Technical Report

DEVELOPMENT OF SUSTAINABLE DATE PALM PRODUCTION SYSTEMS IN THE GCC COUNTRIES OF THE ARABIAN PENINSULA

Improving Date Palm Production in the Sultanate of Oman

Economic Evaluation of a Polycarbonate Drying House for Date Palm Products

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October 2016

1. Scope of the study

The present study is prepared within the framework of the **Development of Sustainable Date Palm Production Systems in Gulf Cooperation Council Countries** project. This research and development project aims to produce new knowledge and practices to improve date palm production systems in the Gulf region. The main activities of the project include improving the productivity of cultivars, managing natural resources (land and water) for optimal performance, optimizing the use of different inputs in the cropping process (fertilizers, pollinators, wastewater, etc.), and studying the genetic diversity of date palms. The transfer of technology and experience between partners is an integral part of the project.

One promising technology introduced through the project is the polycarbonate drying house. This technology is considered to be one of the most attractive and promising applications of solar energy systems in the Cooperation Council for the Arab States of the Gulf (GCC) countries. The aim is to improve the quality of dried dates, accelerate their drying process, and obtain cleaner fruits that are free from dust. This technology reduces the cost of labor and time required, while improving the quality of the fruits. This technical report focuses on an economic assessment of the technology in the Sultanate of Oman and presents a rigorous economic analysis of the return on investment in the technology.

2. Performance analysis and economic evaluation of polycarbonate drying houses for date palm products

2.1. Data collection

Data was collected from two investors/farmers in the Sultanate of Oman with two different polycarbonate drying houses. The data were collected using rapid rural appraisal surveys with a direct interview method conducted at the same time as the survey. The information collected covered the capital cost, capacity of dryer, maintenance costs, life of dryer, amount of subsidy received, and some technical information related to the condition of the fresh and dried dates. The data was used to assess and evaluate the economic significance of the polycarbonate dryer using the payback period method.

2.2. Methodological framework

An economic analysis of the polycarbonate drying house can be performed using three methods, namely annualized cost, lifecycle saving, and payback period (PBP) (Nayak *et al.,* 2012). The annualized cost method allows comparison of the cost of drying per unit weight of the product using different drying techniques, such as solar or electric heaters. The annualized drying cost of a solar dryer remains almost constant over the entire life of the system. The lifecycle savings method determines the savings made in the future years to determine whether the present investment is worth the annual savings over the life of the system. The payback period method gives the investment's return period. This last indicator helps to determine the acceptability of the technology.

Given that the objective of the project is to enhance the adoption of such technology, the PBP was used in this report. The main disadvantage of using the PBP as an investment assessment technique is that it does not take account of the overall profitability of the investment. It takes account of cumulative net cash flows only up to the point where they become positive. Any net cash flows after that point are ignored. For this reason, in this analysis we use PBP in conjunction with the net present value (NPV) and the internal rate of return (IRR). The aim is to provide a clear picture for the end user (farmer, private sector, government, etc.) of the expected investment period for this drying house, and hence, its acceptability.

2.3. Empirical analysis

A Analysis criteria

As mentioned in the previous section, three indicators were used to evaluate the profitability of the polycarbonate drying house: NPV, IRR, and PBP. These are explained in more detail below.

Net present value (NPV) Net present value is simply the sum of the annual discounted net cash surpluses and deficits throughout the life of the project (polycarbonate drying house). If the NPV is positive (i.e. NPV is greater than zero), the investment is normally considered profitable.

Internal rate of return (IRR) Internal rate of return is the discount rate at which the NPV equals zero.

Payback period (PBP) Payback period is the minimum length of time required for the investment to break even. It is the minimum number of years required for the undiscounted cumulative net cash flow to become positive.

Assumptions

Costs and returns Costs and returns are presented in "real" and not "nominal" values. Inflation was not considered. That is, all currency (OMR) amounts in all years are considered to have the same purchasing power and be directly comparable.

Given that our data is based on the information provided by the two farmers, for the cost items, we considered that production of fresh dates represents 65% of the total revenue. The estimation of the returns, from the data collected from Farmer 1, takes into consideration two categories of products and prices (it was assumed that, after drying, 75% of the dates were good quality and consequently could attain a selling price of approximately 1.2 OMR/kg and the remaining 25% of lower quality could attain a price of 0.8 OMR/kg). For Farmer 2, the price attained for dried dates was approximately 1.5 OMR/kg.

Discount rate As real costs and returns are being used, a real discount rate must also be applied. The interest rate at the time the study was conducted (2014) was used. This was approximately 5.1%.

Period of analysis Two periods of analysis were used according to the life of the polycarbonate drying house. For Farmer 1, the profitability of the project was evaluated over 15 years. For Farmer 2, we evaluated the profitability of this technology over 20 years.

B Economic/financial indicators

The major cost of the polycarbonate dryer is the construction, including the drying trays. The parameters required for financial analysis include discount rate, inflation rate, and project lifetime. As indicated above, the cost-benefit analysis was performed assuming prevailing market prices for both fresh and the dried dates in Oman. This is an analysis of the sum of all costs and benefits in a time period derived as annualized cost, benefit-cost ratio, and simplified PBP.

The performance of an investment in a polycarbonate drying house can be studied from the production level. Profit/returns is defined as the difference between sales (PP) with all types of costs. Profits can be written as:

$$PR = PP - CC - PC \quad (1)$$

Where

- PR: Profit (in OMR)
- CC: Capital costs/investment (in OMR)
- PC: Production costs (in OMR)

Production cost includes the costs of fresh material, labor, electricity, maintenance, and insurance.

Return of capital (ROC) is also called the profit from the investment. This indicator is influenced by time of the investment and the life of the system and can be expressed using the following formula:

$$ROC = PR/CC \quad (2)$$

The PBP indicator is defined as the investment cost per average annual net income (PR). This is calculated using the following formula (expressed in years):

$$PBP = CC/PR$$

Net present value, defined as a popular measure of profitability used in corporate budgeting to assess a given project's potential return on investment, and was used to calculate the present value of excess cash flow during the project period. This is calculated as the total for each year of the net cash flow less capital costs, according to the following formula:

$$NPV = \sum_{n=1}^{N} P_n(1+i)^n - CC \quad (3)$$

Where

$$P_n = S(1+i)^n \quad (4)$$

P is the discounted present value (*S*) to be invested in *n* years. The NPV decision criteria state that an investment is usually acceptable if the NPV is greater than zero.

3. Results and discussion

Advantages and constraints of using polycarbonate drying houses

The first assessment of the polycarbonate drying house reveals the following constraints and advantages:

Advantages

- Improves the quality of the fruits, especially in humid areas
- Avoids the contamination of dates by insects, birds, dust, and rain
- Accelerates the drying rate
- Reduces the loss rate
- Could be used for other purposes (e.g. drying other products, such as fish).

Constraints

- High initial investment cost (needs to be subsidized by the government)
- Concerns over the impact of heat on the quality of product (transfer of the plastic material)
- Farmers lack knowledge on the maintenance of the system
- Not profitable for date palm growers with very small holdings

- Lack of extension agents specialized in date palm

Economic and financial analysis of polycarbonate drying house

The CC of the polycarbonate dryer house system is the sum of all the components (collector, drying house, and distribution system) and installation costs. Table 1 show the capital costs of the two polycarbonate dryer houses (small and large) considered in this economic analysis:

Table 1: Estimated capital cost for polycarbonate dryer house for dates

	Farmer 1 (large dryer house)		Farmer 2 (small dryer house)	
	With subsidies (OMR)	Without subsidies (OMR)	With subsidies (OMR)	Without subsidies (OMR)
Total Capital Cost (OMR)	1000	3000	2700	4700

Note: The governmental subsidy for this type of drying house is around 2000 OMR. In UAE, the value of the subsidy is about 50% of the total cost of the house.

The empirical findings indicate that, for the first farmer with a subsidized polycarbonate house, at a real discount rate of 5.1%, the NPV is 12,764.18 OMR (Table 2). Given that the NPV decision criteria states that an investment is usually acceptable if the NPV is greater than zero, then the polycarbonate drying house appears very profitable. The IRR for this project supports this. The estimated IRR (+100%) is much higher than current interest rates (5.1%). This shows how profitable the investment in this drying system is with government subvention. Under this scenario (subvention), the PBP is very small, 0.7 years (Table 2 and Figure 1) compared to the expected life of the dryer (15 years).

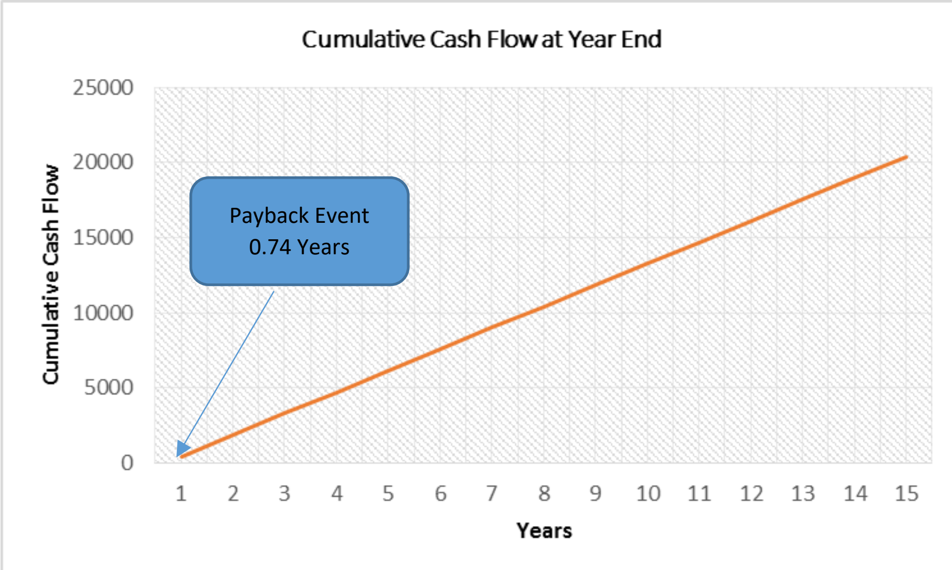
Economic and financial evaluation: Investor 1/Farmer 1

Table 2: Computation of economic indicators and financial indicators (NPV, IRR, and PBP) of the polycarbonate dryer house (Farmer 1)

Items	**Subsidized dryer - FIRR**	**No subsidy for dryer - EIRR**
Fresh dates (OMR/kg)	0.8	0.8
Dried dates (OMR/kg)	1.2	1.2
Product net weight (kg/kg of fresh date)	0.75	0.75
Capacity of dryer (kg/year)	6000	6000
Cost of fresh materials	6000*0.8*0.65 3120	6000*0.8*0.65 3120
Labor and maintenance costs (OMR)	300	300
Electricity costs (OMR)	36	36
Cost of insurance (OMR)	0.0	0.0
Total cost of fresh materials	3456	3456
Capital cost of dryer (OMR)	1000	3000
Life of dryer (years)	15	15
Depreciation (OMR/year)	66.66	200
Total revenue (OMR)	(6000*0.75*0.75*1.2)+(6000*0.75*0.25*0.8) 4950	(6000*0.75*0.75*1.2)+(6000*0.75*0.25*0.8) 4950
Total cost (OMR/year)	4522.66	6656
Net income (OMR/year)	427.34	-1706
Financial Indicators		
Net present value (NPV)	12,764.184	7486.52
Financial and economic internal rates of return (FIRR, EIRR)	Very high (+100%)	76%

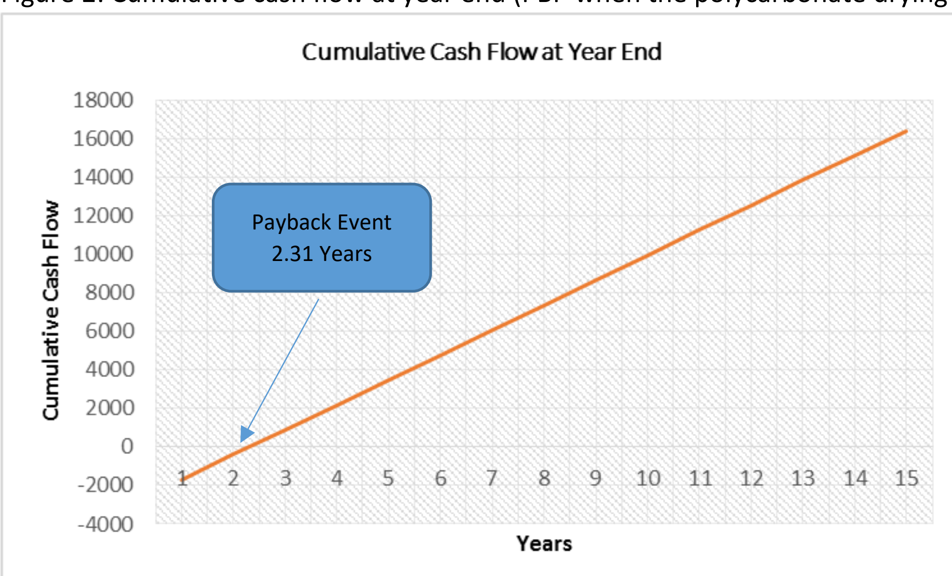
Payback period (PBP, years)	0.7	2.31

Figure 1: Cumulative cash flow at year end (PBP when the polycarbonate drying house subsidized)



Under the second scenario (with the hypothesis of no subsidies from the government), the economic evaluation showed an NPV of 7486.52 OMR (at a real discount rate of 5.1%). The IRR is estimated to be 76% (much higher than the current interest rate). These two indicators illustrate the profitability of investing in a polycarbonate drying house (Table 2). The payback period was also found to be very small (2.31 years) compared to the expected life of the polycarbonate drying system (Figure 2).

Figure 2: Cumulative cash flow at year end (PBP when the polycarbonate drying house is not subsidized)



Economic and financial evaluation – Investor 2/Farmer 2:

The economic evaluation of investing in a polycarbonate drying house for the second case was also conducted under two scenarios: with and without subsidies.

With a subsidized investment, the NPV was found to be 11,339.12 OMR. The IRR was found to be very high (99%), which illustrates the high profitability of this investment (Table 3). The PBP was 2 years, which is very small compared to the 20 years of expected life of the drying system (Figure 3). This indicates that investment or action costs are recovered quickly and can be available again for further use.

The economic evaluation under the second scenario (without subsidies from the government) indicates the profitability of this investment. The NPV was estimated to be 6200.45 OMR and the IRR was estimated to be 36%, suggesting the acceptability of this technology and consequently its suitability for investment. Figure 4 shows a PBP of 3.77 years, which is very small if we compare it with the expected life of the dryer (20 years).

This supports investment in this system given that a shorter PBP is viewed as less risky. It is usually assumed that the longer it takes to recoup expenditure, the more uncertain are the positive returns. For this reason, the PBP is often used as a measure of risk and, in this case (without subsidies), the investment is secure when a new investor (farmer) might decide, for instance, to undertake no major expenditures that do not pay for themselves in 4 years.

Table 3: Calculation of economic indicators and financial indicators (NPV, IRR, and PBP) of the polycarbonate dryer house (Farmer 2)

Items	Subsidized dryer - FIRR	No subsidy for dryer - EIRR
Fresh dates (OMR/kg)	0.8	0.8
Dried dates (OMR/kg)	1.5	1.5
Product net weight (kg/kg of fresh date)	0.75	0.75
Capacity of dryer (kg/year)	3000	3000
Cost of fresh materials	3000*0.8*0.65 1560	3000*0.8*0.65 1560
Labor and maintenance costs (OMR)	300	300
Electricity costs (OMR)	36	36
Cost of insurance (OMR)	0.0	0.0
Total cost of fresh materials	1896	1896
Capital cost of dryer (OMR)	2700	4700
Life of dryer (years)	20	20
Depreciation (OMR/year)	135	235
Total revenue (OMR)	(3000*0.75*1.5) 3375	(3000*0.75*1.5) 3375
Total cost (OMR/year)	4731	6831
Net income (OMR/year)	-1356	-3456
Financial Indicators		
Net present value (NPV)	11,339.11	6,200.45
Financial and economic internal rates of returns (FIRR, EIRR)	99%	36%
Payback period (PBP, years)	2	3.77

Figure 3: Cumulative cash flow at year end (PYP when the polycarbonate drying house is subsidized)

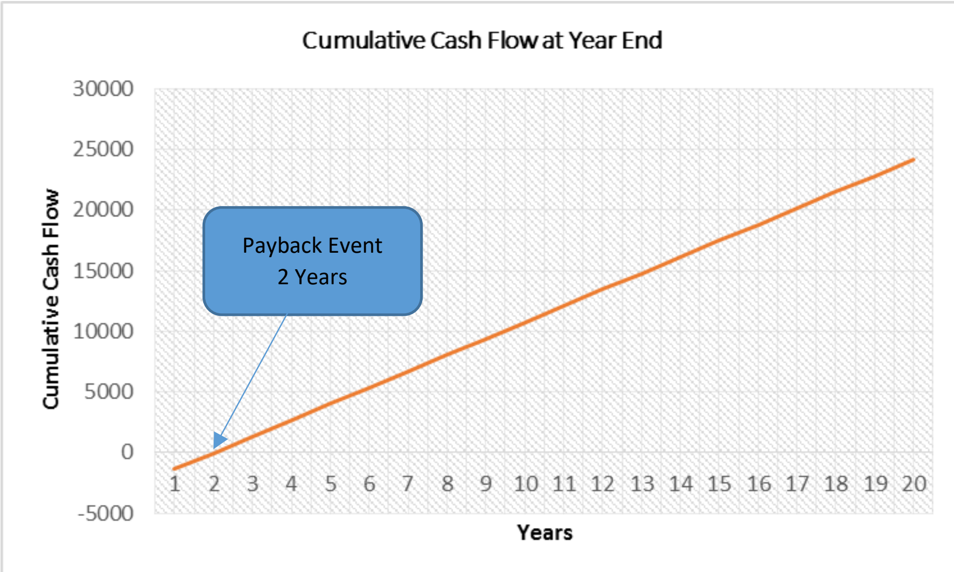
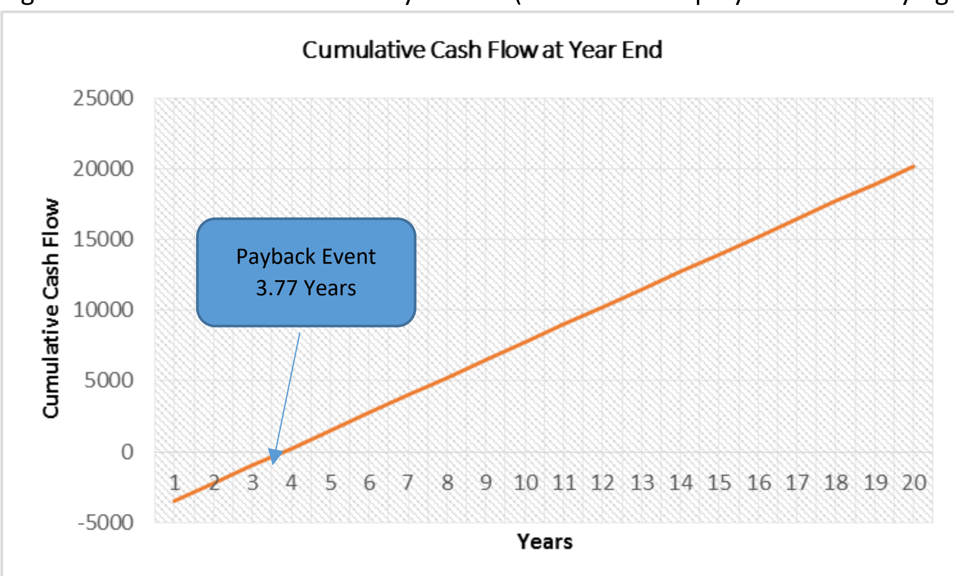


Figure 4: Cumulative cash flow at year end (PBP when the polycarbonate drying house is not subsidized)



4. Concluding remarks and policy implications

Polycarbonate drying houses for dates were evaluated economically for two farmers under two scenarios: with and without governmental subsidies. Empirical findings reveal the high profitability of the polycarbonate drying system, even when it is not subsidized by the government. At a real discount rate of 5.1%, the NPV is positive and very high in all cases. Given this, the decision criterion states that an investment is usually acceptable if the NPV is positive (the investment is profitable). This criterion was also supported by both the IRR and the PBP criteria. The estimated IRR was higher than the current interest rate in the Sultanate, which could encourage both date palm growers and private investors to invest in polycarbonate drying houses. The PBP was found, in the worst case scenario, to be 3.77 years,

which is relatively short considering the life of the system (15-20 years). This suggests that investment or action costs in this dryer system are recovered quickly reducing the risk involved in the investment.
The results from the present research study suggest the following:

- First, given the polycarbonate drying houses meet the technical, economic, and socioeconomic requirements, there is a need for a greater political and institutional input into polycarbonate drying houses projects. In particular, there is a need to design and develop alternative policy instruments (other than subsidies) and institutions for extension, technical assistance, training, and credit services that will facilitate adoption of this technology.
- Second, the benefits of this technology must be clearly perceived by farmers (other than date palm growers), given their own socioeconomic conditions. In GCC areas, increasing farmers' knowledge and perception of the merits of polycarbonate drying houses (and their uses for other products) through better access to technical information, extension, and training will help them to develop a positive economic assessment of the technology.
- Last, regional levels of date palm production are variable and appear to play a very significant role in influencing incentives for technology adoption. The policy implication that emerges from this finding is that polycarbonate projects should be targeted at areas with high levels of date production.

References

Nayak, S., Z. Naaz, P. Yadav and R. Chaudhary. 2012. Economic analysis of hybrid photovoltaic-thermal (PVT) integrated solar dryer. *International Journal of Engineering Inventions* 1(11): 21-27.