ECONOMIC FEASIBILITY STUDY FOR THE PROJECT OF CULTURED BARLEY PRODUCTION WITH HYDROPONIC METHOD

Diana M . Kaleel **E . H . Ali**
Researcher **Prof.**
Dept. Agric. Econ. Coll. of Agric. Engin. Sci .University of Baghdad.
Eskanderhali81@gmail.com

ABSTRACT

The objective of this research is to know the economic feasibility of hydroponics technology by estimating the expected demand for green forage for the years 2021-2031 as well as Identify and analyze project data and information in a way that helps the investor make the appropriate investment decision in addition to preparing a detailed technical preliminary study for the cultivar barley project focusing on the commercial and financing aspects and the criteria that take into account the risks and uncertainties . that indicating the economic feasibility of the project to produce green forage using hydroponics technology. Cultured barley as a product falls within the blue ocean strategy. Accordingly, the research recommends the necessity of implementing such projects that save land, water, and fertilizers and provide green forage throughout the year. The government should provide financial support for the supply and establishment of these projects because they require large capital, and livestock owners need support because the demand for forage is a request to implement an indicative program to introduce the advantages of hydroponics and green forage to breeders to increase the demand for it.

Key ward: Project evaluation, water use efficiency, net present value,forage production, sustainability

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دراسة الجدوى الاقتصادية لمشروع انتاج الشعير المستنبت بطريقة الزراعة المائية

ديانا مجيد خليل اسكندر حسين علي
باحث استاذ
قسم الاقتصاد الزراعي – كلية علوم الهندسة الزراعية – جامعة بغداد

المستخلص

هدف البحث الى معرفة الجدوى الاقتصادية لتقنية الزراعة المائية من خلال تقدير حجم الطلب المتوقع على العلف الاخضر للسنوات 2021 –2031 . والتعرف على بيانات ومعلومات المشاريع وتحليلها بصورة تساعد المستثمر في اتخاذ القرار الاستثماري المناسب. واعداد دراسة اولية فنية تم تفصيله لمشروع الشعير المستنبت مع التركيز على الجوانب التجارية والتمويلية والمعايير التي تأخذ في نظر الاعتبار المخاطرة واللايقين. اشارت طريقة التمهيد الاسي تزايد الكميات المطلوبة من الشعير المستنبت . واشارت النتائج المالية ان صافي التدفقات النقدية بلغت 2423839030 دينار. وان فترة استرداد راس المال كانت 2 سنة وان دليل الربحية بلغ 2.6 وحدة نقدية, اما معيار معدل العائد الداخلي فبلغ 47.9 % ، وهي تشير الى الجدوى الاقتصادية لمشروع انتاج العلف الاخضر المستنبت بتقنية الزراعة المائية. ان الشعير المستنبت كمنتج يندرج ضمن استراتيجية المحيط الازرق الذي في ابعاده يحول الافكار الابداعية الى مخرجات مفيدة تمتلك مؤسساتها ميزة تنافسية في ايجاد فضاء تسويقي للحصول على الحصة الاكبر من الطلب. وعليه يوصي البحث بضرورة تطبيق مثل هكذا مشاريع تقتصد في الارض والمياه والاسمدة وتوفر العلف الاخضر على مدار العام . على الدولة تقديم دعم مالي لتوريد وانشاء هذه المشاريع لانها تحتاج الى راس مال كبير، كما ان اصحاب الثروة الحيوانية بحاجة الى دعم لان الطلب على الاعلاف هو طلب مشتق ، وضرورة نشر و تطبيق برنامج ارشادي للتعريف بميزات الزراعة المائية والعلف الاخضر عند المربين لزيادة الطلب عليه.

الكلمات المفتاحية: تقييم المشاريع، كفاءة استخدام المياه، صافي القيمة الحالية، استدامة.

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INTRODUCTION

Barly (*Hordeum spp*) producton by hydropinc technology Very necessary for Iraqi agricultural sector. These projects establishment requires providing accurate statistical data and adequate knowledge of future changes. Since the investment decision is one of the most difficult decisions facing the owners of projects and institutions because the establishment of the investment project is not only influential on the level of the investor but also on the level of the economy as a whole. Therefore, adopting any economic project requires studying the factors affecting it. Feasibility studies represent one of the important tools that contribute to rationalizing investment and financing decisions. It was found that there is a link between the feasibility study of projects and the rates of economic development achieved, which in fact depend on economic efficiency in using the available amount of economic resources . (4). Hydroponics aims to control the growing environment that is fit for open cultivation. This type of vertical farming depends on technology that provides solutions in various fields such as automated equipment, climate and lighting control technology, and sensors devices so that large production does not lead to any problems in producing plants in different environments. Applying new technology leads to obtaining better food with the growth and increasing population (12, 18, 20, 21, 30). Cultured barley is one of the most important types of green forage used in feeding animals due to its positive effect on the health of livestock as well as various other animals used it as forage; moreover, it provides high-value production throughout the year and improves animal production (dairy, wool, and meat) qualitatively and quantitatively with low cost, in addition to reducing the areas used for this technology, as cultivar barley increases livestock production by 20-25% compared to the traditional agriculture (9, 13) . The production of 45 thousand tons of green forage in traditional agriculture (open cultivation) needs approximately 20 million m3 of water and an area of 800 hectares and about 400 workers, while producing the same amount through hydroponics needs 50 thousand m3 of water, over an area of 2 hectares, and requires about 30 workers. This means that cultivation without soil saves a large amount of water, meaning that this method saves about 19,950,000 m3 of water as well as provides large areas of land, approximately 798 hectares that barley (1, 2, 3, 6, 7, 17, 8, 23 25). can be used to grow other crops to produce the same amount of. Feeding ruminants with high-quality green forage can play an important role in economic production, although there are various constraints faced by farmers to produce green forage, including small land tenure, water scarcity or salinity, as well as labor cost and fertilizer requirements, in addition to the length of the growth period, 45-60 days, and the lack of green forage throughout the year. Because of these problems facing the traditional method, hydroponics technology has become a substantial technological alternative to green forage cultivation (6, 7, 20). Studies confirmed that producing one ton of cultured green forage would reserve 15% of the production cost compared to the traditional agriculture as well as preserve about 95% of irrigation water and 100% of the fertilizers and pesticides in addition to providing 50% of the nutritional needs of green forage for feeding animals (5). Accordingly, one of the economic advantages of growing cultured barley is to save more than 70% of feeding costs, which leads to increaseing profits and maximizing the production of animal breeders with the least effort (14, 17, 22, 24, 26, 27, 28). The problem dealt with by the research is represented in the forage scarcity and the high costs of its production, and its unavailability throughout the year, one of the most important obstacles that limit the expansion in the field of animal production. These problems have contributed to the deterioration of animal productivity. Providing forage with quantities provided by hydroponics requires high costs and that many investors enter the field of investment without examining the economic feasibility studies for their projects, but they consider them as part of the requirements for obtaining a loan in some cases, and this exposes them to loss on the one hand and waste of resources on the other hand. This was research aimed to analyze the market competitor analysis, price analysis, pricing

policy, and market share, besides estimating the expected demand for green forage for the years 2021-2028 and recognizing and analyzing project data and information in a way that helps the investor to make the appropriate investment decision, in addition to preparing a preliminary and then detailed technical study for the cultured barley project with a focus on commercial and financing aspects and standards that take into account risk and uncertainty.

MATERIALS AND METHODS

Based on the nature of the problem at hand, and to reach the desired aims in this study, the researchers try to use the approved approaches in financial and economic studies. And accordingly, the used approach will be descriptive help to clarify the theoretical aspects of the subject that is concerned with collecting data and information to be organized sequentially. For the application aspect, all the criteria used in the economic feasibility studies and all its marketing, environmental and technical branches, will be applied, besides preparing them for the cases of risk and uncertainty and making a decision tree for comparing the alternatives offered. The prices and costs relied on the market price and correspondence with the manufacturers of the techniques used for the project and previous experiences. Some data were collected from the secondary sources represented by the Agriculture and Planning ministries.

RESULTS AND DISCUSSION

Project description: It is a hypothetical productive project in which barley as an animal forage is grown by the hydroponic method in a 1250M2 area in Baghdad, Abu-Ghraib. It is a commercial agricultural activity producing cultured barley as a green forage all over the year. Animals' growers beneficiate from this project as cultured barley improves animal production of dairy and meat as it is found that the cultured barley increases the animal production by 20 – 25%.

Justifications and reasons for the project establishment: There are several reasons for establishing this project. The most important of which are:

1- It is one of the profitability projects that encourages economic income.

2- It contributes to attaining the ideal allocation of economic resources, especially since Iraq suffers from a lack of some resources in particular water, and then allocating resources for the cultured barley project is a good investment opportunity

3-Providing green forage throughout the year where the project is among the solutions for the problem of forage exacerbated recently due to drought and global price raises.

4- Saving a great deal of water amount through using the hydroponic method for culturing barley compared to the traditional method. It is one of the projects that contribute to enhancing water use efficiency as the decrease in water quantities and the scarcity of rain exacerbated the problem of forage and its provision.

5- Reserving large areas of arable land for the production of strategic crops or the production of crops that cannot be grown by the method of culture, and thus it can be a part of the sustainable development process.

6- Trying to recognize the difference between the culturing method and the traditional method for barley growing.

7- Reducing the forage import from abroad as much as possible.

8- Reducing the workforce of the project and thus decreasing the production cost.

9- Reducing the risk of climate fluctuations and weather conditions, as well as diseases and insects, since the hydroponic enables to control of all climate conditions and provides all plant needs of elements and surrounding conditions.

First: Environmental feasibility of the cultured barley project

Environmental problems represented by air and soil pollution are an important indicator of the effect on productivity and economic efficiency, so it is necessary to use environmental criteria in setting up industrial and agricultural projects which are represented by preparing the environmental feasibility of projects to know how to address the environmental influences resulting from each project establishment. The hydroponics project impact of cultured barley is positive for the environment as every $1.5m^2$ of the green floor produces oxygen sufficient for clarifying the air of a person for a whole year. As pollution caused by increasing buildings and facilities

with a lack of vegetation cover reduced the agriculture, it was found that every 1m^2 of the green surface removes 10 g of air pollutants every year. Moreover, unlike traditional agriculture, culturing barley in water is very water-saving and does not deplete much water nor contaminate1(24). it That is to say that this project of culturing barley on a 1250 m^2 area will get rid of 12500g of pollutants from the air within one year. Furthermore, growing cultured barley will produce oxygen sufficient for about 833 individuals for a year. Furthermore, growing cultured barley will produce oxygen sufficient for about 833 people for a year. Hydroponics also leads to reducing the incidence of the diseases caused by insecticides used in traditional agriculture, as well as avoiding groundwater pollution, these factors as a whole result in reducing the environmental pollution. There may be a negative effect of the hydroponic method in the case of using heating and cooling that operate by fuel in the halls and greenhouses. However, this type of agriculture may not have any negative impact on the environment in the case of the use of heating and cooling methods that work with electricity or through solar energy. Hydroponics has a role in providing resources which has a significant impact on the sustainable development process. Hydroponic is land-saving in a large proportion, as well as it saves the using water amount, and decreases laborers compared to the traditional cultivation of barley.

Marketing feasibility

Barley crop prices in Iraq: Barley crop pricing starts mainly from the production cost. The decision of the pricing process consists in discovering the price on the equilibrium price in the global markets for production requirements as the starting point for the price. Therefore, following up on the production costs of the barley crop is a necessary important step, in addition to the equilibrium average price in global markets when making a price decision. Figure 2 illustrates the local prices of the barley crop for the period from 2010 to 2020, as it is noted there is stability in the local prices offered by the government to the farmers for the barley crop. During this period, the highest price of barley reached 47900ID/t in 2012 and achieved good returns for the farmers, but in 2020 the price was 420000 ID/t which is a price supported by the government. The government receives the produced barley amounts according to an agricultural plan that has contributed to increasing the area planted with the crop, as the price support reduces the price risk and ensures the sale of all the produced amount, in addition to the fact, the offered price is rewarding, knowing that we are reviewing the barley prices as concentrated forage and the study project "green forage" because of the link existing between the green and concentrated forage.

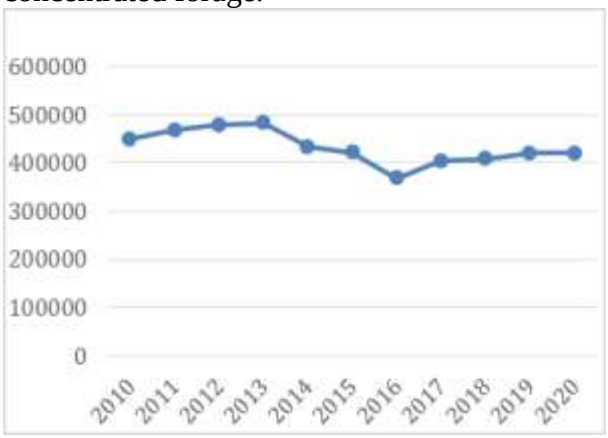

Figure 1. Local prices of barley in Iraq for the period 2010-2020

Reference: Prepared by the researcher based on data from the Ministry of Agriculture

Produced forages (the cultivated area, production, and prices): Figure 2 demonstrates the field prices of the green forages in Iraq. Alfalfa and clover prices were almost stable during the studied period, and the highest price for alfalfa and clover was 360000 ID/t and 440000 ID/t, respectively, in 2013. The lowest price for clover was 404000 ID/t recorded in 2010. It is observed that there a fluctuation for maize and sorghum prices during the period 2010-2020. The highest price for maize was 70000ID/t in 2015, then the prices started to decline where the lowest price of maize reached 350000ID/t. For sorghum, the highest recorded price was in 2016, to be 762000 ID/t, while the lowest price was 632000 recorded in 2010. However, in general, it can be said that the green forage prices are high, which may be encouraging for producers, and at the same time, the forage matter, and its availability for livestock breeders, is complicated, especially in recent years due to the scarcity of rainwater.

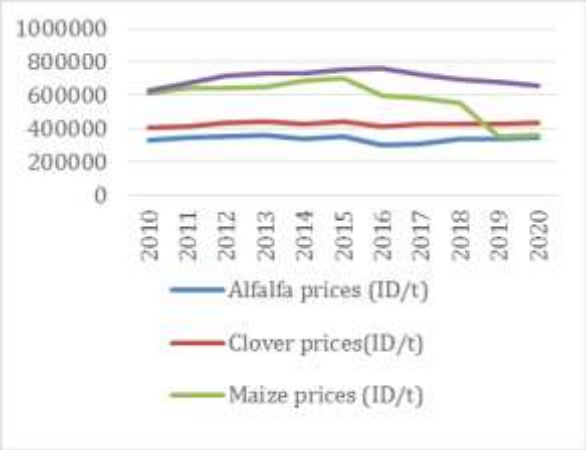

Figure 2. Green forages prices during the years 2010-2020

Reference: Prepared by the researcher based on data from the Ministry of Agriculture

Number of animals according to types (sheep, goats, cows, and buffaloes)

According to the statistics presented by the Ministry of Agriculture - Department of Agricultural Statistics, figure 4 shows the number of animals by type (cows, buffaloes, sheep, and goats) in Baghdad governorate for the years 2010-2020. This survey was carried out by the Ministry of Agriculture and the Ministry of Planning, and the data was estimated based on the latest statistics for livestock in Iraq (the National Survey of Livestock) adopting a fixed rate of growth, which is approximately 3%. It is noticed that the number of animals in Iraq increases over the years during the period 2020-2020. The number of buffaloes in Baghdad occupied the largest percentage of the total numbers in Iraq, reaching 16.75%, followed by the number of cows, 9.32%, while the percentage of the number of goats and sheep was 2.246% and 1.40%, respectively.

Figure 3. Number of animals for the years 2010 – 2020 at the level of Baghdad governorate

Reference: Prepared by the researcher based on the survey of the Ministry of Agriculture in 2008

Estimated rates of animal consumption of cultured barley according to the type:

Cultured barley essential for the livestock nourishment. It could an alternative to the alfalfa, clover, hay, and other green forage. The consumption rate was estimated based on the daily consumption of forage by the livestock and the number of livestock animals in Baghdad so that we can predict the demand for the coming period. Both cows and buffalo consume about 15 kg daily of green forage on average, while sheep and goats have an average daily consumption of 3 kg of green forage, in addition to concentrated dry forage, i.e. the daily consumption of an animal is about 9kg of green forage. Table 3 shows that the daily consumption rates of green fodder for all animals in Baghdad will be approximately 6696.741 tons.

Table 1. The animals' consumption rate of cultured barley during the years 2010-2020

Years	Consumption by cows (t)	Consumption by buffalos	Consumption by sheep	Consumption by goats	Total consumption
2010	3787.035	760.8	333.06	102.27	4983.165
2011	3900.645	783.615	343.05	945.336	5972.646
2012	4017.66	807.21	353.34	108.495	5286.705
2013	4138.185	831.33	363.939	111.747	5445.201
2014	4262.325	856.26	374.856	115.098	5608.539
2015	4390.185	881.94	386.1	118.548	5777.773
2016	4521.885	908.385	397.683	122.103	5950.056
2017	4657.53	935.625	409.611	125.766	6128.532
2018	4797.255	963.69	421.899	129.537	6312.381
2019	4941.165	992.595	434.553	133.422	6501.735
2020	5089.359	1022.37	447.588	137.424	6696.741

Reference: Prepared by the researcher according to the estimates of technicians in the Department of Animal Production / College of Agriculture / University of Baghdad

Predicting the demand for green forage Demanding for the project product (cultured barley) was predicted using the double exponential boot method to recognize the annual project coverage of green forage, specifically the barley culture. Figure 4 illustrates the predicted amounts of the annual total consumption of the green forage in Baghdad govern in the years 2021-2031.

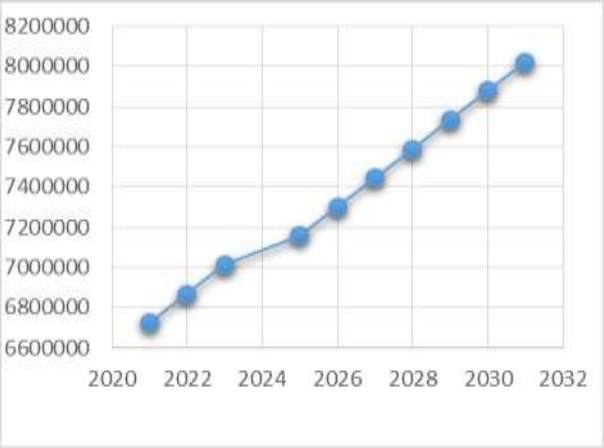

Figure 4. Predicted demand amount of the green forage in 2021-2031

Reference: prepared by the researcher depending on Table 1 using the double exponential boot method

Secand: Technical and financial feasibility study

Technical feasibility of the project: In this study, we will choose the project location, plan the production process, and determine the needs and requirements of the barley culture project, as follows:

1- Project location: The hypothetical site of the project to be built and established was determined to be in the governorate of Baghdad - Abu Ghraib district, on a 1250 m^2 area that was determined and selected based on several points , the most important of which are summarized as follows:

- It is considered one of the important agricultural areas of Baghdad, including a great number of animal breeders, which means a high demand in this region for green forage as animal feeding. So it is possible to agree with livestock breeders to provide them with forage.
- Abu Ghraib connects with a highway net that facilitates product marketing inside the district.

2- Project size: the process of deciding the project size and its production capacity may be viewed in economic and technical ways. The market size and nature are important issues that should be considered when choosing the right size for the project, as well as the availability of capital, raw materials, location, and production capacity to ensure its highly efficient operation where a failure to operate the project at its maximum production capacity will necessarily increase the production costs and consequently lead to the inability to compete in the local market, and this may be a reason for the project failure.

3- Planning the product process: It includes the following:

- **Determining the specifications of the buildings needed to set up the project:** The project will be established on a 1,250 m^2 area where the productive unit area is 96m^2. The project comprises seven production units, each of them comprising ten subunits containing seven racks each. And a room for storing seeds, washing, and sterilizing them to be cultured in a 30 m^2 area. The administration room will be constructed on an area of 25m^2 in addition to two rooms for laborers of 25m^2 each and a shed of a 96m^2 area.
- **Determining production manner:** The manner of intensifying the capitalwill be used that involves greater use of capital (machines, equipment, and buildings) offset by less use of labor.
- **Determine the products of the project**Only one product, the cultured barley, will be produced for livestock nourishment. The production capacity of the project is 10 tons/day.

4- Determine the machinery and equipment needed by the project: the project needs a group of tools and equipment listed in Table 2

Table 2. Machinery and equipment needed for the culturing barley project

Materials	Number
Racks including culture tray	70
Power system installation equipment (lamps, wires, meters, other tools)	/
Watering and feeding system (water pump, water tank, other tools)	/
Air conditioners	23
Tractors	7
Containers for washing seeds before culturing	10
Temperature and humidity meters	7
Generators 100K.V	1
Trucks	2
Pumps inside the hall	7
borehole pump	1
Timer	7

Reference: prepared by the researcher

The study is represented by determining the financial resources of the project and calculating its costs and incomes as well as determining the effectiveness of the project, as follows:

1- Determine the sources of funding: The project relies on self-funding (i.e. it is financed by the investor)

2- Estimating the project costs and incomes: The total costs will be calculated and estimated through estimating investment and operational costs, as shown below:

- **The land:** The project will be laid on a land of 1250 square meters involving seven halls (the project includes seven productive units) with a capacity of 10 tons per week each. It will also contain a store for storing, washing, and sterilizing the seeds before culturing them, in addition to buildings and constructions supporting the project.

Table 3. Purchase costs of the project land

Item	1m2	Unit cost (ID)	Total cost (ID)
Land	1,200	12,000	15,000,000

Reference: Prepared by the researcher relying on the market prices

- **Building:** The project requires buildings and constructions, including seven production units, as well as supporting buildings for the project, such as a warehouse for storing, preparing, and sterilizing seeds before the culturing process, rooms for workers, a room for administration, and restrooms, a shed for placing the product before marketing, and a garage for cars. The project will also be completely fenced. Table 6 shows that the total construction cost of the project is 40525000 ID which is relatively low compared to the other costs since the construction will be made of sandwich panels, which is comparatively cheaper. Knowing that the cost of the seven productive halls constitutes about 72% of the total construction cost.

Table 4. The project construction costs

Item	Number	Area (M^2)	Unit cost (ID)	Total cost (ID)
Production hall	7	96	5,000,000	29,375,000
Seed preparation + warehouse	1	30	1,650,000	1,650,000
Management room	1	25	1,500,000	1,500,000
worker room	2	50	3,000,000	6,000,000
Fence and lanes	/	/	2,000,000	2,000,000
Shades	1	96	3,000,000	3,000,000
Total				40,525,000

Reference: Prepared by the researcher relying on the market prices

- **Machines, equipment and tools:** The project needs many different machines and tools to carry out various operations within the project that can be purchased from the local markets, in addition to importing some of them from abroad. Each culture rack accommodates 125 kg of barley seeds, turning into a ton of green fodder seven days later. It is clear that the cost of equipment, machinery, and tools is 556787804 ID, and the racks and their accessories accounted for the largest proportion of this cost, constituting about 79% of the total equipment cost. The Racks are the most important production units in this project,

followed by the air conditioners, which are necessary to provide a suitable temperature for barley cultures. Table 5 shows the machinery, equipment, and tools required by the project.

Table 5. Machinery, equipment, and tools needed by the project

Item	Number	Unit price (ID)	Total cost (ID)
Racks and other parts	70	2,630,000	441,000,000
Containers for washing and sterilization	10	120,000	1,200,000
Air conditioners	23	1,165,000	26,000,000
Exhaust fans	8	75,000	600,000
Temperature and humidity meters	7	22,000	145,000
Water tanks 1000 liters	9	200,000	1,080,000
Water tank 10000 liters	1	/	624,000
product transport carts	3	200,000	600,000
Generator 100K.V	1	/	8,758,000
Borehole + pump + accessories	/	/	2,400,000
Trucks	2	36,487,006	72,974,012
Power system installation quipment	/	/	3,150,792
Water system	7	150,000	1,050,000
Pumps inside the hall	7	50,000	530,000
Timer	7	73,000	500,000
Total			559,211,804

Prepared by the researcher relying on the market prices

- **Production requirements**: For producing green forage, the culture project needs productive requirements where the most important of them are seeds. Each rack requires 125kg weekly, and thus the project requires 420kg yearly. The seeds constitute 56.3% of the production requirement costs followed by the labor wages occupying 34.55%. All other costs are shared among fuel, maintenance, water, electricity, etc. (Table6).

Table 6. Production requirements needed by the project

Item	Amount	Unit price (ID)	Total cost (ID)
Seeds (kg)	420,000	425	178,000,000
Sterilizers (liter)	36 liter	5,000	180,000
Fuel diesel (liter)	65,000	400	24,000,000
Workers' wages	18	/	109,200,000
Maintenance	/	/	2,000,000
Water fees	/	/	400,000
Electricity fees	/	/	600,000
Advertising	/	/	500,000
Others	/	/	1,000,000
Total	18	/	315,880,000

Reference: Prepared by the researcher relying on the market prices

- **Necessary services**

The project needs necessary services in anticipation of any emergency and against risks. The annual cost and emergency budget of the project is estimated at about 7 million Iraqi dinars.

- **Manpower and annual wages**

The project needs skills for managing and operating, and because the project is a modern technology that requires technical knowledge of production details and of providing appropriate conditions such as heat and lighting as well as regulating the number of daily irrigation times, the project needs 18 workers distributed between management, accounting, and labor, at a total cost of 109,200,000 ID, allocating 49.4% of them for workers and 9.8% for managemen.

Table 7. Required professions and their monthly and annual salaries (ID)

Profession	Number	Monthly salary (ID)	Total cost (ID)
Manager	1	900,000	10,800,000
Accountant	1	700,000	8,400,000
Service employees	1	300,000	3,600,000
Agricultural engineer	1	700,000	8,400,000
Workers	10	450,000	54,000,000
Guards	2	500,000	12,000,000
Drivers	2	500,000	12,000,000
Total			109,200,000

Reference: Prepared by the researcher

- **Operational costs:** These are the costs that the project continues to cover for one production year. The operational cost of the project during a year amounted to about 432,080000 ID. The costs of production requirements accounted for 73.1% of them. As for salaries and workers' wages, they amounted to 25.2% of the operating costs. An amount of 2% of the operational costs are allocated to the emergency budget to face any emergency that could happen to the production process (Table8).

Table 8. Operational costs of the project

Item	Cost (ID)
Production requirements	315,880,000
Salaries and wages	109,200,000
Essential services and emergency budget	7,000,000
Total	432,080,000

Reference: Prepared by the researcher based on the previous tables

- **Summary of the project costs**

Table 9. A summary of the project investment costs and working capital

Item	Cost (ID)
Land	15,000,000
Buildings and facilities	40,525,000
Machines and equipment	559,211,804
Total fixed assets	614,736,804
Working capital	432,080,000
Total	1,046,816,804

Reference: Prepared by the researcher based on the previous tables

- **Expected incomes:** These incomes involve the cultured barley (green forage). To determine the income, the produced quantity and price should be set. Since the daily production will be 10 tons during 358 days of a year and as the cultured barley is a new commodity, it would be priced according to the pricing method based on total costs (15, 16). The price was set at 206000 ID/t, and accordingly, the expected annual income would be 737480000 ID.

Financial analysis

First: Commercial profitability criteria under certain conditions:

First item: Undiscounted criteria: They are the criteria used to measure undiscounted commercial profitability, which means the criteria that ignore the time value of money, that is, the criteria that deal with cash inflows and outflows, as they are without resorting to discounting. They are represented by the following criteria. The result above illustrates that the payback period for the capital, including investment costs, is 2.0, meaning that capital payback occurs within two years. Economically, it is an acceptable period compared to the productive project age of 10 years. Since the cost for the capital of the investment project (borrowing interest) equals 12% and the accounting rate of return is greater than the optimum rate, the project is very encouraging, because this indicator confirms the opportunity to achieve high profits for the project during the expected life of the project (10, 11). As for the undiscounted profitability index, it is noticed that by investing a monetary unit in the project, we get 1.6 monetary units, that is, investing one monetary unit in the barley cultivation project can obtain a profit of 600 Fils per dinar invested. It is a good indicator of encouraging the establishment of such a project as it is economically feasible.

Table 10. Summary of the results of applying the non-discounted financial feasibility criteria for the cultured barley project

Financial criterion	Value	Evaluation
Payback period	2	The period that the project needs to pay back its investment costs is a short and economically acceptable period, meaning that the project is appropriate from the investor's point of view
Accounting return rate	49.9 %	The accounting return rate is greater than the interest rate of 12%, so the project is encouraging to a large degree, that is, it achieves high profits during the expected life of the project
Undiscounted Profitability Indicator	1.6	The criterion of the undiscounted profitability indicator was higher than the correct one, and this indicates the project feasibility

Reference: prepared from the researcher

Second item: Discounted criteria

Table 11. Summary results of applying the discounted financial feasibility criteria for the cultured barley project

Financial criterion	Value	Evaluation
Net present value	1095617329	The net present value of the cash flows is a positive value, which makes the project economically acceptable
Benefit to Cost Ratio	1.354	The discounted profitability index is >1 and it is good from an economic point of view. It means that the dinar invested in the project achieves 0.3 fils.
Internal return rate	47.9%	The internal rate of return criterion far exceeds the alternative costs of capital, meaning that the project achieves good returns from an economic point of view.

Reference: prepared by the researcher

Through the result above, we note that the net present value is 1095617329 ID, which is positive at the specified discount rate. This project is economically acceptable according to the net present value criterion. Since the result of the benefit/cost ratio is positive (> 1), the project is considered acceptable economically. Meaning that the project attains returns exceeding its cost that is, each invested dinar can achieve cash flows or incomes of 300fils, and the internal return rate for the project is 47.984%, which is higher than the average cost of funds by 12%, so the project is feasible economically.

Second: Profitability criteria under uncertainty:

1- Sensitivity analysis:

This indicator is based on testing the project sensitivity toward variables and bad expectations that may occur. This indicator is based on testing the project sensitivity toward variables and bad expectations that may occur. After obtaining the results of the project feasibility, which took place in conditions of certainty and sureness and according to the analyzed data, a new analysis is taking place now that assumes a change for the worse in some aspects of the project (including, the high investment costs of the project, the high operating costs of the project, and a decrease in the green forage price).

Table 12. Sensitivity analysis of the cultured barley project

Financial criterion	investment cost increment by 10%	investment cost increment by 20%	operational cost increment by 10%	operational cost increment by 20%	price lower by 10%
Payback period criterion	2.2	2.4	2.3	2.8	2.6
Accounting return rate	44%	40%	42%	35%	37%
Undiscounted Profitability Indicator	1.46	1.44	1.36	1.26	1.39
Net present value	417869012	355513915	233526734	600909359	2303410000
Benefit to Cost Ratio	1.32	1.3	1.25	1.16	1.2
Internal return rate	%38.8	%39.3	%40.5	%32.9	34.6%

Reference: Prepared by the researcher

Results of the sensitivity analysis of the project indicate that the project is not sensitive to changes in investment costs when the project investments costs increase by 10% and 20% and will still achieve a positive net present value. The project is not sensitive to changes in operating costs when they increase by 10%, as the project remains to achieve a positive net value, however, the project is sensitive to changes in operating costs increases by 20%. It achieves at this percentage a negative net present value, and it is not sensitive to prices fluctuations by 15% of its products and achieves a positive net value.

2- Break-even point

It is the criterion by which it is possible to arrive at the quantity produced or sold at which the total costs equal to total incomes, i.e. the level of production or sales of the project is at its lowest level without exposing the project to loss or risk. The break-even point is calculated mathematically by mathematical equations, including (10). At the break-even point, the safety limit rises, and

then the possibility of losses decreases, and the possibility of profits increases. In the case of the project under study, we find that the break-even point is expressed in absolute quantities amounting to 2352.8 tons, or 65.7% of the production capacity, which represents the number of the produced units, at which the project does not achieve profits nor losses. The break-even point, expressed in the selling price of the produced unit was 146,374 ID, at a rate of 71% of the planned price to sell, as the safety limit is 29%, which is the expected profit margin for each ton produced, and this gives a high margin of safety for the project that reduces the possibility of its loss. For the safety limit of the project, at which the profit area begins, is embodied in the difference between the expected use of the production capacity (100%) and the percentage of the exploited energy at the break-even point. We find that the utilization rate of the project energy at the break-even point is 65.7%, so the safety limit for the project production capacity is 29%.

Table 13. Break-even point indicators Conclusions and recommendations

Indicator	Value
Break-even point to the production amount	**23520.8 tons**
Break-even point as a percentage of total production	**65.7%**
Break-even point as selling price of the produced unit	**146372 ID**
Break-even point as a percentage of the selling price	**71%**
Safety limit of the production capacity	**34%**
Safety limit for the selling price	**29%**

Given the results of the research, it can be concluded that the production of green forage declined in general and achieved negative growth rates due to the scarcity of rain and low water levels. The growing rise in forage prices, affected the development of livestock negatively, in addition to the increase in demand for livestock products, made it is necessary to introduce technologies that contribute to increasing the efficiency of water use and saving resources, such as land, in addition to providing forage throughout the year. This research project came consistent with this technology. It is in line with sustainable development plans and the tendencies of the Food and Agriculture Organization (FAO); furthermore, its environmental feasibility has been proven, as it is considered an environmentally harmless project, but rather works to remove 1250 pollutants from the atmosphere during the year. The project of the green forage production using hydroponics technology is an economically feasible project with an economic return and works to allocate resources optimally. This project is not sensitive to changes in investment, operational costs, and output prices. It has a high safety limit that makes it not afraid of losses in addition to the possibility to increase its profits during its productive life. The cultured barley as a product falls within the blue ocean strategy, which in its dimensions transforms creative ideas into useful outputs whose institutions have a competitive advantage in finding a marketing space to obtain the largest share of demand. Accordingly, the research recommends the necessity of implementing such projects that save land, water, and fertilizers and provide green forage throughout the year. The government should provide financial support for the supply and establishment of these projects because projects like these require large capital; moreover, livestock owners need support because the demand for forage requests an implementation of an indicative program to demonstrate the advantages of hydroponics and green forage to breeders to increase the demand for it.

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