Renewable Energy & Sustainable Development in Indonesia:
Past Experience – Future Challenges
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Dissemination of Hybrid ICDC Solar Drying Systems

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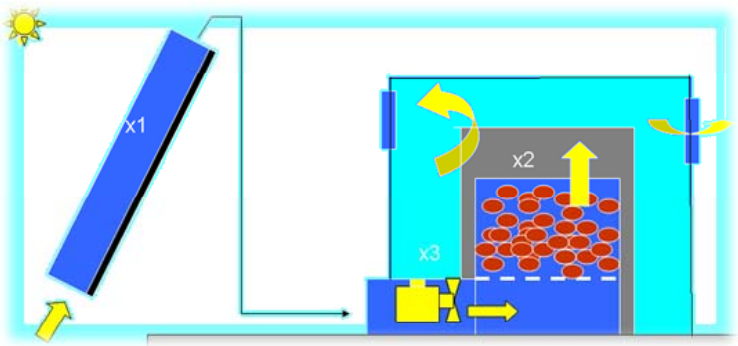
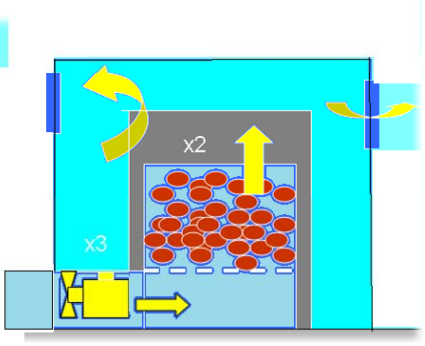
Content

- Solar drying systems
- Field performance of the ICDC hybrid solar dryer
- Lesson learnt
- Sustainability parameters
- Conclusions

Types of solar drying systems

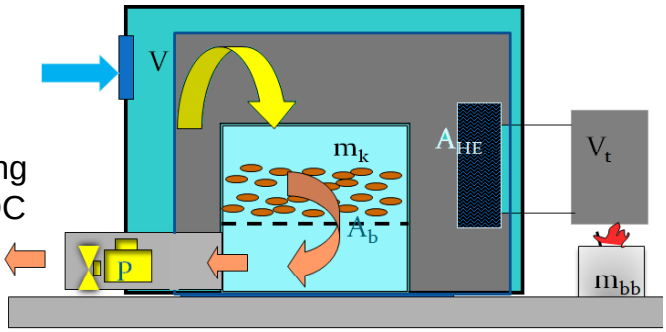


Separate solar collector-drying chamber



Greenhouse type

Integrated collector drying chamber-ICDC



RD/D histories of ICDC solar dryer

- 1992-, Research grants from DGHE, JICA
- 1994, 3rd country training of African engineers-JICA
- 1999, Grassroots project-Japanese ODA
- 2002, Training to ASEAN Engineers-ASEAN secretariat
- 2004, purchase by privates industries, NGOs
- 2005, Training of CMLV countries-NAM center
- 2004-2006, Dissemination to indonesian villages-DGEEU/MoEMR
- 2008-2009
  - Research grant, Ministry of Research and Technology
  - SENADA (USAID) grant, Solar dryer for tanneries
  - Purchase by private industries

Lesson learnt

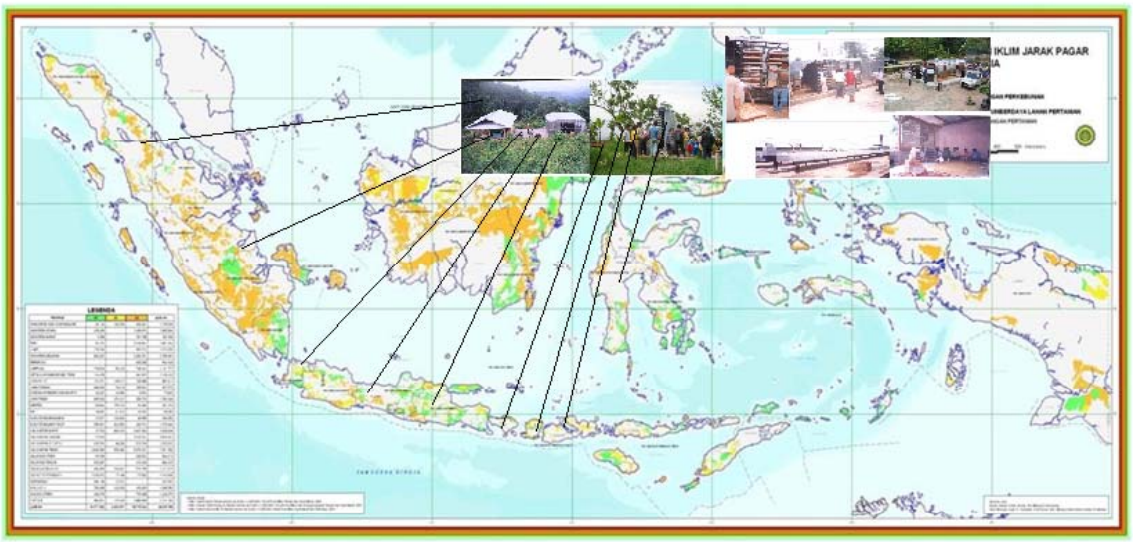
- Key barriers to sustainability
  - Access to working capital
  - Full time managers of the fnstalled facilities
  - Short term assisstances (mostly one year)
  - Market access to products
- Sucessful dissemination efffort
  - Educated managers with good entreprenurial skill
  - Have adequate capital ,captive market and need fuel swich (from kerosene or fuel wood)

Table 3. Patent application

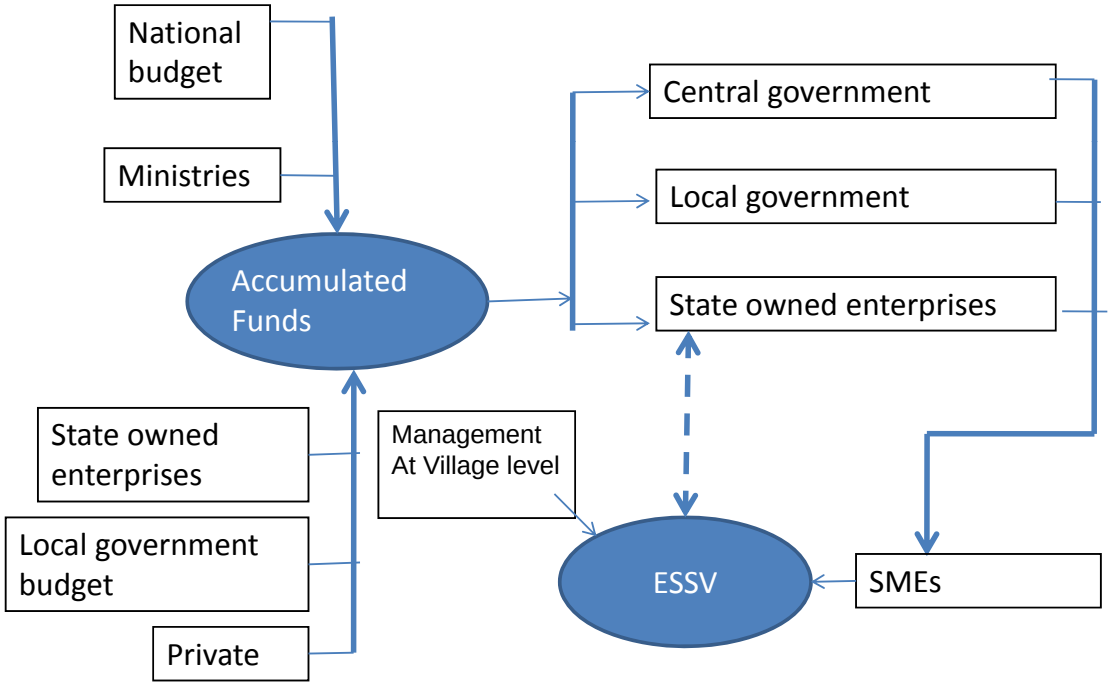
No	Title	No Patent	Status
1.	Solar drying combined with wind and biomass-1	P00200500504	Publication stage 6 mos. (until june 2007)
2.	Solar drying unit combined with wind and biomass-2	P00200200788	Substantive review/July 2007
3.	Vertical type ICDC hybrid solar dryer	P00200800439	Submitted in 2008
4.	Inclined type ICDC hybrid solar dryer	P00200800460	Submitted in 2008

Some examples of dissemination activities

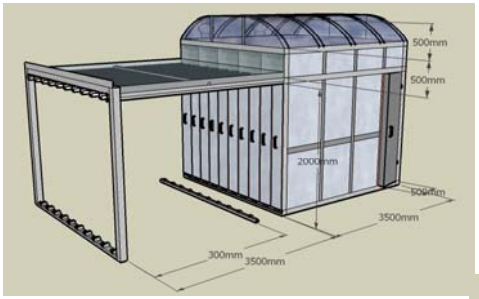
Distribution of GHE solar dryers and SPUs in Indonesia

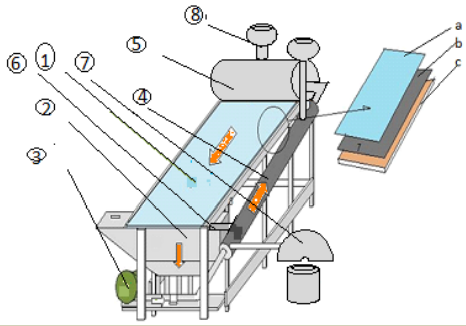


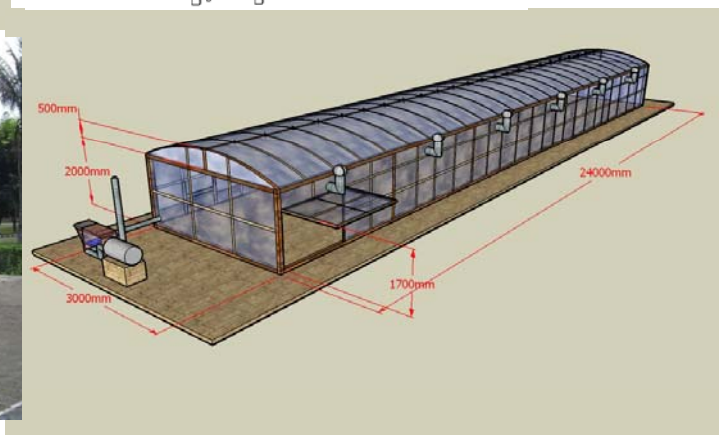
Financing scheme (MoEMR, 2007)



New designs







Continuous flow ICDC dryers-vertical type

- Uses combined solar-biomass -wind to operate the machine for continuous operations
- Main components:
  - pneumatic conveying system
  - Biomas stoves
  - Vortex
- Drying process occurs during conveying at the heat exchanger section of the conveyor and during free fall at the conveyor out let within the drying chamber
- Less drying time is required due to the continuous from and mixing action between grains and drying air.
- Biomass stove can be operated during the night of bad weather
- Good for medium to large capacity drying of grains (corn, rough rice, etc.)

Experiments: Vertical type ICDC solar dryer

- Capacity : 266.4 kg/h
- Dimension : ϕ 2,28 m, height 3,09 m
- Conveyor : Centrifugal Blower
  - Model : CZR – 200
  - Voltage : 220 Volt, 50 Hz
  - Volume : 450 m^3/h
  - Size : Ø 60 mm
  - Pressure : 1200 Pa
  - Power
  - Type : Electric Motor, 0.25 kW
  - Model : YY 632 -2
  - RPM : 2840 rpm
  - Voltage : 220 Volt, 50 Hz, 1,9 A,
- Auxiliary heater
- Type :Biomass stove
- Fuel : Charcoal, saw dust

Test results: Vertical type ICDC solar dryer

	Items	Quantity
1	Intial mass of grain (kg)	155
2	Drying time (hr)	10
3	Mass of grain after 10 hr drying	140
4	Drying rate (%wb)/hr	0,74
5	Average temperature at topsection (C)	40,34
6	Average temperature at the middle section (C)	38,12
7	Temperature of polycarbonate wall (C)	40,65
8	Increase in cracked grains (%)	1,4
9	Homogenity in m.c. (%)	0.05– 0.51
10	Fuel use (MJ/hr)	43,71
	#charcoal (18 kg) (%)	99
	#Solar irradiation (1252,67 Wh)	1

Economic benefit of GHE solar dryer

Case: Drying of cassava processinhg waste sat Mulyo haji village in Lampung

1. DryerSolar (IDR)	35,000,000	**Data**	
2. Biomass fuel 10 kg/batch	0	Selling price IDR/kg	540
3. Operator cost IDR	2,500,000	Yield %	0.5
4. Manager IDR/month	3,000,000	Raw material unit cost IDR/kg	130
5. Raw materials IDR	13,000,000	Drying Capacity, kg/batch	1000
6. Packaging and transport cost IDR	1,000,000	Drying time/batch-hr	8
7. O/M	437,500	Working days/year	200
8. Depreciation 10 year IDR	875,000	Bioomass consumption/batch-kg	90
	55,812,500	Biomassl cost IDR/kg	0

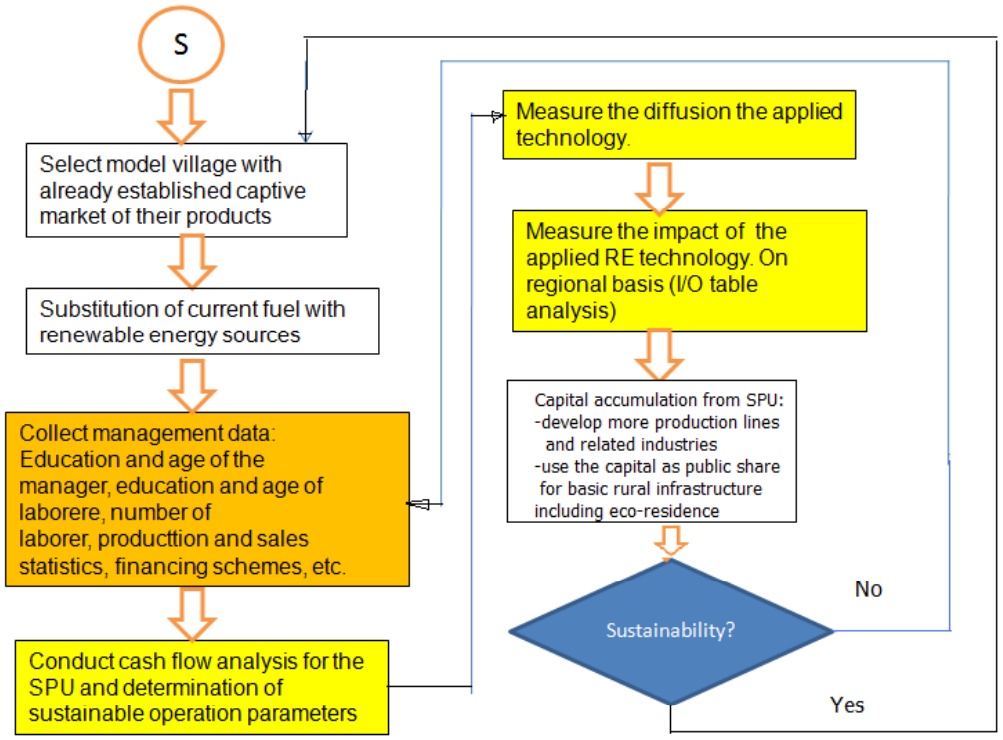
Cash flow in IDR

Year	Revenue	Operation cost	Interest 16%/yr	Net	Cumulative
0	-55,812,500				-55,812,500
1	108,000,000	83,250,000	8,930,000	15,820,000	-39992500
2	108,000,000	83,250,000	6,398,800	18,351,200	-21641300
3	108,000,000	83,250,000	3,462,608	21,287,392	-353908
4	108,000,000	83,250,000	0	24,750,000	24396092
5	108,000,000	83,250,000	0	24,750,000	49146092
6	108,000,000	83,250,000	0	24,750,000	73896092
7	108,000,000	83,250,000	0	24,750,000	98646092
8	108,000,000	83,250,000	0	24,750,000	123,396,092
9	108,000,000	83,250,000	0	24,750,000	148146092
10	108,000,000	83,250,000	0	24,750,000	172896092

29%

IRR = 29%

Measurement of sustainability



Economic benefit of ICDC solar dryer*)

Village name/ Capcity(ton)	Business	Produk	Investment Milllion IDR	ROI (%)	Pay back years
1. Ped, N. Penida./17 units 125 kg each	Private owned	Sea weeds	726,9	18	4
2. Daleman, Klaten 15 units, 16 kg/unit	Private owned	Soun noodles	507,3	35	3
3. Mulyo Haji, Lampung :.1000.(kg)	Farmers group	Cassava flour wastes	55,8	29	4
*) excluding cost of land					

The Production function of SPU

Let C is the production of SPU , kg or Sales/unit time, a_1 , managerial coefficient, and f(t) = external parameters (market, price, etc.), then

$$dC/dt - a_1 C = f(t) \ldots\ldots\ldots\ldots (1)$$

IC : at $t \leq 0, C = 0$

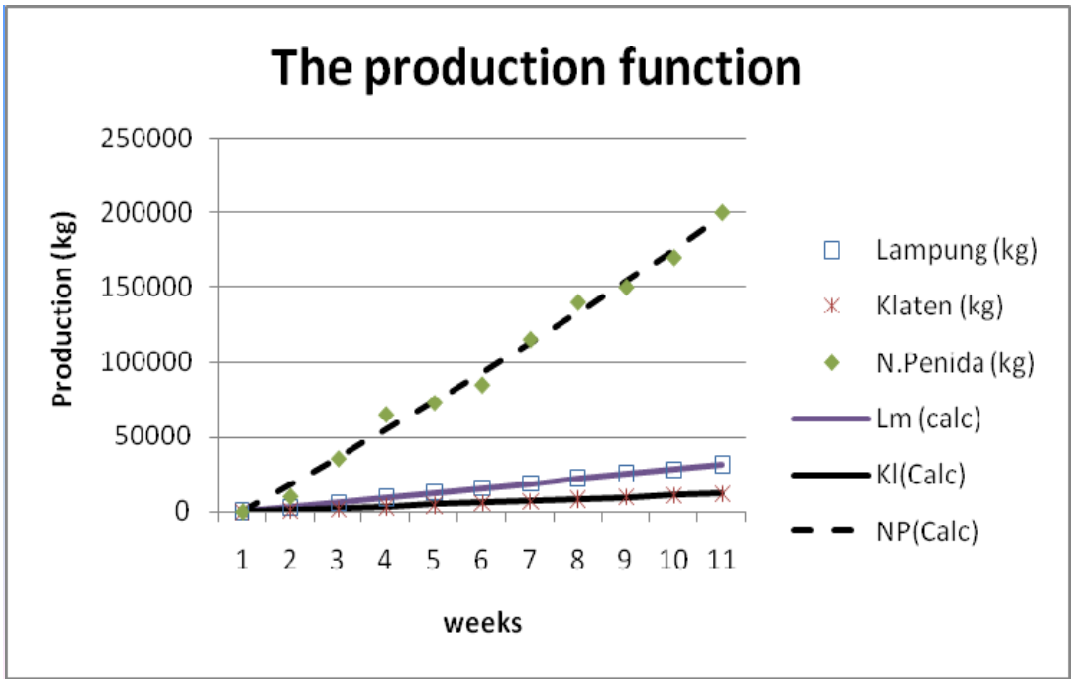
For $F(t) = e^{bt}$

$$C(t) = \frac{1}{(a_1 - b)} \exp(a_1 t) - [\frac{\exp(bt)}{(a_1 - b)}] \ldots\ldots\ldots (2)$$

Collected survey data (2008)

Time (weeks)	Production estimates of SPU aat 3 smaple villages (kg)		
	Lampung (sumatera)	Klaten (Central Java)	N.Penida (Bali)
0	0	0	0
1	2500	1020	10000
2	5500	2160	35000
3	9000	3330	65000
4	12500	4530	73000
5	15500	5790	85000
6	18500	7080	1E+05
7	22000	8370	1E+05
8	25000	9630	2E+05
9	27500	10650	2E+05
10	31000	11790	2E+05

Production coefficients: lampung, a_1 = 0.0043, and b=3040 , klaten a_1= 0.0112 and b=1129, and bali, a_1= 0.0210 and b=17660.



Managerial aspect of SPU

- Let M_1 represent the age of SPU manager and M_2 is his/her age, M_3 the average age and M4 average years of education of the laborers, then the following relation applies

$$\beta_{11}M_{11} + \beta_{12}M_{12} + \beta_{13}M_{13} + \beta_{14}M_{14=} = a_{11}$$

$$\beta_{11}M_{21} + \beta_{12}M_{22} + \beta_{13}M_{23} + \beta_{24}M_{14=} = a_{21}$$

.....

$$\beta_{11}M_{n1} + \beta_{12}M_{n2} + \beta_{13}M_{n3} + \beta_{14}M_{n4} = a_{n1}$$

Managerial competence-data from 3 villages

$$M\beta = A$$

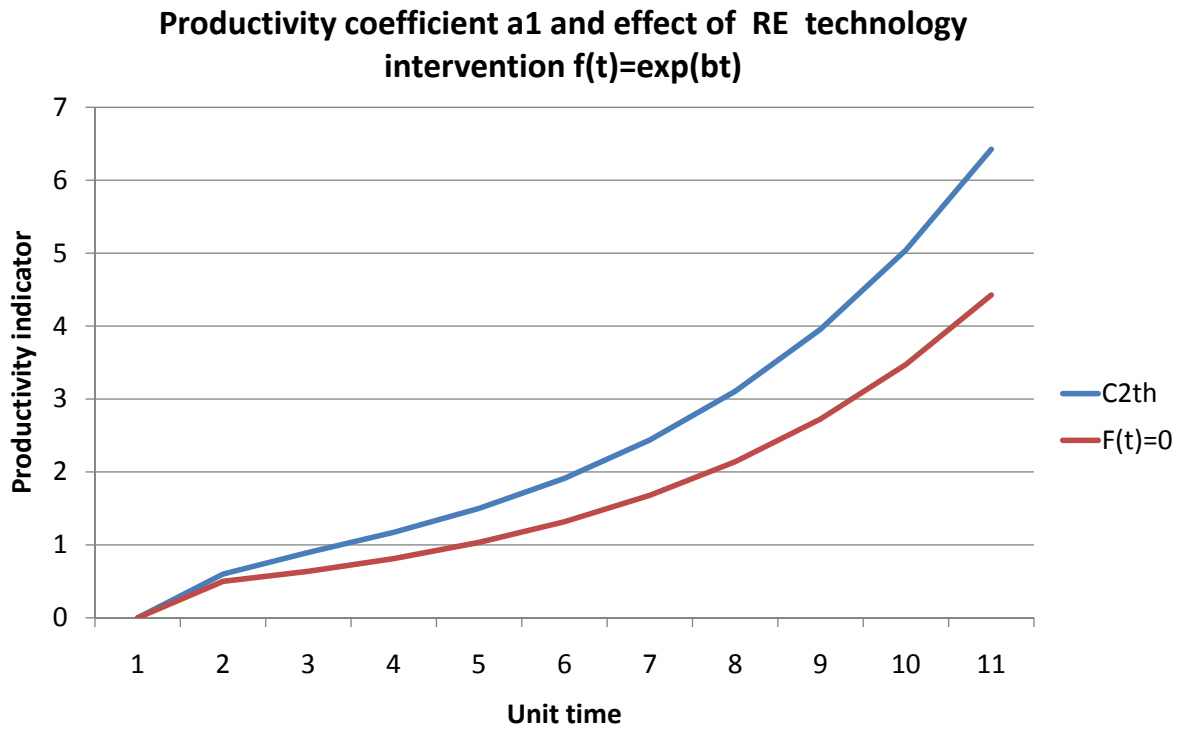
$$M^T M\beta = M^T A_1$$

$$(M^T M)^{-1} M^T M\beta = (M^T M)^{-1} M^T A_1$$

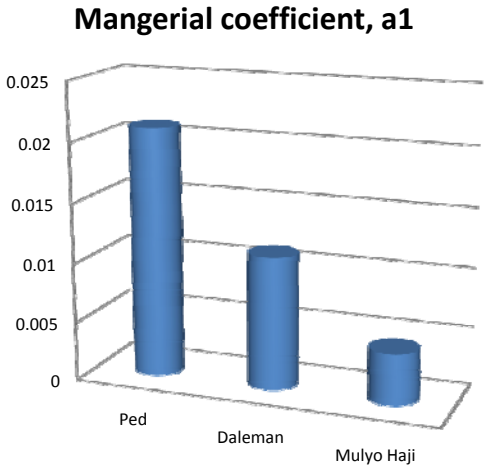
$$\beta = (M^T M)^{-1} M^T A_1$$

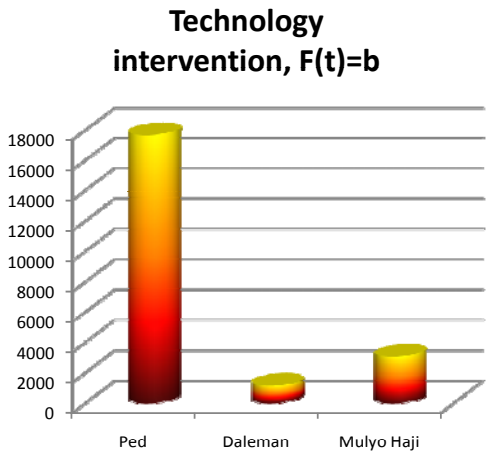
Age coefficien t $\beta_1 = -0015,$

Education coefficien t, $\beta_2 = 0.0045$



Sustainability parameters





Conclusions and Recommendations

- ICDC hybrid solar dryer has been introduced within Indonesia, ASEAN and to African countries
- Several new prototypes of the ICDC hybrid solar dryers have been developed, tested and beginning to attract investment from SMEs.
- Supports and assisstance have been received by the government, international donor agencies including NGOs, however, access to working capitals, multi years financing are imperative for the sustainability of dissemination effort.
- Sustainable indicators have been formulated and is proposed as tools to evaluate new dissemination programs
- Technology developed and method for sustainable dissemination of RE technology can be used to monitor and evaluate the ESSV program