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# Energy Input-Output and Economic Analysis of Rose Production in Turkey

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**Abstract:** Energy and economic analysis in rose production in Isparta province where there is intensive-rose production were performed. A total of 11 villages from Isparta Centre, Atabey, Keciborlu, Gönen, districts of Isparta province were surveyed by applying a face to face questionnaire method with 109 rose growers. Results revealed that total energy consumed per hectare for rose production was 29313.12 MJ ha$^{-1}$ and the most energy demanding input was chemical fertilizers (46.67%), especially nitrogen (39.81%). Energy consumption due to diesel fuel was 21.87% of the total energy input. Total bioenergy output was calculated as 21150.69 MJ ha$^{-1}$ considering its yield (5041.88 kg ha$^{-1}$) and its energy contents (4.20 MJ kg$^{-1}$) Energy use efficiency, specific energy and energy productively of rose production were found to be 0.72, 5.81 MJ kg$^{-1}$ and 0.17 kg MJ$^{-1}$, respectively. It was concluded that the direct and indirect energy inputs were 36.08 and 58.90% of the total energy input, respectively. Renewable energy sources among the inputs constituted 16.43% of the total energy whereas non-renewable resources among the inputs constituted 16.43% of the energy whereas non-renewable resources (chemical fertilizers and diesel fuel) constituted 78.55% of total energy input. Result showed that net return from rose production in the surveyed farms was at satisfying level. Benefit to cost ratio was found to be 1.58.

**Key words:** Rose production, energy use, bioenergy

## INTRODUCTION

Commercially cultivated rose (*R. damascena*), one of the most important commercial essential oil sources, is a perennial bush rose, much branched, thorny, with large, highly scented, roseate flowers. Three main products obtained from rose plants are: oil, concrete and absolute, which vary in their characteristics according to origin (Weiss, 1997). Rose oil is steam distilled from the flowers of the *R. damascena*. Rose oils, extracts and derivates are among the most important of natural perfume ingredients used in perfumery (Kurkcuoglu, 1988). The main rose growing areas are Bulgaria, Southern Russia, Turkey and Morocco where the environment is similar (Weiss, 1997). Although there are 23 rose cultivars in Turkey, *R. damascena* is cultivated for the production of essential oil (Konur, 1990). Approximately 2 tons of rose oil and 5 tons of rose concrete are produced annually in Turkey. Annual world rose oil and concrete production are 4.25 and 13 tons, respectively. With these production capacities, Turkey realizes 47 and 39% of annual world rose oil and concrete production, respectively, according to data provided in 2001 (EPCT, 2004). The value of rose oil exports reached about $ 8 million in 2002 with an increase of 34% compared to the previous year. Turkish rose oil was exported to about 23 countries in 2002. The majority of exports were directed to the European countries, the USA, Japan and Saudi Arabia which were all major processors of essential oils (EPCT, 2004). With a share of 71.94% in rose production in Turkey (Ertan, 2001) Isparta province is ranked first in Turkey in terms of rose farming areas and rose production. However, it was found that there had been a decline in rose farming areas from 8024 ha in 1980 to 1591 ha in 2001 and the rose prices had been declining in real terms (Ertan, 2001). Therefore, these reported problems leads to energy and economic analysis of rose production to investigate possible practical measures to improve the sustainability of agriculture, an identification of the actual flow of the various inputs in rose production. Utilization of energy analysis provides a methodology for analyzing energy flows within an agricultural system (Zucchetto and Bickle,

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1984). Additionally, energy analysis shows ways to minimize the energy inputs and therefore to increase the energy productivity (Fluck and Baird, 1982; Tsatsarelis, 1993; Tsatsarelis and Koundouras, 1994). Numerous researches have been conducted on energy and economic analysis of plant production such as sugar cane production Morocco (Mrini *et al*., 2001), soybean based crop production system in central India (Mandal *et al*., 2002), pearl millet, green gram, wheat crop in India (Singh *et al*., 2002), cluster bean, maize and cotton crop in India (Singh *et al*., 2003), apricot in Turkey (Gezer *et al*., 2003) and sweet cherry in Turkey (Demircan *et al*., 2004). However, no studies have been published on energy and economic analysis of rose production in Turkey. The objective of the present investigation is to make energy and economic analysis of rose production and identify the major energy flows in this system.

## MATERIALS AND METHODS

The study was performed in Isparta province where rose production is concentrated. Therefore, 11 villages from Isparta centre, Atabey, Keciborlu and Gonen districts of Isparta province were surveyed. A questionnaire form was prepared to collect the required information related to direct use of energy (on the farms principally as human labor and diesel fuels) and indirect use of energy (chemicals fertilizers, farm yard manure, machinery and chemicals), the lands possessed by farmers, their utilization pattern, rose yields, operation time, etc. (Singh, 2002; Mandal *et al*., 2002; Singh *et al*., 2002; Singh *et al*., 2003). Using this form, the primary data were collected for energy and economic analysis of rose production for the year 2002-2003 by employing a face to face questionnaire method with rose growers in Isparta province. In addition, the secondary data was obtained from the similar studies and statistics by various individuals and organization related with this subject. Population studied consisted of rose farms being appropriate for the purpose of this study. Stratified random sampling techniques were applied in the selection of representative farms of the area under rose production (Yamane, 1967). Selecting farms randomly, the sample size was determined to be 109.

Methodology of energy analysis outlined by Pimentel (1980) and Fluck (1992) was followed to evaluate energy input and output in rose production in Turkey. The total energy per production unit (hectare) was established by the addition of the partial energies of each input referred to the unit of production. The input categories examined were human labor, animal draft, diesel fuel, machinery, farmyard manure, irrigation, chemical fertilizer (NPK) and agro-chemicals. To estimate energy of inputs as well as agronomic practices, expressed in MJ $ha^{-1}$, their equivalents in Table 1 were utilized. Energy consumed (MJ $ha^{-1}$) due to diesel fuel (Sabanci and Ozguven, 1988) was determined by multiplying tractor power (obtained from each questionnaire) by loading rate of tractor, 0.40 (Amman, 1987), specific fuel consumption for diesel engines 0.30 L $kwh^{-1}$ (Amman, 1987), work efficiency (h $ha^{-1}$) and energy equivalent of diesel fuel, 56.31 MJ $L^{-1}$ (Singh, 2002). A unit of machinery is treated as a store of the embodied energy that went into its production. The store of energy is dissipated over physical life of the particular unit (Schahczenski, 1985). Therefore, total energy embodied in machinery (MJ $h^{-1}$) was calculated taking into account of energy for production (86.36 MJ $kg^{-1}$), energy for repairs and maintenance (MJ $kg^{-1}$), energy for transportation (8.8 MJ $kg^{-1}$), total machinery weight (kg), life of machinery used in Turkey.

Energy output, bioenergy gained from the economic product (rose flower) was calculated using their energy equivalents in Table 1. The energy content of rose flower was determined by bomb calorimeter (ASTM D1989). All inputs and outputs were then transformed into a common energy terms using Table 1.

To evaluate the results of this study, three parameters were used: energy use efficiency, specific energy and energy productivity. Energy use efficiency is the ratio of total caloric energy value of the produced output to total energy input to the defined production system. The higher energy use efficiency the more energy efficient that particular system is in producing food energy. Energy use efficiency serves as an optimality measure to evaluate the efficiency of agricultural production systems (Schahczenski, 1985). Specific energy provides quantitative data on how much energy was spent in the production of 1 kg of rose flower. Energy productivity is the ratio of physical output measured in physical terms (kilograms, pounds etc.,) to energy inputs measured in the energy terms. Energy productivity is a partial measure and is intended explicitly not to be used as the sole criterion of efficiency in any general sense (Fluck and Baird, 1982; Schahczenski, 1985).

For each rose farm, total energy input and output was calculated using Table 1. Analysis of data was done using Microsoft Excel software package considering inputs, outputs and their energy equivalents. The results are tabulated and presented as tables.

Table 1: Energy equivalents for different inputs and outputs

| Inputs and outputs | Units | (MJ/units) | Mass (kg) | Life (h) | References |
|---|---|---|---|---|---|
| Human labor | h | 2.3 | | | Yaldız *et al.* (1993) |
| Animal | h | 10.1 | | | Singh (2002) |
| Tractor and machinery[a] | | | | | |
| Tractor | h | 27.6 | 2000.0 | 10000.0 | Fluck (1992) adapted |
| Sprayer | h | 6.4 | 90 | 2000.0 | Fluck (1992) adapted |
| Knapsack sprayer | h | 1.4 | 20.0 | 2000.0 | Fluck (1992) adapted |
| Plow 2 bottoms | h | 10.8 | 150.0 | 2500.0 | Fluck (1992) adapted |
| Plow 3 bottoms | h | 18.0 | 250.0 | 2500.0 | Fluck (1992) adapted |
| Plow 4 bottoms | h | 21.6 | 300.0 | 2500.0 | Fluck (1992) adapted |
| Horse drawn plow | h | 3.6 | 50.0 | 2500.0 | Fluck (1992) adapted |
| Rotary tiller | h | 28.5 | 500.0 | 2500.0 | Fluck (1992) adapted |
| Disc harrow | h | 17.8 | 300.0 | 2500.0 | Fluck (1992) adapted |
| Cultivator | h | 14.0 | 250.0 | 2500.0 | Fluck (1992) adapted |
| Trailer | h | 64.1 | 900.0 | 2000.0 | Fluck (1992) adapted |
| Horse drawn trailer | h | 4.3 | | | Mrini *et al.* (2001) |
| Chemical fertilizer | | | | | |
| Nitrogen | kg | 60.6 | | | Singh (2002) |
| Phosphate ($P_2O_5$) | kg | 11.1 | | | Singh (2002) |
| Potash ($K_2O$) | kg | 6.7 | | | Singh (2002) |
| Farmyard manure | kg | 0.3 | | | Singh (2002) |
| Chemicals | | | | | |
| Insecticide | kg | 363.6 | | | Pimentel (1980) |
| Fungicide | kg | 99.0 | | | Fluck and Baird (1982) |
| Diesel | l | 56.3 | | | Singh (2002) |
| Water for irrigation | $m^3$ | 0.6 | | | Yaldız *et al.* (1993) |
| Rose flower | kg | 4.2 | | | |

[a]: Sample calculations for energy equivalent of tractors and machineries were performed

## RESULTS AND DISCUSSION

**Management practices in rose production:** In research area, results revealed that farms with area of 0-2, 2-4, 4-6, 6-8, 10-12 and 14-16 da constituted 43.12, 27.52, 16.51, 4.59, 2.75, 5.50%, respectively, of total farms surveyed and average field size of rose farms was found to be 0.4 ha. The information on the management of commercially cultivated roses for oil production, i.e., inputs and operations for rose production were collected based on face to face interviews with sample farmers during 2002-2003 production years in research area (Table 2). Results revealed that tractor drawn plows (2, 3 and 4 furrows plows with the width range of 80-150 cm), rotary tillers with the width range of 60-250 cm, cultivators with the width range of 150-180 cm and disc harrows with the width range of 150-250 cm and horse drawn plows with the width range of 30-35 cm were used for tillage and other land preparation operations. The ranges of tractor power used in tillage operation were 12, 28, 35, 38, 40, 41, 42, 44, 45, 48, 49, 50, 54, 55, 58, 60, 65 and 73 hp. Tillage operations were performed 1.36 times a year between May and September. Roses require an adequate supply of plant nutrients as plantations can remain productive for a decade or more. Therefore, chemical fertilizers (N, $P_2O_5$ and $K_2O$) and farmyard manure were spreaded by manually 1.96 times a year between March and October. Pesticides were sprayed by knapsack applicator with the capacity of 14-20 L or tractor-drawn sprayer with the capacity of 400-600 L Fungicides (Captan, Anvil, Antracol, etc.,) and insecticides (Basudin, Supracide, Folidol, Fosforin, Gusathion, Dursban-4, etc.) were sprayed 2.25 times a year starting from March to May. Hoeing operation was done manually by farmers on average 1.67 times a year between May and September. Irrigation may be required to ensure sufficient soil moisture and thus growth in the important bud formation and early flowering period and to maintain humidity (Weiss, 1997). Rose fields in the region were irrigated 0.80 times a year by irrigation channel between periods of May-August. Annual pruning is essential to keep bushes in shape and promote branching and seasonal pruning to remove dead or diseased shoots to increase productivity and quality (Weiss, 1997). Trees were pruned using hand tools once in year between March and April. Roses were harvested by manually (June-July). Tractor drawn trailer with empty weight of 900-1100 kg (single or double axle) or horse drawn trailer was used for the transportation of the harvested rose flowers.

**Energy requirements of rose production:** Averaged total energy inputs and outputs per hectare (MJ $ha^{-1}$) of 109 individual farm (Table 2) were calculated separately by considering their equivalent energy (Table 1). The third column in Table 3 gives the energy requirements of cultural practices (tillage, fertilization, plant protection, hoeing, etc.) for each input. The last column in Table 3 gives the percentage of each input within total energy

Table 2: Management practices in rose production

| Operations | Average number of operations per year | Operation periods | Characteristics |
|---|---|---|---|
| Tillage | 1.36 | May- September | Plows (2, 3 and 4 furrows), rotary tillers, cultivators, horse drawn plows and disc harrows drawn by a 12-73 hp tractors |
| Fertilization | 1.96 | March-October | Manual |
| Plant protection | 2.25 | March- May | Knapsack applicators or tractor +sprayer combination |
| Hoeing | 1.67 | May- September | Manual |
| Irrigation | 0.80 | May- August | Surface irrigation |
| Pruning | 1.00 | March -April | Manual |
| Harvesting | - | June-July | Manual |
| Transportation | - | June-July | Tractor drawn trailers or horse drawn trailers or manual |

Table 3: Inputs and outputs expressed as quantity per unit area, total energy equivalent and percentage of total energy input

| Quantity | Total energy equivalent | Energy requirements of cultural practices of inputs | Distribution of each input within total energy input |
|---|---|---|---|
| Inputs/cultural practices | MJ $ha^{-1}$ | (%) | (%) |
| Machinery | 1903.03 | 100.00 | 6.49 |
| Tillage | 541.06 | 28.43 | 1.84 |
| Transportation | 858.79 | 45.13 | 2.93 |
| Pest control | 503.17 | 26.44 | 1.72 |
| Diesel | 6411.88 | 100.00 | 21.87 |
| Tillage | 1894.14 | 29.54 | 6.46 |
| Transportation | 1694.35 | 26.43 | 5.78 |
| Pest control | 2823.39 | 44.03 | 9.63 |
| Human Labor | 3855.39 | 100.00 | 13.15 |
| Tillage | 49.45 | 1.28 | 0.16 |
| Hoeing | 535.85 | 13.90 | 1.83 |
| Fertilization | 44.10 | 1.14 | 0.15 |
| Irrigation | 22.37 | 0.58 | 0.08 |
| Pruning | 296.65 | 7.69 | 1.01 |
| Harvest | 2718.76 | 70.52 | 9.27 |
| Transportation | 110.09 | 2.86 | 0.38 |
| Pest control | 78.12 | 2.03 | 0.27 |
| Animal | 308.08 | 100.00 | 1.05 |
| Tillage | 100.08 | 32.48 | 0.34 |
| Transportation | 208.00 | 67.52 | 0.71 |
| Chemical Fertilizers | 13681.09 | 100.00 | 46.67 |
| Nitrogen | 11670.35 | 85.30 | 39.81 |
| Phosphate ($P_2O_5$) | 1998.82 | 14.61 | 6.82 |
| Potash ($K_2O$) | 11.92 | 0.09 | 0.04 |
| Farmyard manure | 652.05 | | 2.22 |
| Water for irrigation | 1472.31 | | 5.02 |
| Chemicals | 1029.29 | 100.00 | 3.51 |
| Insecticide | 786.76 | 76.44 | 2.68 |
| Fungicide | 242.53 | 23.56 | 0.83 |
| Total energy input | 29313.12 | | 100.00 |
| Outputs | | | |
| Total energy output | 21150.69 | | |
| Energy use efficiency (-) | 0.72 | | |
| Specific energy (MJ $kg^{-1}$) | 5.81 | | |
| Energy productivity (kg $MJ^{-1}$) | 0.17 | | |

input. Chemical fertilizers (46.67% of the total energy input) were the highest energy consuming input in rose production. The result is consistent with those reported for cultivation of sweet cherry (45.35%) by Demircan *et al.* (2004) and soybean (45%), wheat (60.03%), mustard (57.40%) and chickpea (30.75%) by Mandal *et al.* (2002). Furthermore, nitrogen had the highest portion (85.30%) among the fertilizers owing to its high energy values (60.60 kg $MJ^{-1}$) (Table 3).

Total energy equivalent of diesel fuel (6411.88 MJ $ha^{-1}$) consumption was 21.87% of total energy input. The result is in agreement with that reported for sweet cherry (21.53) by Demircan *et al.* (2004). Diesel energy was consumed mainly in pest control, tillage and transportation with the percentage of 44.03, 29.54 and 26.43, respectively, of diesel energy input (Table 3). The third most energy consuming input was labor having 13.15% of total energy consumed (Table 3) and this was due to lower mechanization levels in some operations such as fertilizer application, hoeing, irrigation and harvesting (Gezer *et al.*, 2003). Table 3 gives distribution of usage of human labor by agronomic practices in rose production. As it can be seen from Table 3 that, human labor for operation of harvesting consumed bulk of the energy (70.52%) among the agronomic practices. To minimize labor consumed, it is possible to use hand-held mechanical pickers (Weiss, 1997). Energy inputs due to tractor and machinery had a portion of 6.49% of total energy consumed owing to lower mechanization level. Machinery power was consumed mainly in transportation (45.13%), tillage (28.43%) and plant protection (26.44%) (Table 4). The other important energy input was water for irrigation. Although, sprinklers are more efficient in water usage (Weiss, 1997), in research area, sprinkler or drip irrigation systems were not common in rose production in Isparta province since the capital cost is high. Surface irrigation method is mostly used for irrigation. Therefore, only water for irrigation was accounted in the calculation. Rose fields were irrigated 0.80 times a year covering 5.02% of total energy input (Table 3). Chemicals for plant protection had proportion of 3.51% among the total energy inputs. Energy in chemicals utilized mainly in insecticide (76.44%) and fungicide (23.56%). Although its relative size is small, the increase in the use of pesticides is worrisome since average use of pesticide in rose production per hectare in Isparta province is 5.51 times higher than that of Turkey's average (Anonymous, 2000) causing environmental risk problem (Yucel, 1995). Therefore, effort should be directed at finding alternative pest management systems (Table 3). Farm yard or similar organic manure should be applied at the rate of 10-50 t $ha^{-1}$ prior to plantation establishment or replanting and ploughed in (Weiss, 1997) having the energy equivalent per hectare of 3000-15000 MJ ha$^{-1}$. These values were higher than that of obtained from the research area (652.05 MJ ha$^{-1}$).

The average biomass yield of rose obtained from 109 rose farms was found to be 5041.88 kg ha$^{-1}$. It was reported that the flower yield of rose was 3500-6000 kg ha$^{-1}$ for non-irrigated and 8000-9000 kg ha$^{-1}$ for irrigated rose fields (Anonymous, 1987). Therefore, this value falls within those reported for non-irrigated fields. Total bioenergy output was found as 21150.69 MJ ha$^{-1}$ considering its energy contents (4.20 MJ kg$^{-1}$) (Table 3).

The results of energy use efficiency, specific energy and energy productivity of rose production are presented in Table 3. Energy use efficiency of rose as indicated by an energy output: input ratio was found to be 0.72. Specific energy of rose production calculated as 5.81 MJ kg$^{-1}$. Energy productivity of rose production as described reciprocal of specific energy was found to be 0.17 kg MJ$^{-1}$. The energy use efficiency could be better if yields were higher and the inputs for rose production level were maintained. If the flower yield was 9000 kg ha$^{-1}$, the energy use efficiency would be 1.29, which would be more energy efficient. Similarly, specific energy and energy productivity of rose production would be 3.26 MJ kg$^{-1}$ and 0.31 kg MJ$^{-1}$, respectively. An increase in flower yield can be achieved with irrigation of rose fields. Weiss (1997) stated that at flowering period of flower, maintaining soil moisture at 85% capacity increases the flower yield. Therefore, it is necessary to irrigate rose to increase flower yield and total energy output. This causes an increase in energy use efficiency of rose production. Better energy use efficiency could also be achieved by reducing energy inputs. Chemical fertilizers are very energy intensive, especially nitrogen fertilizers having a portion of 85.30% of total energy for chemical fertilizers. Reducing the amount of nitrogen applied in half, would result the energy use efficiency, specific energy and energy productivity be 0.90, 4.66 MJ kg$^{-1}$ and 0.21 kg MJ$^{-1}$, respectively.

**Energetics of cultivation of rose production:** The total mean energy input together with its direct and indirect, renewable and non-renewable form for cultivating rose in Isparta province is presented in Table 4. 58.90% of the total mean energy input was supplied in the indirect form, whereas the remainder (36.08%) was in the direct form. While the indirect inputs were mainly by fertilizer use, especially nitrogen, direct inputs consisted of diesel fuel consumption for field operations. The results on an overall energy input pattern showed that non-renewable energy use dominated accounting for 78.55% of the total energy input. Energy consumed in the form of non renewable was fuel, chemical fertilizer and machinery. Only 16.43% of the total energy input was in the renewable form in the surveyed farms. Therefore, accurate fertilizer management taking into account of amount and frequency of fertilization (especially nitrogen) (Kitani, 1999) and proper tractor selection and management for machinery to reduce direct use of diesel (Isik and Sabanci, 1991) are needed to save non-renewable energy sources without impairing yield or profitability to improve energy use efficiency of rose production (Tsatsarelis and Koundouras, 1994).

Table 4: Total energy input in direct, indirect, renewable and non-renewable form for rose production

| Form of energy (MJ ha$^{-1}$) | Value | (%) |
|---|---|---|
| Total energy input | 29313.12 | |
| Direct energy [a] | 10575.35 | 36.08 |
| Indirect energy [b] | 17265.46 | 58.90 |
| Renewable energy [c] | 4815.53 | 16.43 |
| Non-renewable energy [d] | 23025.28 | 78.55 |

[a] Human, labor and diesel, [b] Chemical fertilizers, farm yard manure, chemicals and machinery, [c]Human labor and farmyard manure, [d] Diesel fuel, chemical fertilizers, chemicals and machinery

**Economics of cultivation of rose production:** Table 5 presents the economic analysis of rose production. Production cost of (Tukish New Lira;YTL) 1 kg of rose flower was calculated by dividing total rose production cost per hectare by rose flower yield per hectare yielding as 1.19 YTL kg$^{-1}$. In the research area, rose flower sale price (YTL kg$^{-1}$), profit margin per kg of rose flower (YTL kg$^{-1}$) and the ratio of profit margin/rose flower sale price (%) was found as 1.95, 0.75 and 38.83, respectively. Gross return was determined by subtracting variable cost of production per hectare (4241.15 YTL ha$^{-1}$) from gross value of production (9831.66 YTL ha$^{-1}$) and was found as 5590.50 YTL ha$^{-1}$. The portion of gross return within gross value of production was 56.86%, which was very high. Net return was calculated by subtracting total cost of production per hectare (variable + fixed cost) from gross value of production.

The portion of net return within gross value of production was 36.74%. Based on these results, it could be said that net return from rose production in the surveyed farms was at satisfying level. Benefit to cost ratio was calculated by dividing gross value of production by total cost of production per hectare (variable + fixed cost) resulting in 1.58. It can be implied that the net return of 1.63 YTL was obtained per 1 YTL of money invested and was cost-effective business based on the data of 2003.

Eleven villages from Isparta Centre, Atabey, Keciborlu, Gönen, districts of Isparta province where there is intensive-rose production was surveyed by

Table 5: Economic analysis of rose production

| Cost and return components | Value |
|---|---|
| Yield (kg ha$^{-1}$) | 5041.88 |
| Sale price (YTL kg$^{-1}$) | 1.95 |
| Gross value of production (YTL ha$^{-1}$) | 9831.66 |
| Variable cost of production (YTL ha$^{-1}$) | 4241.16 |
| Fixed cost of production (YTL ha$^{-1}$) | 1978.26 |
| Total cost of production (YTL ha$^{-1}$) | 6219.42 |
| Total cost of production (YTL kg$^{-1}$) | 1.19 |
| Gross return (YTL ha$^{-1}$) | 5590.50 |
| Net return (YTL ha$^{-1}$) | 3612.24 |
| Benefit to cost ratio | 1.58 |

1US$ = YTL 1.50 in 2003 (average)

applying a face to face questionnaire method with 109 rose growers. The study concluded that chemical fertilizers, especially nitrogen, were most energy consuming inputs. Energy consumption due to diesel was 21.87% of total energy input. Although a small portion (3.51%), of total energy input was chemicals for plant protection, use of pesticide in rose production per ha in Isparta province was almost 5.51 times higher than that of Turkey causing environmental risk problem. As results of calculation of energy budget, energy use efficiency, specific energy and energy productivity of rose production were found to be 0.72, 5.81 MJ kg$^{-1}$ and 0.17 kg MJ$^{-1}$. Total energy input was divided into four groups: Direct, indirect, renewable and non-renewable. It was concluded that the direct and indirect energy input was 36.08 and 58.90% of total energy input, respectively. Energy was consumed mainly in the non renewable form (78.55%) whereas renewable energy sources among the inputs had a share of 16.43% of total energy input. Economic analysis revealed net return from rose production in the surveyed farms was at satisfying level. Benefit to cost ratio was calculated as 1.58 indicating that rose production is cost-effective based on the data of 2003.

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