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ECONOMIC ANALYSIS OF THE FEASIBILITY OF AQUACULTURE PROJECTS IN THE RED SEA GOVERNORATE

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The Gulf of Suez is the most productive fishing ground along the Egyptian sector of Red Sea, where more than 64% of Egyptian Red Sea fish production was harvested. This paper reviews current and proposed regional aquaculture status and describes the process of feasibility of aquaculture projects in the Red Sea Governorate as a case study. The project data were collected and analyzed in this area. The results indicate that the project has a great value of Internal Rate of Return (IRR) of 30.2%, this means that the project is acceptable. Also, the Net Present Value (NPV) of thousand LE 8.58 is greater than zero, which reflects the same result as the IRR. On the other hand, this project is sensitive to decrease the revenue by 5% value, and more sensitive to increase the production cost by 20% value.

Keywords: aquaculture projects, Net Present Value, sensitivity analysis, Internal Rate of Return, Suez

There is, now, more than ever, a growing awareness of the importance of food production with respect to human nutrition, employment, and even recreation in more developed societies. Fish accounts for nearly one quarter of the world's supply of animal protein, the contribution of fish to total animal protein intake was significant – at about 20% (FAO, 2006). It is probably higher than indicated by official statistics in view of the unrecorded production and in some developing countries. Moreover fish has been descried as the "meat" of the "Third World". Important contributions by the fisheries sector to both developing and developed economies are in the form of employment, income, and exchange earnings. Aquaculture, on the other hand, is almost as old as human culture. Fish have been cultivated for centuries; yet, it is still relatively recent phenomenon in some parts of the developed world.

According to the General Authority for Fish Resource Development, fish production in Egypt in 2008 (GAFRD, 2008) was estimated as 1067.6 thousands ton of which 693.81 thousands ton, or 65% of total fish production came from aquaculture. The consumption in Food fish share was estimated at 15.95 kg/year as growth in supply from aquaculture more than offset the effects of product capture fishery production and a rising population. Thus, to face this problem an increasing in the production with a new aquaculture projects is highly needed.

Aquaculture is the farming of freshwater and saltwater organisms such as fish, mollusks, crustaceans and aquatic plants, also known as aqua farming (EIOA, AGC, 2009). Aquaculture involves cultivating aquatic populations under controlled conditions, and can be contrasted with commercial fishing, which is the harvesting of wild fish (American Heritage Definition of Aquaculture).

Farming implies some form of intervention in the rearing process to enhance production, cash as regular stocking, feeding, and protection from predators. Farming also implies some individual or corporate ownership of the stock being cultivated" (GAFRD, 2008). Types of aquaculture in Egypt are intensive raising, floating cages, and rice farms. Also there are many kinds of farms such as state farms, private farms (Parker, 1993). On the other hand, there are many challenges facing Egyptian marine fisheries such as; over-fishing, destructive fishing methods, illegal mesh sizes of nets used, increasing of tourism, industrial expansion and pollution from land-based sources. All these factors led to declining productivity and yields from marine fisheries, so it is urgent to identify and design long-term plan – project - to manage, sustain and enhance the development benefits from these fisheries. Project (conscious enterprise) is really any business with a value driven goals at the core of its business model. Like a traditional business, a conscious enterprise creates products, service or experiences to build revenue (TCEP). Research on the economics of aquaculture plays an important role in the development of aquaculture; it provides a basis not only for decision making among farmers, but also for formulating governmental aquaculture policies (Shang, 1981).

The Red Sea and Gulf of Suez are the most productive fishing grounds along the Egyptian sector of Red Sea, they contain about 64% of Egyptian Red Sea fish production (Sahar and Elgammal, 2007). Egypt has a vast marine shoreline (1080 km on Red Sea) (Sahar and Elgammal, 2007), the average annual fish production from this area is 47.361 thousand ton (GAFRD, 2008). The Gulf of Suez extends about 250 km from Suez in the north (Lat. 29°56' N) to Shadwan Island in the south (Lat. 27°36' N). Its width varies between 20 and 40 km, and its depth throughout its axis is fairly constant with a mean depth of 45 m (Fig. 1). Although Egypt has this marine, it has shortage in fish production, and there is increasing gap between production and consumption. Many studies have been made to evaluate productivity, fish market and fishery status (Sanders and Kedidi, 1984; Mehanna, 1999 and 2002; Elgammal and Mehanna, 2002; Gladstonea et al., 2003; Kotb et al., 2004; Sahar and Elgammal, 2007; Hebicha and Salem, 2008; Murad et al., 2008). The present study concentrated on the feasibility of aquaculture projects in the Red Sea Governorate to increase the aquaculture production in A.R.E. facing the gap between production and consumption.

Fig. (1). Gulf of Suez, Egypt.

MATERIALS AND METHODS

Fish production, like many economic decisions, involves benefits and costs that are expected to occur in the near future. The aquaculturist is often confronted with the problem of evaluating projects that will last several years with varying costs and benefits over the life of the project.

The study is based on two sources of data, primary data generated through a sample survey covering the Red Sea Governorate. The study employs surveying data of 65 aquaculture farms in Red Sea, and Suez Governorates that have been randomly selected, including the input and output data. The secondary data were obtained from the General Authority for Fish Resources Development (GAFRD, 2008). The data include total catch in Egypt, total aquaculture production, governmental and private farms, and all types of aquaculture in Egypt. Also prices for some kinds of fish in Red Sea Governorate like mullet, meager, sea bream, red mullet are included during the period from Jan. 1999 to Oct. 2008.

The method that mostly commonly used for addressing the present study is capital budgeting. Capital that involves large sums of money, the returns of which are expected to extend beyond one year (Jolly and Howard, 1993). The fish farmer or decision maker will search for fish enterprise that will produce the most net benefits. If the projects generated equal returns (annuity) throughout the project life, then the formula for determining the Net Present Value (NPV) would be (Jolly and Howard, 1993):

$$NPV= \frac{S_1}{(1+i_d)} + \frac{S_2}{(1+i_d)^2} + \frac{S_3}{(1+i_d)^3} + \frac{S_n}{(1+i_d)^n} -IQ$$

OR

$$NPV = \sum_{t=I}^{n} \frac{S_t}{(1+i_d)^n} - IQ$$

Where

S_t = the expected net cash flow (gross revenue LOE-taxes) at the end of year

IQ= the initial investment outlay at the time zero

I_d= the discount rate

The net present value (NPV), referred to as the present value of cash surplus or present worth, is obtained by subtracting the present value of periodic cash outflows from the present value of periodic cash inflows (Main, 2002).

The discount rate should reflect the value of the alternative use of funds. An investment project would be accepted if the NPV > 0, and rejected if NPV < 0. This is because the money being invested is greater than the present value of the net cash flow. If NPV = 0, the decision maker would be indifferent.

The Internal Rate of Return (IRR) is reported as a percentage rather than a dollar figure such as the Discounted Cash Flow Rate of Return (DCFROR). The definition of IRR is the interest rate received for an investment consisting of payments (negative values) and income (positive values), that occur at regular periods (Main, 2002). The IRR may be used for ranking projects. The ranking is based on the relative size of the IRR, with the largest IRR receiving the highest rank. Acceptability of each project depends upon comparing the IRR with the investors Required Rate of Return (RRR), sometimes-called Minimum Acceptable Rate of Return (MARR). If IRR is greater than the RRR the project is acceptable, and it would be rejected if not.

The formula for determining the IRR would be:

$$IRR= (NPV_A / (NPV_A – NPV_B)) (IRR_B – IRR_A)+IRR_A$$

Where;

NPV_A= positive net present value

NPV_B= negative net present value

IRR_A = interest rate associated with NPV_A

IRR_B= interest rate associated with NPV_B

Sensitivity analysis (SA) aims to enable the reader to apply global SA to mathematical or computational model. It offers a description of a few selected techniques for sensitivity analysis, used for assessing the relative importance of model. The input factors for these techniques will answer questions such as, (i) which of the uncertain input factors are more important in determining the uncertainty in the output of interest? (ii) If we could eliminate the uncertainty in one of the input factors, which one should we choose to reduce the most variance of the output? (Saltelli et al., 2004).

RESULTS AND DISCUSSION

1. Fish Production

Table (1) and Fig. (2) show the total catch in Egypt during the years from 1999 to 2008. The total production showed an increasing trend from year to another with maximum of 1067.63 thousand tons (2008) and a minimum of 648.938 thousand tons (1999) with an average of 862.321 thousand tons during the investigated years.

Table (1). Fish production in Egypt during 1999-2008 (amounts per 1000 ton).

Year	State	Private	Intensive raising	Floating cages	Rice field	Total aquaculture	Total production
1999	6.279	184.761	0.000	12.885	9.9620	213.887	648.938
2000	8.769	298.895	0.000	16.069	16.360	340.093	724.407
2001	6.744	294.033	0.000	23.716	18.371	342.864	771.515
2002	7.130	323.421	1.015	28.166	16.334	376.066	801.466
2003	7.256	387.516	1.030	32.059	17.007	444.867	875.990
2004	7.183	394.666	2.080	50.403	17.203	471.535	865.029
2005	7.588	492.246	2.472	19.839	17.603	539.748	889.300
2006	7.955	498.885	2.472	80.141	5.576	595.029	970.923
2007	8.539	557.822	1.580	62.276	5.300	635.517	1008.008
2008	8.547	586.435	1.830	69.108	27.900	693.815	1067.630

Sources: General Authority for Fish Resources Development, Fish Production Statics, Cairo, 2008.

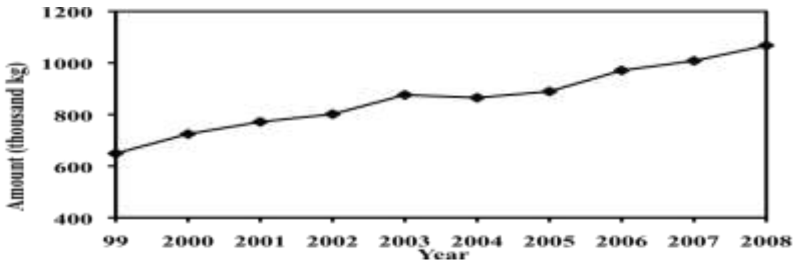

Fig. (2). Time trend of total catch production of fish during the period 1999-2008.

On the other hand, the total aquaculture production, given in Fig. (3) shows an increase from one season to another with maximum quantity of 693.815 thousand tons (2008) and a minimum quantity of 213.887 thousand tons (1999), with an average 465.341 thousand tons during the study period. Fig. (4-8) show fish production in five types of farms, state, private, intensive raising, floating cages, rice field, respectively. All the figures show the same behavior of increasing production with time. The average quantity produced was 7.6, 401.9, 1.3, 39.5, 8.3 thousand tons, respectively.

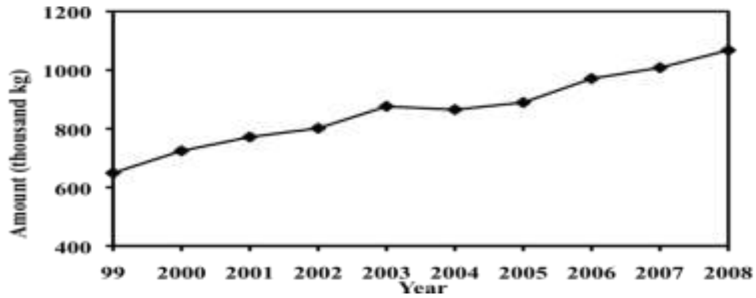

Fig. (3). Time trend of total aquaculture production of fish during the period 1999-2008.

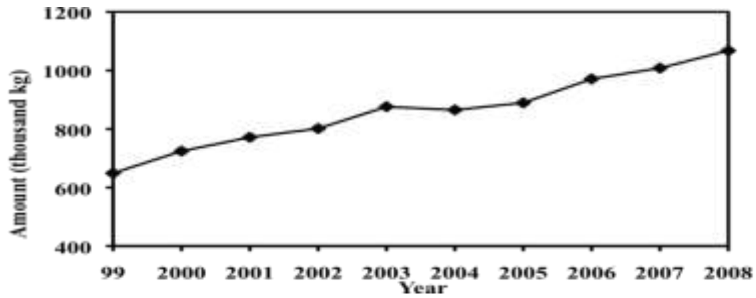

Fig. (4). Time trend of state farms production of fish during the period 1999-2008.

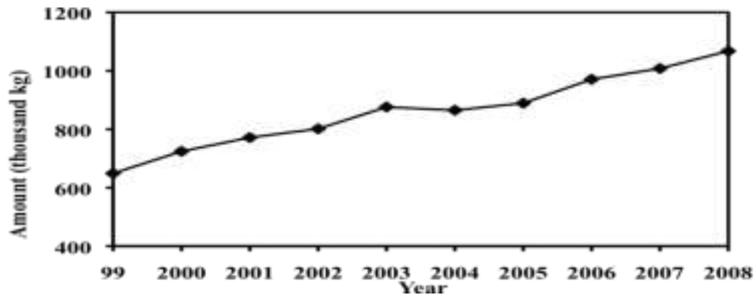

Fig. (5). Time trend of private farms production of fish during the period 1999/2008.

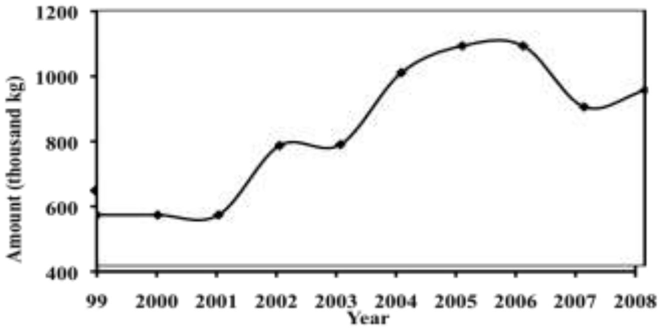

Fig. (6). Time trend of intensive raising production of fish during the period 1999-2008.

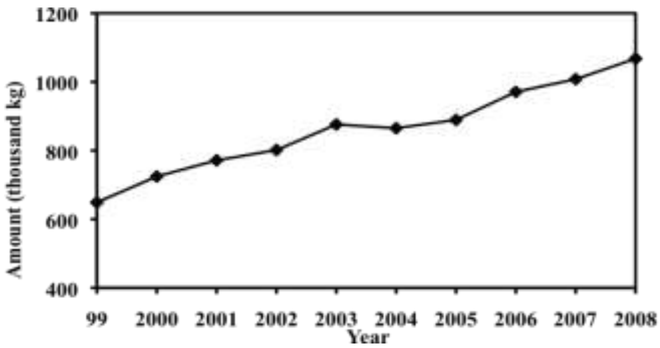

Fig. (7). Time trend of floating cages production of fish during the period 999/2008.

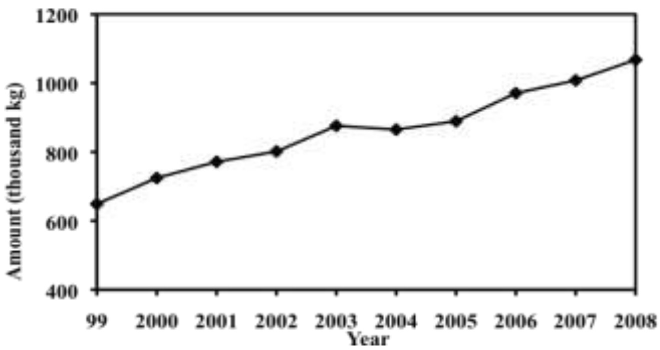

Fig. (8). Time trend of rice field production of fish during the period 1999/2008.

The result of time trend equations of the development of fish production with all types (catch, aquaculture) in Egypt is given in table (2). (i) All the estimated parameters are statistically significant. (ii) equation 1, 2, 3, 4 and 6 estimated time trend coefficients that were positive and significant implying that the total catch, aquaculture, state farms and private farms production were increasing; (iii) equation 5 estimated coefficients of time trend that were positive and significant implying that the intensive raising production were decreasing; (IV) the aquaculture in rice field equation was removed, because its parameter was not significant.

Table (2). Estimated time trend of the development of fish production in Egypt during 1999-2008.

Equation No.	Equation	R^2	Annual rate of change%	Mean	F	
1	$Y = 628.9 + 42.44\,X$ $(41.3)^{**}$ $(17.28)^{**}$	0.97	0.166	862.3	298.5	Total catch
2	$Y = 193.14 + 49.49\,X$ $(12.98)^{**}$ $(20.63)^{**}$	0.98	0.80	465.3	425.9	Aquaculture
3	$Y = 6.73 + 0.15\,X$ (13.6) (2)	0.33	136.5	7.6	3.96	State farms
4	$Y = 169.86 + 42.21\,X$ $(10.22)^{**}$ $(15.77)^{**}$	0.96	0.93	401.9	248.9	Private farms
5	$Y = -0.26 + 0.27\,X$ $(0.56)^{*}$ $(4.29)^{*}$	0.69	186.32	1.25	18.4	Intensive raising
6	$Y = 2.63 + 6.69\,X$ (0.27) $(4.38)^{*}$	0.70	3.39	39.5	19.18	Floating cages

Source: compiled and estimated by authors.

2. Investment and Operation Costs

Table (3) indicates that the investment costs amounted to about thousand LE 45.250, representing approximately 61.8% of the total costs, reflecting the relative importance of fixed capital in fish farms compared to the cost of variable capital.

Table (3). The investment costs of fish farming project.

Statement	Cost (LE)
Buildings	42000
Ground rent	1750
Nets	1500
Total	45250

Source: questionnaire data

Table (4) indicates that the operational costs amounted to about thousand LE 27.905. It is the value of items with different production value of seed, nutrition, labor cost, maintenance, operation, marketing and transport, and it represents about 38.2% of the total cost.

Table (5) shows fish production in four species in fish farms of the Gulf of Suez, mullet, red mullet, meager, sea bream, respectively, The average of the production for these species during the time of investigation were 1500, 350, 350, and 350 kg, respectively. The results also reflect that the annual averages total returns of mullet, red mullet, meagre, and sea bream were estimated at thousand LE 27.450, 4.620, 2.086, 12.320.

Table (4). The operating costs of fish farming project.

Statement	Cost (LE)
Fries	18250
Feed	500
Fertilizer	530
Pesticides and veterinary tools	-
Oils, fuels and lubricants	500
Marketing costs	500
Maintenance	5000
Employees	2000
Insurance	-
Water – electricity	625
Total operating expenses	27905

Source: questionnaire data

Table (5). The annual revenue of fish farming project in Gulf of Suez.

Fish types	Quantity (kg)	Price/kg	Value in LE
Mullet	1500	18.3	27450
Red mullet	350	13.20	4620
Meagre	350	5.96	2086
Sea bream	350	35.2	12320
Total			46476

Source: questionnaire data

Table (6) shows the basic economic indicator of aquaculture project. Results led to the conclusion that the project has B/C ratio greater than 1, it is 1.08. The project has NPV thousand LE 8.58 and IRR 30.2%. Annualized total benefits are estimated as thousand LE 46.476. The corresponding annualized total cost is about thousand LE 73.155. Annualized investment cost is about thousand LE 45.25. Annual net benefit is about thousand LE 18.571.

3. Sensitivity Analysis

Tested options: sensitivity analysis was conducted to reflect the impact on the basic indicators of expected changes in assumptions of the base situation. The tested options were as follows:

Option 1: Production costs increase by 20%.

Option 2: Total revenue decrease by 5% under condition.

Table (7) shows the main results of this analysis. Impact of increasing production costs (option 1) affected negatively benefits. An increase of production costs by 20% resulted in the following: (i) The value of B/C ratio decreased from 1.08 to 0.89, which means that the total benefits were decreased. (ii) The value of IRR decreased from 30.2 to 6.4%. (iii) The value of NPV decreased from thousand LE 8.58 to -12.8. (IV) This option is the most affecting factor within this group of options and this means that the project is not acceptable in this case.

Table (6). The most important indicators of economic efficiency and productivity of the draft aquaculture project.

Statement	
Investment cost (thousand LE)	45.250
Operating cost (thousand LE)	27.905
Total cost (thousand LE)	73.155
Total benefits (thousand LE)	46.476
Net Benefits (thousand LE)	18.571
Total production/ton	2.550
Average productivity (kg/Feddan)	510.000
Average price LE/kg	18.160
Benefit / cost (B/C)	1.080
NPV value (thousand LE)	8.580
IRR %	30.200

Source: result of the analysis

Table (7). Basic indicators for aquaculture project under different options.

Indicators	**Unit and level**	**Base**	**Option 1**	**Option 2**
B/C	Ratio	1.08	0.89	1.03
IRR	%	30.2	6.4	23.9
NPV	Thousand LE	8.58	- 12.8	2.78

Source: result of the analysis

Impact of decreasing benefits (option 2) affected positively benefits but in a lower image of the base. A decrease in return by 5% resulted in the following: (i) The value of B/C ratio decreased from 1.08 to 1.03, which means that total benefits were decreased. (ii) The value of IRR decreased from 30.2 to 23.9%. (iii) The value of NPV decreased from thousand LE 8.58 to 2.78. (IV) This option comes in the second degree of the affecting factors within this group of options, in this case the project can continue but with some risks.

The results indicate that the project has a great IRR; this means that the project is acceptable. Also, because the NPV is greater than zero it reflects the same result. On the other hand this project is sensitive to the decrease in the revenue by 5%, and more sensitive to increase the production cost by 20%.

SUMMARY AND CONCLUSION

The objectives of this study were to analyze the feasibility of aquaculture projects in the Red Sea Governorate, estimate cost return from this type of projects and focus on the sensitive analysis to know whether this project can face reduced return and increased variable cost or not. Result showed that the fish production in both fisheries (catch and aquaculture) has increased from year to another. On the other hand, fish production in five types of fish farms, state, private, intensive raising, floating cages, and rice field, respectively, has followed the same behavior of increasing production with time.

The time trend statistics indicate that all estimated parameters are significant and negative. These parameters include the total catch, aquaculture, state farms and private farms. This reflects the lack of production, except estimated coefficients of intensive raising and floating cages. Which is significant and positive, indicating the increase in production output. On the other hand, the aquaculture in rice field equation was removed, because its parameter was not significant.

The investment costs represented approximately 61.8% of the total costs, while the operational costs represented about 38.2% of the total cost. This means the relative importance of fixed capital in fish farms if compared to the cost of capital variable. On the other hand, the annual average total returns of mullet, red mullet, mearge, and sea bream were estimated as thousand LE 27.450, 4.620, 2.086, 12.320, respectively. So the net profit equals thousand LE 18.571.

The results indicate that the project has a great value of IRR 30.2%, which means that the project is acceptable. Also, the value of NPV thousand LE 8.58 is greater than zero, it reflects the same result as the IRR.

Sensitivity analysis showed that the increase in production costs by 20% means that the project is not acceptable in this case, and the decrease in the revenue by 5% negatively affects the viability of the project, so that the project can continue but with some risk.

ii- The project is sensitive to the decrease in the revenue, and more sensitive to the increase in the production cost.

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التحليل الإقتصادي لجدوى مشروعات تربية الأحياء المائية في محافظة البحر الأحمر

سها مصطفى الديب* وداليا السيد أبوزيد
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يعتبر مشروع إنشاء المزارع السمكية أحد المشروعات التي يعقد عليها الآمال لسد الفجوة الغذائية من البروتين الحيواني. حيث يمكن تكثيف عوامل الإنتاج وتزايد قدرات الإدارة وبالتالي كفاءتها لتحقيق الإستغلال الأمثل للعناصر المتاحة. وذلك للنهوض بالثروة السمكية من خلال طرق الإستزراع السمكي المختلفة. وتعد محافظة البحر الأحمر من أكبر محافظات مصر، حيث تطل كل مدنها وقراها على ساحل البحر الأحمر بطول ١٠٨٠ كم، مما يجعلها مقصدًا للإستثمارات المحلية والعالمية في مجال الإنتاج السمكي. وتستعرض الدراسة الجدوى الإقتصادية لإقامة مشروع إستزراع سمكي بالمحافظة، للمشاركة في زيادة إستغلال هذه المساحات الهائلة على طول الساحل لزيادة الثروة السمكية. وتشير النتائج إلى أن المشروع مقبول إقتصاديًا، حيث يحقق معدل عائد داخلي يقدر بنحو٢٠.٣٪ وصافي قيمه حالية تبلغ ٨.٥٨ ألف جنيه. كما تشير النتائج إلي مدى حساسية المشروع لإنخفاض العائد الكلي بنسبة ٥٪ وأكثر حساسية لزيادة تكاليف الإنتاج بنسبة ٢٠٪.