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The Technical Coefficient of Reused Inputs in Alternative Agriculture System: A Case Study from Khon Kaen Province, Thailand

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ABSTRACT

The objective of this paper is to discuss the technical coefficient of reused inputs in alternative agriculture system, primarily through the use of Input-Output analysis to estimate technical coefficients displayed in an Input-Output Table. The information used was obtained from 51 cases of primary data from a stratified random sample in Khon Kaen Province, Thailand. The technical coefficients of reused inputs from the Alternative Agricultural I/O table were rather low, mainly because there are few activities in Alternative Agriculture, resulting in limited techniques of how to reuse by-products and low demand. Nevertheless, the exchanged value of technical coefficients was still low. They still have a potential to be higher in the future through the development of reused input techniques. Besides, all of the reused inputs were only a waste in the monocropping system which required the cost input to eliminate.

Key words: alternative agriculture; reused input; technical coefficient; Thailand

INTRODUCTION

The economic situation in Thailand has changed over the past 30 years from agricultural-based to industrial-based in 1995 the agricultural sector was 11.5% of GDP while the industrial sector was 30.5%. However, this does not mean that the agricultural sector is less important, since a majority of Thai citizens are still rural farmers, mostly numbered among the poorer people in Thailand. The financial crisis which struck in 1997 worsened the lot of many of these farmers, as prices tumbled and the market diminished. Less money also resulted in increased environmental impacts and less sustainable farming methods. A few of the larger farmers survived this crisis and even prospered, through increased exports in some sectors due to the floating currency, but in general small and medium size

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farmers suffered.

Alternative agriculture has been an option for many small farmers since at least 1980, when the concept was first popularized in Thailand by a number of NGOs. The concept generally involved a change in philosophy, from producing crops to sell in large markets, to producing a variety of crops primarily for self-sufficiency; and also using farming methods which were designed with environmental sustainability in mind, rather than maximizing product yield – generally following the LEISA principle – Low External Input Sustainable Agriculture.

Currently in Thailand a number of different types of alternative agriculture are practiced such as Organic Farming, Integrated Farming, Agroforesty and Natural Farming. Recently His Majesty the King introduced a new theory of agriculture which is based on self-reliance. His Majesty's system is based on a permanent pond, which stores water and is also used for raising fish, and an integrated farming system, with inteqrated of crops and animals. Thai Ministry of Agriculture and Co-operatives (MOAC) adopted His Majesty's concept and instituted a program to promote it to Thai farmers under the name New Theory of Agriculture Project.

In Figure 1 below, the basic steps of input-production-output are shown. It will be seen that following the initial production, by-and waste-products from the production process are then, insofar as possible, reused in subsequent production cycles, reducing the need for external inputs. As the production process matures, the need for external inputs will continue to lessen, thus reducing both the environmental burden, and the cost of production.

Integrated Agriculture is one form of alternative agriculture practices, and the input-output model will be applied to the general case. Several processes (as shown in Figure 1) may occur simultaneously, as in any given farming operation, and several varieties of both plants and animals will be involved, all having different but integrated production cycles. This is one of the most efficient agricultural systems, in the sense of having a minimum of non-reusable byproducts at the end of the production process. There are also many positive externalities involved (meaning things which contribute to a healthy and positive lifestyle and production cycle, but which do not show up on a financial balance sheet) – i.e. growing various tree crops together allows for larger trees to provide shade for smaller trees in their early stages – or animals, farm or people; or environmental sustainability is enhanced when farming practices do not release large amounts of toxic chemicals into the local

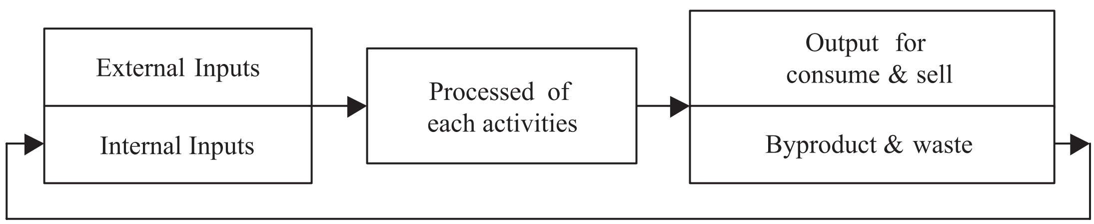

Figure 1 Production cycle diagram.

environment.

There are many types of alternative agriculture, ranging from organic farming, agroforesty, natural farming, integrated farming, and so on. The overall degree of integration of production and local environmental factors varies with each system. The general life style of small farmers – i.e. small with, usage of household labor – encourages the adoption of some form of alternative agriculture, where the initial financial requirement is low, and in the two decades since it was first introduced to Thailand the number of practitioners has increased steadily.

The objective of this paper is to estimate the technical coefficient of reused inputs which was enhanced by production integration in alternative agriculture.

CONCEPTUAL FRAMEWORK AND METHOD

The Wassily Leontief Input-Output Table (Leontief, 1986) will be the main tool used to study the efficiency of Alternative Agricultural systems by estimating a technical coefficient of byproduct and waste. As nations have many inputs and outputs, so do alternative agricultural farming systems. There are also many internal linkages, as byproducts and waste-products are reused, such as the use of rice straw or cow dung for organic fertilizer, as shown in the following diagram.

Based on the above diagram, we can construct a matrix such as the following, to show farm input-output data:

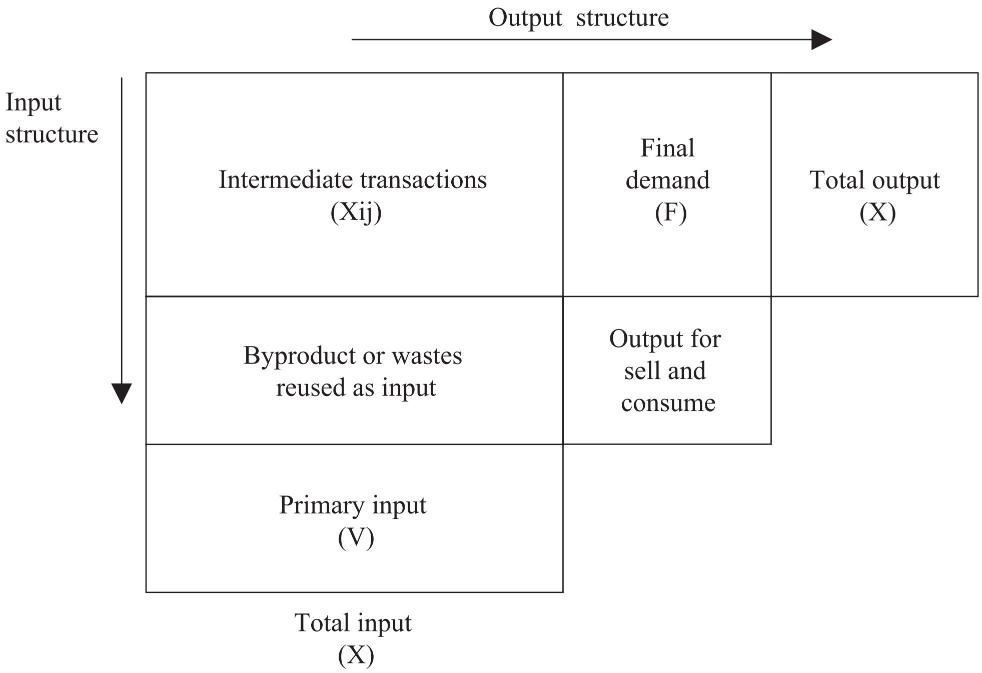

Figure 2 The internal linkage among activities of alternative agriculture system.

$$
\begin{array}{l}
a_{11}X_{11} + a_{12}X_{21} + \ldots\ldots\ldots + a_{1j}X_{il} + Y_1 + E_1 = X_1 \\
a_{21}X_{21} + a_{22}X_{22} + \ldots\ldots\ldots + a_{2j}X_{i2} + Y_2 + E_2 = X_2 \\
\vdots \\
a_{il}X_{ij} + a_{i2}X_{2j} + \ldots\ldots\ldots + a_{ij}X_{jj} + Y_i + E_i = X_i
\end{array}
$$

Where

X(ij) = value of by-product and waste from activity i to be reused in activity j

X(i) = value of total by-product and wastes from activity (i)

Y(i) = value of output from activity (i) for personal consumption and sharing among neighbors in the community

E(i) = value of output from activity i for selling at the market

$$a(ij) = \frac{X_{ij}}{X_i}$$ = Technical Coefficient of by-product and waste from Activity i to be used in activity j and total output of activity I

The following assumptions of this study are used for construction the Input-Output Table.

1. Homogeneity: each unit of output is produced from the same type of inputs;

2. Proportionality or fixed input ratio: when amount of output is changed, the proportion of input used will change accordingly; and

3. Constant return to scale: the structure of inputs will be fixed even though the production expands.

So we can now develop an Input-Output

Table 1 Input-output table of alternative agriculture at farm level.

Output / Input		Byproduct from activity i reused in activity j					Output i	
		(1)	(2)	(3)	.....	(s)	Final	Total
Input from reused byproduct								
	(1)	X_{11}	X_{12}	X_{13}	.....	X_{1s}	F_1	X_1
	(2)	X_{21}	X_{22}	X_{23}	.....	X_{2s}	F2	X_2
	(3)	X_{31}	X_{32}	X_{33}	.....	X_{3s}	F_3	X_3
	.....	....				.....	.....	.....
	(S)	X_{s1}	X_{s2}	X_{s3}	.....	X_{ss}	f_s	X_s
Farm profit or loss								
	(V)	V_1	V_2	V_3	.....	V_s		V
External input from farmer and family								
	(1)	m_1	m_1	m_1	.....	m_1		m_1
	(2)	$m^1{}_2$	$M^2{}_2$	$M^3{}_2$	.....	$M^s{}_2$		M_2
	.....	1	2	333	-	s		.....
	(m)	m_m	m_m	m_m	.....	m_m		m_m
Total input		X_1	X_2	X_3	.....	X_s		
Internal Input from farmer and family								
Land (rai)		La_1	La_2	La_3	.....	La_s		La
Labor(hrs)		Lo_1	Lo_2	Lo_3	.....	Lo_s		Lo

Table of an Alternative Agriculture system at the farm level as follows:

The sectors or activities can classify by physical characteristics between crops and animal. So we will classify as 8 activities:

1. Rice plant
2. Vegetables crops or soil covered crops, which are the lowest level tree
3. Fruit crop, or medium-level trees
4. Wood tree, or highest-level trees
5. Raise fish in a pond or a rice field
6. Chicken
7. Swines
8. Cattle

There are various ways of calculating the monetary value assigned to the variables. Farmer's actual costs can be used in some cases. At other times the valuation of final output products must be based on a combination of consumption, community distribution and sale – a calculation based on the sold value of the product related to the amount consumed multiplied by the retail price. Market price can be used for wastes or byproducts which are available in a market, but the value of byproducts such as fallen leaves, shade value, and wind breaks, for instance, cannot be estimated.

The target population of this study was a group of 200 farmers in 2 Amphurs (districts) of Khon Kaen Province who had adopted alternative agricultural techniques on the whole or part of their land, and were continuing to use this system at the time of data collection. 50 farmers were selected for study by using the stratified random sampling technique. (Prayukvong, 1997)

RESULTS

Most farmers in the case study group owned several plots of land. The average total area of land holding from each of these plots were to 20 rai, located in a rainfed area. The alternative farming systems encountered in the case study were small plot located near the owner's house. There were usually about 4-8 activities on these plots, such as rice and vegetable cropping, fruit growing in an orchard, and chicken raising, although the choice of activities depended on the farm location and the amount of family labor available.

Since AA techniques have become more widely accepted, the use of waste and/or by-products has increased, and also their market price, which, prior to the idea of reusing such things, was zero. During the time of data collection for this study, the market prices of selected waste/byproducts was also observed, and the data collected are shown in Table 2.

The data collected from all farms in the study groups and average were used to construct an I – O Table and a technical coefficient was calculated as follows:

The value of technical coefficients from table 4 were very low, which could be due to various reasons, for example:

a) The monetary value assigned to waste- and by-products was actually a market value, which in practice would be a low value and not reflect the use value of the product. However, the trend of market prices of such products is increasing, due to increasing demand.

Table 2 Market price of selected farm waste/by-products.

By – product/ waste source	Particulars of waste/by-product	Unit of measurement	Market price Per unit (baht)
Rice plant	Straw	Pick-up truckful	500
	Broken pieces of rice seed	kilogram	5
	Rumkoa	"a large can"	10-15
	Husk	N/A*	N/A*
Vegetables	Seeds/inedible portions	Number	Depends on type
	Old leaves	Kilogram	1
	Rest of dead parts	ton	500
Fruit crops	Inedible portions of plant	Number	Depends on type
	Overripe fruit	Kilogram	1
	Parts of dead tree	ton	500
	Fallen leaves	N/A*	N/A*
Wood tree	Formerly unused parts	Number	Depends on type
	Fallen leaves	N/A*	N/A*
Fish pond	Used water from fish pond	N/A*	N/A*
	Pond mud	ton	500
Chicken/swine /cattle	Animal dung	ton	500

Source: Prayukvong, 1997.
*N/A: not currently sold at market, but one appears to be developing

b) Positive externalities such as windbreak or shading arising from internal farm activities were not measured for this model.

c) It was very difficult to precisely measure the quantity of waste-and by-products reused.

d) The techniques of reused byproducts and wastes are developed by farmer's wisdom and traditions, which make the number of techniques limited, and the distribution of particular knowledge narrow. Such uses are usually ignored by government extension workers or academic researchers, who tend to feel the only use of by-or waste products is for organic fertilizer.

CONCLUSION AND RECOMMENDATIONS

The technical coefficiency occurred from the integration techniques of Alternative Agricultural system, which is a complementary and supplementary relationship among multiple products. This technique is the heart of Alternative Agricultural principles that treat a farm like an ecological system. There are not widespread homogeneous techniques, but the techniques will be different for each location, type of crop and manure, and other variables.

The value of technical coefficiency are small

Table 3 Input-Output table of alternative agriculture systems at the farm level from average of case studies.

Unit : baht

Output / Input	Byproduct or waste from activity i reused in activity j								Output i	
	rice	veget.	fruit	wood	fish	Chicken	Swine	Cattle	Consume &sell	Total
Rice	199.13	21.67	51.55	1.43	-	-	-	64.14	4,295.30	4,633.22
Vegetable	20	91.57	-	-	58.57	42.78	2.2	-	3,534.12	3,749.24
Fruit	-	-	222.69	-	10.38	-	1.92	-	4,481.32	4,716.31
Wood	-	-	-	-	-	-	-	-	552.00	552.00
Fish	-	4.31	31.37	-	-	-	-	-	5,112.24	5,147.92
Chicken	50.84	55.75	35.61	8.82	17.75	-	-	-	3,611.37	3,780.14
Swine	60.78	8.37	11.43	-	-	-	-	-	3,403.56	3,484.14
Cattle	26.79	15.38	13.61	-	2.35	-	-	-	1,196.00	1,254.13
External Inputs	2,535.93	351.36	1,802.61	1,067.44	2,185.28	2,185.28	2,068.78	811.98		
Profit/Loss	1,739.75	3,200.83	2,547. 44	-525.69	2,873.59	1,552.08	1,411.24	378.01		
Total	4,633.22	3749.24	4,716.31	552.00	5,147.92	3,780.14	3,484.14	1,254.13	26,185.91	27,317.10

Source: Prayukvong 1997

Table 4 Technical coefficient table of alternative agriculture system at farm level average from case studies.

	Rice	Veget.	Fruit	Wood	Fish	Chicken	Swine	Cattle	Consume &Sale	Total
Rice	0.043	0.006	0.011	0.003	-	-	-	0.051	0.164	0.170
Vegetable	0.004	0.024	-	-	0.011	0.011	0.001	-	0.135	0.137
Fruit	-	-	0.047	-	0.002	-	0.001	-	0.171	0.173
Wood	-	-	-	-	-	-	-	-	0.021	0.020
Fish	-	0.001	0.007	-	-	-	-	-	0.195	0.188
Chicken	0.011	0.015	0.008	0.016	0.003	-	-	-	0.138	0.138
Swine	0.013	0.002	0.002	-	-	-	-	-	0.130	0.128
Cattle	0.006	0.004	0.003	-	-	-	-	-	0.046	0.046
Profit/loss	0.376	0.854	0.540	-0.953	0.560	0.411	0.404	0.716		
External Input	0.547	0.094	0.382	1.934	0.424	0.578	0.594	0.233		
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		

Source: Prayukvong 1997

because there are no market price or no estimation technique to estimate all the reused input or the benefit from them. However, it does not make alternative agriculture system less beneficial, especially when compared to monocropping. Alternative systems reuse most of the by-and waste products of the crop production process, which monocropping simply disposes of these wastes, at additional social and environmental costs. Beside, the value of technical coefficients have a potential to be higher in the future through the development of reused techniques

If the government uses fixed and rigid techniques to evaluate these systems, they will not be seen as providing a great benefit. The true value of integrated systems can only be shown if the many integrated factors are fully accounted for, and they are not looked at only as a smaller-risk system. Policy makers who wish to promote alternative agriculture should understand this and work to increase researches on the techniques and valuation of reusing on-farm products.

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