THE POLICY ANALYSIS MATRIX OF RICE CULTIVATION IN INDIA

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ABSTRACT

This paper combines policy analysis matrix techniques to model the analysis of profitability from farming. Policy analysis matrices are computed for a sample of rice growers located in the wetland of the *Tamil Nadu* (Southern India) under observed conventional and profit-efficient farming conditions. While conventional analysis points to a lack of profitability, farmers are shown to make positive profits at private and social prices when data reflecting efficiency adjustments are used in the analysis. The main conclusion is that the usefulness of the policy analysis matrix might be substantially enhanced by simulating profitability after efficiency-improving managerial decisions have been adopted.

Keywords: *Tamil Nadu Rice growers*, Policy Analysis matrix, NPC, EPC, ERP, DRC, Indian agricultural policy, multifunctionality.

Abbreviations used: CAP (common agricultural policy), c.i.f. (cost, insurance and freight), CMO (Common Market Organisation), DEA (data envelopment analysis), Nominal Protection Coefficient (NPC), Effective Protection Coefficient (EPC), Effective Rate of Protection (ERP) and Domestic Resource Cost (DRC) f.o.b. (free on board), OECD (Organisation for Economic Cooperation and Development), PAM (policy analysis matrix).

THE POLICY ANALYSIS MATRIX OF RICE CULTIVATION IN INDIA
Introduction

This paper evaluates the private and social profitability of farming systems by the use of the policy analysis matrix (PAM). Since the seminal work by Monke and Pearson (1989), the PAM has been widely employed to compute market-driven and social profits for a variety of farming systems under different technological and institutional scenarios. Here, it is shown that important additional insights might be obtained if the farmers' efficient behaviour is considered, in addition to their observed behaviour. This methodological approach is applied to rice farming in the Tamilnadu rice growers, a coastal wetland with great ecological value and located in the Southern Region of India. This empirical application responds to the concern over whether or not those Tamilnadu farming systems that can be deemed multifunctional, because of the important environmental functions performed, will be able to survive in the policy context of the post-2003 common agricultural policy (CAP).

The Uruguay Round of the GATT (1986-94) paved the way for an improvement in the access of third country exporters to the internal Indian market, and a further move in the direction of trade liberalisation is currently envisaged, as a likely outcome of the Doha Round negotiations (Swinbank, 2005). Partial or total decoupling of agricultural support from current production levels has been the answer of Indian policy-makers to the criticisms raised by foreign competitors concerning the socalled trade-distortion effects of the CAP.

For Indian authorities, the political problem of supporting farmers' incomes in an increasingly open economic environment has been further compounded by the need to take on board the impact of trade liberalisation on the non-commodity outputs of Indian agriculture. There is a growing recognition that, beyond its primary function of supplying food and fibre, agriculture can provide environmental benefits and contribute to the sustainable management of renewable natural resources, as well as to the preservation of biodiversity, and the maintenance of the economic viability of less favoured rural areas. These new concerns are frequently summarised under the heading of multifunctional agriculture and have become an integral part of the Indian model of agriculture (EC, 1999, 2000). The research concerning the multifunctional character of agriculture is no longer restricted to international trade policy. A recent book included a variety of papers on different aspects of the multifunctionality of agriculture, focusing on the Spanish case (Gómez-Limón and Barreiro, 2007), while Spanish research on multifunctionality is reviewed in Reig (2006). Furthermore, starting with a basic piece of analysis by the OECD (2001), a variety of analytical tools to be used in the modelling of multifunctionality have been discussed in the last few years (Randall, 2002; Buysse *et al.*, 2007) and some of them, mainly concerned with assessing social preferences, have been put to use in Spain (Gómez-Limón and Atance, 2004; Kallas *et al.*, 2007).

Rice (*Oryza sativa* L.) farming provides an interesting case of a multifunctional crop that performs an important ecological role and where the IU has assumed the need to provide more room for imports from developing countries. Rice cultivation in Mediterranean wetlands represents a system of land management that, besides helping to shape highly valued traditional landscapes, performs an important non-marketable function linked to the protection of biodiversity and the environment. Tamilnadu rice growers is a protected wetland area that is representative of the sort of rice fields that were mentioned as a source of positive environmental externalities in the review of the Indian literature on agricultural multifunctionality, commissioned by Pragadeeswaran, 2007.

The private and social profitability of rice farming is assessed, as previously noted, using the PAM. In addition, this paper goes one step beyond conventional profitability analysis: instead of adopting a purely static viewpoint based on what farmers are currently doing, the perspective of what they could do in order to rise to the challenge posed by international competition is introduced. Rice farmers will have to adjust in the coming years to a less protective policy environment, by using their productive assets more efficiently and cutting costs, thereby improving their chances of survival in the face of strong import competition. Hence, a clear distinction between observed and efficient farming behaviour is drawn, leading respectively to observed and efficient outcomes. Efficient[1] conditions are potential for most of the farms and represent the productive plans that would prevail if farms were optimally operated, in terms of profit-efficiency.

Usually, the analysis of farming systems has attempted to assess farms' viability by dealing with actual farmers' behaviour, implicitly assuming that all farmers behave efficiently. But, one could legitimately ask: what would happen if the current farming practices of some individual farmers were inefficient when compared to best practices under presently available technologies? The answer to this question has important economic policy implications. The impact of agricultural policies on farmers' income might be widely different under observed and efficient behaviours. Likewise, the assessment of private and social profitability for a particular farming system can change substantially after major input adjustment decisions have been adopted in response to the diffusion of best management procedures. Profits obtained after all those adjustments could provide a useful benchmark for current production practices, showing whether enough room exists for an improvement in farms' financial situation.

In this paper *efficiency* is used in connection with the PAM, refers to a social benchmark for the calculation of costs and revenues based on the adoption of international prices and the removal of the effects of subsidisation and taxation.

DATA AND SAMPLE: THE SOUTHERN INDIA

The study relied on secondary data pertaining to export of major agricultural commodities in Tamil Nadu. The secondary data included production of the selected agricultural commodities in Tamil Nadu and India, export and import prices, domestic wholesale and world market prices for the periods between 1994-95 and 2008-09 at district and state level. These data were collected from various issues of Seasons and Crop Report of Tamil Nadu, Agro Stat published by different sources and web database of Food and Agriculture Organization and IndiaStat. Value of export of agricultural commodities through Chennai and Tuticorin ports was also collected from the custom houses (Sea Cargo) for the periods of ten years (1999-2000 to 2008-09).

The price data are monthly quotations for nominal spot price (US $/metric ton) for specific agricultural commodities (like rice, cotton, sugar, tea, coffee, tobacco and groundnut etc) were collected from UNCTAD website. The data span from January 1994 to December 2010 was collected. The dataset used in this paper corresponds to a sample of 337 single crop rice farms located in the Tamilnadu districts. The data were collected from a comprehensive survey carried out by the authors with support from the Tamilnadu Ministry of Agriculture and correspond to the year 2010. The dataset provides data for one output and seven inputs. Output is measured in kilograms of rice production. The only fixed input is cultivated land, measured in hectares. Variable inputs are: labour (working days), in addition to capital, fertilisers, seeds, herbicides and fungicides, all of which are measured in Indian rupees.

Construction of the PAM for rice cultivation in the Southern India The policy analysis matrix: theoretical aspects

PAM is essentially a double-accounting technique that summarizes budgetary information for farm and post farm activities. While simple to use, it is theoretically rigorous and derived from social cost-benefit analysis and international trade theory in economics. The basic steps in using the PAM method are identifying the commodity system, assembling representative budgets for each activity in the system, calculating social values, aggregating the budgetary data into a matrix, analyzing the matrix and simulating policy changes. The method rests upon a familiar identity: Profit = Revenue – Costs. For reasons that will soon be apparent costs are divided into those inputs that are traded on international markets (fertilizers, pesticides, hybrid seeds) and those domestic factors (labour, land, and capital), which are not traded internationally.

This gives us the following profit identity:
Revenue – Cost of tradable inputs – Costs of domestic factors = Profit

PAM is measured in two types of prices: private and social, which are defined clearly in the context of working with PAM. Private Values, are prices at which goods and services were actually exchanged and those used in the budgets the price of crop, the cost of seed, fertilizers, farm yard manures, pesticides and the going wage rate. These are also called market or financial prices. Social values are the prices, which would prevail in the absence of any policy distortions (such as taxes or subsidies) or market failures (such as monopolies). They would reflect the value to society as a whole rather than to private individuals, and were the values used in economic analysis when the objective is to maximize national income. These are sometimes called shadow prices, efficiency values, or opportunity costs. The determination of social values is one of the main tasks of economists, since these values offer the best indication of optimizing income and social welfare. For internationally traded goods, world prices [Free on Board (FOB) for exports and Cost Insurance and Freight (CIF) for imports] were used and in case of domestic factors, which are not traded on international markets, figuring out social prices would be difficult and one way to do so would involve mentally subtracting the effects of policy. The social costs have been calculated using value marginal product approach, using factor share (Si) of various inputs (Xi) together with the mean values of inputs and outputs (Y) and prices (Pi). The computation of the social cost of input is as follows.

$$P\,x\,i = [(Si / Xi)^{*}\ Y]\ Py$$

Once all private values have been matched with their social equivalents, two identities would be arrived.

Private revenue – Private cost of tradable inputs – Private cost of domestic factors = Private profit

Social revenue – Social cost of tradable inputs – Social cost of domestic factors = Social profit.

Table:1 Policy Analysis Matrix

Description	**Value of outputs**		**Value of inputs**		**Surplus**
	Tradable	**Non-Tradable**	**Tradable**	**Non-Tradable**	
Private prices	A	-	B	C	N = A – (B+C)
Social Prices	D	-	E	F	O= D- (E+F)
Policy Transfers	G	-	H	I	P= (N-O)

An important thing is that for a given commodity system, the costs and profits would represent an aggregate for all activities from farm to wholesale. For revenues, A is the wholesale price, and E is the world price of the comparable product in the comparable location.

From this table, several useful values would appear. Private profit (N) is the aggregate measure of net returns for all activities in the system and a high value would suggest a system that is competitive from a financial point of view. In other words, profits being generated for the participants in that system. A negative value would be a strong indication that the system is unsustainable, since there are no incentives for individual firms or farmers to participate and they would leave the industry.

In contrast, social profit (O) would represent the foreign exchange saved by reducing imports or earned by expanding exports of a unit of this commodity. A positive value would indicate that production is adding to national income, while a negative value would suggest that the country as a whole would be better off in terms of national growth by not producing that commodity. As such, it is an indication of international comparative advantage. Cell P is the difference between N and O, and it describes the value of the resources going in to (if positive) or coming out of (if negative) the commodity system from the economy as a whole.

In the Ricardian one-factor-two good model, countries will export goods that their labour produced relatively efficiently and imports good that their labour produced relatively inefficiently. In other words, a country's production pattern is determined by comparative advantage. Samuelson (1971) and James (1971) postulated in their Specific Factor Model that differences in resources would cause countries to have different relative supply curves, and thus would result in international trade. In this model, factors specific to export sectors in each country would gain from trade, while factors specific to import sectors would lose. Mobile factors that can work in either sector may either gain or lose. One of the most influential theories of international economics developed by Eli Heckscher and Bertile Ohlin often referred as Heckscher – Ohlin (Factor-Proportions) theory showed that comparative advantage is influenced by the interaction between nations' abundance of resource intensity (Technology) used in the production of different goods. In other words, countries tend to export goods that were intensive in the factors with which they are abundantly supplied (Krugman and Obstfeld, 2004).

However, trade can be resulted from economies of scale (internal-within the firm or external-within the industry), imperfect competition and difference in technology. Dumping is a profit maximizing (imperfect competition) strategy that occurred when export sales were more price responsive than domestic sales. Furthermore, international factor movements, trade policy instruments (like tariffs, quotas, subsidies and trade restrictions), macroeconomics and controversies in trade policies among countries would also greatly influence the trade participation and benefits.

Measures of Competitiveness

Nominal Protection Coefficient (NPC), Effective Protection Coefficient (EPC), Effective Subsidy Coefficient (ESC) and Domestic Resource Cost (DRC) are the indices used in the computation of the trade competitiveness of commodities. These indices are calculated either under exportable hypothesis or under importable hypothesis depending upon whether the commodity under consideration is treated as an exportable or an importable item. Under exportable hypothesis, the domestic good would compete at foreign port. Under importable hypothesis, the competition is supposed to be taking place at domestic port. Border price under the exportable hypothesis is Free On Board (FOB) price, net of the transportation costs (both domestic and international), port clearance charges, marketing costs, traders' margin and processing costs necessary to make the commodity tradable. Under importable hypothesis, the relevant border price to be compared to farm gate price is Cost, Insurance and Freight (CIF) price at out port plus the domestic transport cost, port charges, handling cost etc. Four different cases and the suitable measure of competitiveness for application to each category (Datta, 2001) is furnished in the following Table.2.

Table:2 Competitiveness Measures of Agricultural Export

Whom	What
Exclusive exporter / importer de-linked from agro-processing and farming	NPC
Exporter / Importer engaged in value-addition through agro-processing	EPC, ESC, DRC
Exporter / Importer engaged in agro-processing of main product and also backwardly integrated with farming activities	DRC
Exporter / Importer engaged in agro-processing of main product as well as byproducts and also backwardly integrated with farming activities	DRC

Though the aforesaid measures of competitiveness are theoretically sound these measures lack in few fronts, which are also crucial for export of commodities. These measures concentrated only on the price or resource use and not the quality dimension. There can be several varieties of same commodity and usage of wide range of input mix for cultivation. There are lot of difficulties in estimating the shadow prices and adjustments for CIF or FOB which would raise possibilities of running into error by different researchers. Policy instruments like exchange rates and tarification were also not considered in calculations. Ministry of Commerce and Industry (2001) opined that participation of Indian farmers is very marginal. On the other hand, selective extension of high domestic support and export subsidies to a few commodities in the developed countries has not only eroded the competitiveness of products originating in developing countries but had also introduced an unfair competition for local producers. Evidences indicated that the international agricultural markets were imperfectly competitive in structure (Deodhar, 2001). As reported by Gill and Brar (1996), the trade in agricultural commodities was dominated by a few multinational companies and trading agencies. Emprical studies of Deodhar and Sheldon (1995) also indicated that multinational firms enjoyed a certain degree of market power in the agricultural export markets. It would therefore be appropriate to consider a measure to assess the competitiveness of agricultural commodities in traders' perspective instead of farmers' resource use efficiency.

Nominal Protection Coefficient (NPC)

The Net Protection Coefficients were estimated for selected agricultural commodities under exportable hypothesis for the period from 1996-97 to 2008-09 in order to measure the extent to which domestic prices diverge from border equivalent prices. It was estimated as follows.

$$NPC = P_d/P_b$$

Where,

P_d = the domestic producer price; and

P_b = the border equivalent producer price computed as explained below.

Border equivalent prices or world prices adjusted for transport, marketing and processing costs, were estimated to serve as yardstick to indicate the extent to which domestic prices have been distorted by the various government interventions. The border equivalent producer price at the farm gate was derived by deducting ocean freight and insurance charges from the world price to obtain f.o.b. border price. From the latter, transport, processing and marketing charges from the farm to the domestic market were deducted and the value of by-products was added to arrive at the border equivalent producer price. Algebraically,

$$P_b = P_w - T_w - T_d - C_d + V_b$$

Where,
Pb = Border Price
Pw = World Price
Tw = Ocean freight and insurance charges
Td = Handling, transport and marketing charges from port to domestic markets
Cd = Transport, processing and marketing charges farm gate to domestic market
V_b = The value of by-products.

An NPC greater than one would show that the domestic market price of the commodity exceeded the border price, which discouraged the export of that particular commodity.

Effective Protection Coefficient (EPC)

In the present study, Effective Protection Coefficient (EPC) was estimated as the ratio of value added in private prices to value added in social prices. The EPC indicates the combined effects of policies in the tradable commodities markets.

$$EPC = VP_d / VP_b$$

Where,
VP_d = the value added in domestic price (private price)
VP_b = the value added in border price (social price)

An EPC greater than one would indicate positive incentive effects of commodity policy (an export subsidy to producers), whereas an EPC less than 1 shows negative incentive effects (a tax on producers). Both the EPC and the NPC ignored the effects of transfers in the factor market and therefore do not reflect the full extent of incentives to farmers.

Domestic Resource Cost (DRC)

To measure the comparative advantage (or) efficiency of Indian agricultural commodities in the world market, domestic resource cost coefficient was estimated as given below.

$$DRC = SP_d / VP_b$$

Where,
SP_d = the shadow price of the agricultural commodities; and
VP_b = the value added measured at world prices.

DRCs greater than one would indicate that the value of domestic resources used to produce the commodity exceeded its value added in social prices. Production of the commodity, therefore, does not represent an efficient use of the country's resources. DRCs less than one would imply that a country has a comparative advantage in producing the commodity. Values less than one would mean that the denominator (value added measured at world prices) exceeded the numerator (the cost of the domestic resources measured at their shadow prices).

DRC, the most useful indicator of the three, is used to compare the relative efficiency or Comparative advantage between agricultural commodities and defined as the shadow value of nontradable factor inputs used in an activity per unit of tradable value added (F/(D-E)). The DRC indicates whether the use of domestic factors is socially profitable (DRC<1) or not (DRC>1). The DRC values were calculated for each commodity in each State. The commodities have been ranked according to the DRC values and this ranking was taken as an indication of comparative advantage or disadvantage within that State. A state will have a comparative advantage in a given crop if the value of the DRC for that crop is lower than the DRC for other crops grown in that state. Although the DRC indicator is widely used in academic research, its primary use has been in applied works by the World Bank, the Food and Agriculture Organization, and the International Food Policy Research Institute to measure comparative advantage in the developing countries. However, DRC was found to be biased against activities that relied heavily on domestic nontraded factors such as land and labor. A good alternative to the DRC would be the Social Cost/Benefit (SCB), which accounted for all costs (Fang and Beghin, 1999).

Effective Rate of Protection (ERP)

To measure the structure of protection like tariffs, import bans, quantitative restrictions on Indian rice exports, Effective Rate of Protection coefficient was estimated, which measured the percentage increase above value added in world prices that was permitted by the structure of protection.

$EPC = VAD_p/VAB_p$

$ERP= (VAD_p- VAB_p)/VAB_p$

Where,

VAD_p = Value added at domestic price

VAB_p = Value added at border price

$ERP = EPC – 1$ or $EPC = ERP +1$

Greater the ERP, higher would be the protection for that commodity to be traded in the world markets and vice versa.

Since the seminal work by Monke and Pearson (1989), the PAM approach has been widely used. It has been applied to studying the profitability of maize cultivation in Portugal, before this country joined the Indian Community (Fox *et al.*, 1990), and also in various developing countries (Nelson and Panggabean, 1991; Pearson *et al.*, 1995; Adesina and Coulibaly, 1998; Fang and Beghin, 2000). The possibility of incorporating environmental considerations into the PAM has opened new perspectives for the analysis of farming in areas of high ecological value (Kydd *et al.*, 1997; Pearson *et al.*, 2003). The results of PAM analysis are always contingent to a specific set of output and input prices and input/output technical coefficients, but matrices can be updated to incorporate both technological and price changes.

In this paper, the PAM methodology is employed in order to learn about the possibilities of maintaining rice cultivation in the Tamilnadu rice growers. As previously noted, two different matrices are built. The first is based on the observed values for inputs and outputs, revenue, costs and profits.

RESULTS AND DISCUSSION

The first finding comes from conventional PAM analysis and shows that rice farming in the Tamilnadu was a non-profitable agricultural system, according to the conditions prevailing in 2010, in the aftermath of the *Mid-Term* CAP reform. The lack of social profitability is even more noteworthy than farmers' private losses. Lack of policy support shows up in output valuation, which drops, and in the elimination of subsidies. Costs are also lower at social prices, but not enough to compensate for the income loss. The main item with a different valuation at social and private prices is land, because the social opportunity cost of the land rent is zero, as explained previously.

Table:3 PAM for Tamil Nadu Rice Export (in Rupees)

Description	Value of outputs		Value of inputs		Surplus
	Tradable	Non-Tradable	Tradable	Non-Tradable	
Domestic prices	(A) 8577.67	-	(B) 1528.23	(C) 3238.02	N= 3811.42
Economic prices					
Social Price	(D) 8196	-	(E) 2368.75	(F) 3780.91	O= 2046.34
Policy transfers	381.67	-	840.52	542.89	P = 1765.08

However, trade can be resulted from economies of scale (internal-within the firm or external-within the industry), imperfect competition and difference in technology. Dumping is a profit maximizing (imperfect competition) strategy that occurred when export sales were more price responsive than domestic sales. Furthermore, international factor movements, trade policy instruments (like tariffs, quatos, subsidies and trade restrictions); macroeconomics and controversies in trade policies among countries would also greatly influence the trade participation and benefits.

Assumptions for the present study: Rice Policy Analysis Matrix

Value of non-tradable output: Not available
Value of tradable output:
(i) Straw – Straw boards and artistic works
(ii) Bran – Bran oil, fuel and ashes
Value of tradable input:
Seed, Fertilizer, Pesticides cost
Value of non-tradable input:
Family Labour, Attached Farm Servants, Bullock Labour Owned, Machine Labour Owned, Irrigation Charges.

It is presented in Table.3 the policy analysis matrix for Tamil Nadu rice export. The data in the first row provide the measure of private profitability (Rs. 3811.42) demonstrates the competitiveness of the agricultural system, given current technologies, prices for inputs and outputs and policy. The social profit (Rs.2046.34) indicates that the state uses scarce resources efficiently and has a static comparative advantage in the production of rice at the margin. In other words, the cost of domestic production exceeded the cost of imports suggesting that the sector can survive without government support at the margin. The difference between the private and social values of revenues, costs and profits was Rs.1765.08 which can be explained by policy interventions. In this model, factors specific to export sectors in each country would gain from trade, while factors specific to import sectors would lose.

Table:4 Competitive Measures for Rice

Year	NPC	EPC	ERP	DRC
2000-01	1.1	0.59	-0.41	0.13
2001-02	0.9	0.84	-0.16	0.12
2002-03	1.2	1.43	0.43	0.19
2003-04	1.0	1.30	0.30	0.30
2004-05	1.0	1.44	0.44	0.44
2005-06	1.0	1.20	0.20	0.43
2006-07	1.1	1.06	0.06	0.26
2007-08	0.8	0.97	-0.03	0.33
2008-09	0.4	0.96	-0.04	0.36
2009-10	0.6	0.93	-0.07	0.45
Average	0.91	1.07	0.07	0.30

Rice

In general the trade competitiveness of a commodity would reveal whether a country has an opportunity to encourage its export trade. The estimated rice policy measures for the period from 2000-01 to 2009-10 are furnished in Table 5.16. It could be seen from the table that the NPC values for rice was less than unity in 2001-02, 2007-08 through 2009-10. These indicate that rice had been largely competitive on exportable basis during the aforesaid period. The rest of the period rice was found to be not competitive. EPC estimates showed that only in four years out of ten year reference period, it was more than one indicating that the Government policy through development programmes had protected the crop only in those years. The average NPC and EPC were 0.91 and 1.07 respectively. The EPC had been declining from 2006-07 onwards which indicate an increasing rate of competitiveness of rice. These may plausibly due to adoption of advanced production technology.

An estimate of ERP shows that competitiveness was fluctuating over the time period. In the earlier years, rice production was highly competitive and there was the possibility of pulling out the resources to rice production. From 2007-08 onwards the ERP was found to be negative there by clearly indicating the disadvantages of diverting subsidized resources to rice production. Under these circumstances efficient use of resources in rice production is of paramount important to make rice production more competitive for which technology has to play a vital role rather than subsidizing the factor inputs.

Rice is the major crop in Karnataka State, had been largely competitive on an importable basis with its NPC values being below unity during the reference period. EPC revealed that Karnataka is an efficient producer of rice. Over the years, EPC had been declining, which implies an increasing rate of competitiveness of rice. This could be due to the emergence of efficient production technology and the impact of economic reforms in the country. The estimates of DRC revealed that the state had a comparative advantage in rice production (DRC was below one). The level of DRC shows that the value of domestic resources used in producing 1 ha of rice in Karnataka was less than the cost of its import. DRC level decreased in the post liberalization period, which reveals an improvement in the comparative advantage of rice production in recent years (Reddy *et al*., 2008).

The estimates of DRC revealed that the state had comparative advantage in rice production since the values were less than unity in all the period under consideration. These clearly indicate that the wage of domestic resources in producing one hectare of rice was less than the cost of export. This fact should be taken into consideration and the nation should take special care to conserve its wetlands. However, the levels of incentives provided to farmers are very meager as compared to the magnitude of protection in developed countries (Reddy *et al*., 2003).

CONCLUDING REMARKS

This paper performs a modelling exercise on the private and social profitability of a rice farming system located in the Tamilnadu, a protected wetland site of great ecological value located in the Southern Indian coast. A PAM based on observed data has been constructed. The results show that the average farm makes losses, both at private and social prices, when the opportunity costs of all the domestic factors involved in rice production are taken into account. In the long run, the survival of this system is clearly compromised because of its international competitiveness, an outcome that could seriously endanger the preservation of both a highly regarded semi-natural landscape and also a wealth of biodiversity.

An efficient PAM has been built on the basis of this information, yielding new estimates of private and social profitability. Now, farms are able to make positive profits and the society also obtains a net welfare gain from the resources allocated to rice production. So, an increase in the efficiency of rice growing may make this activity financially viable and guarantee the preservation of its multifunctionality. Also, PAM-based policy advice concerning the impact of distorting and efficiency-restoring policies on the profitability of rice growing is distinctively different under observed and profit-maximising scenarios.

It could be argued, with regard to the lack of social profitability of rice farms with observed data, that social profitability is too narrowly defined in the PAM context, because it does not include a direct appraisal of the worth of the positive environmental externalities that stem from rice cultivation. The PAM methodology could be extended by including the valuation of the public goods (landscape and biodiversity among them) jointly produced with the private or commercial output in the social row of the matrix. A trade-off could then arise between negative economic returns and the production of non-commercial, i.e. multifunctional, outputs. However, this line of thinking has not been pursued in this paper.

The lack of relevant empirical information that could be used for widening the scope of social efficiency prevents us from providing a sound justification of private and social losses grounded on society's quest for non-commodity outputs from agriculture. But differences between private and social profits per hectare can be used to establish a lower threshold for the valuation of the annual supply of public good services jointly produced with rice output. Then, the computed figure can be compared with an independent estimate, e.g. contingent valuation, of the value of those services to the public.

Instead of pursuing a line of analysis that concentrates on the construction of an environmental PAM, the possibilities offered by computing a virtual PAM, assuming profit maximisation on behalf of farmers, is explored. This helps to assess whether there is a way out of the current financial difficulties rice growers are experiencing that could allow the valuable non-commercial functions currently performed by this farming system to be maintained. The findings point to a very positive outcome, both in terms of private and social profits, after farmers adopt the best practices of efficient farms.

Finally, it is worth highlighting a couple of the conclusions of this research. On the one hand, it vindicates the potential of the policy analysis matrix to yield fruitful information about particular rice cultivation. Furthermore, the usefulness of this methodological approach may be substantially enhanced if the analyst can simulate the profitability of the system after all sorts of efficiency-improving changes have been adopted by farmers. On the other hand, the results of this research lead to a noteworthy conclusion in terms of economic policy. In order to preserve the nonmarketable function of the Tamilnadu rice system linked to the protection of biodiversity and the environment, local and regional authorities need to make a greater effort to spread the adoption of best practices among rice farmers, helping them to improve their profit efficiency and financial viability.

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