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Financial and Economic Feasibility Study for a Non-Traditional Feed Manufacturing Project in Fayoum Governorate, Egypt.

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The study aimed to optimize the utilization of agricultural waste in Egypt and propose the most economically and environmentally viable methods for its management. Specifically, it assessed the financial and economic feasibility of recycling wheat straw into non-traditional feed. The research employed descriptive and regression analysis (2010-2022) and sensitivity analysis (case study 2022).

Three financial scenarios were incorporated to test the project's resilience under market fluctuations: (1) a 10% increase in total costs, (2) a 10% decrease in total revenues, and (3) a combined scenario of both increased costs and decreased revenues. These scenarios aimed to evaluate the project's viability under potential economic risks.

The findings of the financial and economic feasibility study for the non-traditional feed manufacturing project in Fayoum Governorate revealed a cost-benefit ratio of approximately 1.3, indicating that every Egyptian pound invested generated a profit of 30 piasters. The project's internal rate of return (IRR) was estimated at 37.7%, confirming its economic feasibility. Sensitivity analysis demonstrated that a 10% increase in variable costs would reduce the IRR from 37.7% to approximately 32.7%. Similarly, a 10% decline in revenue would lower the IRR from 37.7% to about 27.8%. If both costs increased and revenues declined by 10%, the IRR would drop to 17.8%, making the project economically unfeasible.

The study recommends investing in non-traditional feed production, particularly utilizing wheat straw, as a crucial step to reducing the animal feed gap and mitigating associated risks. Additionally, it highlights the importance of establishing a specialized agricultural extension unit dedicated to supporting and promoting non-traditional feed production. Furthermore, the study emphasizes the need to encourage agricultural cooperatives to prioritize waste recycling initiatives and actively support these projects both financially and technically.

Keywords: Non-traditional feed; Financial and economic feasibility study; sensitivity analysis, wheat straw.

Introduction

The year-round availability of nutritionally rich and adequate forage is a critical prerequisite for realizing the full productive potential of livestock. In Egypt, livestock feeding during the winter season relies predominantly on Egyptian clover (Trifolium alexandrinum L.), which serves as the primary forage resource. Nevertheless, a significant forage deficit emerges during the summer months, underscoring the urgent need for alternative forage species capable of meeting the nutritional requirements of livestock during this critical period (Salama & Nawar, 2016). In response to this challenge, recent years have witnessed a growing interest in Egypt in utilizing agricultural waste as a viable solution, driven by both environmental imperatives and the need to adapt to ongoing agricultural and economic transformations. This trend reflects the strategic importance of integrating agricultural waste management into the broader framework of sustainable agricultural development. The considerable expansion in crop cultivation over recent decades has led to a marked increase in the volume of agricultural residues. Coupled with the increasing scarcity of natural and financial resources in agricultural production, these residues have gained significant economic and social value.

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From a resource-efficiency perspective, agricultural waste represents a potentially valuable input that, if left unutilized or mismanaged, constitutes a loss of resources that could otherwise be redirected toward productive purposes, particularly in supporting livestock feed systems during periods of forage scarcity. A critical issue emerges when the volume of waste generated exceeds the environment’s capacity to absorb it naturally and safely. This has intensified concerns about environmental degradation and health risks, especially for rural populations. For instance, the amount of wheat straw in Egypt averages about 8.516 million tons annually, accounting for approximately 38.8% of the total plant waste (21.924 million tons) during the period from 2010 to 2022.

Despite Egypt producing an estimated 35 million tons of agricultural waste annually, only about 11 million tons are effectively utilized, while a significant portion remains unprocessed or is incinerated—practices that contribute to environmental degradation and result in substantial economic losses (Elzaawely et al., 2017; Marzouk et al., 2023). The horizontal and vertical expansion of agricultural production largely drives this growing accumulation of waste. Of the total plant-based waste, only limited amounts are converted into organic fertilizer and animal feed, leaving approximately 12 million tons unused annually. Similarly, around 12 million tons of animal waste are produced annually, yet nearly 9 million tons are discarded without recovery or reuse (Abdelraouf et al., 2024). In this context, the transformation of agricultural waste into non-traditional feed offers a promising strategy to enhance resource efficiency and promote environmental sustainability.

Numerous studies highlight the potential of agricultural residues, such as rice straw, sugarcane bagasse, and husks, as nutrient-rich materials suitable for animal feed production (Abdulwahab, 2023). These materials demonstrate good digestibility and protein content, offering a viable alternative to conventional feed sources. Additionally, advanced processing techniques have been developed to enhance their nutritional value, producing functional protein concentrates that support animal health (Abdulwahab, 2023) .

Bioconversion technologies, including composting and biogas production, further reinforce the viability of using agricultural waste in sustainable agriculture (Elfeki et al., 2017). These methods provide alternative energy sources and contribute to soil fertility, aligning with global trends toward circular and sustainable agricultural systems.

From a practical standpoint, feed manufacturers in Egypt can adopt low-cost, simple processing techniques to integrate these alternative materials into existing formulations. This reduces the need for significant capital investment and facilitates broader adoption across the livestock sector (Chandra et al., 2012). The growing demand for poultry and sheep feed in local and global markets also underscores the economic potential of non-traditional feed products (Aziz, 2012). Given these opportunities, conducting a financial and economic feasibility study for a non-traditional feed manufacturing project, such as one proposed in Fayoum Governorate, becomes essential. Such a study should evaluate financial, technical, and market aspects comprehensively. It should also consider project costs, potential revenues, return on investment (ROI), and risk factors (Jabar & Jassim, 2023; Jabbar & Awad, 2021; Al-Khaqani, 2018; Al-Hamdani & Al-Hamid, 2018; Al-Tamimi & Makki, 2022; Ali, 2014).

However, obstacles remain, particularly farmers' limited technical knowledge of feed production methods. This highlights the need for training programs and awareness campaigns to support technology adoption (Sadkhan, 2018). Additionally, government support and financial allocations are critical for project implementation and long-term success (Aziz, 2012).

In conclusion, the integration of agricultural waste into non-traditional feed production represents a strategic opportunity for Egypt. It can enhance environmental sustainability, reduce economic waste, and contribute to the resilience of the agricultural and livestock sectors. A well-designed feasibility study is essential to guide investment decisions and ensure project viability and sustainability.

Research problem

Egypt suffers from a shortage of animal feed despite the abundance of agricultural waste. Consequently, the country imports large quantities annually to bridge the feed gap, which negatively affects the country’s foreign currency reserves due to rising costs resulting from the successive floating policies of the pound and the increase in customs duties. It is noted that available feed supplies fall short of livestock requirements, and the deficit in the feed budget tends to increase year after year, leading to a decrease in the animal protein per capita in Egypt compared to the global average. In addition, the weak role and contribution of agricultural cooperative societies and agricultural extension in manufacturing non-traditional feed remain evident.

Research objective

The study aims to maximize the benefit from Egyptian agricultural waste and suggest the best economic and environmental methods to deal with these wastes, which lead to an increase in national agricultural income and achieving sustainable agricultural development. This is done by estimating the net present value, return on costs, and internal rate of return for projects to produce non-traditional fodder from wheat straw. The research also aims to show the role of the recycling process in employing new workers and increasing incomes, and the added value of the raw product.

Previous studies

Al-Ashmawy (2003) indicated in his study of Dakahlia Governorate that the feed containing rice straw treated with ammonia is the best feed used in the production of milk and meat, as it achieved an increase in the value added to the farms by about 94% for dairy buffaloes, 100% for dairy cows, 94.5 % for fattening cattle. This is a result of a decrease in the cost of feeding by 38.4%-44% for fattening cattle and dairy buffaloes, in addition to an increase in milk and meat production. The study also concluded that these results could be generalized across the Republic, and recommended the use of rice straw treated with ammonia in Lower Egypt regions and the use of corn stalk silage in the rest of the Republic regions.

The results of the study conducted by Noha Khudair (2006) showed that agricultural cooperatives play a major role in educating farmers on how to benefit from plant waste, as they contribute fundamentally to encouraging farmers, especially small farmers, to benefit from plant waste in an economical and environmentally beneficial ways. It also provides some automated agricultural equipment for recycling operations, such as mills, presses, pallets, scales, etc., in addition to providing production requirements with soft and subsidized loans.

Rabab Al-Khatib’s study (2010) aimed to maximize the benefit from Egyptian plant waste and suggest the best economic and environmental methods to deal with these wastes. The study showed that the average value of plant waste for the period (1994-2007) amounted about 2.423 billion pounds, representing about 2.86% of the national agricultural income, which amounted about 8.577 billion pounds. The value of these wastes also represented about 4.65% of the value of plant output, which amounted about 51.646 billion pounds during this period. The results also indicate that there are many problems facing farmers, the most important of which is the difficulty in marketing plant waste and also the lack of benefit from it due to the lack of recycling machines and technologies, and the lack of awareness among farmers about how to benefit from plant waste.

Essam Al-Mihy’s study (2023) showed that farmers in the field sample recycle agricultural waste to produce unconventional feed treated with urea. The study found that producing one ton of urea-treated wheat straw costs approximately 1,170 pounds. The average cost of producing a ton of wheat straw treated with urea and stimulant with cumin is about 1220 pounds. It was also found that the cost of producing one ton of silage using cobs is 357.5 pounds. The cost of producing a ton of organic fertilizer from recycling agricultural waste was about 234 pounds. The most important recommendations of the study for agricultural economic policy makers in this field are summarized as follows:

1 -Activating and creating laws and rules that govern the granting of concessions for waste recycling and environmental preservation, as well as imposing penalties to reduce their negative effects.
2 -Providing capabilities and equipment for recycling agricultural waste in Qalyubia Governorate by activating the role of the productive cooperative sector, or by assigning it to agricultural cooperative societies, or through soft loans to young graduates as job opportunities (removing all financing problems).
3 -Activating the role of agricultural extension in training on recycling agricultural waste in extension fields, and raising awareness about the use of organic fertilizers as an alternative to chemical fertilizers that are harmful to the environment and humans.
4 -Activating the state’s role in facilitating the establishment of a number of factories for recycling and treating waste, and manufacturing organic and unconventional fertilizers instead of chemical fertilizers.

Methodology

The study used descriptive and quantitative statistical analysis, along with general trend equations, to assess the economic importance of plant waste, including wheat straw, also to study the economic feasibility of recycling agricultural waste. The study relied on secondary published and unpublished data from the Ministry of Agriculture and Land Reclamation, as well as statistical records from the Directorate of Agriculture in Fayoum Governorate. It also relied on field study data in the Youssef Al-Siddiq and Tamiya Centers in the Governorate through a questionnaire for the agricultural season 2022/2023. Different analytical techniques were used to achieve the stated objectives: descriptive, regression analysis, and financial metrics sensitivity analysis.

Results and discussion

This section presents the results derived from the financial and economic feasibility study of a non-traditional feed manufacturing project in Fayoum Governorate during the period from 2010 to 2022. The analysis included key financial indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period, in addition to a detailed assessment of costs, revenues, and profitability. The results demonstrate the economic viability of the project, highlighting the impact of various variables on its financial performance.

1 -Agricultural plant waste in Egypt

Table 1 shows the trend equations for the quantity of agricultural plant waste, wheat straw, in both Egypt and Fayoum Governorate during the period (2010-2022). It is clear from equation 1 that there is a significant annual increase in the amount of waste estimated at about 185.5 thousand tons, representing about 0.85% of the average amount of plant waste/annum, which was about 21.92 million tons. Moreover, the R2 value of 0.67 indicates that 67% of the waste changes are due to time.

2- Trends of wheat straw in Egypt and Fayoum Governorate(2022-2010)

Table 1 presents the general trend equations for the quantity of plant wastes and wheat straw in Egypt, as well as in Fayoum Governorate, during the period (2010–2022). According to Equation 1 in the table, the quantity of plant waste in Egypt has shown a statistically significant increase over time. The average quantity during the study period reached approximately 21.924 million tons. The same equation shows that the coefficient of determination (R^2) is 0.67, indicating that 67% of the increase in plant residues can be attributed to the time factor . In a related context, Equation 2 analyzes the general time trend of wheat straw in Egypt, which reveals a statistically significant decreasing trend during the period (2010–2022). The annual decline is estimated at 99.7 thousand tons, representing approximately -1.4% of the average wheat straw quantity, which is 8.515 million tons.

At the level of Fayoum Governorate (Equation 3), there is a statistically significant annual increase estimated at 7.9 thousand tons. The annual rate of change in the quantity of straw in Fayoum is estimated at 1.4%, equivalent to approximately 0.568 million tons. The coefficient of determination (R^2) is about 0.49, indicating that 49% of the variation in straw quantities can be attributed to the time factor during the period (2010–2022). The result suggests that the quantity of wheat straw in Fayoum Governorate has increased despite its decline at the national level, which reflects an expansion in the area cultivated with wheat in the governorate.

Table 1. General trend equations for plant residues and wheat straw during the period (2010-2022).

Variable (thousand tons)	No.	Equation	T-value	Average (Million Tons)	R^2	Annual Change Rate (%)
Quantity of plant waste	1	$\hat{Y} = 20626.2 + 185.5X_n$	(4.7)**	924.21	0.67	0.85
Quantity of wheat straw in Egypt	2	$\hat{Y} = 9213.7 - 99.7X_n$	(-3.3)**	515.8	0.50	1.4-
The quantity of wheat straw in Fayoum	3	$\hat{Y} = 512.7 + 7.9X_n$	(3.3)**	5680.	0.49	1.4

**: Refer to significance at 0.01

The value of R^2 ranges between (0: 1)

Source: collected and estimated from the Table (1) In the Appendix,

The Technical study of the project:

1. Non-traditional feed: It is a biological conversion process of cellulose compounds by cultivating certain fungi on agricultural residues such as wheat straw, rice husks, or sawdust to improve their nutritional value, increase their digestibility, and enhance their protein content. Additionally, fungi can build fungal protein, thereby contributing to increasing the protein content of plant residues. This helps to compensate for a large part of the deficiency in roughage feed resources used in animal feed production, with feed between the die and the roller to form the final feed shapes and sizes.

The path of mixed feed through the press components:

• The feed is transported to the mixer, and the amount of feed inside the mixer and the press energy are adjusted by changing the speed of the feed motor.

• The feed is cooked by mixing it with steam (liquids and oils can be added).

• The cooked feed is then moved to the press, where it is compressed between the rollers and the die, emerging from the die holes in various shapes.

• The pressing process ensures high-quality pellets by balancing heat, moisture, and pressure.

• The feed is cooked by adding 2-6% moisture to the mixture at a temperature of 60-90 degrees, with a cooking time ranging from several seconds to 20 minutes or more. This process leads to the gelatinization of the starch (10-12%) and in the raw materials (25%), and in the mixer to about 40% after the pressing process, which is the reason for the cohesion of the feed pellets, and partial digestion of the fibers and proteins occurs.

• Moisture and high heat are removed from the pellets (equivalent to the moisture content of the feed, the sum of the moisture content of the raw materials), and this is where the cooling unit comes into play, as it must cool the feed to approximately the ambient temperature without drying it.

Benefits of the Pressing Process

• **For feed quality**: Pressing reduces transportation costs, minimizes the formation of fines and dust, and prevents the separation of components in the feed, unlike mixed feed.

• For animal performance: It increases nutrient intake due to the reduced feed volume (increased density), improves digestibility through partial feed digestion, enhances feed conversion rate, minimizes feed wastage, facilitates the addition of concentrates and medicines to the feed, eliminates bacteria and fungi through heat, and reduces the excretion of nutrients in manure.

3. Storage in the feed factory: The storage capacity of raw materials, enough for a month's consumption, generally allows the feed factory to continue operating even if there is a temporary halt in the supply of raw feed materials due to unforeseen circumstances. Many feed factories aim to store raw materials sufficient for 14 days of consumption, with the final decision depending on confidence in the sources of raw material supply and the ease of access to the feed factory.

4. Description of project elements:

A- Project Investment Costs:

Table 2 shows the investment costs of the project according to the agreed-upon items.

proportions ranging from 30% to 50% in integrated animal feeds. (Goodman, 2020)

2- **The function of the feed factory** is to produce complete feed mixtures that provide the nutritional needs of the animals. Each feed is designed to provide specific nutritional requirements. This usually results in lower cost or a lower price per unit weight of the resulting feed. Additional activities required for feed manufacturing include nutrition specialists (preparing suitable formulations) and chemical analysts (analyzing raw materials and final feeds). The mill uses four ingredients: wheat bran (the subject of the study), corn gluten feed, yellow corn, and soybean meal or soybean hulls.

Section A: The blending section starts with the reception and external storage of raw materials in silos, and the extraction of materials to the grinding section and internal storage in the designated tanks (bunkers), which supply the mixers with ingredients according to their weights, as well as the mixing equipment, conveyors, and mixer discharge tanks. In small and medium feed mills that produce 1-10 tons per hour, some parts of this section are manually operated, while others are operated through a limited control panel. The number, capacity, horizontal and vertical arrangement of these tanks vary according to the plant installation system, operating capacity, and the feed materials required for manufacturing the desired feed, as well as the extraction process (a 2-ton per hour feed mill requires a 7-ton capacity tank). Precise nutritional components are prepared and added to the mixture in small quantities, typically measured in grams per ton, with the appropriate dispersion level set at 127 parts per million (the minimum quantity that can be mixed is 127 grams per ton). It is important to ensure the accuracy of the periodic weighing of the materials to be mixed, as well as the specified time for mixing. The mixers used in feed mills include three types: horizontal, vertical, and continuous, with horizontal and vertical mixers being the most commonly used. Gradual solubility urea is used as a safe and effective alternative to compensate for the recent significant increase in the price of soybean meal in the rations for cattle and fattening, to provide nutritional and economic value for the livestock, while improving the health of the herd and increasing economic returns.

B. pressing process: It is a process of increasing the density of the mixed feed by pressure, heat, and moisture and converting it into different forms. The pressing machine consists of 3 parts: the feeder, mixer, and pelleting machine. The feeder transfers the mixed feed into the mixer. The mixer is a cylinder with a rotating shaft, mixes the feed with the dried steam and forwards it to the pelleting machine. The pelleting machine compresses the

Table 2. Costs of a non-traditional animal feed factory project in 2022.

Investment Costs	**Value (thousand pounds)**
Assets	**-**
Project buildings	**1100**
Administrative building equipment	**400**
Grinding and Mixing Units	**320**
Semi-automatic pressing machines	**310**
The kettle	**85**
Radiator	**50**
Packing machine	**65**
Store	**250**
Total assets	**2580**
Working capital/month	**853**
Establishment, advertising expenses	**43**
Total	**3476**

Source: Collected and calculated from the questionnaire form at the Tamiya Center in Fayoum Governorate, 2022.

workers X 3000 pounds X 12 months) + manager (1 X 5000 pounds/month X 12 months) = 312 thousand pounds. In addition to, temporary labor (18 workers * 90 days * 100 pounds) = 162 thousand pounds.

D- Other Expenses (Average): Electricity (42 thousand pounds/first year), Water (20.4 thousand pounds/first year), Rental of Feed Transport Vehicles (8 transports X 400-500 pounds X 40 transport) at the buyer's expense.

Raw Materials Used and Their Costs by Type

A- Total Percentage of Components in Hay Fodder:

Wheat Straw (25%), Bran (15%), Yellow Corn (35%), Soybean Husks (12%), Molasses (5%), Limestone (1.5%), Urea (2%), Salt (0.5%), Minerals, Vitamins, and Toxins (4%).

B- Automated work: Machines work an average of 10 hours per day.

C- Human Labor: Permanent annual labor (7

Table 3. Depreciation, Scrap Values, Consumed Values, and Remaining Values in Thousands of Pounds of Project Assets.

Assets	**Value**	**Age in**	**Scrap**	**Acting**	**Average**	**Used**	**remaining(**)**
Project buildings	1100	20	275	825	41.3	412.5	412.5
Administrative building	400	15	80	320	21.3	213.3	106.7
Grinding and Mixing	320	15	64	256	17.1	170.7	85.3
Semi-automatic	310	15	62	248	16.5	165.3	82.7
The kettle	85	15	17	4.5	4.5	45.3	22.7
Radiator	50	10	10	40	4	40	0
Packing machine	65	10	13	52	5.2	52	0
Store	250	20	50	200	10	100	100
Total	2580	-	571	2009	119.9	1199.2	809.8

(*) The scrap value and the remaining value are added to the revenues of the last year of the project because they were not used, and the working capital is also added.

Remaining: The remainder of the investment assets at the end of the project period

Value of assets – used = Remaining

Scrap = ((Investment costs * 10/100) - Investment costs) / Project duration

Source: Collected and calculated from data in Table 2.

Table 4. Variable costs for full operation from the first year of the project in 2022.

Items	Quantity (tons)	Value (thousand pounds)
Estimated land rent	-	60
Hay	206	206
bran	124	432
yellow corn	289	3465
Seed and peel soybeans	99	594
Molasses	41	820
Urea	17	340
Limestone	12	240
Old salt	4	40
Minerals, vitamins, and anti-toxins	33	1450
Bags and packaging supplies	-	200
Project operational management fees	-	474
Value of electricity and water consumption	-	62.4
Annual depreciation	-	120
Annual maintenance from the second year (5% of the asset value)* and spare parts	-	27
Total	-	8530,4

(*) Maintenance value (pounds) = 5% of the value of fixed assets, including machinery, equipment, and buildings, divided over 9 years from the second year.
Source: Collected and calculated from the questionnaire form at the Tamiya Center - Fayoum Governorate, 2022.

3. Investment costs: They amount to about 3.476 million pounds, which are the costs of assets purchased in year zero, working capital (one month), advertising and establishment expenses, and incidental expenses.

4. Annual operating costs: amounting to about 8.53 million pounds, which is the land rent, labor and management wages, and production inputs such as hay, yellow corn, bran, soybean shells or meal, molasses, urea, calcium, salt, vitamins, minerals, and antitoxins.

5. Total revenues: their value at the beginning of the project is about 13.05 million pounds.

4. Annual production of non-traditional feed: 900 tons, price of a ton of feed: 12.500 pounds for the first year (value of feed and waste = 11.250 + 1.800 = 13.050 million pounds).

Financial feasibility study for wheat straw in Fayoum Governorate:

1. Discount rate: was assumed to be 17% (the average interest rate on bank deposits), to analyze the research sample data based on the arithmetic average values of the farm's revenues and costs.

2. The project's useful lifespan: 10 years was assumed

Table 5. Total costs and revenues during the project years.

Year	cost (*)	Revenues (*)	35%	Adjusted Costs	Adjusted Revenue	Net	40%	Adjusted Costs	Adjusted Revenue	Net
0	3476	0	1	3476	0	3476-	1	3476	0	3476-
1	53.8	13050	0.741	6321	9670.1	3349	0,714	6090.7	9317.7	3227
2	53.8	13050	0.549	4683.2	7164.5	2481.2	0,51	4350.6	6655.5	2304.9
3	53.8	13050	0.406	3463.4	5298.3	1834.9	0,364	3105.1	4750.2	1645.1
4	438.9	13050	0.301	2824.5	3928.1	1103.6	0,26	2439.8	3393	953.2
5	438.9	13050	0.223	2092.6	2910.2	817.6	0,186	1745.4	2427.3	681.9
6	438.9	14355	0.165	1548.3	2368.6	820.3	0,133	1248	1909.2	661.2
7	32.10	14355	0.122	1259.3	1751.3	492	0,095	980.6	1363.7	383.1
8	32.10	14355	0.091	939.3	1306.3	367	0,068	701.9	976.1	274.2
9	32.10	14355	0.067	691.6	961.8	270.2	0,048	495.5	689	193.6
10	35.11	15283.8	0.05	567.7	764.2	196.5	0,035	397.4	534.9	137.5
total	539.99	137953.8	-	27867	36123.2	8256.2	-	25030.9	32017	6985.8

(*) Annual costs were increased by 10% every 3 years, and annual revenues were increased by 10% after 5 years as a security measure for **the** study.
(***) Working capital, scrap, and residual value were added to the revenues of the last year.
Source: calculated by the authors from the collected primary data (Tables 2 and 3).

First: In the normal state of the project (assuming that no changes occur)

1. The net present value of the project: estimated at about 8.256 million pounds.

2. The return on costs ratio: It is about 1.3, meaning that the profit from the pound is 30 piasters (30%), which is higher than the bank interest for the study period, which was 17%.

3. The project's internal rate of return: It is estimated at about 37.7%, which is higher than the current bank interest of 17%. This indicates that the project is financially feasible.

Second: Sensitivity analysis of the project (assuming changes in costs and revenues in the market)

Tables (6,7, and 8) show sensitivity analysis of changes in revenues and costs

Scenario 1: costs increased by 10%, and revenue unchanged. It is clear from Table 6 that

a. Net revenues decrease from 8,256 million pounds to 7,032 million pounds.

B. The revenue-to-costs ratio decreases from about 1.3 to 1.21, but remains more than one.

C. The internal rate of return decreases from 37.7 to 32.7, which is still higher than 17%.

Table 6. Total costs increase by 10% with total revenues remaining constant during the project years.

Year	cost*	Revenues*	30%	Adjusted Costs	Adjusted Revenue	Net	35%	Adjusted Costs	Adjusted Revenue	Net
0	3476	0	1	3476	0	3476-	1	3476	0	3476-
1	9383.7	13050	0.769	7215.9	10035.5	2819.5	0.741	6953.2	9670.1	2716.8
2	9383.7	13050	0.592	5555.1	7725.6	2170.5	0.549	5151.6	7164.5	2012.9
3	9383.7	13050	0.455	4269.5	5937.8	1668.2	0.406	3809.7	5298.3	1488.6
4	10322.1	13050	0.35	3612.7	4567.5	954.8	0.301	3106.9	3928.1	821.1
5	10322.1	13050	0.269	2776.6	3510.5	733.8	0.223	2301.8	2910.2	608.3
6	10322.1	14355	0.207	2136.7	2971.5	834.8	0.165	1703.1	2368.6	665.4
7	11354.3	14355	0.159	1805.3	2282.4	477.1	0.122	1385.2	1751.3	366.1
8	11354.3	14355	0.122	1385.2	1751.3	366.1	0.091	1033.2	1306.3	273.1
9	11354.3	14355	0.094	1967.3	1349.4	282.1	0.067	760.7	961.8	201
10	12489.7	15283.8	0.072	899.3	1100.4	201.2	0.05	624.5	764.2	139.7
total	99539.1	109145.5	-	34199.7	41231.8	7032.11	-	30306.1	36123.2	5817.1

Source: Collected and calculated from data in Table 5.

B. The ratio of revenues to costs decreases from about 1.3 to 1.20.

C. The internal rate of return decreases from 37.7 to 27.8, still higher than 17%.

Scenario 2: **revenues decrease by 10% while costs remain unchanged:**

a. Net revenues decrease from 8.256 million pounds to 7.078 million pounds.

Table 7. Total revenues decrease by 10% while total costs remain constant during the years of the project.

Year	cost (*)	Revenues (*)	15%	Adjusted Costs	Adjusted Revenue	Net	20%	Adjusted Costs	Adjusted Revenue	Net
0	3476	0	1	3476	0	3476-	1	3476	0	3476-
1	8530.5	11745	0.87	8163.8	10218.2	2054.3	0.833	7816.6	9783.6	1967.0
2	8530.5	11745	0.756	7094.1	8879.2	1785.1	0.694	6512.3	8151.0	1638.7
3	8530.5	11745	0.657	6165.1	7716.5	1551.4	0.579	5433.2	6800.4	1367.2
4	9383.7	11745	0.572	5904.2	6718.1	813.9	0.482	4975.3	5661.1	685.8
5	9383.7	11745	0.497	5130.1	5837.3	707.2	0.402	4149.5	4721.5	572.0
6	9383.7	12919.5	0.432	4459.1	5581.2	1122.1	0.335	3457.9	4328.0	870.1
7	10322.1	12919.5	0.376	4269.2	4857.7	588.5	0.279	3167.8	3604.5	436.7
8	10322.1	12919.5	0.327	3712.9	4224.7	511.8	0.233	2645.6	3010.2	364.7
9	10322.1	12919.5	0.284	3224.6	3669.1	444.5	0.194	2202.7	2506.4	303.6
10	11354.3	13978.8	0.247	3085.0	3452.8	367.8	0.161	2010.8	2250.6	239.7
total	99539.1	124381.8	-	54684.1	61154.8	6470.7	-	45847.7	50817.3	4969.6

Source: calculated by the authors from collected data in Table 5.

B. The revenues/costs ratio decreases from about 1.3 to 1.12, still remaining more than one.

C. The internal rate of return decreases from 37.7 to 17.8. which is more than 17%.

Scenario 3: Combined 10% cost increase and revenues decline:

a. Net revenues decrease from 8.256 million pounds to 4.697 million pounds, still profitable.

Table 8. Increase in total costs and decrease in total revenues by 10% during the years of the project

Year	cost (*)	Revenues (*)	15%	Adjusted Costs	Adjusted Revenue	Net	20%	Adjusted Costs	Adjusted Revenue	Net
0	3476	0	1	3476	0	3476-	1	3476	0	3476-
1	9383.7	11745	0.87	8163.8	10218.2	2054.3	0.833	7816.6	9783.6	1967.0
2	9383.7	11745	0.756	7094.1	8879.2	1785.1	0.694	6512.3	8151.0	1638.7
3	9383.7	11745	0.657	6165.1	7716.5	1551.4	0.579	5433.2	6800.4	1367.2
4	10322.1	11745	0.572	5904.2	6718.1	813.9	0.482	4975.3	5661.1	685.8
5	10322.1	11745	0.497	5130.1	5837.3	707.2	0.402	4149.5	4721.5	572.0
6	10322.1	12919.5	0.432	4459.1	5581.2	1122.1	0.335	3457.9	4328.0	870.1
7	11354.3	12919.5	0.376	4269.2	4857.7	588.5	0.279	3167.8	3604.5	436.7
8	11354.3	12919.5	0.327	3712.9	4224.7	511.8	0.233	2645.6	3010.2	364.7
9	11354.3	12919.5	0.284	3224.6	3669.1	444.5	0.194	2202.7	2506.4	303.6
10	12489.7	13978.8	0.247	3085.0	3452.8	367.8	0.161	2010.8	2250.6	239.7
total	99539.1	124381.8	-	54684.1	61154.8	6470.7	-	45847.7	50817.3	4969.6

4. **Delaying the project for one year**: the net amount is 305.3 thousand pounds, i.e. twice the feasibility of the project.

5. Delaying project implementation for a period of one or two years: When delaying one year, the rate will decrease to 14.6%, while this rate reaches 11.5% in two years (any delay in project implementation has a significant impact on its feasibility).

The financial and economic feasibility study for non-traditional feed manufacturing in Fayoum Governorate highlights a promising opportunity for investment, particularly for young graduate entrepreneurs and investors. With a cost-benefit ratio of 1.3 and an internal rate of return (IRR) of 37.7%, the project demonstrates strong economic viability. However, sensitivity analysis indicates that a 10% increase in costs or a 10% decline in revenue could significantly affect profitability, emphasizing the need for effective risk management and support mechanisms.

The Role of Agricultural Extension in Supporting Non-Traditional Feed Production

Agricultural extension services play a crucial role in maximizing the benefits of such feasibility studies by facilitating knowledge transfer and promoting the adoption of innovative feed manufacturing practices. Historically, Egypt's centralized extension system has struggled to meet the diverse needs of farmers, but recent reforms advocate for a more participatory approach, particularly in supporting sustainable agribusiness initiatives (McDonough et al., 2014; Nawar et al., 2019). For young graduate investors, agricultural extension can provide essential training on feed production techniques, business planning, and market access. The integration of mobile-based extension services further enhances their ability to make informed decisions, offering real-time data on feed formulation, pricing, and industry best practices (Kassem et al., 2019). This digital approach aligns with broader national strategies aimed at improving food security and sustainability (Tran et al., 2022). Furthermore, customized feasibility studies tailored for small-scale farmers can help them optimize their production processes and reduce costs, ensuring wider adoption of non-traditional feed manufacturing. By strengthening the linkage between feasibility studies and extension services, Egypt can enhance entrepreneurial opportunities for young graduates while empowering small-scale farmers to contribute to a more sustainable agricultural sector.

Conclusion

Egypt faces a significant shortage of animal feed despite the availability of substantial agricultural waste, necessitating large-scale imports to bridge the feed gap. This dependency has driven up feed prices, leading to a decline in animal protein supply due to increased production costs. To address this issue, converting agricultural waste, such as wheat straw, into a sustainable, non-traditional feed source presents a viable alternative. With an estimated 8.52 million tons of wheat straw available annually, accounting for 38.8% of total plant waste, this resource holds significant potential for economic and environmental benefits.

The study assessed the financial and economic feasibility of producing non-traditional feed from wheat straw, demonstrating strong profitability and sustainability. The project's cost-return ratio of 1.3 indicates that every invested pound generates a profit of 30 piasters, with a net present value of approximately 8.256 million pounds. Moreover, the internal rate of return (IRR) of 37.7% surpasses the bank interest rate of 17%, confirming the project's viability. However, sensitivity analysis reveals potential risks: a 10% increase in costs reduces the IRR to 32.7%, while a 10% decrease in revenue lowers it to 27.8%. A combined 10% rise in costs and reduction in revenue would render the project unfeasible, with an IRR of 17.8%. Additionally, project delays significantly impact feasibility, as a one-year delay reduces the IRR to 14.6%, and a two-year delay further decreases it to 11.5%.

In summary, wheat straw for non-traditional feed production offers a promising solution to Egypt's feed shortage, enhancing national agricultural income and promoting sustainable development. Agricultural extension plays a crucial role in facilitating the adoption of this innovative approach by providing farmers and young entrepreneurs with the necessary knowledge, technical training, and economic guidance. Through participatory extension programs, farmers can better understand feed formulation techniques, cost-benefit analysis, and market opportunities, ensuring wider adoption and long-term success. Moreover, digital extension services can further enhance outreach by offering real-time information on feed production best practices and risk management strategies. However, proactive risk management, effective extension interventions, and timely project implementation are essential to maintaining economic feasibility and maximizing the project's potential benefits.

Recommendations:

- Investing in non-traditional feed production, particularly wheat straw, is essential in reducing the animal feed gap and mitigating associated risks.
- Establishing a specialized agricultural extension unit dedicated to promoting and supporting non-traditional feed production.
- Encouraging agricultural cooperatives to prioritize waste recycling initiatives and actively support these projects both financially and technically.

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دراسة الجدوى المالية والاقتصادية لمشروع تصنيع أعلاف غير تقليدية في محافظة الفيوم، مصر

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هدفت الدراسة إلى تحسين استغلال المخلفات الزراعية في مصر، مع التركيز على تقييم الجدوى المالية والاقتصادية لإعادة تدوير قش القمح وتحويله إلى أعلاف غير تقليدية. استخدمت الدراسة التحليل الوصفي والانحداري للفترة من 2010 إلى 2022، بالإضافة إلى تحليل الحساسية لدراسة حالة عام 2022.

تم اختبار ثلاثة سيناريوهات مالية لقياس مرونة المشروع في مواجهة تقلبات السوق:

1- زيادة إجمالية في التكاليف بنسبة 10%.

2- انخفاض إجمالي في الإيرادات بنسبة 10%.

3- سيناريو مزدوج يجمع بين زيادة التكاليف وانخفاض الإيرادات بنسبة 10%.

أظهرت نتائج الدراسة أن نسبة المنافع إلى التكاليف بلغت حوالي 1.3، مما يشير إلى أن كل جنيه يُستثمر يحقق ربحًا قدره 30 قرشًا. كما قُدرت نسبة العائد الداخلي (IRR) للمشروع بنحو 37.7%، مما يؤكد جدواه الاقتصادية. وبيّن تحليل الحساسية أن زيادة التكاليف المتغيرة بنسبة 10% تؤدي إلى انخفاض معدل العائد الداخلي إلى حوالي 32.7%، بينما يؤدي انخفاض الإيرادات بنسبة 10% إلى تراجع العائد الداخلي إلى نحو 27.8%. أما في حالة تزامن زيادة التكاليف وانخفاض الإيرادات بنسبة 10%، فإن معدل العائد الداخلي ينخفض إلى 17.8%، مما يجعل المشروع غير مجدٍ اقتصاديًا.

توصي الدراسة بالاستثمار في إنتاج الأعلاف غير التقليدية، خاصة باستخدام قش القمح، كخطوة ضرورية لسد الفجوة في الأعلاف الحيوانية والحد من المخاطر المرتبطة بها. كما تؤكد على أهمية إنشاء وحدة إرشاد زراعي متخصصة لدعم وتعزيز إنتاج الأعلاف غير التقليدية، وتشجع على تفعيل دور التعاونيات الزراعية في إعطاء أولوية لمبادرات تدوير المخلفات ودعم هذه المشاريع ماليًا وفنيًا.

الكلمات المفتاحية :الأعلاف غير التقليدية؛ دراسة الجدوى المالية والاقتصادية؛ تحليل الحساسية؛ قش القمح.

Appendix

Appendix No. (1) Quantity of plant waste and wheat straw in Egypt and Fayoum Governorate (2010-2022).

Year	Plant waste	wheat straw In Egypt (million tons)	wheat straw in Fayoum (thousand tons)
2010	20.299	37.8	495.6
2011	20.49	66.8	489.9
2012	21.44	22.9	524.4
2013	21.92	11.9	576
2014	22.06	24.9	628.2
2015	21.79	91.8	591
2016	22.83	29.8	554.1
2017	21.86	83.7	578.7
2018	21.799	81.7	567.9
2019	21.62	97.7	556.8
2020	22.75	22.8	591
2021	22.97	16.8	608.1
2022	23.195	10.8	625.2
Average		8.52	586