The application of a parabolic greenhouse solar dryer together with raw material preparation techniques to extend shelf-life and enhance quality of agricultural products
24 April –5 May 2023

Lecture 14: Supply and value chain of solar dried products in Thailand
May 3, 2023 (Time: 12.00-13.00)

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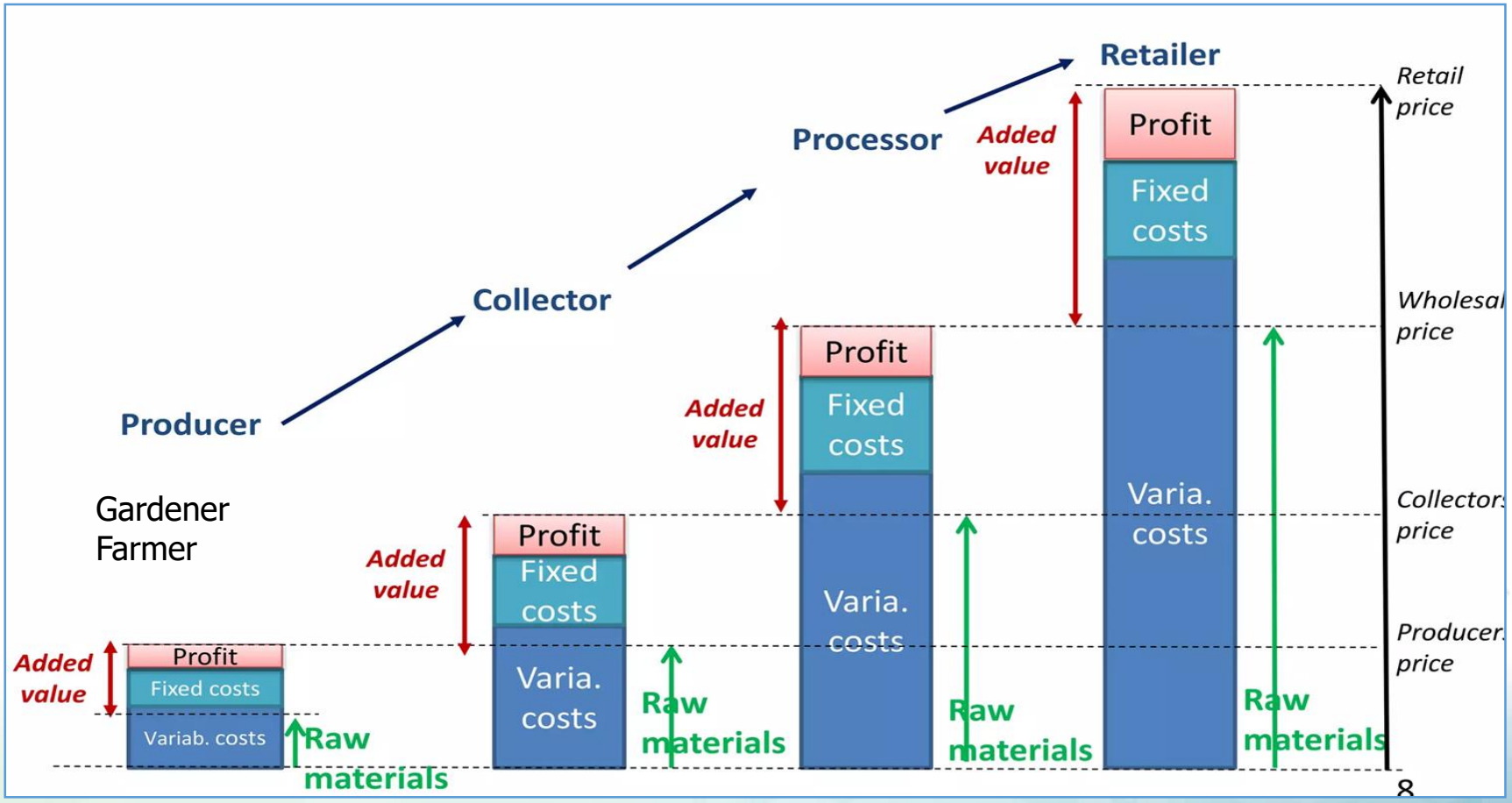
CONTENT

- The definition of the value chain and economic analysis by Asst. Prof. Dr.Kanokwan Kingphadung
- The case study of solar-dried products in Thailand by Mr.Samatcha Krungkaew

Value added along the chain



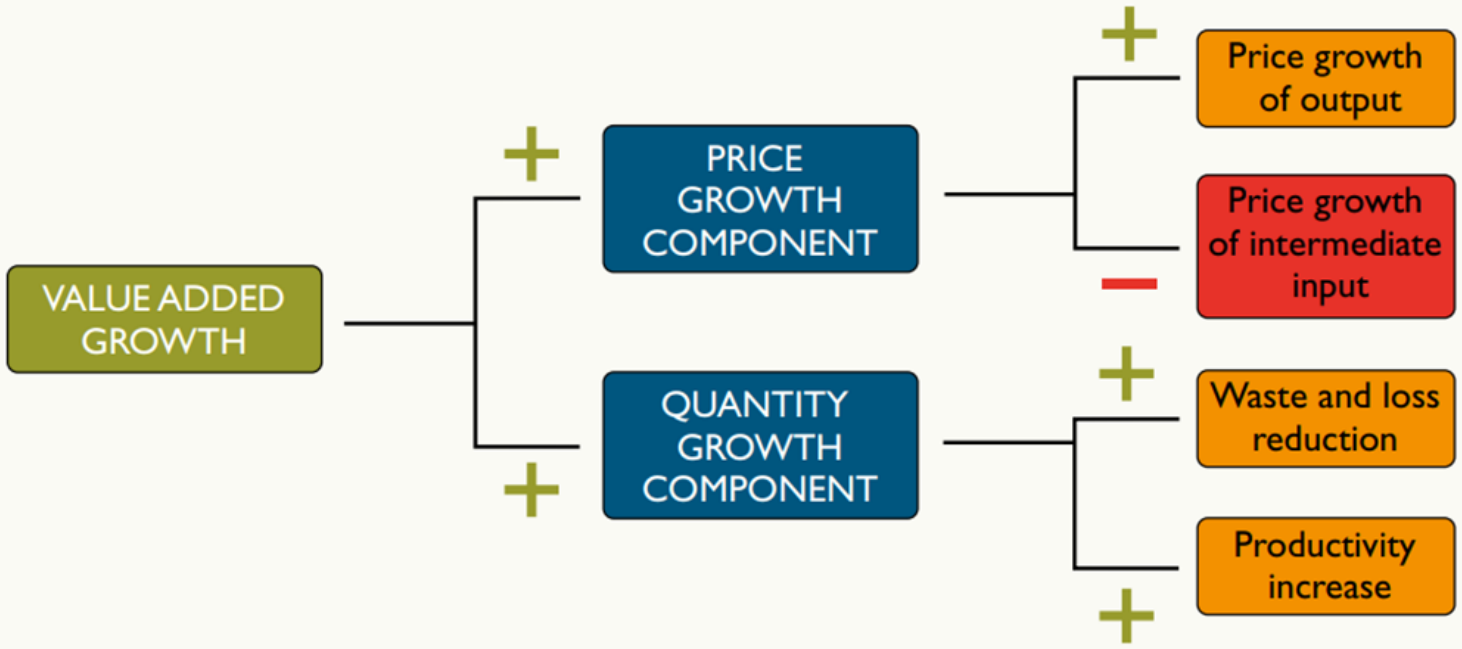
Source: Cadilhon (2015)

Price = Fixed costs + Variable costs + Profit = Total costs + Profit

Concept of value-added growth in a value chain

Note: + and – indicate respectively a positive and a negative effect on value-added growth.

Source: Authors.



Source: Flammini *et al.* (2018)

Kaew Kamin mango

Farmer

10 Baht/kg
(0.3 USD/kg)

Collector

30 Baht/kg
(0.9 USD/kg)

Hot Air Dryer

Processor

250 Baht/kg
(7.1 USD/kg)

Butterfly pea

Fresh

100 Baht/kg
(2.9 USD/kg)

Dried butterfly pea

360 Baht/kg
(10.3 USD/kg)

Butterfly pea tea
(10 bags/30 g): 40 Baht

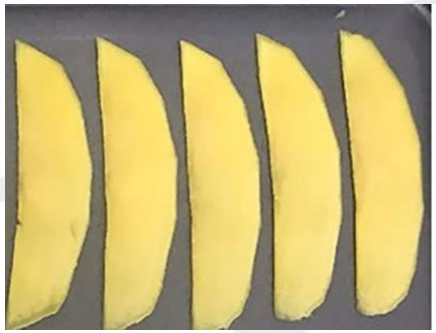
1,334 Baht/kg
(38.1 USD/kg)

processes
MDPI

Article

Comparison of Performance and Economic Efficiency for Greenhouse Solar versus Hot Air Drying: A Case of Crispy Mango Production

Kanokwan Kingphadung [1], Patsanan Kurdkaew [1], Prasong Siriwongwilaichat [1] and Suphaphat Kwonpongsagoon [2,3,*]



Fresh → **Hot air dryer** **Greenhouse solar dryer**




Source: Kingphadung *et al.* (2022)

Economic analysis

Present value factor

Net Present Value

NPV

$$NPV = \sum_{t=0}^{T} \frac{(B_t - C_t)}{(1+r)^t} \geq 0$$ or $$\sum_{t=0}^{T} (B_t - C_t) \quad X \quad \left(\frac{1}{(1+r)^t}\right)$$

Benefit Cost Ratio

BCR

$$BCR = \frac{\sum_{t=0}^{T} \frac{B_t}{(1+r)^t}}{\sum_{t=0}^{T} \frac{C_t}{(1+r)^t}} \geq 1$$ or $$\frac{\sum_{t=0}^{T} B_t \quad X \quad \left(\frac{1}{(1+r)^t}\right)}{\sum_{t=0}^{T} C_t \quad X \quad \left(\frac{1}{(1+r)^t}\right)}$$

Internal Rate of Return

IRR

Unit:%/year

$$\sum_{t=0}^{T} \frac{(B_t - C_t)}{(1+IRR)^t} = 0 \quad \Rightarrow IRR \geq r$$

r = Discount Rate

12

Pay Back Period

$$PBP = \frac{\sum \text{investment costs}}{\sum \text{annual benefit} - \text{annual costs}}$$

r = the interest rate or discount rate
t = the specific year of investing
T = the total number of years of investing
B_t = the benefit received or revenue of dryers
C_t = operating cost of dryers

Details for computation of economic analysis

No.	Item	Value		Units
		Hot air dryer	Greenhouse solar dryer	
1	Capital cost of dryer	6,452	12,903	USD
2	Life span of dryer	15	15	Years
3	Capacity of dryer	48	96	Kg/batch
4	Price of fresh mango	1.61	1.61	USD/kg
5	Price of dried mango	7.74	7.74	USD/kg
6	Salvage value	10% of capital cost	10% of capital cost	USD
7	Maintenance cost	10% of capital cost	1% of capital cost	USD
8	Operational labor cost	12.90	6.45	USD/batch
9	Electricity cost	3.68	-	USD/batch
10	Packaging cost	0.06	0.06	USD/kg
11	Interest rate	4.875	4.875	%/year

Note: (1 USD=31 Baht)

Source: Kingphadung *et al.* (2022)

Economic analysis of mango slices using hot air and greenhouse solar dryers

Items	Hot air dryer	Greenhouse solar dryer	Unit
NPV	151,417	190,050	USD
IRR	150	233	%
PBP	0.67	0.43	Years
BCR	15.73	24.47	-

Source: Kingphadung *et al.* (2022)

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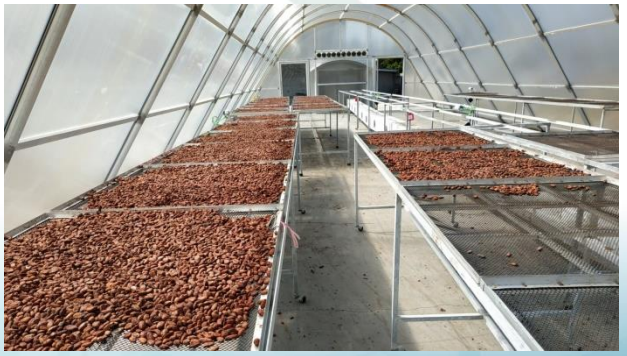
AITC course 2023 : The application of a parabolic greenhouse solar dryer together with raw material preparation techniques to extend shelf-life and enhance quality of agricultural products

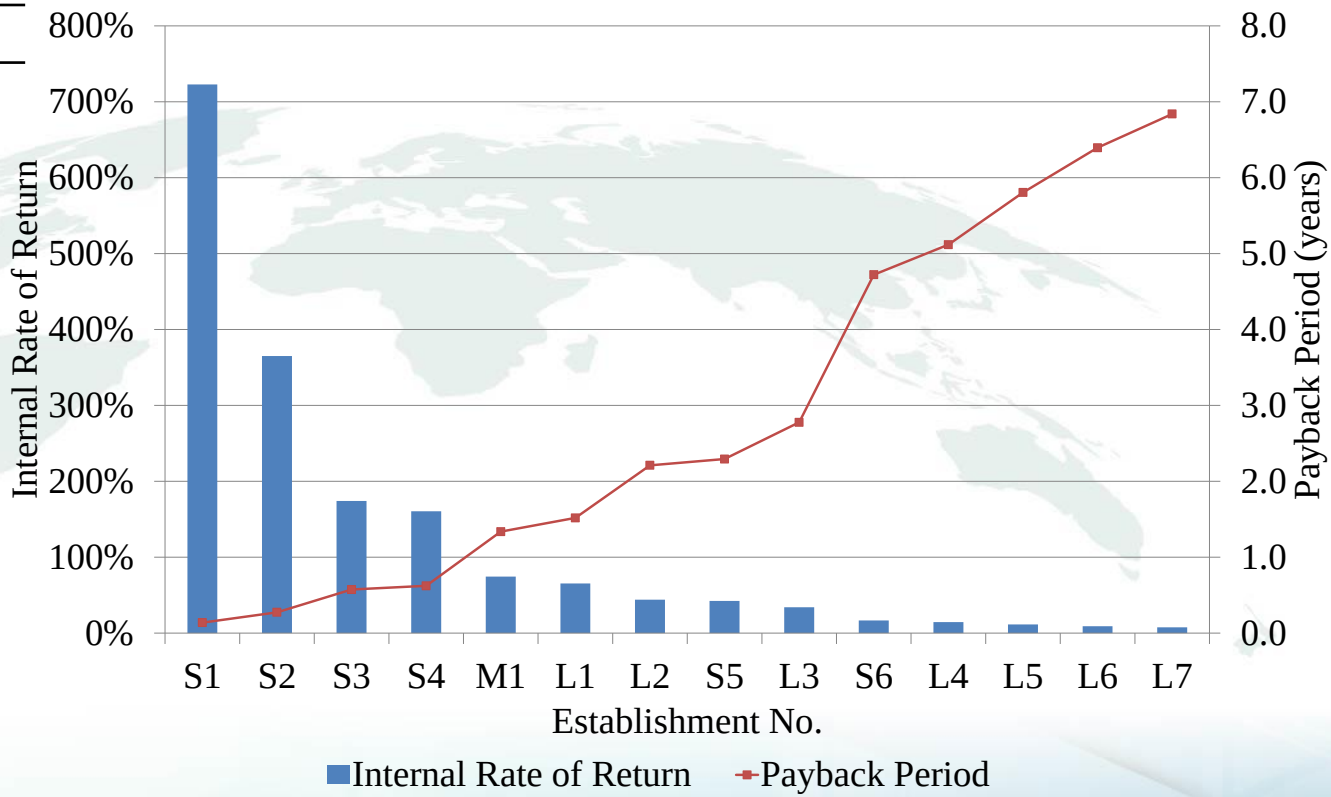




Internal rate of return and payback period of the investments

Enterprise	Product
S1	Mango and strawberry
S2	Mulberry
S3	Potato
S4	Longan
M1	Mangosteen powder
L1	Sweet tamarind
L2	Pickled papaya
S5	Banana
L3	Banana
S6	Banana
L4	Banana
L5	Mango sheet
L6	Banana
L7	Banana



Note: S = Small; M = Medium; L = Large

Source: Krungkaew *et al.* (2019)

International Journal of GEOMATE, March, 2020, Vol.18, Issue 67, pp. 96-101
ISSN: 2186-2982 (P), 2186-2990 (O), Japan, DOI: https://doi.org/10.21660/2020.67.5798
Special Issue on Science, Engineering and Environment

COSTS AND BENEFITS OF USING PARABOLIC GREENHOUSE SOLAR DRYERS FOR DRIED HERB PRODUCTS IN THAILAND

Samatcha Krungkaew[1], *Kanokwan Kingphadung[1], Suphaphat Kwonpongsagoon[2], Busarakorn Mahayothee[1]

Sun drying

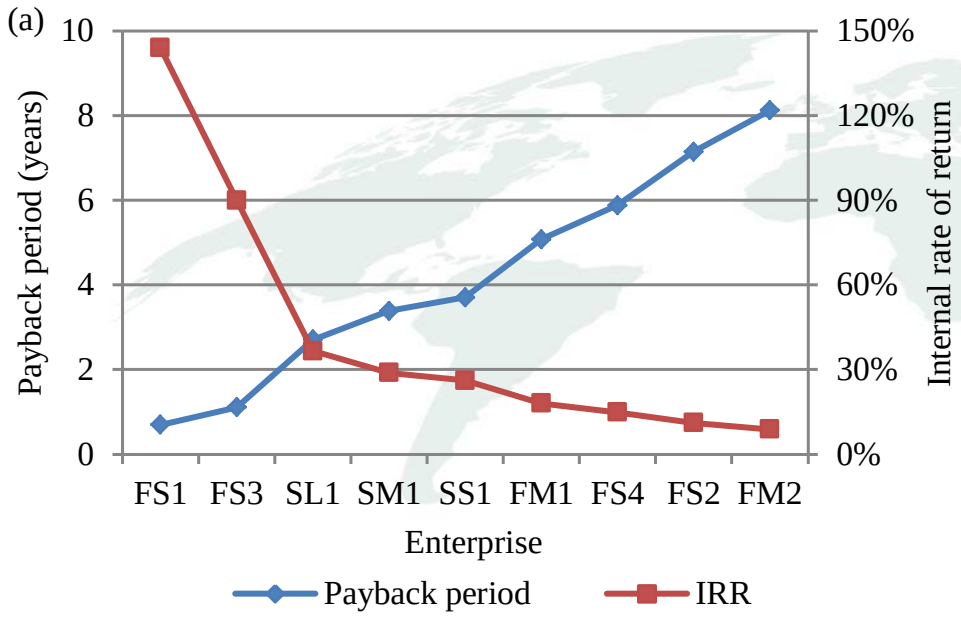
Code	Dried product
SS1	Moringa leaf, Bamboo grass
SS2	Jewel vine, Indian gooseberry, Kariyat, Butterfly pea
SS3	Bael, Long pepper
SS4	Kaffir lime peel, Barbed grass
SM1	Kariyat, Turmeric
SM2	Cat whiskers plant, Turmeric
SM3	Pandan leaf
SL1	Stevia

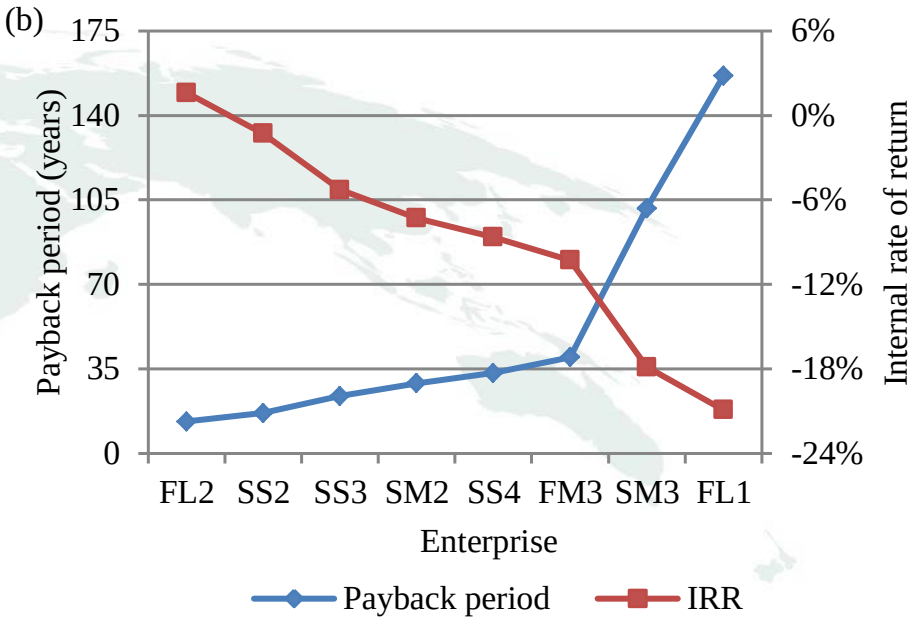
Fuel

Code	Dried product	Conventional fuel used
FS1	Mixed herbs	LPG and Wood
FS2	Stevia	Wood
FS3	Kariyat, *Stephania venosa*, *Curcuma zanthorrhiza*	Electricity
FS4	Butterfly pea, Sabah snake grass	Electricity
FM1	Turmeric, Cassumunar ginger	Electricity
FM2	Turmeric, Pandan leaf	Electricity
FM3	Ginger, Galangal	Electricity
FL1	Mixed Tom Yum herbs	Electricity
FL2	Chilli	LPG

Note: The first letter: F = Fuel, S = Sun drying
The second letter: S = Small; M = Medium; L = Large

Internal rate of return and payback period of the investments

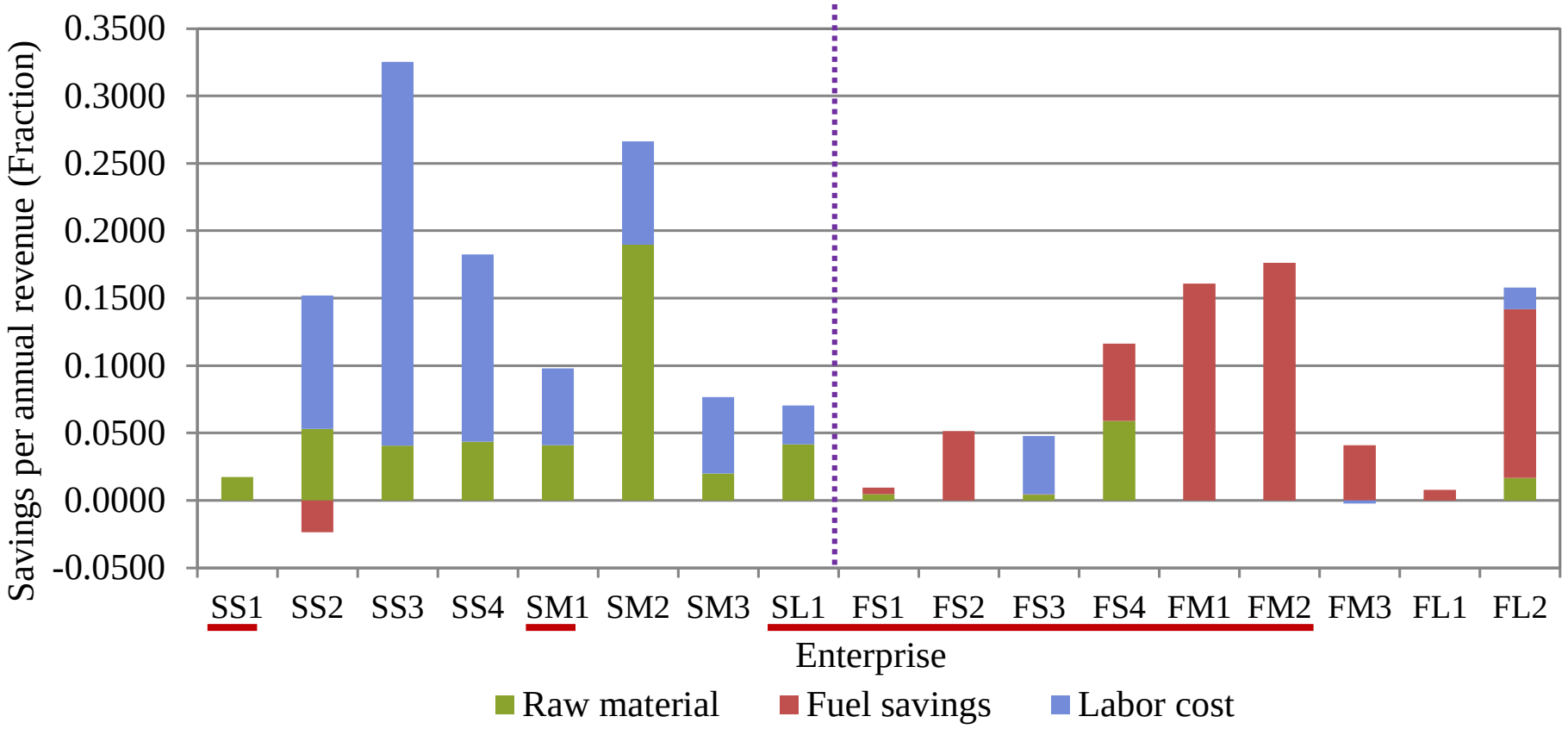




Note: The first letter: F = Fuel, S = Sun drying
The second letter: S = Small; M = Medium; L = Large

Source: Krungkaew *et al.* (2020)

Savings obtained from the investments



Note: The first letter: F = Fuel, S = Sun drying
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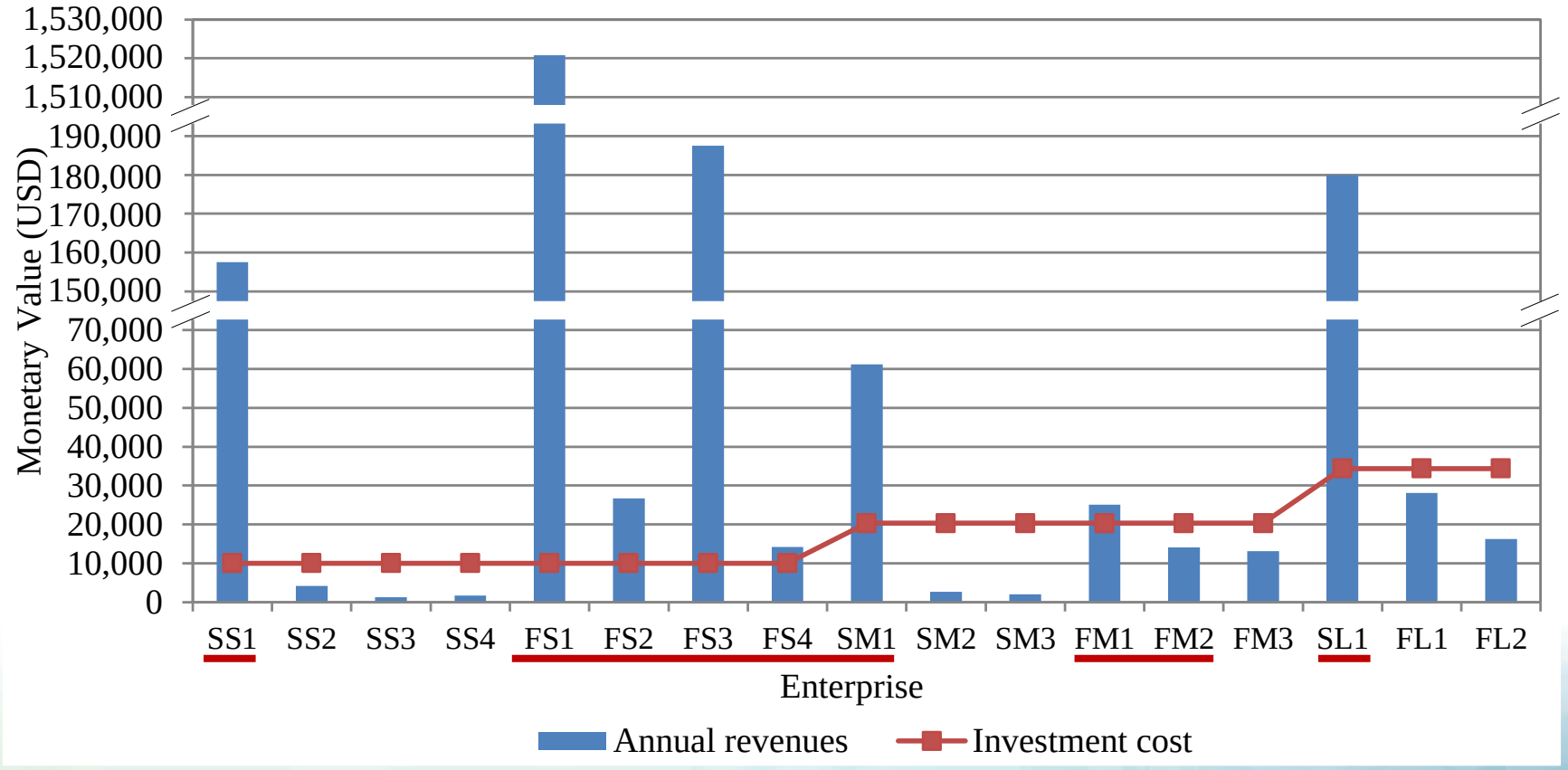
Source: Krungkaew *et al.* (2020)

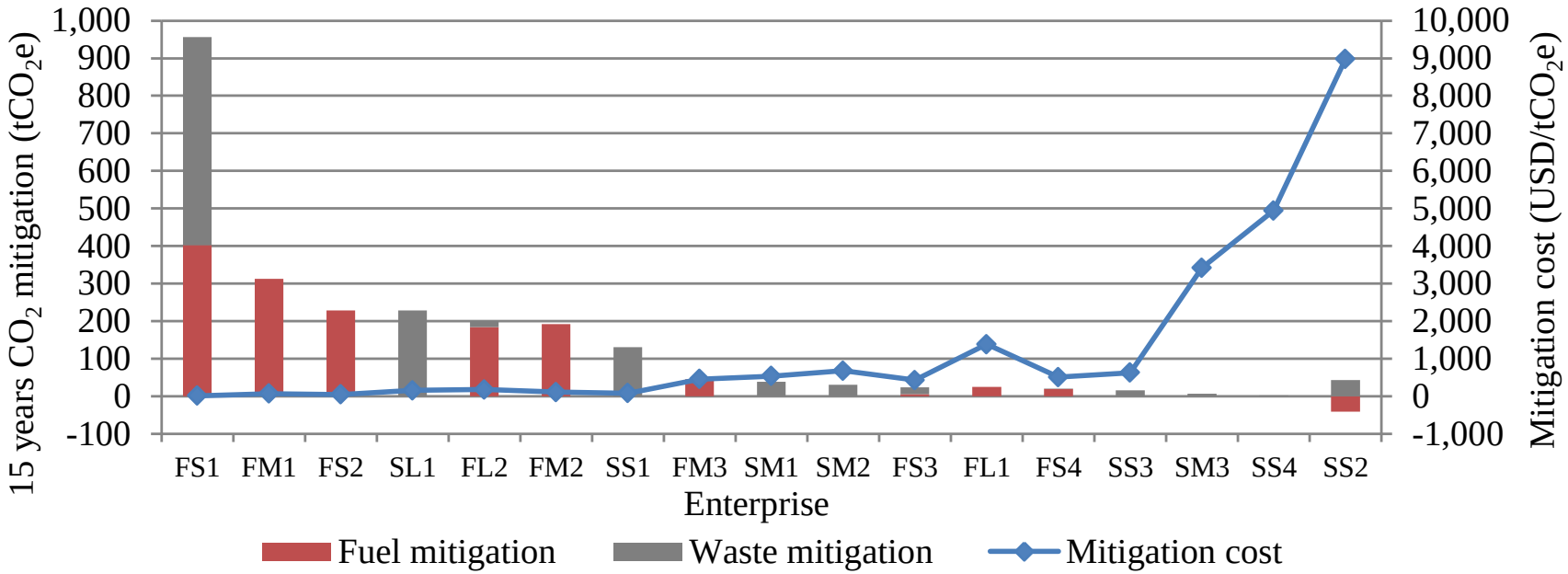
Annual revenues and investment cost



Note: The first letter: F = Fuel, S = Sun drying
The second letter: S = Small; M = Medium; L = Large

Source: Krungkaew *et al.* (2020)

Environmental impact mitigation

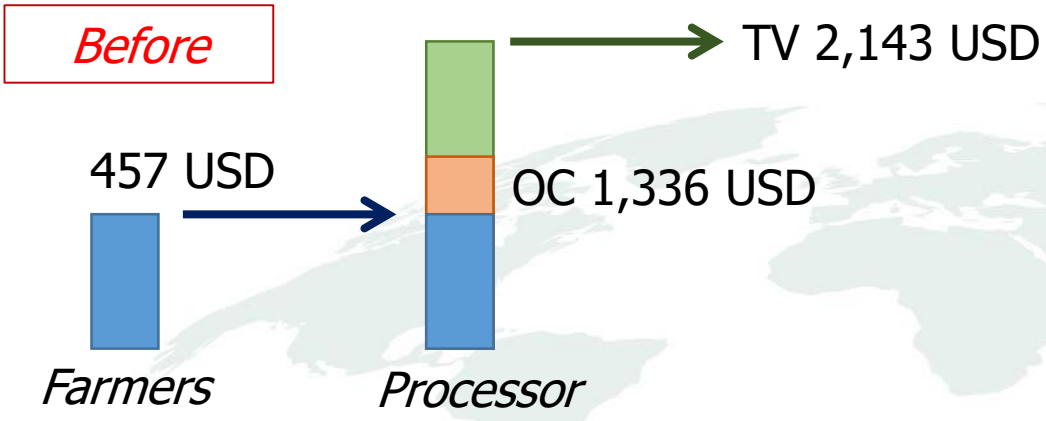


Note: The first letter: F = Fuel, S = Sun drying
The second letter: S = Small; M = Medium; L = Large

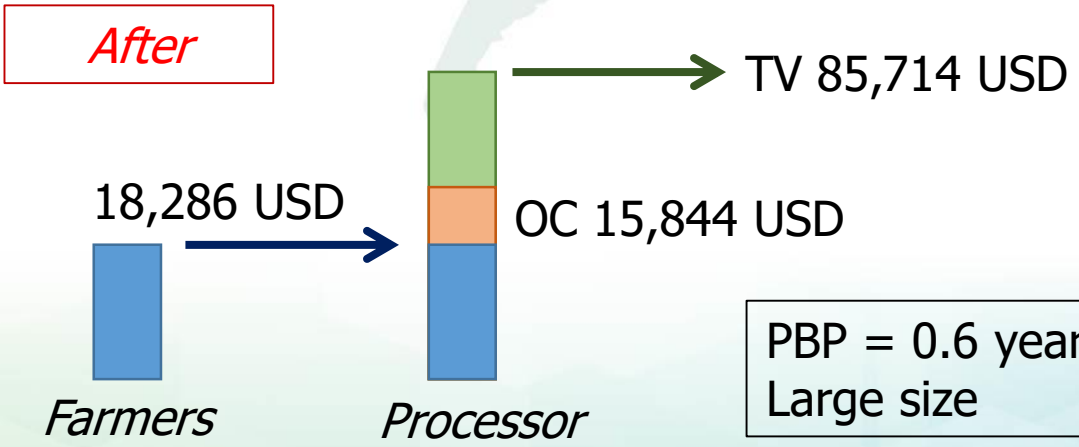
Source: Krungkaew *et al.* (2020)

Banana stick

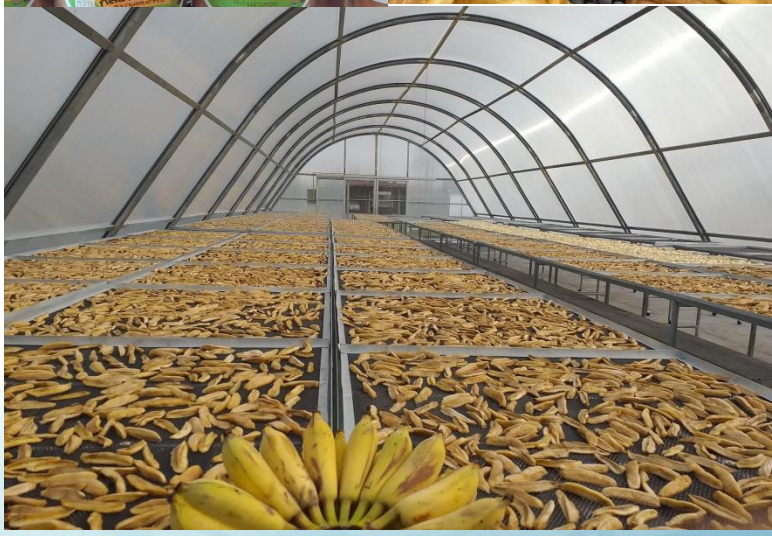
Before



After



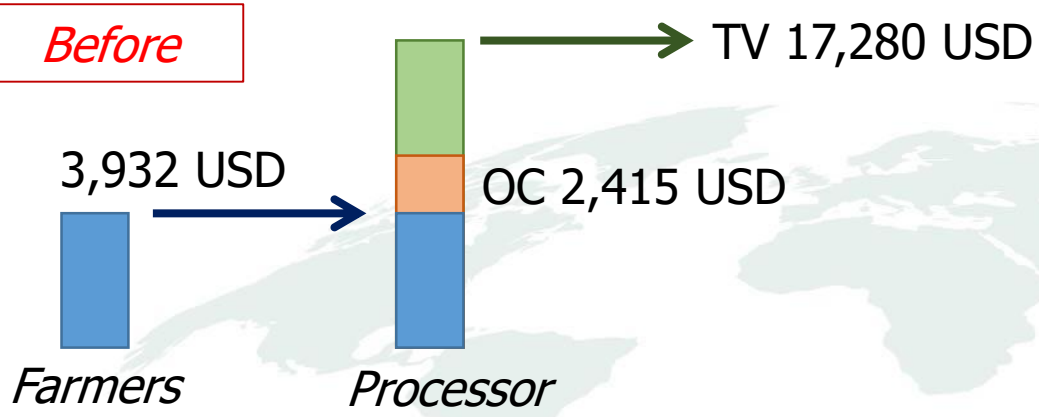
PBP = 0.6 years
Large size



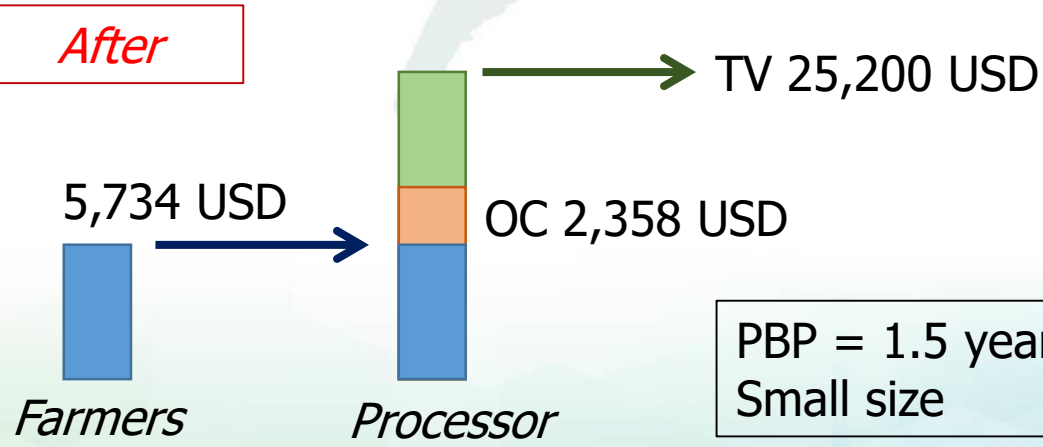
TV = Total value, OC = Operational cost, PBP = Payback period

Indian marsh fleabane

Before



After



PBP = 1.5 years
Small size

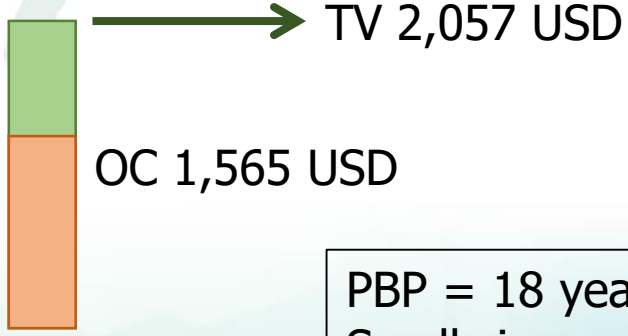
TV = Total value, OC = operational cost, PBP = Payback period

Lotus petals

Before

**Product loss 50%*

After



PBP = 18 years
Small size

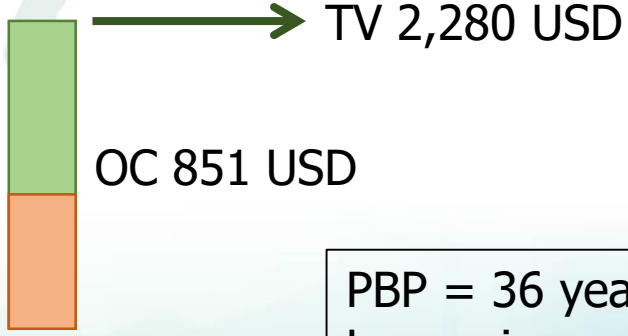
TV = Total value, OC = operational cost, PBP = Payback period

Chilli

Before

Processor

After



Processor

PBP = 36 years
Large size

TV = Total value, OC = operational cost, PBP = Payback period

Ideas for considerations

- To replace sun drying
  - Raw material or product losses
  - Labor cost savings
- To replace fossil-based fuel
  - Energy savings
- Production capacity
- The annual revenues

Additional Benefits

- Reduce physical contamination
- No Mold detected
- Better color of the products
- Reduce drying time
- Food management quality system
- Sustainability

References

1. Cadilhon, J.-J. (2015). Costs and value added calculation in livestock value chains—A technically robust process. Presented at the REVALTER Project Seminar, Hanoi, 7 January 2015. Nairobi, Kenya: ILRI.
2. Flammini, A., Bracco, S., Sims, R., Cooke, J., Elia, A. (2018). Costs and benefits of clean energy technologies in the milk, vegetable and rice value chains the Food and Agriculture Organization of the United Nations (FAO) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).
3. Krungkaew, S., Mahayothee, B., Phupaichitkun, S., and Kingphadung, K. (2019). Economic analysis of using parabolic greenhouse solar dryer for fruit drying in Thailand. 7th European drying conference (EuroDrying'2019), Torino, Italy. July, 10-12 2019; 533-539.
4. Krungkaew, S., Kingphadung, K., Kwonpongsagoon, S., and Mahayothee, B. (2020). Costs and Benefits of Using Parabolic Greenhouse Solar dryer for dried herb products in Thailand. *International Journal of GEOMATE*. 18(67), 96-101.
5. Kingphadung, K., Kurdkaew, P., Siriwongwilaichat, P., Kwonpongsagoon, S., (2022). Comparison of performance and economic efficiency for greenhouse solar versus hot air drying**:** a case of crispy mango production. *Processes*. 10(2), 311. https://doi.org/10.3390/pr10020311.