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COST ANALYSIS OF THREE PHASED OLIVE MILLS IN TURKEY WITH LIFE CYCLE COSTING APPROACH: THE CASE OF MILAS REGION

SUMMARY

Olive which has attracted people throughout its history has made great contributions to the economic development of countries in Mediterranean basin because of its multi-purpose usage possibilities in daily life and its economic value. Turkey, supplying the 8% of world olive production and 5% of world olive oil production and export, is among to top five countries in the world together with Spain, Italy, Greece and Tunisia. In Turkey, olive sector as one of the most important branches of agriculture and agro-based industries has a significant place both socially and economically. In Turkey, where there are 800 thousand hectares of land and about 150 million olive fruit-bearing olive trees, an average of 1.1 million ton olive and 200 thousand ton olive oil is being produced. Oil cultivation is the direct income source of 400 thousand families and about 2 million people and contributes to their revenue. Milas where this study was carried out has an important place in Turkey olive and olive oil production. Moreover, for Milas olive and olive oil is not only a source of income but also a source of culture. Olive oil production facilities which are among the important stakeholders of olive sector constitute the subject of this study. There are about 100 olive mills operating within Milas district. In this respect, in this study in which olive mills operating in Milas district were examined, first, the structural features of these olive mills were introduced. Then, the terms “cost” and “cost in olive production” were addressed and factors effecting the calculation of olive oil costs were summarized. Finally in order to quantify the costs a formula was offered by using Life Cycle Costing Method.

Keywords: Milas, Olive oil, Olive Mills, Cost Analyses, Life Cycle Costing.

INTRODUCTION

The Mediterranean region where olive oil trees accounts for 95% of total world olive oil trees (Mohammad, 2009) is world’s leading olive growing area, and olive processing has been an important and traditional industry for its

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countries since ancient times (La Cara et al., 2012). Olive is grown in nearly 40 countries in the Mediterranean or under the Mediterranean climate (FAO, 2013). Olive oil is also produced out of the Mediterranean basin in some countries like Chili, Argentina, Australia, and the USA (Mohammad, 2009). Olive industry has significant social, economic and environmental relevance within Mediterranean countries (Gunden *et al*., 2010). The factors such as employment, foreign trade, national income, and value added contributions have olive industry's importance increased (Artukoglu and Olgun, 2008).Mediterranean countries alone produce 97% of the total olive oil production, while European Union (EU) countries produce 80–84% (Paraskeva and Diamadopoulos, 2006).Turkey is among to top five countries in the world together with Spain, Italy, Greece and Tunisia (FAO, 2012). Olive and olive oil sector is an important part of the Turkish agriculture and economy. According to FAO statistics, Turkey is the fourth largest olive (with 1 820 thousand tons) and olive oil (with 206 thousand tons) producer in the world (FAO, 2012). Turkish Statistics Institute (hereafter TUİK) statistics indicate that a large number of Turkish households- about 400 thousand families and about 2 million people- are involved in olive cultivation as well as in oil production and trade as olives planting is considered as their main source of income (TUİK, 2012).

Olive oil is produced from olives in olive mills either by the discontinuous (classical) press-based method or by more modern (two or three-phase) continuous centrifugation method (Paraskeva and Diamadopoulos, 2006; Yemiscioglu *et al*., 2001; Tunalıoglu and Bektas, 2012). Leading olive oil producing countries prefer modern (two or three-phase) continuous centrifugation method to extract olive oil. For example, while Spain prefers two-phase system, Greece, Italy (Tunalıoglu and Bektas, 2012) and Turkey (Olgun *et al.*, 2012) prefers three-phase system. The two- and three-phase production systems are similar in the steps involved. The fundamental difference between the two is in the output; whereas three-phase system results in pomace and Olive Mill Waste Water (hereafter OMWW) separately, the OMWW in the two-phase system is a mixed solid-liquid waste consisting of pomace and OMWW. It has been suggested that the use of the two-phase system yields up to 20% energy reductions and savings of 80% in water usage over the three-phase system (Azbar *et al.*, 2004).

There are about 25 000 olive mills worldwide (Paraskeva and Diamadopoulos, 2006) and 1250 of them are in operation in Turkey (Tunalıoglu and Bektas, 2012). In Turkey, most of the olive mills which are geographically scattered in Marmara, Aegean and Mediterranean regions are relatively small sized and low capacity enterprises. Olive oil production, from the planting of the trees to pressing the olives at the mill, is associated with a variety of cost. In this study we focused on the costs for the three-phased olive mills operating in Turkey especially in Milas. 91 of 1250 olive mills are in operation in Milas district (Demirbas *et al*., 2014). More than 90% of the olive mills in Milas prefer three–phased system (Demirbas *et al*., 2014). The three-phased olive mills in

Milas faces high production costs such as capital cost (cost of land acquisition, cost of building construction, cost of equipment acquisition and cost of olive oil storage tanks)and operating costs (electrical energy costs for mill equipment's, labour costs, water usage costs and, maintenance and technology upgrading costs). In this respect, in this study in which olive mills operating in Milas district were examined, first, the structural features of these olive mills were introduced. Then, the terms "cost" and "cost in olive production" were addressed and factors effecting the calculation of olive oil costs were summarized. Finally in order to quantify the costs a formula was offered by using Life Cycle Costing Method was based on the cash flow analysis.

Importance of Cost for Olive Mills

Cost is important in terms of evaluating the activities in economic terms. Thus, it is an important concept for organizations to operate in accordance with their own conditions rationally and efficiently and related outcomes of their operations. The importance of the term "cost" for organizations operating in farming sector emerges in a way not only limited to calculation of production cost and providing benefits to decision mechanisms but also serve to the formation of database which will form the basis for government's farming policies such as subvention, price and income.

As is the case with other industries olive industry investments are long-term projects. Olive oil production, from the planting of the trees to pressing the olives at the mill, is associated with a variety of cost (Komilis *et al*., 2003; Olgunet *et al*., 2012; Aldesit, 2014) such as capital cost (cost of land acquisition, cost of building construction, cost of equipment acquisition and cost of olive oil storage tanks) and operating costs (electrical energy costs for mill equipment, labour costs, water usage costs and, maintenance and technology upgrading costs). Olive mills must maximize their revenue while minimizing their expenses and costs in order to be able to compete in the intense competition of local and global markets, to continue their activities, and to ensure business continuity and profitability. Otherwise, businesses lose their shares in markets losses, which can result in losses in the company assets, and even an irreversible collapse in business. Due to the Olive Mills are long-term investments Life Cycle Costing (LCC) which is a technique to estimate the total cost of ownership (Ozbay *et al*., 2003) can be used for an effective cost analysis for Olive Mills. LCC, also, can assist decision-making for olive mill investment projects. Life Cycle Costing in this study was based on the cash flow analysis, by calculating all the costs and revenues associated to the olive mills.

Life Costing Approach

The determination of costs is an integral part of the asset management process and is a common element of many of the asset manager's tools, particularly Economic Appraisal, Financial Appraisal, Value Management, Risk Management and Demand Management. In the past, comparisons of asset alternatives, whether at the concept or detailed design level, have been based mainly on initial capital costs. Growing pressure to achieve better outcomes from assets means that ongoing operating and maintenance costs must be considered as they consume more resources over the asset's service life (NSW Treasury, 2004). So that LCC approach includes both the capital and the ongoing operating and maintenance costs. A LCC process usually includes steps such as planning of LCC analysis (e.g. definition of objectives), selection and development of LCC model (e.g. designing cost breakdown structure, identifying data sources and uncertainties), application of LCC model, and documentation and review of LCC results (Ozbay *et al.*, 2003; NSW Treasury, 2004).

According to Ozbay *et al*. (2004) LCCA, as an evaluation technique, is predominantly considered necessary for appraising long-term public projects. Although this technique is based on well-founded principles of economics and engineering, many open questions about LCCA, as well as misconceptions about its applications, still linger. These open questions and misconceptions bring about certain mistrust in the LCCA outcome and doubt in its reliability

MATERIAL AND METHODS

The financial characteristics of olive mills in Turkey were studied based on typical designs for the three-phased olive mills. The capital and operating costs were calculated based on those typical designs. In this study, since there is not any typical Olive Mill Waste Water (OMWW) treatment and also OMWW treatment is rarely practised in Turkey like abroad, OMWW treatment was not included to the cost analyses. It should be noted that OMWW management can be unique for each olive mill based on social, environmental and spatial conditions. Therefore, OMWW management should be viewed individually and separately for each olive mill (Komilis *et al*., 2003).

Project costs that occur at different points in the life of a building cannot be compared or summed directly due to the varying time value of money. They must be discounted back to their present value through the appropriate equations. Costs must first be converted into their time-equivalent value at the base date before being combined to compute the LCC of a project stage or of a whole project.

In the present study, the annual net cash flow was determined for each year by calculating the total costs and revenues of all agricultural practices. Net cash flow was used for determining the profitability of both systems based on the Net Present Value (NPV) and the Internal Rate of Return (IRR). They are the preferred methods for long-term economic evaluation, since they consider the time value of money as well as the size of cash flow through the full investment life cycle (Kay *et al*., 2008). Cost Recovery Factor (CRF) also offered for olive mills. It was assumed that typical three-phased olive mills lifetime is 50 years and in operates for 12 hours a day and 90 days per year during all the cost calculations presented below.

RESULTS AND DISCUSSION

Present Value (PV)

If it does not matter when costs and benefits incur they can be added without consideration. However, if the timing of costs and benefit flows is important, the investment calculus needs to reflect this. A common technique is the use of discounting (Pernilla and Henrikke, 2004). The present value can be thought of as the amount of money that would need to be invested today, at an interest rate equal to discount rate, in order to have the money available to meet the future cost at the time when it was predicted to occur. The basic discount equation is as follows:

$$PV = \frac{FV}{(1+i)^n}$$

Where PV is the present value of a building or system, FV is the value in the future, i is the discount rate and n is the number of years in the future

Net Present Value (NPV)

NPV is the Present Value (PV) of the stream of future cash flows from a project minus the project's net investment. The cash flows are discounted at the firm's required rate of return or cost of capital. *NPV* can be calculated based on Eq. (1):

$$NPV = \sum_{a=1}^{n} \frac{P_a}{(1+i)^a} - \sum_{a=1}^{n} \frac{C_{Ta}}{(1+i)^a} \qquad (1)$$

where NPV is the Net Present Value, P_a is the net cash flow in year a, i is the discount rate and C_{Ta} is the total cost of the investment and expenses in year a. Eq. (1) can be wrote as Eq. (2)

$$NPV = \left[\frac{P_1}{(1+i)^1} + \frac{P_2}{(1+i)^2} + \cdots + \frac{P_n}{(1+i)^n}\right] - \left[\frac{C_{T1}}{(1+i)^1} + \frac{C_{T2}}{(1+i)^2} + \cdots + \frac{C_{Tn}}{(1+i)^n}\right] \qquad (2)$$

Net Cash Flow (P_a) of an olive mill can be calculated based on Eq. (3)

$$P_a = p \text{ x } m \qquad (3)$$

where P_a is the net cash flow in year *a*, *p* is the price of olive oil (in TL/kg) in year *a* and *m* is the total amount of olive oil (in kg) in year *a*.
Cost and expenses can be calculated based on Eq. (4):

$$C_{Ta} = C_{Ca} + C_{Oa} \qquad (4)$$

where C_{Ta} is the the total cost of the investment, C_{Ca} is the capital cost in year a, C_{Oa} is the operational cost in year a, and i is the discount rate.

The Internal Rate of Return

The Internal Rate of Return is the discount rate that makes the net present value equal to zero (Kay et al., 2008). It was calculated using Eq. (1), by making the net present value equal to zero and solving the equation for the rate of return (i), as shown in Eq. (5):

$$\mathrm{NPV} = \sum_{a=1}^{n} \frac{P_a}{(1+i)^a} - \sum_{a=1}^{n} \frac{C_{Ta}}{(1+i)^a} \tag{1}$$

If *NPV* equals zero Eq. (1) can be wrote as Eq. (5)

$$\sum_{a=1}^{n} \frac{C_{Ta}}{(1+i)^a} = \sum_{a=1}^{n} \frac{P_a}{(1+i)^a} \tag{5}$$

Eq. (5) can be wrote as Eq. (6)

$$\left[\frac{C_{T1}}{(1+i)^1} + \frac{C_{T2}}{(1+i)^2} + \cdots + \frac{C_{Tn}}{(1+i)^n}\right] = \left[\frac{P_1}{(1+i)^1} + \frac{P_2}{(1+i)^2} + \cdots + \frac{P_n}{(1+i)^n}\right] \tag{6}$$

Net Cash Flow (P_a) of a olive mill can be calculated based on Eq. (3). Cost and expenses can be calculated based on Eq. (4).

Capital cost includes cost of land acquisition, cost of building construction, cost of equipment acquisition and cost of olive oil storage tanks and, operating costs includes electrical energy costs for mill equipment, labour costs, water usage costs and, maintenance and technology upgrading costs.

Capital Recovery Factor (CRF)

Capital recovery factor (CRF) is the amortization factor or annual payment whose present value at compound interest is 1.CRF is used to convert capital costs to equal annual costs of the corresponding investment through the lifetime of that investment (Komilis *et al.*, 2003). It is the function of the interest rate and years of life of the investment. The basic discount equation is as follows:

$$\mathrm{CRF}\,(i, n) = \frac{i(1+i)^n}{(1+i)^n - 1}$$

Where CRF is the Capital Recovery Factor, is the decimal interest rate and n is the design life of equipment in years.

Capital Recovery Factor can be used as a technique in olive mills as shown below.

Calculating of Capital Costs (C_c)

Capital cost (C_C) includes cost of land acquisition (C_{Land}), cost of building construction ($C_{Building}$), cost of equipment acquisition ($C_{Equipment}$) and cost of olive oil storage tanks (C_{Tanks}). C_c can be calculated based on Eq. (7):

$$C_c = C_{Land} + C_{Building} + C_{Equipment} + C_{Tanks} \tag{7}$$

Cost of Land Acquisition (C_{Land})

For an olive mill an indoor area (building) and land are requıred. Therefore land acquisition cost must be included in the overall capital cost. The lifetime of the land is estimated to 50 years. Cost of Land Acquisition (C_{Land})can be calculated as shown below.

$$C_{Land} = \frac{CRF(i,n) x P_{Land}}{N x h x c}$$

where C_{Land} is the cost of land acquisition in Turkish Lira per ton olive (TL/ton olive), *CRF* is the Capital Recovery Factor for 50 years, *i* is the decimal interest rate and *n* is the design life of equipment in years, P_{Land} is the price of required land area in Turkish Lira (TL), N is olive mill operate days per year, h is olive mill operate hours per day and c is the olive mill capacity in ton olive per hour.

Cost of Building Acquisition ($C_{Building}$)

Olive mill equipment operates in an indoor area in other word in a building. The building construction cost can be calculated same as the land acquisition cost. The lifetime of the building can be assumed 50 years. Cost of building acquisition ($C_{Building}$) can be calculated as shown below.

$$C_{Building} = \frac{CRF(i,n) x P_{Building}}{N x h x c}$$

where $C_{Building}$ is the cost of building acquisition in Turkish Lira per ton olive (TL/ton olive), CRF is the Capital Recovery Factor for 50 years, *i* is the decimal interest rate and n is the design life of equipment in years, $P_{Building}$ is the price of required building area in Turkish Lira (TL), N is olive mill operate days per year, h is olive mill operate hours per day and c is the olive mill capacity in ton olive per hour.

Cost of Equipment Acquisition ($C_{Equipment}$)

Olive mill consists of some mechanical equipment such as leaf washer, crushing machine, malaxing machine, decanters and separators. Olive mill is the most expensive part of an olive mill. In order to maintain periodically, lifetime of an olive mill can be assumed average 15 year. Cost of equipment acquisition ($C_{Equipment}$) can be calculated as shown below.

$$C_{Equipment} = \frac{CRF(i,n) x P_{Equipment}}{N x h x c}$$

where $C_{Equipment}$ is the cost of equipment acquisition in Turkish Lira per ton olive (TL/ton olive), CRF is the Capital Recovery Factor for 15 years, i is the decimal interest rate and n is the design life of equipment in years, $P_{Building}$ is the price of required equipment in Turkish Lira (TL), N is olive mill operate days per year, h is olive mill operate hours per day and c is the olive mill capacity in ton olive per hour.

Cost of Tank Acquisition (C_{Tank})

Olive oil must be storage in stainless tanks. Stainless tank is very important for the quality and lifetime of olive oil. Lifetime of a stainless tank can be assumed average 20 years. Cost of tank acquisition (C_{Tank}) can be calculated as shown below.

$$C_{Tank} = \frac{CRF(i,n) x\, P_{Tank}}{N\, x\, h\, x\, c}$$

where C_{Tank} is the cost of tank acquisition in Turkish Lira per ton olive (TL/ton olive), CRF is the Capital Recovery Factor for 15 years, i is the decimal interest rate and n is the design life of equipment in years, P_{Tank} is the price of per tank in Turkish Lira (TL), N is olive mill operate days per year, h is olive mill operate hours per day and c is the olive mill capacity in ton olive per hour.

Operating Costs (C_O)

Operating costs **(**C_O) includes electrical energy costs for mill equipment (C_{Elec}), labour costs (C_{Labour}), water usage costs (C_{Water}) and, maintenance and technology upgrading costs (C_{Main}).C_o can be calculated based on Eq. (8):

$$C_{co} = C_{Elec} + C_{Labour} + C_{Water} + C_{Main} \tag{8}$$

Electrical Energy Cost ($\mathbf{C_{Elec}}$**)**

Typical three-phased olive mills work with electrical energy. The electrical energy which is needed by olive mill varies according to the olive mill design capacity. The electrical energy cost can be calculated shown below:

$$C_{Elec} = \frac{Px\, F_E}{c}$$

where C_{Elec} is the cost of electrical energy in Turkish Lira per ton olive (TL/ton olive), P is total power requirement in Kw, $\mathbf{F_E}$ is the fee of electrical energy in Turkish Lira (TL), and c is the olive mill capacity in ton olive per hour.

Labour Costs ($\mathbf{C_{Labour}}$**)**

Total labour cost can be calculated according to the number of people shown below:

$$C_{Labour} = \frac{qxS_L}{h\, x\, c}$$

where C_{Labour} is the cost of labour in Turkish Lira per ton olive (TL/ton olive), q is the number of employees, $\mathbf{S_L}$ is the salary of an employee in Turkish Lira (TL) per day, h is olive mill operate hours per day and c is the olive mill capacity in ton olive per hour.

Water Usage Costs ($\mathbf{C_{Water}}$**)**

In Milas just as in Turkey, private wells are the main source of water for olive mills. If only electrical energy cost for wells is calculated as follows:

$$C_{Elec} = \frac{Px\, F_E}{c}$$

where C_{Elec} is the cost of electrical energy in Turkish Lira per ton olive (TL/ton olive), P is total power requirement in Kw, F_E is the fee of electrical energy in Turkish Lira (TL), and c is the olive mill capacity in ton olive per hour.

Maintenance and Technology Upgrading Costs (C_{Main})

Maintenance and technology upgrading costs (includes equipment, storage tanks and building) can be set equal to a presentences (between 2% and 4%) of the overall capital costs (Gunluk, 2014).

$$C_{main} = C_C \times 0{,}03$$

Where C_{main} is the cost of maintenance in Turkish Lira per ton olive (TL/ton olive), $C_C$is total capital cost in Turkish Lira (TL) per ton olive.

CONCLUSIONS

The major contribution of this paper is the determination of the all costs (except OMWW) for three-phased olive mills in Milas region. In order to explain the all costs Life Cycle Costing (LCC) approach was used. The main purpose of LCC as an analysis techniqueis to determine, analyse, forecast, report and manage all kinds of costs in all life cycle stages of a product (Bengu and Kara, 2010). LCC builds on the well-founded principles of economic analysis to evaluate the over-all-long-term economic efficiency between competing alternative investment options. LCC does not address equity issues. It incorporates initial and discounted future agency, user, and other relevant costs over the life of alternative investments. It attempts to identify the best value (the lowest long-term cost that satisfies the performance objective being sought) for investment expenditures (PDIT Bulletin, 1998).As a basis for considering Life Cycle Costing, it is imperative to formulate a cost model (Gram and Schroeder, 2012). A well designed LCC method can be very useful for three-phased olive mill owners ın order to manage to their costs.

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