# Economics analysis of feeding effect with $co_2$ on greenhouse cucumber production in Iran (Case study of Greenhouses of Mahalat Township)

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**Abstract:** Mahalat Township having 27 hectare cultivated area of modern greenhouse cucumber is the main centers of greenhouse cucumber in the country. In this study we examine economics effect of feeding with co2 on greenhouse cucumber production in Mahalat Township. For this purpose function Cobb - Douglas that compared with other types of flexibility production functions, with attention to performed statistical tests were detected more appropriate, were used. Statistics and data used in this study obtained in personal and through completion 78 questionnaires of production costs from Beneficiaries of greenhouse cucumber production of Mahalat township in 2011-2012.The results of the data analysis indicates that beneficiaries that used co2 gas in their greenhouses, compared with beneficiaries that did not use it, on average, 26/1 percent more cucumber were harvested, in other words, efficiency improvement of greenhouse cucumber production, due to early growth of production with feeding co2 gas is known as major factor of production development. Those beneficiaries on average have 25 percent precocity in their production. Also the total cost of greenhouse cucumber in units that feeding with co2 gas on average 120 Rails in kilo, is lower.
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## 1. Introduction

Carbon is one of the required elements of the plants that its rate in comparison with the other elements is too high. Nearly 40% of the plant dry weight is carbon. Plants get their required carbon from existing carbon dioxide in the air and most of the gas through the leaves stomas that have open state enter into the plant. When carbon dioxide gas enters into the plant cells, using energy of sunlight is converted to the carbohydrates (sugars). Produced carbohydrates are transferred to other parts of the plant and participate in structure of other plant material (Powell, 1993).

In winter to prevent heat loss, the air exchange of inside the greenhouse with the outside due to blocking of the space to minimize, this situation especially in northern areas of the earth that cold continues consecutive days to cause in the sunshine day, existing carbon dioxide in space of the closed greenhouse frequently become decreased. Following this change, the process of photosynthesis consistent with this change to decrease and the time reaches that the plant growing is stopped completely. On average, slightly more than 0/03% of air is carbon dioxide that its rate in current condition is 345 parts in per million (345ppm) (Hosndokht,2005).

However, amount of carbon dioxide in a closed greenhouse, may to drop in a few hours to a critical point and finally its growing to stop. Concentration of co2 that causes this condition is variable and depends entirely on the type of greenhouses plant. Generally this condition once happens that amount of co2 is between 50-125. If this deficiency happens for several days in a cultivation period, lead to prolong cultivation period and reduction of the quality of crop. Lack of carbon dioxide around the plant (canopy) may be higher than other parts, so greenhouses ventilation can maintain uniformity of co2 concentration inside the greenhouse (Powell, 1993). It should be noted that greenhouses ventilation in maximum can reach concentration of co2 gas to usual limit that is same 345 ppm (part per million) that it's increasing with feeding co2 gas to ppm1300 (part per million) causes ideal greenhouse cucumber growing (Barzegar, 2010).

With increasing consumer awareness about nutritional issues, amount of Vegetable consumption in the food basket of households is growing and hence attention to the current methods and technologies to produce these products should be considered. Lack of resources, has prompted human that find more efficient solutions for own food supplying, on the other hand seasonality of agricultural products especially summer crop in conditions of ongoing demand and also increasing significance of quality level and market-friendly of produced crops, has caused in recent years see increasing development of the greenhouses in our country.

So given the greenhouses economy and enhance production efficiency especially in the current situation that plan of making targeted the subsidies has been implemented is very important. In this study we want to estimate economic impact of feeding with co2 on greenhouse cucumber production Mahalat township so that with respect to revenues and expenses of using this technology suggestions and recommendations will be presented. Generally, in Iran economic study in the field of effects of feeding co2 on greenhouse cucumber production hasn't done, but in the field of foreign studies in this regard studies has been done.

Mahmoud Shoor and et al (2010) in a study entitled examination of the effects of increasing carbon dioxide on anatomical and morphological traits of marigold in a greenhouse condition, for anatomical, morphological, precocity of the plant seedling, put them in control concentrations (350) 700, 1050 and 1400 micromoles mol of carbon dioxide. This experiment was conducted in experimental design completely randomized with three replications and characteristics such as stem diameter, number of leaves, height, chlorophyll content, stoma density, epidermal cell density, stoma index, stoma length and width, length and width of guard cells, leaf total area and shoot dry weight were studied. The results showed that high concentrations of carbon dioxide, affected most of the understudy traits. But concentration of 700 micro mol on mol carbon dioxide had greatest effect on under study traits. As Average stem diameter69% and increased stem height compared to the control mean more than twice. The high concentration of carbon dioxide significantly increased the stoma and epidermal cell density, length and size of stoma, guard cell length, leaf area and plant dry weight. Concentrations of 700 micromoles on carbon dioxide accelerated flowering 15 to 20 days compared with control plants.

Mohammad Banayan aval(2009) performed a research under the title performance evaluation of crops growth models in condition of increasing co2 rice and peanuts. In this study he used of published data from two international research on rice (increased carbon dioxide and nitrogen) and peanuts (increased carbon dioxide and temperature). Simulation models of plant response to increased carbon dioxide have forecasted production increase to 30% in controlled environments and situations that there isn't water and nutrients limitation.

Alireza Kochaki and et al (2008) to calculate the interaction of increasing co2 on photosynthetic parameters have used SUCROS [1] model. For evaluation of co2 concentration Interaction and increasing temperature of wheat yield in three concentrations 350 (current), 550 and ppm700 (double) in combination with increasing mean daily temperature to zero, 1, 2, 3, 4 centigrade degree was simulated. They showed that effect of increasing co2 concentration without heating on wheat yield was positive.

Sanchez and et al (2009) in a study entitled effects of feeding with co2 gas with consumable water in the hydroponic greenhouse using statistical methods showed that the in effect of feeding with co2 gas in greenhouse, cucumber production rate, increases 19% compared to other greenhouses that hadn't fed with co2 gas, without any change in using consumable water.

Chalabi and et al (1990) in research entitled a general optimal strategy for feeding with co2 gas in greenhouse showed that feeding with carbon dioxide causes increased greenhouse cucumber dry weight. They performed their research in the greenhouse by injecting co2 on cucumber bush that obtained optimum amount of co2 gas for cucumber photosynthesis. They showed that increasing co2 cause increasing the production and its quality.

Pandy and et al (17) showed that if rose plants exposed to high concentrations of carbon dioxide 1000 ppm and temperature 28 centigrade in day and 18 in night for 50 days, caused significant increase in stoma density (68/7% relative to control plants) and epidermal cell density (37/3% relative to control plants).

Also Dath (18), Operty and et al (19) were reported increasing in stoma length, length and width of guard cells under conditions of carbon dioxide with high concentrations in numbers cabbage and rice respectively.

## Materials and Methods

Statistics and data used in this study through in personal interviews and completion 78 questionnaires cost of greenhouse cucumber production in simple randomly was collected from Mahalat township.

Then for examination of feeding effect with co2 gas on greenhouse cucumber production have been used from production function estimation.

For this purpose three generalized production functions Cobb - Douglas, Translog and Leontief was estimated.

(1)

$$y = A.L^{\alpha 1}.K^{\alpha 2}.W^{\alpha 3}.La^{\alpha 4}.e^{u}$$

$$ln(y) = a_0 + \sum_{i=1}^{n} \beta_i \, ln\, x_i + \frac{1}{2}\sum_{i=1}^{n} \beta_{ii} \,(ln\, x_i)^2 + \sum_{i=1}^{n}\sum_{j=2}^{n} \gamma_{ij}\, (ln\, x_i)(ln\, x_i) +$$

(2) $u \quad i \neq j$

(3)

$$y = a_0 + \sum_{i=1}^{n} \beta_i (x_i)^{\frac{1}{2}} + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij}\, x_i^{\frac{1}{2}} x_j^{\frac{1}{2}} + u \qquad i \neq j$$

In the above equations, y is amount of product, Xi quantities of used inputs in production, α, β, and γ model parameters and Ln is the natural logarithm symbol. Also Equation (1) shows the mathematical form of the Cobb - Douglas production function, equation (2) mathematical form of Translog function production and equation (3) mathematical form of Leontief production function.

After estimating above production functions, Cobb - Douglas production function according to results of Wald test[1] was recognized as a superior form. For examination feeding effect with co2 gas on greenhouse cucumber production used a virtual variable to greenhouses that have used co2 gas to produce cucumber have been separated from the other greenhouses.

The general form of the production function presented in equation (4) (Chambers 1988):

(4) Q=f(x,z)

Where Q is the production rate, f functional equation, x variable input vector and z is a fixed input vector.

With estimating production function for each production estimation of marginal product of each input can be achieved.

Thus, from the parties of Cobb - Douglas production function, equation (1) from natural logarithm to equation (5) is obtained, which with respect to the parameters is linear.

(5)

*Y=f(L,K,W,La,fu,* $co_2$*)*

$$lnY = c + \alpha_1 lnL + \alpha_2 lnK + \alpha_3 lnw + \alpha_4 lnLa + \alpha_5 \ln fu + Co2 + u_i$$

y: production rate (tons)
L: Greenhouse cultivation area (square meter)
K: capital stock (thousand RLs)
W: water volume (cubic meters)
La: Number of labor (man-day)
fu: rate of gas consumption (cubic meters)
co2: feeding virtual variable with co2
ui: error
c: fixed number (intercept)

K: capital stock: for the calculation of capital inputs, at first the capital storage and capital flows should be separated.

Basically, capital goods are durable goods which in a period production, didn't consume entirely, but only part of them is used in each period.

For this reason, economists distinguish capital storage and capital inputs.

Capital input refers to that part of the storage capital which is consumed during the production period.

Accordingly, the theory of capital input is defined as follows (Ward, 1976):

(6) Qk=K. rk+RFP+DEPN

In the above equations K is cost of capital goods purchase such as machinery and rk the average cost of per unit capital (average rate of bank interest).

These part, in fact is same used capital opportunity cost to purchase capital goods.

Also RFP is the annual maintenance cost, DEPN is annual depreciation cost, and QK is same took capital inputs or services from total capital storage in one period of production.

In cases where a portion of capital has rented by farmer, the lease payments also as other component of capital inputs are accounted.

Thus, the total input of capital in this case can be expressed using the following equation (Salami, 2000).

(7) Qk=K. rk+RFP+DEPN+RENT

W: to calculate the volume of consumable water, given that greenhouse owners for irrigation greenhouses were used from pools of 20 thousand liters, 15 liters or 10 thousand liters, number of times that pool water become empty for calculation the amount of irrigation water was calculated.

La: To calculate the number of workers (person - day) used in the production of greenhouse cucumbers given that the three categories of labor, employment, family and day worker work in the greenhouses to calculate them, we calculate all three cases with attention to number of workers and number of days that they have worked and sum them.

Fu: rate of consumable gas, to calculate consumable gas, gas bills which are issued by National Gas Company is used.

**Results and Discussion**

The results of the estimated coefficients of the Cobb - Douglas production function for cucumber in Mahalat Township have been reported in (Table 1).

Our findings indicate that with one percent increase in Greenhouse cultivated area assuming remaining constant the other factors, to expect on average amount of greenhouse cucumber production increase 0/92% that this variable statistically is significant.

Also coefficient 0/033 of the fuel amount of consumable (gas) indicate that with each ten percent increase in fuel consumption production amount of greenhouse cucumber increase 33 % which statistically in level 5% is significant.

A virtual variable coefficient of Feeding with co2 gas is positive and statistically significant. These coefficients indicate that beneficiaries who using co2 gas in feeding greenhouse with assuming to remain constant other production factors, on average 26/1% more than other greenhouse owner during the year harvest cucumber. 25% precocity and improvement produced cucumber in greenhouse which used co2 gas in production, cause the number of times of cucumbers cultivation over the years, in this type greenhouse increase a period. Thus, it seems using co2 gas to provide efficient utilization of land and capital for greenhouse owners.

As shown in Table 1 the estimated coefficients of the variables of labor, capital, and water are all positive but not statistically significant. It seems that similar pattern of production units in utilization of the production factors that in viewpoint of construction time of the greenhouses and technology are very homogeneous caused these coefficients aren't statistically significant.

Table 1: Estimated coefficients of Cobb - Douglas production function

| | Statistics t | Standard deviation | Coefficient | Variable name |
|---|---|---|---|---|
| | 31.653** | 0.114 | 3.616 | Intercept |
| | 13.903** | 0.066 | 0.925 | Under cultivated area |
| | 0.446 | 0.065 | 0.029 | Water |
| | 0.790 | 0.014 | 0.011 | Labor |
| | 0.120 | 0.007 | 0.000 | Capital |
| | 2.069 | 0.016 | 0.033 | Fuel |
| | 9.991** | 0.026 | 0.261 | $co_2$ |
| **R-squared** | | | 0.975 | |
| **Durbin-Watson** | | | 1.597 | |

Source: Research findings

* Significant at 5% level ** significant at 1%

White test was performed to determine the anisotropy variance that hypothesis H0 based on the absence of anisotropy variance at the level 5% will be accepted.

**Comparison of greenhouse cucumbers total price with/without co2**

Income per year is obtained by multiplying amount of greenhouse cucumbers

Given that greenhouse cucumber production units in Mahalat township have been built in 84-1379, so to include cost of inputs in cucumber total price at first using engineering economic relations, capital expenditures, greenhouse construction, plant, machinery and installed co2 production machinery at first become changed into the base year 2011 and then using an interest rate of 10% and 20 years useful life, each them have been converted to the annual value of future using the following formula.

(8) $F = P(1+i)^n$

where, P is current value, F future value, i interest rates and n time in terms of years (useful life).In the above formula, $(1+i)^n$ is called the conversion ratio that is shown by (F / P, i, n).For this purpose, using the formula (8) turn the present value into future. Then, using formula (9) turn the present value into the uniform series of 20-year (Soltani, 2009).

(9) $$A = P\left[\frac{i(1+i)}{(1+i)^n}\right.$$

A= equivalent uniform of annual value

Depreciation expense includes 5% of the total cost of construction (baghban, 2011)

Total revenue includes total incomes minus total costs (DK, 1990).

Table 2: Average annual costs for greenhouse cucumber production in Mahalat Township instead of 1000 square meters

| Greenhouses without feeding co2 | Greenhouses with feeding co2 | Costs (fixed) investment |
|---|---|---|
| 20.505.992 | 20.505.992 | opportunity cost of constructing greenhouse Building |
| - | 1.197.600 | opportunity cost of constructing installing co2 production machinery |
| 6.866.645 | 7.165.640 | Opportunity cost of facilities and equipment |
| 456.750 | 679.320 | Opportunity cost of other tools and machinery |
| 27.829.397 | 29.548.552 | Opportunity cost of capital inputs |
| - | - | Current costs |
| 37.800.000 | 49.540.000 | Personnel salary |
| 954.500 | 1.308.566 | Poison |
| 16.600.000 | 28.560.000 | Fuel and energy |
| 17.600.000 | 26.400.000 | Seed |
| 12.500.000 | 19.600.000 | Fertilizer |
| 4.410.000 | 4.590.000 | Maintenance |
| 7.620.000 | 7.650.000 | Depreciation |
| 97.484.900 | 137.648.000 | Total current costs |
| 137.344.297 | 179.437.118 | The total annual production costs |
| 40.000 | 53.000 | average cucumber production (kg) |
| 3.370 | 3.25 | Total cucumber prices (USD / kg) |
| 6.000 | 6.500 | The average sales price |
| 240.000.000 | 344.500.000 | The average annual income |
| 102.655.703 | 165.062.882 | greenhouse net profit |
| 39.859.397 | 41.788.552 | Cost of capital inputs |

Source: Research findings

The total cost of per kilo of cucumbers that is obtained by dividing the total costs on performance show beneficiaries who used the gas co2, the total cost of per kilogram of their cucumbers is 3/250 Rails and beneficiaries who did not use the gas co2 total cost of per kilogram of their cucumbers is 3/370Rails, in other words despite of increasing 31% in cucumber production costs using gas co2, but due to significant promotion of production performance, total cost of greenhouse cucumbers in the first group is 120 Rails less than second group.Also beneficiaries who used gas $co_2$ instead of per 1000 square meters, 13 thousands greenhouse cucumber, more than the second groups were harvested.

Considering that the net profit of the greenhouse owners that have used gas co2 in feeding cucumbers annually on average instead of per 1000 square 62.407.179 Rails (61 percent),have been more of the other beneficiaries. Therefore, given that the average size of cucumber production greenhouses in Mahalat township is 3000 square meters, it is clear that using gas co2 in cucumbers feeding, is increased net profit of farmers on the average 187.221.179 Rials.

**Suggestions:**

Given that the findings research indicate that operation of the greenhouse cucumber production in greenhouses which is used gas co2 in their feeding, on the average is 26% more than other beneficiaries, so recommend to officials of agriculture organizations in provinces to celebrate training classes and extension courses and familiar greenhouse owners from benefits of co2 gas in cucumber production so that provide the way of performance improvement of existing resources and assets.

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