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Private Costs and Benefits of Traditional and Improved Brick Kilns in An Giang Province, Vietnam

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ABSTRACT : Brick production industry generates negative impacts on the environment in respect of air quality, human health and vegetation in particular. It is necessary have to change new technology less pollution. Therefore, estimating cost-benefit for traditional and Radonel kiln were done.It shows that cleaner technologies are more attractive than traditional technologies. Replacing existing brick kilns with Radonel kiln would reduce the impact of brick pollution in An Giang by 44-60%. Net Present Value of $46,4 (i=1%); $18.9 (i=7%) per thousand bricks for traditional kiln and $71,6 (i=1%); $39.6 (i=7%) per thousand bricks for Radonel kiln. Economic efficiency of Radonal kilns compared to traditional kilns are the basis to help managers and manufacturers choose the right technical solutions to promote production and prevent pollution in the villages producing baked bricks in An Giang province.

KEYWORDSL: *Cost-Benefit, Air Pollution, Radonel, Brick kiln.*

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I. INTRODUCTION

The growth in Vietnam's economy and population, coupled with urbanization, has resulted in an increasing demand for residential, commercial, industrial, and public buildings as well as other physical infrastructure. Vietnam's building construction sector is expected to grow strongly at an annual average of above 7% over the next decade (Ngoc Thuy, 2020). The brick kiln industry represents one of the industries which fulfill the growing demand for urban expansion. According to Vietnam Construction Association: About 12 billion bricks was produced in 2000, 22 billion bricks in 2007, 32 billion bricks in 2015 and 2020 it increased to 42 billion bricks (Phu An, 2018). The building stock is expected to multiply five times next time, resulting in a very large increased demand for building materials. According to a report by the provincial Construction Department, An Giang province has about 1,557 traditional brick kilns, output 878 million brick/year, created jobs for nearly 50,000 workers, 46 kilns were produced by advanced technology and 1,481 traditional kilns are located nearly residential areas. It takes a brick kiln 8days to produce a batch of products, but the kilns do not have a system to reduce smoke. Brick production has made over 1,100 people sick with tuberculosis of the lungs and eyes in region. In addition, every year, about 50 hectares of agricultural land is lost below a depth of 1.2 meters and more than 1,400 hectares of agricultural land are degraded due to the exploitation of topsoil for raw materials for brick production (An Giang-Sweden cooperation project, 2016). Although the kilns are harmful, they have brought a stable income to many households in the village in recent years and have created jobs for thousands of people. Most local residents earned their living through working at brick kilns. Despite this importance, the vast majority of kilns use outdated, energy intensive technologies that are highly pollutingm (Skinder et al. 2014, Blackman, 2000). The smoke and dust caused by traditional brick kilns has long been considered a threat to the environment and residents' health (Lelia Croitoru, 2012), but many obstacles stand in the way of their elimination. According to the Prime Minister's Decision No. 115/2001/QD-TT dated August 1st, 2001, all traditional kilns must be removed by 2010. Accordingly, An Giang Provincial People's Committee has made a decision to convert craft brick kilns into improved kilns. Addressing the impact of emissions from kilns and finding alternative options is very important. Localities have been asked to move all existing kilns in the area into the planned area. However, this change still faces many difficulties.

To convince brick factories to switch to Radonel kilns is very difficult. Therefore, in order to have a scientific basis, we conduct surveys, compare to emissions between traditional kiln and Radonel kiln and estimates for the benefits and costs of two kilns. From that, convince factory owners to apply Radonel technology that causes less environmental pollution, saves saving fuel ensures the sustainable development of brick production in An Giang province.

II. METHODS

Data and information were collected using interview method based on the questionnaire. Two brick-making units were selected purposively as respondents. Data collected included investment, labor, production process, market and government involvement. Interviews were done with brick producers and workers in the selected brick- making enterprises supported by direct observation of the production process in the shed and brick clamp. Data and information obtained were used first to establish assumptions for the analysis related to parameters of production process, technology, and costs (Table 2). These assumptions were established based on observation in the field and discussions with bricks producers and workers. Estimating the net returns from each technology is based on the Cost-Benefit Analysis (CBA) approach, includes all direct costs and benefits for the entrepreneur. Costs cover investments (e.g., cost of buildings and kiln chimney, land, other inputs, and taxes), while benefits comprise the value of brick production. The costs and benefits are estimated at market prices. The formula for the net present value of a project is:

$$NPV = \sum_{1}^{t} \frac{B_t - C_t}{(1+i)^t} \quad (1)$$

Where:

NPV = Net Present Value

Bt = Revenues or positive cash flows in year t

Ct = Costs or negative cash flows in year t

t = year in which the cash flow occurs

i = interest rate

BCR: It is computed as the present value of benefits divided by the present value of costs as follows:

$$BCR = \frac{\sum_{1}^{t} B_t(1+i)^t}{\sum_{1}^{t} C_t(1+i)^t} \quad (2)$$

If the ratio is greater than one, the project is yielding more benefits than its costs. Investment is accepted is the BCR exceeds 1 and is not accepted if it is less than 1.

IRR: it is the discount rate that makes the net present value equals to zero. Hence, IRR is the interest rate equalizes the present value of costs and revenues. The higher the IRR, the more desirable project becomes.

III. RESULTS AND DISCUSSION

*** Traditional brick kiln**

The traditional brick kiln is about 11m high, 9m long, 6m wide, with a capacity of 13,000 bricks. Burning time is 8 days. Consume a large amount of husk 0.8 kg/kg brick. The percentage of raw bricks is 96%. The fuel of the traditional kiln is husk and firewood. Heat mobile from low to high. There is no temperature control system, the temperature is checked by the kiln's experience. The kiln is burned intermittently in batches of products. Exhaust gas is released from the furnace door, heat is lost through the inlets on the sides, at the top of the kiln, at the kiln body and in the bottom compartment when the cycle is completed. Thus, the manual kiln will operate intermittently in batches, consuming a lot of fuel and polluting the environment around the kiln.

*** Radonel brick kiln**

RADONEL type of improved kiln is the result of research and improvement from a Thailand kiln, Height: 2,300mm, width 8,000mm, length 12,000mm; capacity of kiln/1month: 165,000bricks, firing time: 192hours, consuming 0.2kg of husk/kgbrick. Electricity 0.016kwh/kgbrick. With this new technology, the RADONEL kiln has demonstrated outstanding advantages compared to traditional kiln such as: continuous burning, 2.5times higher output, more than 52% fuel savings per brick. Compared with traditional kilns, the quality of bricks is guaranteed to be uniform according to high technical standards, especially 80% of dust and CO emissions are reduced. Because the exhaust part of Radonel kiln is improved from dispersed to concentrated and raised the air outlet by 30-50%. The kiln is installed with a dust filter with a high filtration efficiency of 99%, filtering fine particles, small pressure loss, large filtration capacity. Unlike other brick kilns, RADONEL kiln has an automatic, closed system of supplying and mixing husks, so there is no heat loss. There are 4 combustion chambers and are designed to ensure the maturity of all bricks in the combustion chamber, the percentage of quality bricks is over 90%, but it takes a lot of time to maintain the kiln.

Figure 1. RADONEL kiln

Figure 2. Traditional kiln

Comparison of pollution parameters of Radonel and traditional kiln.

Kilns were monitored for sulfur dioxide (SO_2), oxides of nitrogen (NOx), carbon monoxide (CO) emissions, Oxi (O_2) and carbon dioxide (CO_2), dust. Table 1 provides the emission factors for various pollutants monitored in the study. The result showed that the Specific Energy Consumption (SEC) is the amount of thermal energy required to fire 1 kg of brick. Lower SEC signifies efficient operationof the kiln. The improved Radonel kiln had SEC requirement at 0.54MJ/kg of fired brick, while traditional kiln was 2,16MJ/kg, it consumed 4 times more energy than a Radonel kiln. Suspended Particulate Matter (SPM) is a term used for airborne particles of diameter less than 100µm.The emission factorin terms of $mg/m^3$of fired brick. Radonel had the lower 105 times SPM emission factor than traditional kiln (Table1). Due to the addition of powdered fuel with the clay and husk and steady-state combustion conditions, Radonel kilns were among the lowest emitters of SPM in Vietnam. Better combustion conditions resulted in lower SPM in properly operated Radonel kiln compared to traditional kiln. The SO_2 content of the traditional kiln is 20 times higher than that of the Radonel kiln. NOx emissions were generally very lowand below the detectable levels. Emissions of carbon monoxide (CO) are an indication of incomplete combustion of fuel. Radonel kilns had the lower much CO emissions compare to traditional kiln. Good fuel-feeding and operating practices support this improvement. CO_2 emissions are directly related to the SEC and carbon content of fuels being used in the kiln. Hence the CO_2 emissions show a similar ranking hierarchy to SEC. The difference in emissions between Radonel and traditional kiln is not only caused by the fuel, but also is attributable to the management of the fuel-air mixing and proper handling of the exhaust products. Emissions of the Radonel kiln in general met Vietnam standar in all emissions parameters.

Table 1: *Emission Factors for the Monitored Kilns*

Emission Factors	Unit	Radonel kiln	Traditional kiln	Vietnam standard 5939-2005
SO_2	mg/Nm^3	64	1.263	1.500
NO_X	mg/Nm^3	542	624	1.000
CO	mg/Nm^3	684	15.000	1.000
O_2	%	18,52	8,24	-
CO_2	%	7,90	18,90	-
Suspended Particulate Matter (SPM)	mg/m^3	62	6.520	300
Temperature of flue gas	^0C	64,5	134	-
The Specific Energy Consumption (SEC)	MJ/kg	0.54	2,16	

Benefits and Costs

Radonel kiln has improved gas supply system, exhaust system and raised chimney to increase dust filtration efficiency and reduce flue gas temperature compared to traditional brick kilns. Cost-benefit analysis is a basic economic method for comparing the economic and environmental benefits of two kilns. To determine the investment feasibility on brick-making enterprise, three financial tools of decision making, namely Net Present Value (NPV), Benefit-Cost Ratio (BCR), Internal Rate of Return (IRR) were applied. Table below is basic information about two kilns to aid in the cost benefit calculation.

Table 2: Comparison of economic benefits between RADONEL and traditional kilns.

	Unit	Traditional Kiln	Radonel Kiln
Basic information about kilns			
Area occupied by kilns	VNĐ/ha	200.000.000	200.000.000
Investment cost/kiln	VNĐ	25.000.000	185.000.000

Husk consumption	VNĐ/brick	61.9	46.2
Electricity	VNĐ/brick	--	30
Land material	VNĐ/brick	175	175
Labour	VNĐ/brick	80	50
Discount (kiln,device,broken brick)	VNĐ/brick	36.8	25
Tax	VNĐ/year	24,000,000	76,000,000
Annual production/kiln	Brick/year	624,000	1,980,000
Life cycle	Year	7	7
Costs	VNĐ/brick	432	458.1
Market price	VNĐ/brick	800	980
Benefit	VNĐ/brick	367.78	522

Note: *US $1 = 23,200 VNĐ*

Table 3. *Calculation net present value with i_1 = 1%/year (Unit: USD)*

Year	Traditional kiln			Radonel kiln		
	$Bt/(1+i)^t$	$Ct/(1+i)^t$	NPV_1	$Bt/(1+i)^t$	$Ct/(1+i)^t$	NPV_2
0	0	9,698.27	- 9,698.27	0	16,594.83	-16,594.83
1	21,304.2	20,046	1,258.59	82,809.83	55,132.98	27,676.85
2	22,327.05	10,340	11,987.09	109,121.44	38,319.27	70,802.18
3	32,518.98	10,238	22,281.39	149,898.05	37,939.87	111,958.18
4	42,089.63	10,136	31,953.41	187,964.02	37,564.22	150,399,79
5	50,875.49	10,036	40,839.62	222,678.86	37,192.30	185,486.56
6	58,542.29	9,936	48,605.79	253,527.45	36,824.06	217,786.38
7	65,405.02	9,838	55,556.90	281,143.89	36,459.47	244,684.43
Σ	293,062.7	90,268.14	202,794.5	1,287,143.5	294,944.0	992,199.54

Table 4. Calculation net present value with i_2 = 7%/year (Unit: USD)

Year	Traditional kiln			Radonel kiln		
	$Bt/(1+i)^t$	$Ct/(1+i)^t$	NPV_1	$Bt/(1+i)^t$	$Ct/(1+i)^t$	NPV_2
0	0	9,698.28	- 9,698.28	0	16,594.83	-16,594.83
1	20,109.57	18,921.6	1,188.01	78,116.29	52,041.41	26,124.88
2	19,893.29	9,212.85	10,680.44	95,871.09	34,142.27	61,728.82
3	18,534.25	8,610.14	9,924.11	118,662.57	31,908.66	86,753.91
4	24,563.46	10,136.22	14,427.23	129,991.12	29,821.18	100,169.94
5	22,417.25	7,520.43	14,896.92	131,052.47	27,870.26	103,182.21
6	23,951.32	7,028.44	16,922.88	124,486.15	26,046.97	98,439.18
7	22,676.85	6,568.64	16,108.21	113,388.47	24,342.97	89,045.51
Σ	153,145.98	88,244.35	82,876.53	791,618.16	242,768.5	548,849.6

From the calculation results, the following observations can be drawn: Cost-benefit analysis for traditional and Radonel kiln at the discounted rate of 1% per year or 7% year helps to evaluate the advantages of the improved kiln. The results showed that at both 1% and 7% discount, the net benefit of the improved kiln is higher than the net benefit of the traditional kiln by $789,405.04and $465,973 respectively. The results also showed that at 7% discount, the benefits of both kiln are reduced compared to the benefits at 1% discount. The reduced amount is $119.917.97 for the traditional kiln and $443,349.94 for the improved kiln. Thus, the lower the interest rate for production, the higher the net profit, and the State should support low interest rates for investment projects that are more environmentally friendly. With i=7%, for Radonel kilns producing bricks from the 2nd year onwards will be profitable, reaching the highest level in the 5thyear. After 5 years of production, profits start to decrease due to many factors such as: outdated technology, increasingly competitive... it is necessary for producers to find ways to adapt to do business effectively. BCR calculated at the 1% preferred discount factor is 3.24 for the traditional kiln and 4.36 for the improved kiln. BCR at the 7% discount factor is 1.73 for the conventional kiln and 3.26 for the improved kiln. This shows that when BCR is low, the profit for the business is low. In other words, BCR is directly proportional to the profit. Intrinsic coefficient of return for traditional kiln 0.11 and improved kiln 0.15.

In conclusion, the results of all investment criteria in Table 5 confir that brick-making enterprise is financially feasible due to at the discounted rate of 1% per year and 7% during the period of 7years, NPV is positive (>0), BCR higher than 1. Satisfactory financial feasibility means that, if seen from the prospect of brick-making business, producers could fully and timely repay the microcredit taken from commercial banks.

Table 5: Financial Feasibility Indicator of Brick-Making.

Index	Traditional kiln	Radonel kiln
i_1=1%	NPV = $202,794 BCR = 3.24	NPV = $992,199 BCR = 4.36
i_2=7%	NPV = $82,876 BCR=1.73	NPV = $548,849 BCR=3.26

IRR	IRR =0.11	IRR=0.15

IV. CONCLUSIONS

This analysis shows that traditional polluting technologies are relatively profitable for the entrepreneur with net returns of $46,4 per thousand bricks. Cleaner technologies stand out as the more profitable, with net returns of $71,6 per thousand bricks. Replacing existing brick kilns with cleaner technologies would reduce the impact of brick pollution in An Giang by 44-60%. The development of the brick sector in An Giang in the next time should aim at: moving from traditional brick-making technologies to cleaner ones; diversifying products that are less energy intensive; increasing the proportion of largescale enterprises with higher capacity to adapt to cleaner technologies. To achieve these goals, some recommendation is provided below.

Recognize brick kilns as a formal industry.This would enable easier access to financial resources and improved working conditions.

Facilitate the availability of subidized credit lines to account for reduced health impacts from pollution and of other economic incentives supporting the production of new wall materials.

Enforce the existing regulations and policies, such as the ban of traditional high polluting kilns, particularly those located close to large population centers, upstream of the wind in the dry season, from November to April.

Introduce regulations and policies that encourage adoption of cleaner technologies, such as revising emissions standards for brick kilns.

REFERENCES

[1] Blackman, A., S. Newbold, J. Shih and J. Cook, "The Benefits and Costs of Informal Sector Pollution Control: Mexican Brick Kilns,", p. 40-46 (2000). http://www.rff.org [Citation Time(s): 2.

[2] Ban quản lý dự án hợp tác An Giang – Thụy điển (2016): Chuyển đổi sản xuất gạch theo công nghệ mới thân thiện với môi trường. http://www.scp.gov.vn/tin-tuc/t1340/an-giang-chuyen-doi-san-xuat-gach-theo-cong-nghe-moi-than-thien-voi-moi-truong.html.

[3] Lelia Croitoru, 2012. Benefits and Costs of the Informal Sector: The Case of Brick Kilns in Bangladesh. *Journal of Environmental Protection*.3 (6) (2020), Article ID: 20050 , 9 pages DOI:10.4236/jep.2012.36058.

[4] Ngoc Thuy, 2020. Vietnam construction sector forecast to grow over 7% over next decade. http://hanoitimes.vn/vietnam-building-construction-sector-forecast-to-grow-over-7-over-next-decade-fitch-312049.html.

[5] Skinder B.M., Sheikh A.Q., Pandit A.K. and Ganai B.A. (2014). Brick kiln emissions and its environmental impact: *Journal of Ecology Natural Environment*. 6 (1) p.1-11 (2014). DOI: 10.5897/JENE2013.0423.

[6] Tầng Phú An, 2018. Giới thiệu các công nghệ và kiểu lò nung gạch tại Việt Nam. https://www.phudien.vn/kien-thuc/gach-tuynel/gioi-thieu-cac-cong-nghe-va-kieu-lo-nung-gach-tai-viet-nam.html. [Translate]