	No	Pumped / Transported / Thrown in Valley
0.4	No	Pumped / Transported / Thrown in Valley
2	No	Pumped / Transported / Thrown in Valley
2.5	No	Pumped / Transported / Thrown in Valley
1.5	No	Pumped / Transported / Thrown in Valley
0.4	No	Pumped / Transported / Thrown in Valley
1.2	No	Pumped / Transported / Thrown in Valley
0.4	No	Pumped / Transported / Thrown in Valley
1.5	No	Pumped / Transported / Thrown in Valley
1	No	Pumped / Transported / Thrown in Valley
1.2	No	Pumped / Transported / Thrown in Valley
1	No	Pumped / Transported / Thrown in Valley
1	No	Pumped / Transported / Thrown in Valley
0.4	No	Pumped / Transported / Thrown in Valley
1.5	No	Pumped / Transported / Thrown in Valley
0.4	No	Pumped / Transported / Thrown in Valley
0.4	No	Pumped / Transported / Thrown in Valley
0.6	No	Pumped / Transported / Thrown in Valley
0.4	No	Pumped / Transported / Thrown in Valley
1.26	No	Disposed to Sewer System
1.5	No	Disposed to Sewer System
0.8	No	Pumped / Transported / Thrown in Valley
1.5	No	Most of OMWW is Disposed by pipe from Cesspit Directly to Vally
1.2	No	Pumped / Transported / Thrown in Valley
0.4	No	Pumped / Transported / Thrown in Valley
0.4	No	Pumped / Transported / Thrown in Valley
1	No	Pumped / Transported / Thrown in Valley
2	No	Disposed to Sewer System
1	No	Pumped / Transported / Thrown in Valley
1.2	No	Disposed to Natural Opening Underground
1.5	No	Disposed to Sewer System
1.5	No	Disposed to Sewer System
1.124130435	No : 100 %	Pumped / Transported / Thrown Away : 78 %
0.616104522		Disposed to Sewer System : 13 %
0.4		Most of OMWW is Disposed by pipe from Cesspit Directly to Vally : 7%
2.5		Disposed to Natural Opening Underground : 2%

Col. 9.4	Col. 10.1a	Col. 10.1b	Col. 10.1c	Col. 10.2a	Col. 10.2b	Col. 10.2c
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	150	Plastic Bags	0	0	/	/
/	0	/	/	0	/	/
/	150	Plastic Bags	0	0	/	/
/	130	Plastic Bags	0	0	/	/
/	100	Plastic Bags	0	0	/	0
/	100	Plastic Bags	0	0	/	0
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	100	None	All	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	200	None	All	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	60	Plastic Bags	0	0	/	/
/	100	None	All	0	/	/
/	160	None	All	0	/	/
/	40	Plastic Bags	0	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	0	/	/	For Sale	Metal	0
/	80	None	All	0	/	/
/	200	None	All	0	/	/
/	100	None	All	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	20	Plastic Bags	0	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	0	/	/	0	/	/
/	200	Silo	Little	0	/	/
/	200	Silo	Little	0	/	/
	45.43478261					
	69.04769758					
	0					
	200					

Col. 10.3a	Column 10.3b	Col. 10.3c	Column 10.4a
200	Plastic Container	0	37
1000	Metal	0	33
2400	Metal & Plastic Containers	0	15
8000	Metal	0	100
900	Metal	0	6
2400	Metal	0	84
1000	Plastic Container	0	50
1000	Plastic Container	0	50
0	/	/	1
0	/	/	2
0	/	/	24
0	/	/	70
0	/	/	12
60	2 Plastic Containers	/	2
6	Metal	0	64
0	/	/	3
1	Plastic Container	0	13.5
0	/	/	0
0	/	/	5
0	/	/	21
0	/	/	8
0	/	/	0
0	/	/	2
0	/	/	60
0	/	/	150
0	/	/	4
0	/	/	0
0	/	/	0
0	/	/	7
0	/	/	100
0	/	/	4
0	/	/	20
0	/	/	20
0	/	/	40
0	/	/	9
0	/	/	40
0	/	/	400
0	/	/	130
0	/	/	8
0	/	/	6
0	/	/	36
400	Metal	0	100
2000	Metal	0	7
2200	Metal	0	12
2000	Metal	0	20
2000	Metal	0	20
555.8043478			39.0326087
1351.2413			65.77625392
0			0
8000			400

Column 10.4b	Col.10.4c	Col. 10.5a
Reinforced Concrete (25m3) & Metal (12m3)	0	10
Reinforced Concrete (30m3) & Metal (3m3)	0	18
Reinforced Concrete	0	14
Reinforced Concrete	0	100
Reinforced Concrete	0	10
Reinforced Concrete (80m3) & Plastic Container (4m3)	0	50
Metal	0	50
Metal	0	150
Metal	0	20
Plastic Container	0	10
Reinforced Concrete (16m3) & Metal (8m3)	0	80
Concrete Plastered Cistern	Yes	4
Reinforced Concrete	0	10
2 Metal Containers (1m3 each)	0	/
Reinforced Concrete	0	50
Metal	0	80
Plastic Container	0	100
/	/	30
Metal	0	36
Reinforced Concrete (20m3) & Plastic Container (1m3)	0	20
4 Plastic Containers (2m3 each)	0	80
/	/	20
2 Plastic Containers (1m3 each)	0	30
Reinforced Concrete	0	2.5
Reinforced Concrete	0	12
Metal	0	35
/	/	240
/	/	60
Reinforced Concrete	0	30
Reinforced Concrete	0	70
Plastic Container	0	30
2 Metal Containers (10m3 each)	0	9
Reinforced Concrete (8m3) & 2 Metal Containers (6m3 each)	0	4
20 Metal Containers (2m3 each)	0	/
3 Plastic Containers (3m3 each)	0	/
Reinforced Concrete	0	18
Reinforced Concrete	0	50
Concrete Plastered Cistern(125m3) & 5 (Metal & Plastic) Containers	0	25
4 Metal Containers	0	30
6 Metal Containers	0	20
Concrete Plastered Cistern (30m3) & Metal Container (6m3)	0	30
Reinforced Concrete	0	/
Reinforced Concrete (6m3) & Metal (1m3)	0	12
6 Metal Containers (2m3 each)	0	Very Big
Reinforced Concrete (10m3) & 5 Metal (2m3 each)	0	/
Reinforced Concrete (10m3) & 5 Metal (2m3 each)	0	/
Reinforced Concrete : 26 % Metal : 26 %		42.29487179
Reinforced Concrete & Metal : 15 % None : 9 %		45.83490367
Rein. Concrete & Plastic: 4 % Plastic Containers : 14 %		2.5
Concrete Plastered Cistern : 2 %		240
Concrete Plastered Cistern & Metal Container : 2 %		
Concrete Plastered Cistern & Metal & Plastic : 2 %		
Average Volume of Concrete Water Cistern: 61.8 m3		

Column 10.5b	Column 10.5c	Column 10.6a
Cesspit	Yes	50
Comon Cesspit	Yes	18
Cesspit	Yes	4
Cesspit	Yes	100
Reinforced Concrete Common Cesspit	No	10
Cesspit	Yes	60
Cesspit Disposed Directly to Vally	Yes	400
Comon Cesspit Disposed Directly to Vally	Yes	150
Comon Cesspit	Yes	20
Cesspit	Yes	50
Cesspit	Yes	80
Cesspit	Yes	6
Comon Cesspit	Yes	10
/	/	/
Comon Cesspit	Yes	50
Comon Cesspit	Yes	80
Comon Cesspit	Yes	100
Cesspit	Yes	80
Cesspit	Yes	150
Comon Cesspit	Yes	20
Reinforced Concrete Cesspit	No	40
Concrete (Plastered) Cesspit with Reinforced Top	Little (Yes)	36
Cesspit	Yes	70
Cesspit	Yes	40
Cesspit	Yes	75
Comon Cesspit	Yes	35
Comon Cesspit	Yes	240
Reinforced Concrete Cesspit	No	80
Reinforced Concrete Cesspit	No	250
Reinforced Concrete Cesspit	No	170
Cesspit	Yes	30
Cesspit with Reinforced Concrete Top	/	75
Cesspit	/	90
/	/	/
/	/	/
Reinforced Concrete Cesspit	No	150
Cesspit	Yes	12
Cesspit	Yes	380
Reinforced Concrete Cesspit	No	70
Reinforced Concrete Cesspit	No	60
Reinforced Concrete Cesspit	No	150
/	/	/
Common Cesspit	Yes	12
Natural Underground Opening	All (Yes)	Very Big
/	/	/
/	/	/
Cesspit : 35 % Rein. Concrete Cesspit : 17 %	Yes : 63 %	89.82051282
Common Cesspit : 22% Rein. Conc. Common Cesspit : 2%		92.69272151
Cesspit with Reinforced Concrete Top : 2 %		4
Concrete (Plastered) Cesspit with Reinforced Top : 2 %		400
Cesspit Disposed Directly to Vally : 2 %		
Comon Cesspit Disposed Directly to Vally : 2 %		
Natural Underground Opening : 2 % None : 14 %		

Column 10.6b	Col. 10.6c	Col. 10.7a
Cesspit	Yes	0
Comon Cesspit	Yes	0
Cesspit	Yes	0
Cesspit	Yes	0
Reinforced Concrete Common Cesspit	No	0
Cesspit	Yes	0
Cesspit Disposed Directly to Vally	Yes (All)	0
Comon Cesspit Disposed Directly to Vally	Yes (All)	0
Comon Cesspit	Yes	0
Cesspit	Yes	0
Reinforced Concrete Cesspit	No	0
Cesspit	Yes	0
Comon Cesspit	Yes	0
/	/	0
Comon Cesspit	Yes	0
Comon Cesspit	Yes	0
Comon Cesspit	Yes	0
Cesspit	Yes	0
Cesspit	Yes	0
Comon Cesspit	Yes	0
Reinforced Concrete Cesspit	No	0
Concrete (Plastered) Cesspit with Reinforced Top	Little	0
Cesspit	Yes	0
Cesspit	Yes	0
Cesspit	Yes	0
Comon Cesspit	Yes	0
Comon Cesspit	Yes	0
Reinforced Concrete Cesspit	No	0
Reinforced Concrete Cesspit	No	0
Reinforced Concrete Cesspit	No	0
2 Cesspits	Yes	0
Reinforced Concrete Cesspit	/	0
Cesspit with Reinforced Concrete Top	/	0
/	/	0
/	/	0
Reinforced Concrete Cesspit	No	0
Hole Direct to the Vally (by pipe & motor)	Yes (All)	0
Reinforced Concrete Cesspit(160m3)&2Normal Cesspits(160&60m3)	No & Yes	0
Reinforced Concrete Cesspit	No	0
Reinforced Concrete Cesspit	No	0
Reinforced Concrete Cesspit	No	0
/	/	0
Common Cesspit	Yes	0
Natural Underground Opening	Yes (All)	0
/	/	0
/	/	0
Cesspit : 26 % Reinforced Concrete Cesspit : 22 % None : 14 %	Yes : 59%	
Common Cesspit: 22% Reinforced Concrete Common Cesspit: 2%		
Cesspit with Reinforced Concrete Top : 2 %		
Reinforced Concrete Cesspit & Normal Cesspits : 2 %		
Concrete (Plastered) Cesspit with Reinforced Concrete Top : 2 %		
Cesspit & Comon Cesspit Disposed Directly to Vally : 4 %		
Natural Underground Opening: 2% Hole Direct to the Vally: 2%		

Col.10.7b	Col. 10.7c	Col. 10.8	Col. 10.8a	Col. 10.8b	Col. 10.8c	Col. 11.1	Col. 11.2
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
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/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
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/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
/	/	/	/	/	/	No	No
						No 100 %	No 100 %

Col. 11.3	Col. 11.4	Col. 11.5	Column 12.1	Column 12.2	Column 12.3
No	No	No	Mostly OIL	18:01	/
No	No	No	Mostly OIL	17:01	/
No	No	No	Mostly OIL	17:01	/
No	No	No	Mostly OIL	15:01	/
No	No	No	Mostly OIL	17:01	/
No	No	No	Mostly OIL	14:01	/
No	No	No	Mostly OIL	20:01	/
No	No	No	Mostly OIL	20:01	/
No	No	No	Mostly Olive	12:01	/
No	No	No	Mostly Olive	14:01	/
No	No	No	Mostly OIL	15:01	/
No	No	No	Mostly OIL	17:01	/
No	No	No	Mostly OIL	12:01	/
No	No	No	Mostly OIL	15:01	/
No	No	No	Mostly OIL	15:01	/
No	No	No	Mostly OIL	17:01	/
No	No	No	Mostly OIL	20:01	/
No	No	No	Mostly OIL	15:01	/
No	No	No	Mostly OIL	12:01	/
No	No	No	Mostly OIL	12:01	/
No	No	No	Mostly OIL	13:01	/
No	No	No	Mostly OIL	12:01	/
No	No	No	Mostly OIL	12:01	/
No	No	No	Mostly OIL	15:01	/
No	No	No	Mostly OIL	15:01	/
No	No	No	Mostly OIL	20:01	/
No	No	No	Mostly OIL	14:01	/
No	No	No	Mostly OIL	12:01	/
No	No	No	Mostly OIL	10:01	/
No	No	No	Mostly OIL	12:01	/
No	No	No	Mostly OIL	12:01	/
No	No	No	Mostly OIL	17:01	/
No	No	No	Mostly OIL	17:01	/
No	No	No	Mostly OIL	13.5:01	/
No	No	No	Mostly OIL	11:01	/
No	No	No	Mostly OIL	10:01	/
No	No	No	Mostly OIL	12:01	/
No	No	No	Mostly OIL	13:01	/
No	No	No	Mostly OIL	11:01	/
No	No	No	Mostly OIL	11:01	/
No	No	No	Mostly OIL	10:01	/
No	No	No	Mostly Cash	/	250 NIS Per 1 Ton
No	No	No	Mostly Cash	/	200 NIS Per 1 Ton
No	No	No	Mostly Cash	/	350 NIS Per 1 Ton
No	No	No	Mostly Cash	/	400 NIS Per 1 Ton
No	No	No	Mostly Cash	/	400 NIS Per 1 Ton
No 100 %	No 100 %	No 100 %	Mostly OIL : 89 %	av:14.3:1	av: 320 NIS Per 1 Ton
			Mostly Cash :11 %		

Col. 13	Col. 14	Col. 15	Col. 16	Column 17	Column 18
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	4	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	4	1	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	2	0	0
Yes	Yes	Yes	4	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	Deliberate Fire in 1995	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	1	0	0
Yes	Yes	Yes	3	0	0
Yes	Yes	Yes	4	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	3	0	0
Yes	Yes	Yes	3	0	0
Yes	Yes	Yes	2	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	4	0	0
Yes	Yes	Yes	2	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	2	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	2	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	2	0	0
Yes	Yes	Yes	5	0	0
Yes	Yes	Yes	5	0	0
Yes 100 %	Yes 100 %	Yes 100 %	4.282608696	0.022222222	0
			1.186274158	0.149071198	0
			1	0	
			5	1	

Column 19
0
In 1996,Complaints about Starting the Press/ Press Started After Permission from Ministry of Health
0
0
0
0
0
0
0
0
0
0
0
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0
0
0
Complaints about Amount of Oil Produced (Less than Expected)
Complaints about Amount of Oil Produced (Less than Expected)
7.00%

Column 20 (a)	Column 20 (b)	Col. 20 (c)	Col. 20 (d)_	Column 20 (e)
In 1998 Turbine Problems	0	0	0	0
0	0	0	0	0
Spare Parts are Expensive	0	0	0	0
0	0	0	0	0
0	0	0	0	0
Another Turbine is Needed	0	0	0	0
0	0	0	0	Lack of Electricity
0	0	0	0	Lack of Electricity
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
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0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	No Respect for Qs	0	0	0
7.00%	2.00%	0	0	Lack of Electricity : 4 %

Column 21
Ministry of Health, Environment, Agriculture / Painting, Cleaning, Start on October,15th
Ministry of Health, Environment, Agriculture / Painting, Cleaning, Start on October,15th
Ministry of Health, Environment, Agriculture / Painting, Cleaning, Start on October,15th
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Ministry of Health, Environment, Agriculture / Painting, Cleaning, Start on October,15th
Ministry of Health, Environment, Agriculture / Painting, Cleaning, Start on October,15th

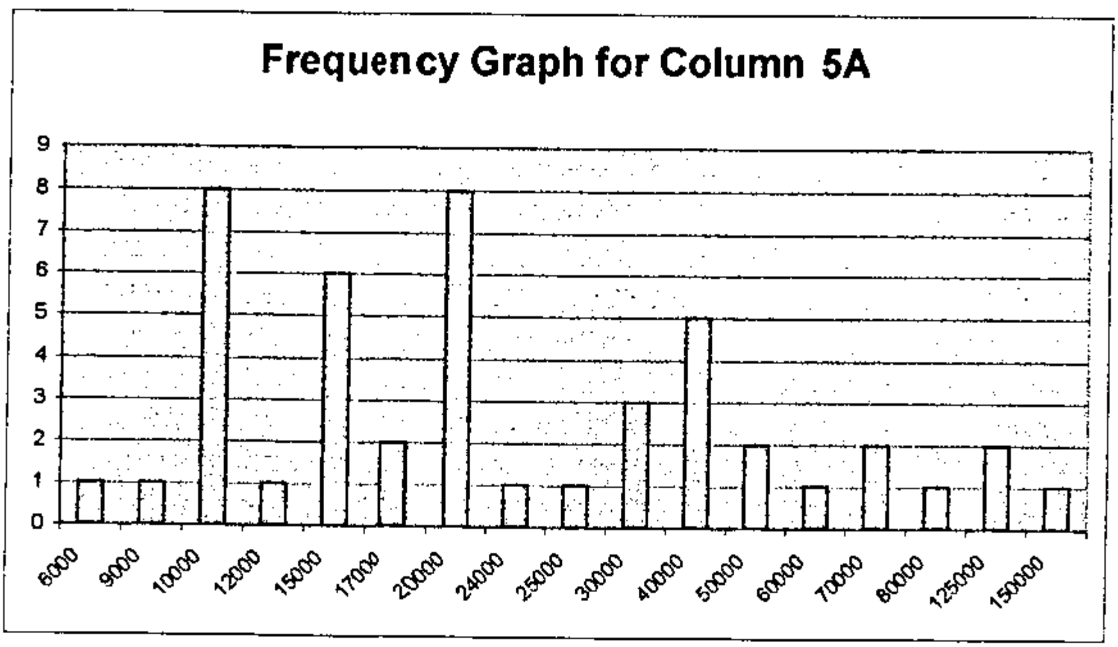
Column 22	Column 23 (a)	Column 23 (b)
Oil Filter / Costs 30000 JD	2	Less
Automatic Filler /Costs 30000 JD	2	Less
Aditional Final Separator	2	Less
2 Turbines, 2 Final Separators / 10000 JD	2	Less
/	2	Less
/	1	Less
/	3	Less
Turbine for Final Separation Instead of Pistons / 40000 JD	3	Less
/	4	Less
Washing Mashine/3000 JD, Transporter for Seeds/3500 JD	4	Less
/	1	Less
/	1	Less
Substituting Pistons with Turbines /21000 JD	1	Less
/	1(not operating)	Less
Renewing the Two Pistons / 250000 JD	2	Less
/	2	Less
/	0	/
/	0	/
/	2	Less
/	2	Less
/	1	Less
Modernization to Full Automatic / 80000 JD	0	/
/	1	Less
Third Final Separator / 15000 JD	2	Less
Belt, Final Separator, Washing Machine / 15000 JD	2	Less
Second Line / 60000	0	/
/	0	/
/	1	Less
New Turbine / 25000 JD	5	Less
/	5	Less
/	5	Less
/	2	Less
Two Pistons/Spreader/Two Final Separators/9000 JD	2	Less
/	0	/
Aditional Final Separator / 8000 JD & Tiling 4000 JD	0	/
/	0	/
/	0	/
/	0	/
/	0	/
/	2 (Bawabir)	Less
New Turbine / 70000 JD	0	/
/	3	Less
/	0	/
/	0	/
/	4	Less
New Turbine / 70000 JD	4	Less
Need to Develop Press : 37 %	1.659090909	Less : 69.6 %
	1.554336497	
	0	
	5	

Column 23 (c)	Column 24.1	Col. 24.2	Column 25	Column 25(a)
No	No	/	No	Clean / No Oil Loss
No	No	/	No	Clean / No Oil Loss
Yes	No	/	No	Clean / No Oil Loss
Yes	No	/	No	Clean / No Oil Loss
Yes	No	/	No	Clean / No Oil Loss
No	No	/	No	Clean / No Oil Loss
No	No	/	Yes	Clean / No Oil Loss
No	No	/	Yes, but Not for All Years	Better Oil Quality
Yes	Yes(Modern)	/	Yes	Better Oil Quality
Yes	No	/	No	Better Oil Quality
Yes	No	/	Yes, but Not for All Years	Clean / No Oil Loss
Yes	No	/	No	Clean / No Oil Loss
Yes	No	/	No	Better Oil Quality
No	No	/	Yes	Clean / No Oil Loss
Yes	No	/	No	Clean / No Oil Loss
Yes	No	/	Yes	Better Oil Quality
No	No	/	No	Clean / No Oil Loss
No	No	/	No	Clean / No Oil Loss
No	No	/	Yes	Clean / No Oil Loss
No	No	/	Yes	Better Oil Quality
Yes	No	/	No	Clean / No Oil Loss
No	No	/	No	Better Oil Quality
Yes	No	/	No	Better Oil Quality
Yes	No	/	No	Clean / No Oil Loss
Yes	No	/	No	Clean / No Oil Loss
No	No	/	Not Sure	Clean / No Oil Loss
No	No	/	Yes, but Not for All Years	Clean / No Oil Loss
No	No	/	Yes	Better Oil Quality
Yes	No	/	No	Clean / No Oil Loss
Yes	No	/	No	Better Oil Quality
Yes	No	/	No	Better Oil Quality
No	Yes	/	Yes	Better Oil Quality
No	Yes	/	Yes	Better Oil Quality
No	No	/	No	Clean / No Oil Loss
No	No	/	No	Clean / No Oil Loss
No	No	/	No	Clean / No Oil Loss
No	No	/	Yes	Clean / No Oil Loss
No	No	/	No	Clean / No Oil Loss
No	No	/	No	Better Oil Quality
Yes	No	/	Yes	Better Oil Quality
No	No	/	Yes	Clean / No Oil Loss
No	No	/	No	Clean / No Oil Loss
No	No	/	Yes	Clean / No Oil Loss
No	No	/	Not Sure	Clean / No Oil Loss
No	No	/	No	Clean / No Oil Loss
No	No	/	No	Clean / No Oil Loss
Yes : 39 %	Yes : 7 %		No : 61 %	Clean / No Oil Loss : 67 %
			Yes : 28 %	Better Oil Quality : 33 %
			Not Sure : 4 %	
			Yes, but Not for All Years:7%	

Column 25(b)
Appreciate It Very Much
Appreciate It Very Much
Fairly Appreciate It
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Fairly Appreciate It
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Fairly Appreciate It
Appreciate It Very Much
Fairly Appreciate It
Fairly Appreciate It
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Appreciate It Very Much
Fairly Appreciate It
Appreciate It Very Much
Fairly Appreciate It
Appreciate It Very Much
Fairly Appreciate It
Appreciate It Very Much
Appreciate It Very Much
Fairly Appreciate It
Fairly Appreciate It
Appreciate It Very Much : 78 %
Fairly Appreciate It : 22 %

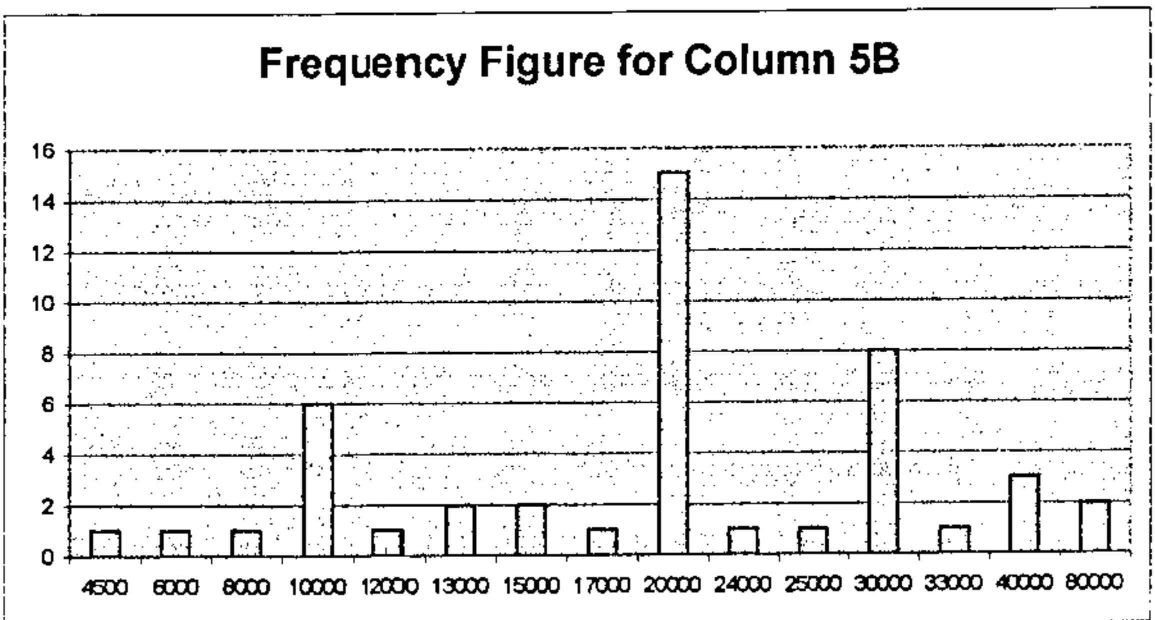
Frequency Table for Column 5A

Valid	Frequency	Percent	Cumulative Percent
6000	1	2.2	2.2
9000	1	2.2	4.3
10000	8	17.4	21.7
12000	1	2.2	23.9
15000	6	13	37
17000	2	4.3	41.3
20000	8	17.4	58.7
24000	1	2.2	60.9
25000	1	2.2	63
30000	3	6.5	69.6
40000	5	10.9	80.4
50000	2	4.3	84.8
60000	1	2.2	87
70000	2	4.3	91.3
80000	1	2.2	93.5
125000	2	4.3	97.8



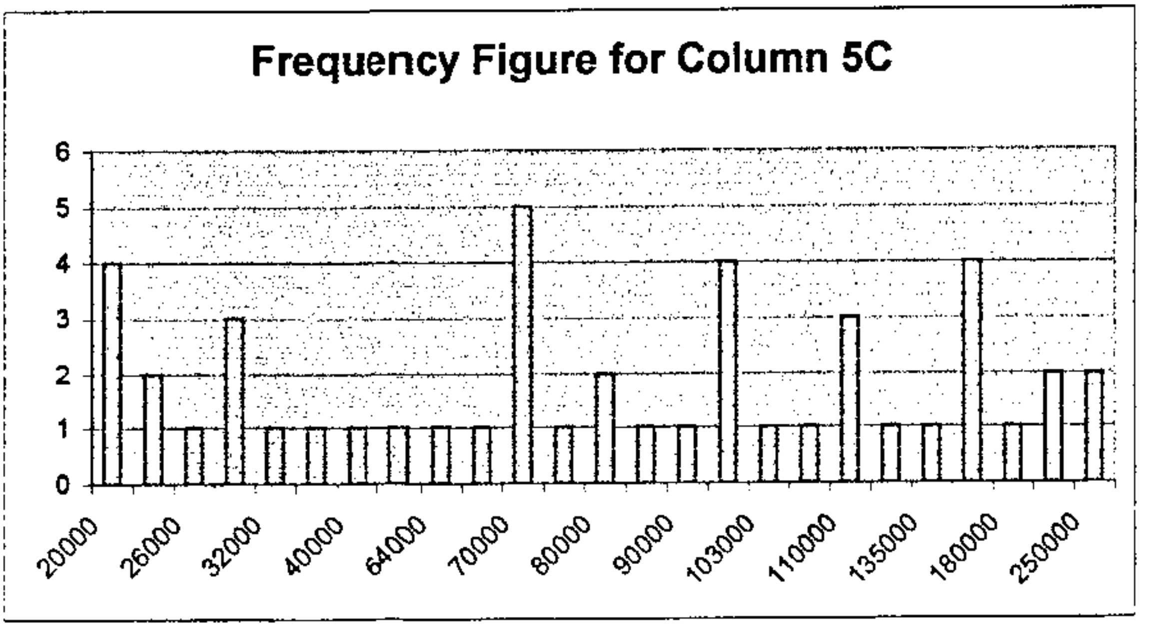
Frequency Table for Column 5B

Valid	Frequency	Percent	Cumulative Percent
4500	1	2.2	2.2
6000	1	2.2	4.3
8000	1	2.2	6.5
10000	6	13	19.6
12000	1	2.2	21.7
13000	2	4.3	26.1
15000	2	4.3	30.4
17000	1	2.2	32.6
20000	15	32.6	65.2
24000	1	2.2	67.4
25000	1	2.2	69.6
30000	8	17.4	87
33000	1	2.2	89
40000	3	6.5	95.7
80000	2	4.3	100



Frequency Table for Column 5C

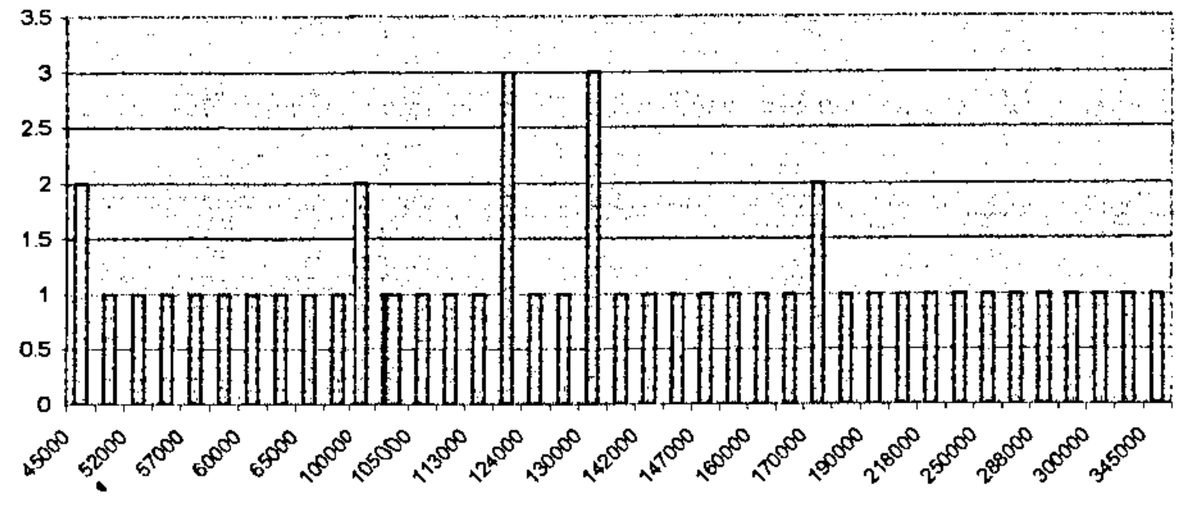
Valid	Frequency	Percent	Cumulative Percent
20000	4	8.7	8.7
25000	2	4.3	13
26000	1	2.2	15.2
30000	3	6.5	21.7
32000	1	2.2	23.9
33500	1	2.2	26.1
40000	1	2.2	28.3
60000	1	2.2	30.4
64000	1	2.2	32.6
65000	1	2.2	34.8
70000	5	10.9	45.7
79000	1	2.2	47.8
80000	2	4.3	52.2
85000	1	2.2	54.3
90000	1	2.2	56.5
100000	4	8.7	65.2
103000	1	2.2	67.4
105000	1	2.2	69.6
110000	3	6.5	76.1
120000	1	2.2	78.3
135000	1	2.2	80.4
150000	4	8.7	89.1
180000	1	2.2	91.3
200000	2	4.3	95.7
250000	2	4.3	100



Frequency Table for Column 5D

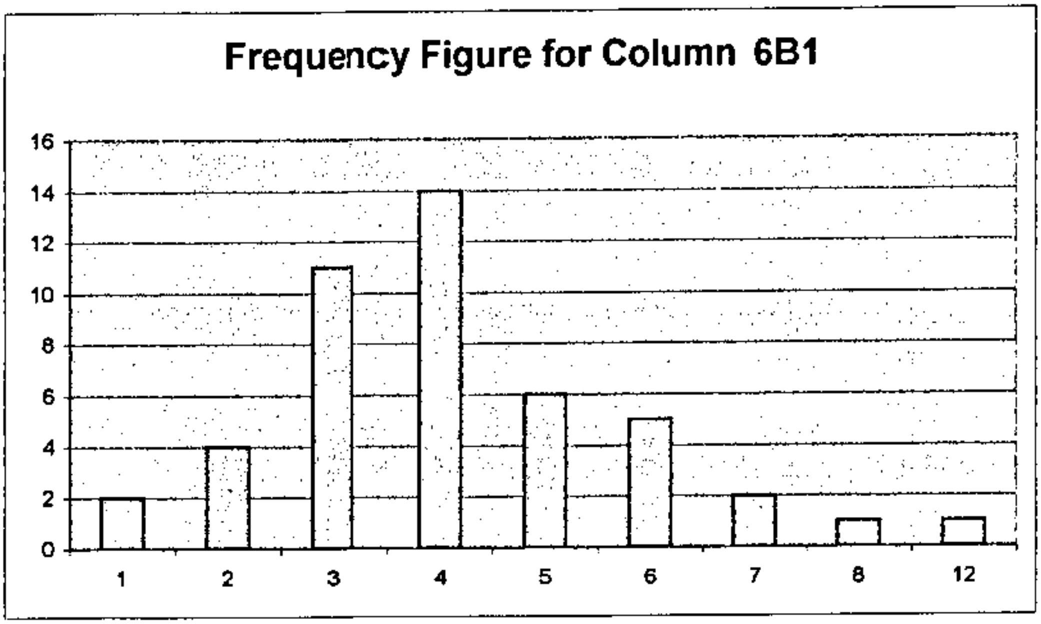
Valid	Frequency	Percent	Cumulative Percent
45000	2	4.3	4.3
50000	1	2.2	6.5
52000	1	2.2	8.7
55000	1	2.2	10.9
57000	1	2.2	13.0
59500	1	2.2	15.2
60000	1	2.2	17.4
62000	1	2.2	19.6
65000	1	2.2	21.7
80000	1	2.2	23.9
100000	2	4.3	28.3
104000	1	2.2	30.4
105000	1	2.2	32.6
110000	1	2.2	34.8
113000	1	2.2	37.0
120000	3	6.5	43.5
124000	1	2.2	45.7
125000	1	2.2	47.8
130000	3	6.5	54.3
134000	1	2.2	56.5
142000	1	2.2	58.7
145000	1	2.2	60.9
147000	1	2.2	63.0
152000	1	2.2	65.2
160000	1	2.2	67.4
166000	1	2.2	69.7
170000	2	4.3	73.9
175000	1	2.2	76.1
190000	1	2.2	78.3
210000	1	2.2	80.4
218000	1	2.2	82.6
245000	1	2.2	84.8
250000	1	2.2	87.0
260000	1	2.2	89.1
288000	1	2.2	91.3
294500	1	2.2	93.5
300000	1	2.2	95.7
330000	1	2.2	97.8
345000	1	2.2	100.0

Frequency Figure for Column 5D



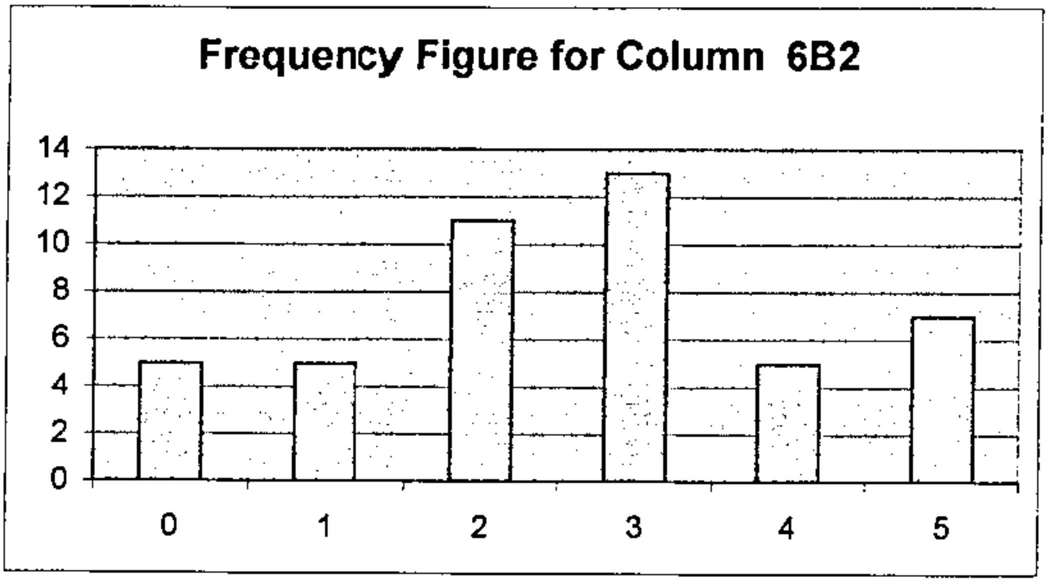
Frequency Table for Column 6B1

Valid	Frequency	Percent	Cumulative Percent
1	2	4.3	4.3
2	4	8.7	13.0
3	11	23.9	37.0
4	14	30.4	67.4
5	6	13	80.4
6	5	10.9	91.3
7	2	4.3	95.7
8	1	2.2	97.8
12	1	2.2	100.0



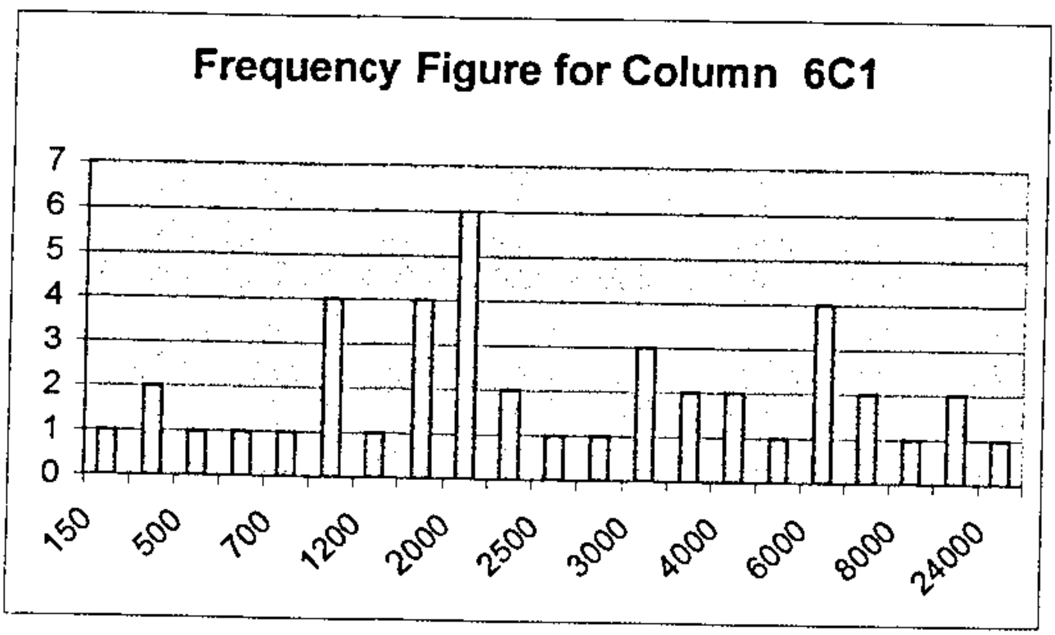
Frequency Table for Column 6B2

Valid	Frequency	Percent	Cumulative Percent
0	5	10.9	10.9
1	5	10.9	21.7
2	11	23.9	45.7
3	13	28.3	73.9
4	5	10.9	84.8
5	7	15.2	100



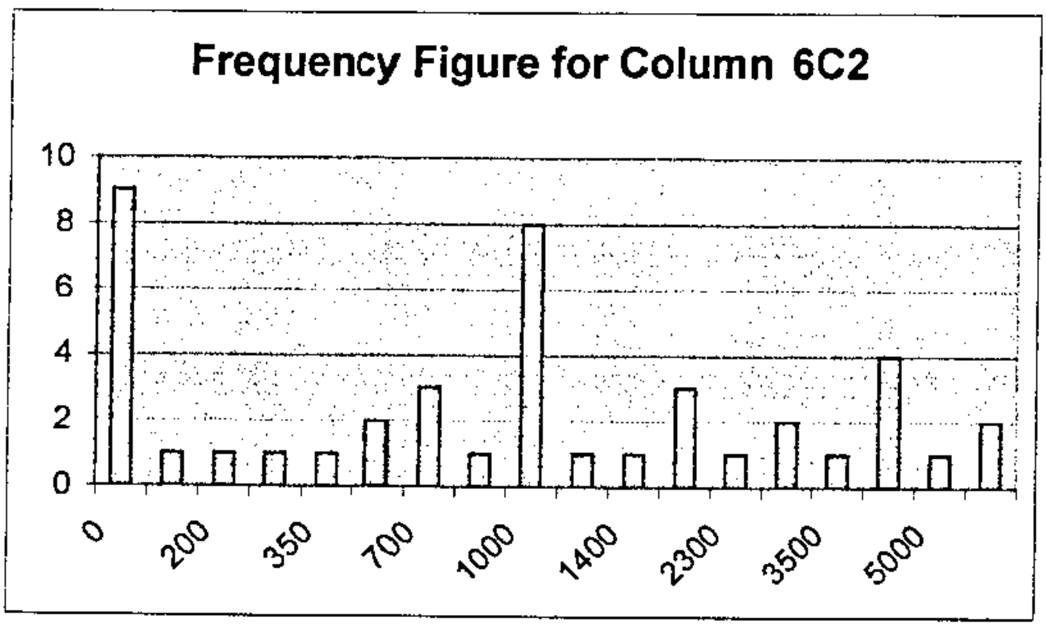
Frequency Table for Column 6C1

Valid	Frequency	Percent	Cumulative Percent
150	1	2.3	2.3
300	2	4.7	7
500	1	2.3	9.3
600	1	2.3	11.6
700	1	2.3	14.0
1000	4	9.3	23.3
1200	1	2.3	25.6
1500	4	9.3	34.9
2000	6	14	48.8
2400	2	4.7	53.5
2500	1	2.3	55.8
2700	1	2.3	58.1
3000	3	7	65.1
3500	2	4.7	69.8
4000	2	4.7	74.4
5000	1	2.3	76.7
6000	4	9.3	86.0
7000	2	4.7	90.7
8000	1	2.3	93
10000	2	4.7	97.7
24000	1	2.3	100



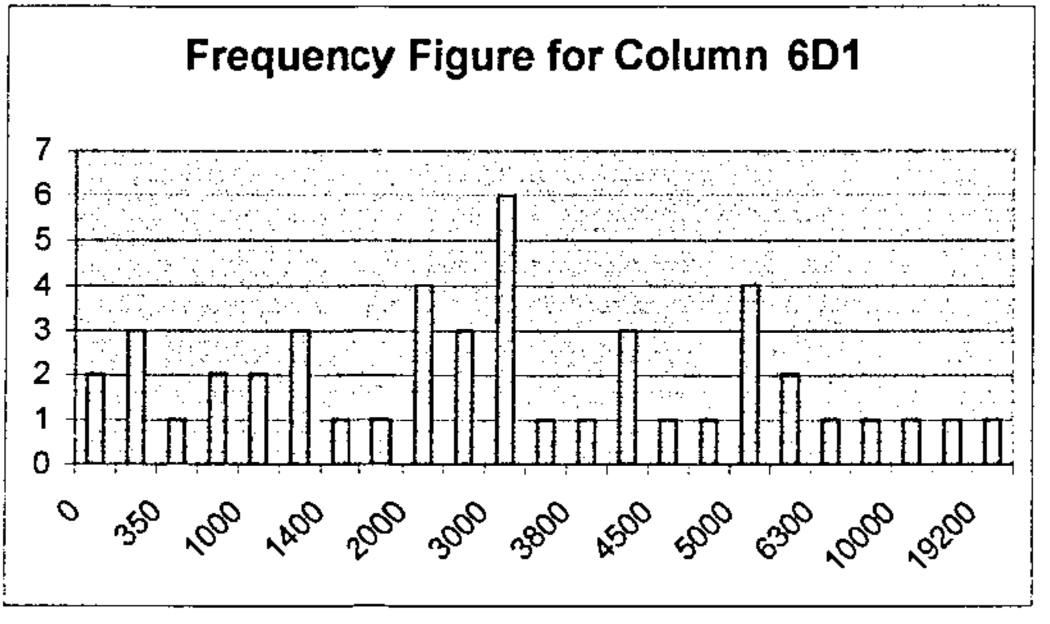
Frequency Table for Column 6C2

Valid	Frequency	Percent	Cumulative Percent
0	9	20.9	20.9
100	1	2.3	23.3
200	1	2.3	25.6
300	1	2.3	27.9
350	1	2.3	30.2
500	2	4.7	34.9
700	3	7	41.9
800	1	2.3	44.2
1000	8	18.6	62.8
1200	1	2.3	65.1
1400	1	2.3	67.4
2000	3	7	74.4
2300	1	2.3	76.7
3000	2	4.7	81.4
3500	1	2.3	83.7
4000	4	9.3	93.0
5000	1	2.3	95.3
6000	2	4.7	100.0



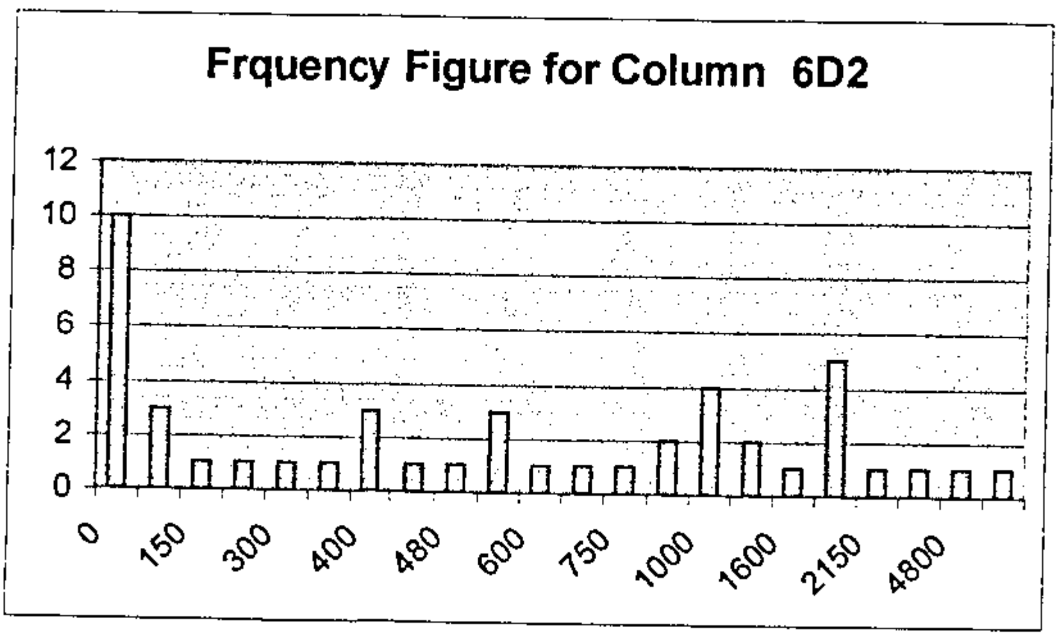
Frequency Table for Column 6D1

Valid	Frequency	Percent	Cumulative Percent
0	2	4.3	4.3
200	3	6.5	10.9
350	1	2.2	13.0
400	2	4.3	17.4
1000	2	4.3	21.7
1200	3	6.5	28.3
1400	1	2.2	40.4
1800	1	2.2	32.6
2000	4	8.7	41.3
2500	3	6.5	47.8
3000	6	13	60.9
3500	1	2.2	63.0
3800	1	2.2	65.2
4000	3	6.5	71.7
4500	1	2.2	73.9
4700	1	2.2	76.1
5000	4	8.7	84.8
6000	2	4.3	89.1
6300	1	2.2	91.3
7000	1	2.2	93.5
10000	1	2.2	95.7
12000	1	2.2	97.8
19200	1	2.2	100.0



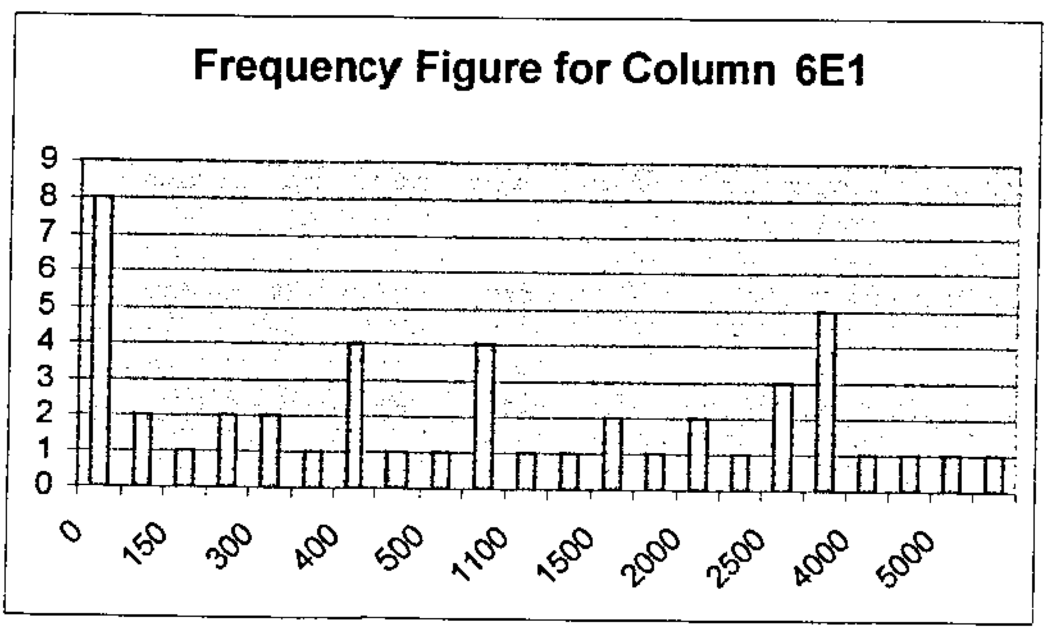
Frequency Table for Column 6D2

Valid	Frequency	Percent	Cumulative Percent
0	10	21.7	21.7
100	3	6.5	28.3
150	1	2.2	30.4
200	1	2.2	32.6
300	1	2.2	34.8
320	1	2.2	37.0
400	3	6.5	43.5
420	1	2.2	45.7
480	1	2.2	47.8
500	3	6.5	54.3
600	1	2.2	56.5
700	1	2.2	58.7
750	1	2.2	60.9
800	2	4.3	65.2
1000	4	8.7	73.9
1500	2	4.3	78.3
1600	1	2.2	80.4
2000	5	10.9	91.3
2150	1	2.2	93.5
3500	1	2.2	95.7
4800	1	2.2	97.8
6000	1	2.2	100.0



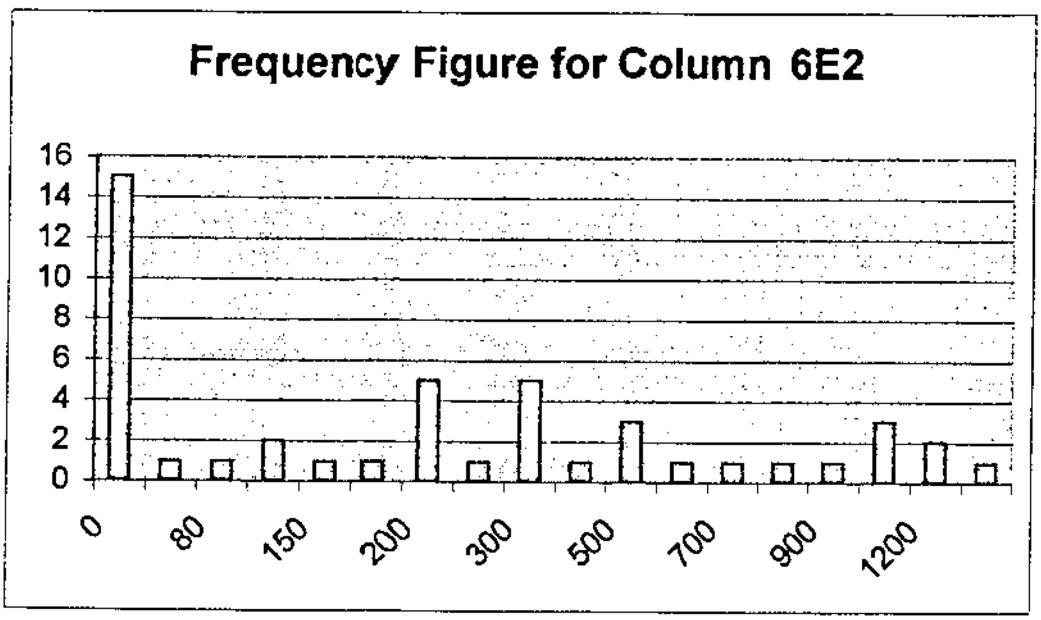
Frequency Table for Column 6E1

Valid	Frequency	Percent	Cumulative Percent
0	8	17.4	17.4
100	2	4.3	21.7
150	1	2.2	23.9
200	2	4.3	28.3
300	2	4.3	32.6
350	1	2.2	34.8
400	4	8.7	43.5
450	1	2.2	45.7
500	1	2.2	47.8
1000	4	8.7	56.5
1100	1	2.2	58.7
1300	1	2.2	60.9
1500	2	4.3	65.2
1900	1	2.2	67.4
2000	2	4.3	71.7
2300	1	2.2	73.9
2500	3	6.5	80.4
3000	5	10.9	91.3
4000	1	2.2	93.5
4500	1	2.2	95.7
5000	1	2.2	97.8
10000	1	2.2	100.0



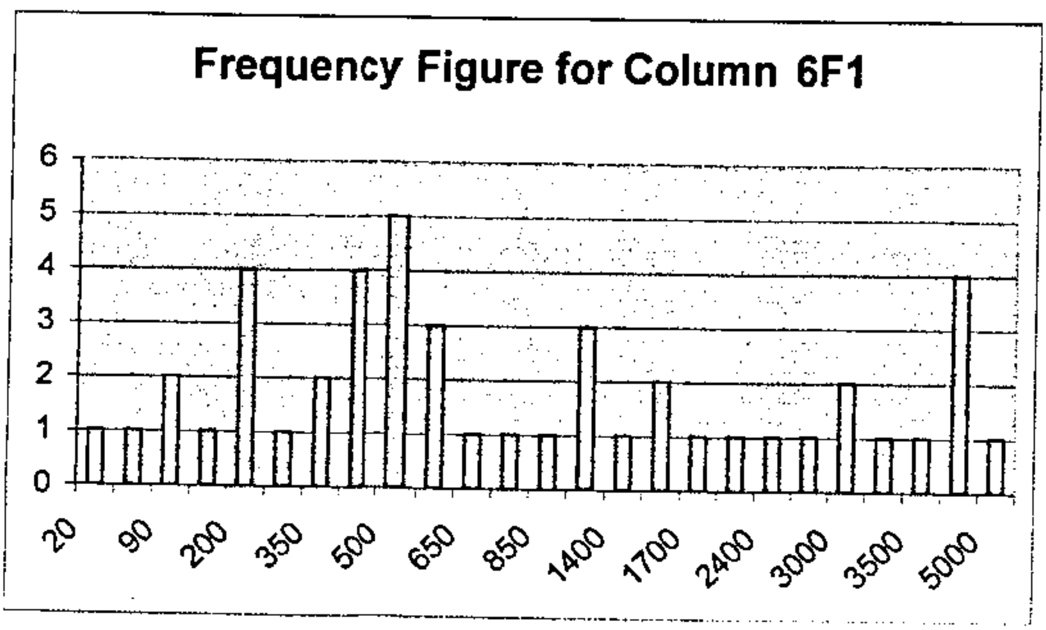
Frequency Table for Column 6E2

Valid	Frequency	Percent	Cumulative Percent
0	15	32.6	32.6
50	1	2.2	34.8
80	1	2.2	37.0
100	2	4.3	41.3
150	1	2.2	43.5
180	1	2.2	45.7
200	5	10.9	56.5
250	1	2.2	58.7
300	5	10.9	69.6
400	1	2.2	71.7
500	3	6.5	78.3
600	1	2.2	80.4
700	1	2.2	82.6
800	1	2.2	84.8
900	1	2.2	87.0
1000	3	6.5	93.5
1200	2	4.3	97.8
2500	1	2.2	100.0



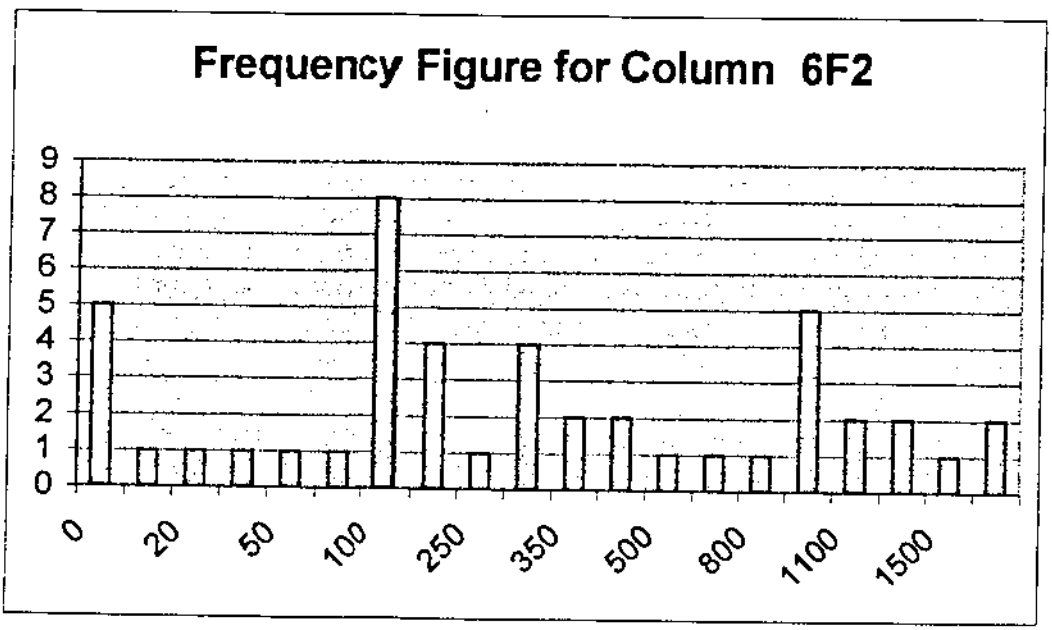
Frequency Table for Column 6F1

Valid	Frequency	Percent	Cumulative Percent
20	1	2.2	2.2
80	1	2.2	4.3
90	2	4.3	8.7
100	1	2.2	10.9
200	4	8.7	19.6
250	1	2.2	21.7
350	2	4.3	26.1
400	4	8.7	34.8
500	5	10.9	45.7
600	3	6.5	52.2
650	1	2.2	54.3
700	1	2.2	56.5
850	1	2.2	58.7
1000	3	6.5	65.2
1400	1	2.2	67.4
1500	2	4.3	71.7
1700	1	2.2	73.9
2000	1	2.2	76.1
2400	1	2.2	78.3
2600	1	2.2	80.4
3000	2	4.3	84.8
3400	1	2.2	87.0
3500	1	2.2	89.1
4000	4	8.7	97.8
5000	1	2.2	100.0



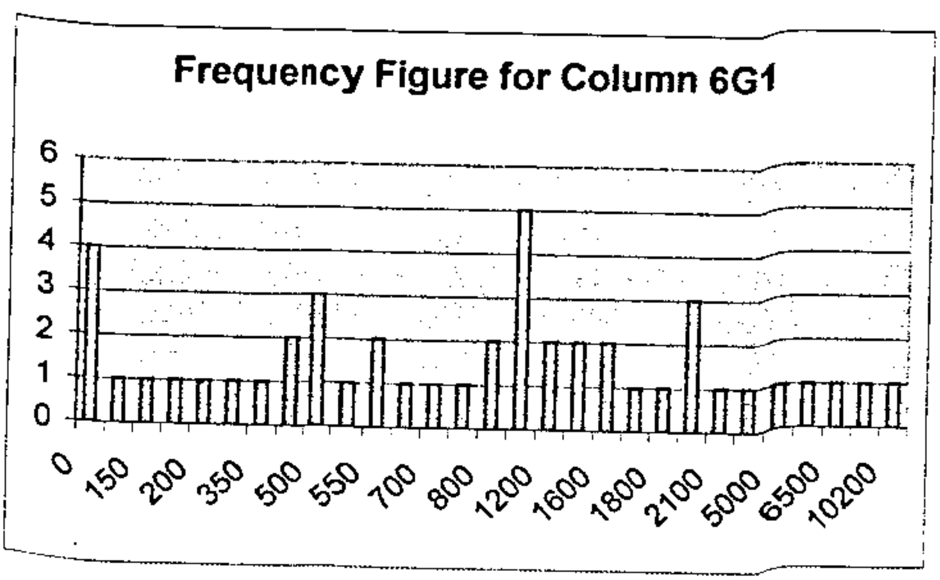
Frequency Table for Column 6F2

Valid	Frequency	Percent	Cumulative Percent
0	5	10.9	10.9
10	1	2.2	13.0
20	1	2.2	15.2
40	1	2.2	17.4
50	1	2.2	19.6
70	1	2.2	21.7
100	8	17.4	39.1
200	4	8.7	47.8
250	1	2.2	50.0
300	4	8.7	58.7
350	2	4.3	63.0
400	2	4.3	67.4
500	1	2.2	69.6
600	1	2.2	71.7
800	1	2.2	73.9
1000	5	10.9	84.8
1100	2	4.3	89.1
1200	2	4.3	93.5
1500	1	2.2	95.7
2000	2	4.3	100.0



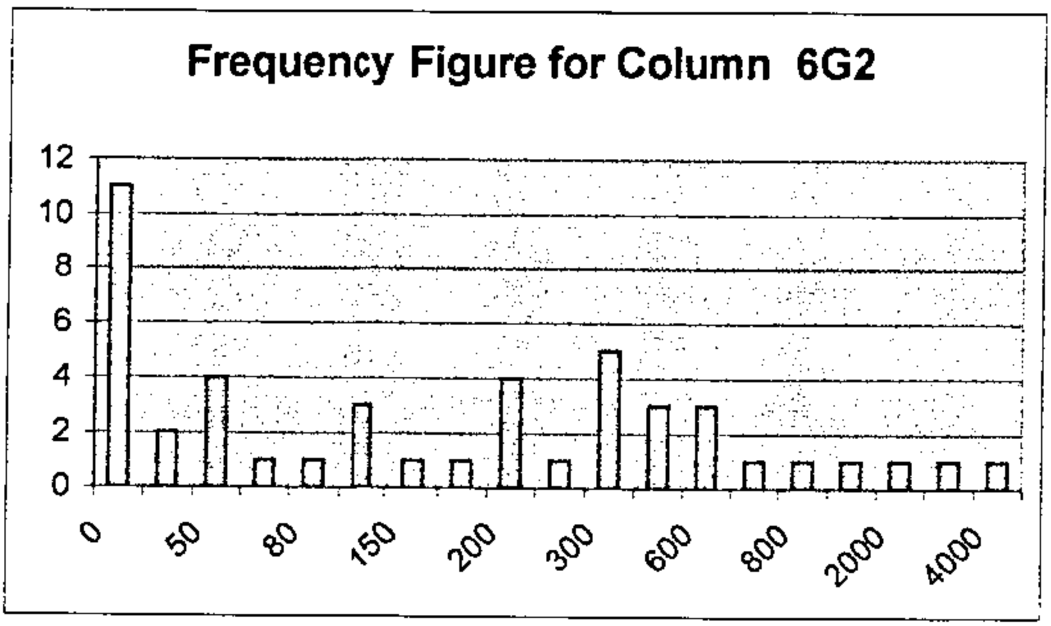
Frequency Table for Column 6G1

Valid	Frequency	Percent	Cumulative Percent
0	4	8.7	8.7
50	1	2.2	10.9
150	1	2.2	13.0
180	1	2.2	15.2
200	1	2.2	17.4
300	1	2.2	19.6
350	1	2.2	21.7
400	2	4.3	26.1
500	3	6.5	32.6
520	1	2.2	34.8
550	2	4.3	39.1
600	1	2.2	41.3
700	1	2.2	43.5
750	1	2.2	45.7
800	2	4.3	50.0
1000	5	10.9	60.9
1200	2	4.3	65.2
1500	2	4.3	69.6
1600	2	4.3	73.9
1700	1	2.2	76.1
1800	1	2.2	78.3
2000	3	6.5	84.8
2100	1	2.2	87.0
3000	1	2.2	89.1
5000	1	2.2	91.3
6000	1	2.2	93.5
6500	1	2.2	95.7
10000	1	2.2	97.8
10200	1	2.2	100.0



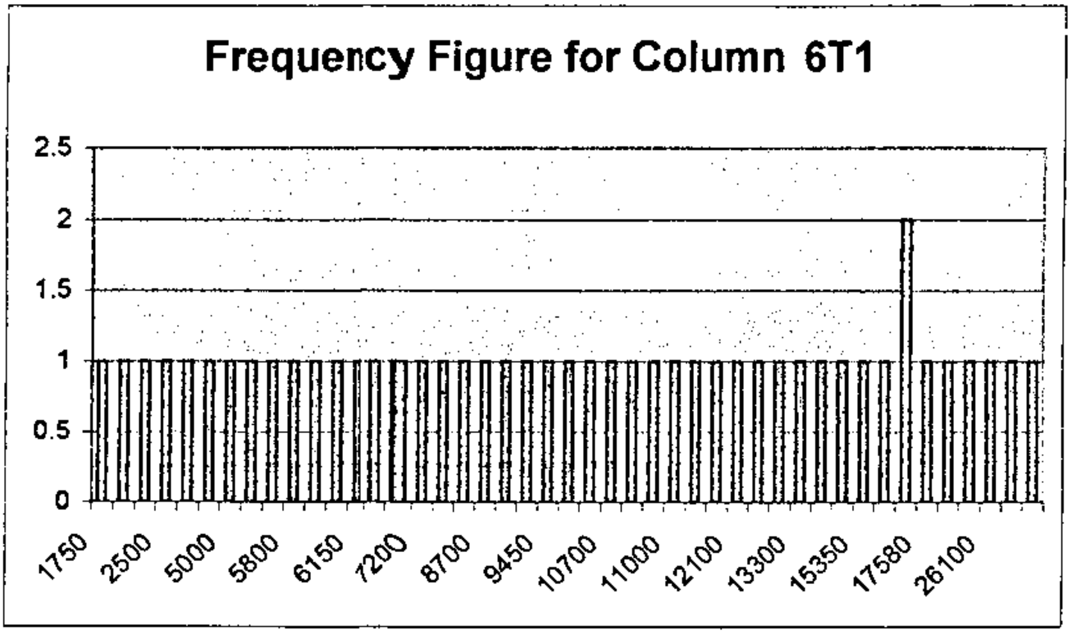
Frequency Table for Column 6G2

Valid	Frequency	Percent	Cumulative Percent
0	11	23.9	23.9
20	2	4.3	28.3
50	4	8.7	37.0
60	1	2.2	39.1
80	1	2.2	41.3
100	3	6.5	47.8
150	1	2.2	50.0
180	1	2.2	52.2
200	4	8.7	60.9
250	1	2.2	63.0
300	5	10.9	73.9
500	3	6.5	80.4
600	3	6.5	87.0
700	1	2.2	89.1
800	1	2.2	91.3
1200	1	2.2	93.5
2000	1	2.2	95.7
2500	1	2.2	97.8
4000	1	2.2	100.0



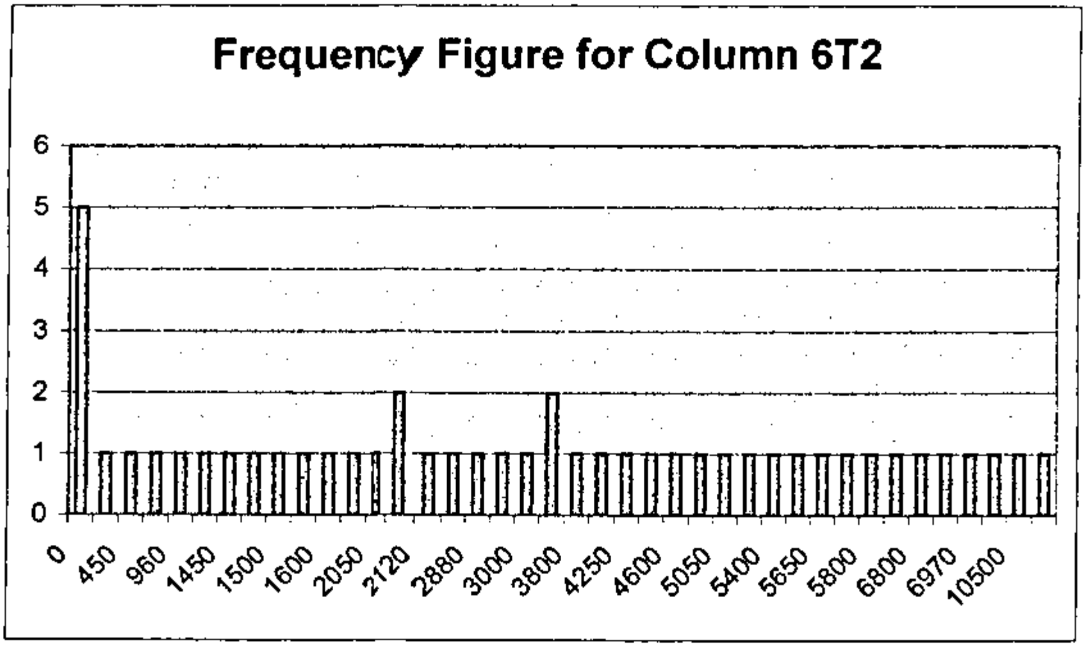
Frequency Table for Column 6T1

Valid	Frequency	Percent	Cumulative Percent
1750	1	2.2	2.2
2000	1	2.2	4.3
2250	1	2.2	6.5
2500	1	2.2	8.7
2620	1	2.2	10.9
3700	1	2.2	13.0
5000	1	2.2	15.2
5250	1	2.2	17.4
5790	1	2.2	19.6
5800	1	2.2	21.7
5920	1	2.2	23.9
6100	1	2.2	26.1
6150	1	2.2	28.3
6200	1	2.2	30.4
6300	1	2.2	32.6
7200	1	2.2	34.8
8400	1	2.2	37.0
8600	1	2.2	39.1
8700	1	2.2	41.3
8800	1	2.2	43.5
9180	1	2.2	45.7
9450	1	2.2	47.8
9500	1	2.2	50.0
9600	1	2.2	52.2
10700	1	2.2	54.3
10900	1	2.2	56.5
10950	1	2.2	58.7
11000	1	2.2	60.9
11390	1	2.2	63.0
11750	1	2.2	65.2
12100	1	2.2	67.4
12250	1	2.2	69.6
12900	1	2.2	71.7
13300	1	2.2	73.9
14300	1	2.2	76.1
14800	1	2.2	78.3
15350	1	2.2	80.4
15900	1	2.2	82.6
16200	2	4.3	84.8
17580	1	2.2	89.1
21000	1	2.2	91.3
26000	1	2.2	93.5
26100	1	2.2	95.7
51700	1	2.2	97.8
52000	1	2.2	100.0


Frequency Figure for Column 6T1
2.5
2
1.5
1
0.5
0
1750
2500
5000
5800
6150
7200
8700
9450
10700
11000
12100
13300
15350
17580
26100

Frequency Table for Column 6T2

Valid	Frequency	Percent	Cumulative Percent
0	5	10.9	10.9
250	1	2.2	13.0
450	1	2.2	15.2
530	1	2.2	17.4
960	1	2.2	19.6
1170	1	2.2	21.7
1450	1	2.2	23.9
1490	1	2.2	26.1
1500	1	2.2	28.3
1510	1	2.2	30.4
1600	1	2.2	32.6
1750	1	2.2	34.8
2050	1	2.2	37.0
2100	2	4.3	41.3
2120	1	2.2	43.5
2300	1	2.2	45.7
2880	1	2.2	47.8
2900	1	2.2	50.0
3000	1	2.2	52.2
3300	2	4.3	56.5
3800	1	2.2	58.7
4040	1	2.2	60.9
4250	1	2.2	63.0
4500	1	2.2	65.2
4600	1	2.2	67.4
4800	1	2.2	69.6
5050	1	2.2	71.7
5350	1	2.2	73.9
5400	1	2.2	76.1
5600	1	2.2	78.3
5650	1	2.2	80.4
5700	1	2.2	82.6
5800	1	2.2	84.8
6750	1	2.2	87.0
6800	1	2.2	89.1
6840	1	2.2	91.3
6970	1	2.2	93.5
7680	1	2.2	95.6
10500	1	2.2	97.8
11400	1	2.2	100.0


Frequency Figure for Column 6T2
6
5
4
3
2
1
0
0
450
960
1450
1500
1600
2050
2120
2880
3000
3800
4250
4600
5050
5400
5650
5800
6800
6970
10500