Agricultural Policy Options to Maintain Indonesian Rice Self-Sufficiency

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ABSTRACT

Rice self-sufficiency, defined as domestic production satisfying consumption at stable prices, has been achieved in Indonesia through a package of policies. Significant policies were the development of irrigation and the lowering of fertiliser costs to encourage their use as a necessary input for high-yielding rice varieties. However, these were high-cost policies and their continued effectiveness has been questioned with the slowdown in yield gains. More efficient policy mixes with an emphasis on research and extension have been suggested. This paper investigates the definition of Indonesian rice self-sufficiency and develops a framework to analyse the cost-effectiveness of policy options.

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Introduction

Indonesia has long had a policy of achieving self-sufficiency in rice, interpreted initially as domestic production satisfying consumption at stable prices (Mears and Moelyono 1981). In fact this policy has tended to dominate Indonesian agricultural policies (Hedley and Tabor 1989).

Rice self-sufficiency was first achieved in Indonesia in 1984 through the use of a package of policy instruments (Rosegrant et al. 1987, Parton etal. 1990). Significant instruments used were public investment in irrigation infrastructure and the lowering of fertiliser costs through subsidies, the aim of which was to encourage the use of water and fertilisers, necessary inputs for newly developed, high-yielding rice varieties. Other complementary policies were also seen as necessary ingredients to achieving rice self-sufficiency. These included the provision of pesticide subsidies and credit, at times raising producer prices above world prices, and some research and extension advice. Many components of the current mix of policies work in unison. For example, the expansion and upgrading of irrigated land and fertiliser and rice price policies complemented each other in achieving the production benefits of the newly developed, high-yielding rice varieties (O'Brien 1992).

However, there were high costs associated with achieving rice self-sufficiency through such policies. Budgetary expenditures on the fertiliser subsidy to farmers are currently around $500m but have at times reached twice this amount (World Bank 1992). Other possible costs include losses in economic efficiency, welfare costs and environmental damage from excessive fertiliser use. Moreover, the continued effectiveness of the current mix of policies is being questioned (Tabor 1992), especially in view of the slowdown in yield gains from the introduction of high-yielding rice varieties.

Rice self-sufficiency remains a goal of Indonesian policy, although redefined somewhat to allow a small level of imports in the short term (Manning 1992). Given questions concerning the cost and continued effectiveness of the current mix of policies, it is worthwhile considering other policy mixes and their cost-effectiveness. The policy mixes under current consideration have less emphasis on fertiliser subsidies and new irrigation infrastructure investment and more on research and extension advice, to shift farmers closer to efficient production frontiers (World Bank 1992).

This paper considers the policy options available to maintain Indonesian rice self-sufficiency. In the next section self-sufficiency is defined in some detail. This is followed by some background on the trends in inputs, production, consumption, trade and other relevant variables so as to give an overview of the operation and performance of the current mix of policy instruments. The policy instruments are described within a diagrammatic framework; the need to change the policy mix is then addressed in the context of the cost-effectiveness of current policy instruments. Finally, other policy options are assessed in terms of their cost-effectiveness.

Self-sufficiency defined

Self-sufficiency in its most basic sense means domestic production satisfying consumption. The basic supply demand identity is:

Production less seed and losses plus imports and stock changes
equals available consumption.

However, seed and losses and stock changes tend to be relatively small (Mears and Moelyono 1981) and self-sufficiency concerns mainly domestic production satisfying consumption. Other more detailed definitions

of self-sufficiency will be discussed throughout this section, but first the underlying objectives of self-sufficiency are considered.

Underlying objectives of self-sufficiency

In Indonesia, rice self-sufficiency is not pursued for its own sake. Clearly, there are underlying objectives that make the costs, such as high budgetary expenditures, worthwhile.

Food self-sufficiency is just one approach to achieving the broader objective of food security, which is basically concerned with ensuring adequate and stable supplies of food. However, self-sufficiency may not be the most effective approach to achieving food security. Relying solely on domestic production introduces greater production risks because there is a narrower range of potential climatic conditions. In some countries, such as Japan, food self-sufficiency is dependent on the availability of imported inputs and so is not self-sufficiency in any real sense. Moreover, this approach to food security is only as secure as the supplies of inputs. Alternative approaches to food security include holding stocks, direct investments or long-term contracts in food supplies from other countries or securing such supplies through market dependencies with domestic food processors, and developing a more efficient domestic production sector (ABARE 1988).

It has been argued that Indonesia has monopsony power in the world rice market and that self-sufficiency is thus cost-effective. However, allowing imports, and applying a tariff if it is believed Indonesia has some monopsony power in the world rice market, would be a more efficient means of satisfying consumption than the implicit quota introduced through a self-sufficiency policy (Fane 1992).

As rice is a basic foodstuff, self-sufficiency in rice has been justified on the grounds that it provides support for farmers and consumers, as well as stability in prices, politics and the macroeconomy. However, with development the importance of rice in production and consumption has and will continue to diminish, as will the possible merit of these justifications. Still, stability appears to be the main underlying justification for the rice self-sufficiency policy.

These objectives will be analysed in more detail later. However, it is worth noting at this stage that key instruments in the self-sufficiency policy (such as the fertiliser subsidy) have not changed over a period when the underlying objectives justifying such policies have changed, for example from addressing market failures such as in information to providing greater stability. These policy instruments must to be very flexible to remain optimal in such changing circumstances.

At what price or quantity?

It is evident from considering traditional stable supply and demand curves as functions of price that there is always a price or a constrained quantity where domestic production will satisfy consumption. Initially the total quantity demanded at the going price may exceed the total quantity planned to be supplied at that price. An excess demand situation may also occur as the result of the banning of imports, perhaps the easiest but most unjustifiable means of achieving self-sufficiency. With excess demand some buyers will be unable to satisfy demand. In such circumstances, prices will be bid up and plans revised until demand and supply equilibrate. In some situations, such as the banning of imports, the movement in prices can result in significant revenue transfers.

The level of prices and quantities at which domestic production and consumption equilibrate may not be socially acceptable. Thus a more meaningful definition of self-sufficiency would incorporate, explicitly or implicitly, 'acceptable' levels of price and consumption. What is 'acceptable' needs to be determined on some

concrete basis, for example, nutritional standards in the case of consumption. The initial definition of self-sufficiency used in Indonesia included the qualifier that domestic production needed to satisfy consumption at stable prices. If the consumption level were socially acceptable at the stable level of prices then this would indeed fit the more meaningful definition of self-sufficiency that has emerged. Socially acceptable consumption levels will tend to be based on minimum levels of nutrition achieved by the majority of the population and as such will be affected only indirectly by general economic factors.

Consumption patterns tend to change with development and rising incomes. If Indonesia follows the pattern of other developing countries then it would be expected that per capita demand for rice would gradually diminish as development progressed. In addition, Indonesia's calorie consumption per person is already high given its level of development, lying just below the estimated maximum level associated with the diet of high-income Asian countries such as Korea, Singapore and Japan (World Bank 1992). The cereals component of Indonesia's calorie consumption is also relatively high. It would appear, therefore, that by world standards and from an average nutritional point of view, the per capita consumption levels of rice associated with previous self-sufficiency targets and prices would be judged as acceptable and that the values of these per capita levels would tend to be high as development progresses. Even when per capita levels of consumption are acceptable there may be large groups of the population consuming unacceptably low levels. However, only policies that specifically target these groups should be considered to address this issue, not general policies that affect overall consumption such as price subsidies. Another aspect of changing consumption patterns, the diversification of products consumed, has implications for self-sufficiency. Self-sufficiency in a particular product such as rice becomes less relevant as development progresses, and the issue becomes more one of nutritional self-sufficiency.

Implications in an open economy

The discussion to this point has been in terms of a closed economy. In an open economy with excess demand, trade would take place at world prices until demand was satisfied. These traded prices would be lower than the prices at which excess demand would be satisfied in a closed economy. This leads to a truer or fuller definition of self-sufficiency as domestic production satisfying consumption in an open economy, or with domestic prices at world prices. To reflect this fuller definition, a definition that will be more relevant when Indonesia joins a regional free trade arrangement, the initial Indonesian definition of self-sufficiency would have to be qualified to incorporate domestic production satisfying consumption 'at stable world prices'

Timmer (1991) makes the point that 'getting prices right' is not the same as free trade at world prices, due to additional considerations such as the instability of world prices. He describes what he calls the 'stabilisation' approach or school of thought. This approach contends that efficiency is maximised when intervention is used to stabilise short-run prices but domestic prices reflect longer-run trends in international prices. Also, competitive marketing agents operate within the price bands established by intervention. More details on this approach are given in the section dealing with the need for policy change. The fuller definition of self-sufficiency would fit the stabilisation school of thought if world prices were qualified to refer to longer-run world price trends.

Indonesia has revised its position to a definition of self-sufficiency that is satisfied on a 'trend' basis. It is not clear exactly what this policy means, except that a level of imports or 'external supplies' is now being allowed in some years, for example when there is a drought, and is presumably being balanced by exports in other years. The 'trend' definition of self-sufficiency fits the stabilisation school of thought. An efficient buffer stock stabilisation scheme is likely to involve imports and exports determined on the basis of such factors as

optimum levels of storage and the impact of world prices. These optimum levels of imports and exports are unlikely to balance at the end of a fixed period, say five years. A policy imposing this arbitrarily could involve large costs. For example, initial years of drought, decreased domestic supplies and high import prices could be followed by 'balancing' exports at prices lowered as a result of the excess supplies stimulated by earlier high prices

A comprehensive definition and Indonesia's performance

Demand and supply are not just functions of the price of the commodity in question, as assumed earlier. For example, supply is influenced by the costs of production, which in turn are influenced by policies such as input subsidies. Similarly, demand is influenced by incomes, and these are affected by policies such as welfare support. While self-sufficiency may be achieved at world prices in an open economy, it may also be just a consequence of input subsidies stimulating production by lowering production costs. A truer definition of self-sufficiency needs to include not just domestic production satisfying consumption at world prices in an open economy but account being taken of food market distortions as well. Rather than saying self-sufficiency can be achieved at a price, it is perhaps more informative to say that there can be an economic cost to achieving self-sufficiency. Measuring the costs associated with self-sufficiency is far more informative than citing the self-sufficiency rate (ratio of the total value of domestic production to the total value of domestic consumption) that is often presented in the debate on self-sufficiency. For example, Indonesia and Thailand, both major exporters, have self-sufficiency rates of around or above 100 per cent, but Indonesia is currently achieving this at a high cost. It would be more informative to present these rates with and without particular distortions as has been done by Anderson and Tyers (1992). As an aside, it is interesting to note that Anderson and Tyers show that the removal of industrial countries' food market distortions improves the self-sufficiency of developing countries as a group (including Indonesia) and that this situation is further improved by the removal of the developing countries' own distortionary policies

The economic costs of achieving self-sufficiency should not be compared necessarily to zero costs. Often an open market policy will have associated costs; for example, there will generally be costs associated with the instability that often occurs in open markets. Self-sufficiency is not the same as stabilisation, and the costs of policies need to be compared to alternative policies aimed at achieving the same objectives — satisfying consumption or achieving stabilisation, for example.

In the period 1984–88 when few rice imports entered Indonesia, domestic prices, although higher than international prices (Fane and Phillips 1991), did follow the long-term trend in international prices. However, input subsidies were substantial over this period, ranging between $600m and $900m. Parton et al. (1990) use a price policy model to estimate what the production and consumption situation would be without fertiliser subsidies and price support. These estimates show that self-sufficiency in its strictest sense would not have been achieved in the period between 1985 and 1988 with estimated rice deficits of between 2,561 and 4,820 thousand tonnes.

The path to self-sufficiency

How was rice self-sufficiency achieved in Indonesia in 1984? Returning to the basic supply–demand identity, consumption has tended to gradually increase, as a result of both total population and per capita consumption increasing under such influences as improving incomes (Table 1). Population increased from an estimated

135.2 million in 1976 to an estimated 179.3 million in 1990, an annual growth rate of around 2 per cent. Real GDP per capita increased from around 500 tRp in 1983 to around 600 tRp in 1989, an annual growth rate of approximately 3 per cent.

Yield increases the key factor

Imports have been the balancing item in the basic supply–demand identity. Looking at the trend in production and imports, it can be seen that rice self-sufficiency was achieved through large increases in rice production, negating the need for imports. Stimulating production to satisfy consumption, within the constraints of stable prices, has been the main policy instrument. However, if production failed to satisfy consumption because of unforeseen circumstances such as a drought then stocks would be run down by the delegated authority, Bulog. Bulog regulates the market for rice and other commodities through its stock holdings, sales and purchases, including its exclusive control over rice exports and imports which are important instruments under trend self-sufficiency. Its objectives have been stated as stabilising consumer supplies and prices; promoting domestic production and producer incomes; supplying the military and civil service; and maintaining reserve stocks. Bulog receives input from other agencies on such aspects of its operations as floor and ceiling prices and provides input on related aspects such as fertiliser prices (through the relationship with rice prices).

The large increases in rice production were unexpected if past projections such as those of Mears and Moelyono (1981) are any guide. Mears and Moelyono, in their projections of rice consumption and production up to 1985 under alternate income elasticity and production growth rate estimates, only came close to self-sufficiency with upper bound production (based on, at the time, very optimistic production growth rate estimates) and lower bound consumption projections. As it turned out, the consumption projections were distributed around the actual outcome whilst even the most optimistic production projections were below the actual outcome.

Where did the increases in production come from — increases in areas under production (extensification), improvements in yields (intensification) or a combination of the two? The figures in Table 1 would suggest the latter although improved yields appears to be the dominant factor. Area under crop and area under irrigation, a necessary input for the use of high-yielding rice varieties, both increased.[1] However, the increase in yields was much more marked.

Rice is produced mainly in Java. During 1963-90, Java accounted for more than 52 per cent of total rice area and more than 60 per cent of total rice production. Among off Java provinces, North Sumatra and South Sulawesi were notable contributors to rice production with annual contributions of 6 and 7 per cent respectively. Substantial investment and intensification efforts would be required for areas outside Java to approach Java's level of rice production.

Large increases in inputs

What factors or policies were responsible for increases in yields? The answers to similar questions about increases in irrigated area are fairly obvious, but in the case of yields a number of interconnected reasons and relevant policies were at work. The introduction of high-yielding rice varieties following research at the International Rice Research Institute was a key factor, as were some of the policies that facilitated the

[1]There have been some losses of high-yielding irrigated areas as a result of factors such as urban encroachment and industrialisation. Policies aimed at restricting the conversion of some irrigated lands to other purposes have been put in place to try to arrest these losses.

availability and use of the necessary inputs for applying this new technology. The increase in irrigated area has already been discussed, but it can be seen from Table 2 that other key inputs such as fertilisers also increased. The increases in plantings of new varieties were such that, in 1987, high-yielding varieties constituted 95 per cent of total rice area plantings and 97 per cent of rice production. As an indication of the increase in credit, the number of rural credit banks grew from 545 in 1971/72 to 3,646 in 1986/87 (Hedley and Tabor 1989).

The story with regard to research and extension appears different. Research and development expenditures in 1990/91 prices fell from 104 bRp in 1982/83 to 78 bRp in 1990/91 (World Bank 1992). And although the number of extension workers rose from 1,584 in 1971/72 to 31,474 in 1986/87 (Hedley and Tabor 1989), expenditure per extension worker in 1990/91 prices fell, for example from an estimated 790 tRp in 1985/86 to 357 tRp in 1990/91 (World Bank 1992).

Policies aimed at increasing inputs

The higher rice prices and subsidised fertiliser prices obtained by farmers (Table 3) illustrate how policies were designed to promote the greater use of inputs and increase production. The design was quite explicit in some cases; for example, the ratio of rice and fertiliser prices was used explicitly in the setting of these prices. The ratio has declined in recent years as the fertiliser subsidy has declined. Improved productivity in the use of fertilisers, for example through the introduction of new technologies such as deep placement, means that the incentives for using fertilisers were even greater than these price ratios suggest. Series of information on irrigation subsidies and credit are not available. However, the available evidence suggests that these production inputs have been subsidised for as long as fertilisers have been. For example, the KUT scheme, aimed mainly at rice farmers, provides credit at rates that are subsidised to the extent of not covering some of the administrative costs, despite a rate of only 3 per cent being charged by the Bank of Indonesia (Fane 1991). The government also faces large costs for supplying irrigation water to farms. Costs currently run at about $US100 per hectare per year (World Bank 1992), and are not passed on to consumers. However, some policies, such as those that assist sugar production, counteract policies aimed at promoting rice production.

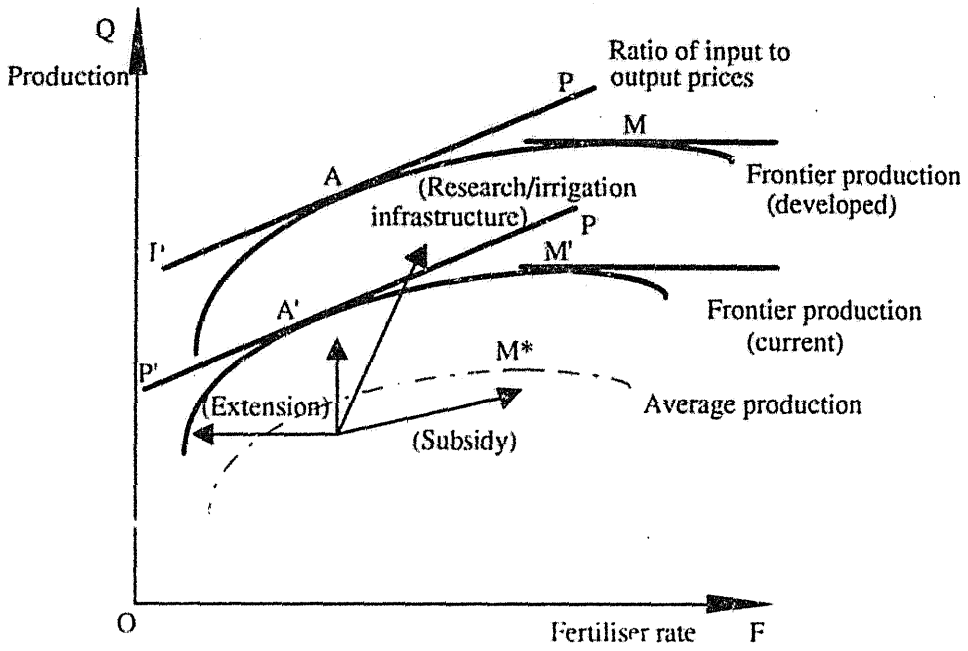
It is more difficult to describe the impact of research and development on increased production. Research and development tends to be lumpy in nature, in contrast to the more continuous nature of other inputs, and thus there is no obvious short-term relationship between expenditures on research and development and the associated benefits. Certainly, in the longer term, expenditure on research and development will lead to production benefits as it has in the past, one example being the development of high-yielding varieties of rice. The timing and extent of these benefits, however, will be difficult to predict.

Policy options

Figure 1 illustrates the various policy options within a production function framework. The figure contains three quadratic production functions in one input, in this case fertiliser. One represents the average production function currently facing farms which are evenly spread around this function. The other two represent frontier or technically efficient production functions for two separate technologies, one the current technology and the other a more advanced technology. The tangential lines are the ratio of input to output prices and touch the frontier production functions at the points of allocative efficiency, represented by *A*s. The points of maximum production are represented by *M*s.

The various policies can also be represented in the figure. The policies of raising producer prices and subsidising fertilisers can be represented by a flattening of the tangential lines, moving the points of allocative

Figure 1



efficiency towards corresponding points of maximum produc' ... idies could be represented in a similar fashion to fertiliser subsidies in a figure with more ...ts than just fertilisers, in particular capital. Irrigation infrastructure investment can be represented by the movement from an 'old' technology up to a 'new' technology. Research can similarly be represented by a movement upwards to a potential new production technology. Extension can be represented by a movement from the average pro luction function to the corresponding frontier production function.

Initially, the main objective of the policies was to move farms more tow' ds the highest possible point of maximum production *M* by subsidising inputs. Efficiency is now being promoted by agencies such as the World Bank (1992), so that the point of allocative efficiency *A* has become more relevant.

The need for policy change

If the current mix of policies has been deemed successful in the past by Indonesian policy-makers, why the concern ·th changing the policy mix? One reason, evident from the trends presented earlier, is the recent plateauing in yields, the increase in which had been the main factor in the achievement of self-sufficiency. Given that, certainly in the short term, population growth will not fall away and per ·apita consumption of rice will remain high, production will have to continue to increase for self-sufficiency to be maintained. Recent studies on Indonesian food demand all project continued growth in rice consumption albeit at a significantly slower rate, from 1.6 to 2.8 per cent per annum compared to 3.7 per cent in the 1980s (World Bank 1992). The most significant factor in these projections is population growth; in general, income growth and other factors are of little importance.

Future production increases will have to come either from an expansion in the area under irrigation (movement up), renewed increases in yields or a combination of these. Renewed increases in yields would have to come from research results raising the current yield plateau (movement up), additional gains from even more intensive use of inputs (movement along) or improvements in the efficiency of the current technology (movement towards). The current mix of policies primarily targets the first two, an expansion in irrigation and intensive use of inputs.

Efficiency and policy packages

Before discussing the other main reason for concerns about the current mix of policies — their cost — it is worth making a number of general points about these policies. The first point is that, purely from the viewpoint of economic efficiency, self-sufficiency in its basic form is not the most economically efficient means of satisfying consumption. It is not even a sure means of satisfying consumption, as illustrated by recent experiences with drought in Indonesia. As mentioned earlier, it has been argued that self-sufficiency is a cost-effective policy because Indonesia has monopsony power in the world rice market. Parton et al. (1990) estimated that gains from the effects of Indonesian domestic policies on the international market were between 180 and 620 bRp from 1985 to 1988 and that these gains led to positive net social benefit in Indonesia. However, if Indonesia has monopsony power in the world rice market, then allowing imports and applying a tariff would be a more efficient means of satisfying consumption than the implicit quota introduced by a self-sufficiency policy (Fane 1992). Despite these qualifications, throughout the remainder of this paper it is taken that self-sufficiency as interpreted by Indonesia is a firm policy objective, certainly in the short term, and that the issue to be addressed is whether this policy objective can be achieved most efficiently through subsidies, price support, extension or other means. The justifications for self-sufficiency will be discussed later.

This is not to say that efficiency is unimportant in relation to self-sufficiency. Efficiency gains take the form of more production for the same amount of inputs, the same production for fewer inputs (these saved inputs being able to be applied to other production), or some position between these two. In this way, gains in efficiency can lead directly to increased production, but they can also lead to secondary production gains. In a competitive economy, resources will be allocated to their most efficient marginal use, and so relative efficiency gains in an activity will attract additional resources and lead to greater production in this relatively more efficient activity. Take irrigation as an illustration of this point. Currently it is being suggested that resources not be invested in new irrigation developments because they are unlikely to deliver an acceptable rate of return. Efficiency gains that lowered the cost of developing new irrigation infrastructure or increased the return from each unit of irrigation water could raise this rate of return to an acceptable level. This would lead to increased irrigation investment, or a slowing of the loss of irrigated lands to other uses, and increased production. Efficiency gains should offer the same general incentive to increase production as input subsidies would seem to have offered. It is not a lower input cost per se that stimulates increased production from a farmer but the better rate of return these lower input costs induce.

The final general point is that multiple objectives generally require multiple policy instruments. The 'self-sufficiency' policy has always meant more than domestic production satisfying consumption. Bulog when it was first formed had the additional objective of stabilising prices (Timmer 1991). Achieving this objective along with the goal of self-sufficiency just by setting producer prices would be difficult, as one policy instrument cannot readily achieve two policy objectives (Preston and Pagan 1982).

Justifications for the current policy mix

The following justifications for the current mix of policies are couched mainly in terms of the fertiliser subsidy, until recently the most expensive component. They are, however, often more generally applicable to other components as well. Most of the other components, including the component that currently costs the most, irrigation development, can be thought of as input subsidies. For example, new irrigation developments would deliver economic returns of well below 10 per cent (World Bank 1992) and would have to be subsidised if undertaken in the current environment. Output price support will be dealt with in the next section.

A number of arguments citing economic efficiency have been put forward to justify fertiliser subsidies (Hedley and Tabor 1989, Timmer 1991). Examples, many of which are interrelated, include that the subsidy resulted in a desired accelerated adoption and optimal level of application of the new technology of high-yielding rice varieties, by:

- redressing a lack of information about and difficulties in technology transfer;
- compensating for a credit market failure;
- lowering the risks faced by individual farmers, high risk causing the private level of activity to fall below the socially optimal level;
- stabilising the dominant cash input as part of an overall stabilisation approach aimed at maximising economic efficiency;
- helping to achieve self-sufficiency which, given Indonesia's apparent monopsony power in the world rice market, could be cost-effective; and
- assisting in the development and/or realisation of economies of size in the fertiliser production industry.

Such justifications can be broadly grouped into those addressing market failure, price instability and market power. Apart from the factors of dominant cash input and economies of size in fertiliser production, the specific justifications apply to other input subsidies as well.

There is also an economic welfare case based on the transfer of resources to the rural sector that may result from the subsidy (Hedley and Tabor 1989, Timmer 1991). It is argued that the fertiliser subsidy results in a more direct, timely and efficient transfer of resources to the rural sector than, say, product price policies on their own. The economic welfare case for agricultural assistance is stronger if opportunities outside the sector are limited and the sector has to provide the major employment and income opportunities. In recent times growth in other sectors such as manufacturing and services has meant agriculture is no longer the major provider of new employment and income opportunities (Tomich 1992). The promotion of agri-business and agri-industry will further enhance employment opportunities outside the agricultural sector.

Criticisms of the current policy mix

The above arguments are not universally supported. Many of the justifications tend to be short term in nature and no longer apply once development has taken place. A number of authors (for example, Hedley and Tabor 1989) have commented on how Indonesia's fertiliser subsidy, even if appropriate in the past, has become inappropriate as its share of costs, and demand and supply responses, have shifted with development. With the fertiliser subsidy now making up only a small proportion of variable costs and output prices, large changes in the subsidy would be required to change farmers' behaviour. Crop output responses with respect to fertiliser price are now small relative to those with respect to crop prices, suggesting that output price policies could be a much more powerful self-sufficiency tool than fertiliser subsidies. In addition, labour demand is larger with

respect to crop prices than it is with respect to fertiliser price. The marginal productivity of fertiliser has dropped in relative terms as knowledge about and consumption of fertiliser has increased, so smaller benefits in terms of increased production are now received from additional fertiliser application. Responses in rice demand to income and price changes have weakened, while the responses between foods, and between food and non-food goods, to changes in relative prices have strengthened. These changed responses all suggest that the dominant position of rice in consumer demand is weakening and with this its dominant policy position. The strategic trade or infant industry justification for assisting fertiliser production also diminishes over time.

Moreover, even if some of the rationales for the fertiliser subsidy are accepted in the longer term then policies other than the fertiliser subsidy policy may achieve the same goals more directly. For example, if the rationale is to redress an information failure then the appropriate policy would be better extension services. Credit market failures would be better addressed through policies aimed directly at correcting the amount of credit available. Governments can probably best assist in the management of farm risk by facilitating the development of private risk markets, through the provision of general market information, for example (Coase 1960). Similarly, stabilisation is probably best addressed through the development of private risk markets, such as futures markets, that are currently not available (Newbery and Stiglitz 1981). This may appear to be an option only for the large estates. However, given time to develop without being crowded out by government-sponsored institutions, such markets can also become an option for the small farmer, either directly or with the assistance of intermediaries such as farming cooperatives or merchants. If Indonesia has monopsony power in the world rice market then this should be exploited by taxing trade directly rather than subsidising an input to production. The best way of transferring resources to the rural sector will change with development and the introduction of a more sophisticated taxation and social welfare network, just as elasticities of supply and demand have changed over time.

As mentioned in the introduction, input subsidies and other current policies may impose costs in the form of budget costs, economic inefficiencies, welfare losses and environmental costs. These costs are discussed in Hedley and Tabor (1989), O'Brien (1992), Parton et al. (1990), Tabor (1992), Timmer (1986), Timmer (1991) and World Bank (1992). Examples of such costs are:

- budget costs that take funds away from other important budget allocations, such as extension or research, or that lead to distortions in the overall budgetary processes and macroeconomic management;
- the physical and economic overuse of subsidised inputs;
- the inefficient allocation of resources in both consumption and production, such as the skewing in cropping towards those crops that make greater use of the subsidised inputs (these costs are larger the closer are the consumption and production substitutes);
- an orientation towards quantity (for example, hybrids) at the expense of quality, leaving consumers' real demands unsatisfied;
- high-cost stocks;
- a less competitive fertiliser production industry open to cost-plus practices;
- spillover impacts on other sectors and the macroeconomy as a result of strong and growing intersectoral linkages throughout the Indonesian economy;
- farmers, the group the subsidy is supposed to benefit, now receiving only a small proportion of the financial benefits of the subsidy; and
- fertiliser overuse and the associated reduced incentive for land conservation, both of which contribute to environmental costs in the form of greenhouse gases, soil degradation and water pollution.

Timmer (1991) states that the choice between a free-market, an interventionist and a stabilisation approach, each with its inherent benefits and costs, will be empirical rather than theoretical. The key question is whether the full benefits of stabilisation are worth costs such as those just listed. Newbery and Stiglitz (1981) developed an approach for weighing up such costs and benefits, but Timmer (1991) is critical of the approach for ignoring the effects of stabilisation on broader investment behaviour and the macroeconomy, as well as on consumer preferences for stability when there are adjustment costs. General equilibrium analysis incorporating the dynamic effects of instability on investment behaviour is required to fully address this issue. Appropriate models do not exist at the moment but are an objective of the overall project covering this work. Despite this gap in knowledge it is still worthwhile considering other policy options that may have many of the benefits of the current policies, such as those relating to stability, but fewer costs.

Choice of policy options

The policy options consist mainly of components of the suite of policies used previously. In the past the emphasis has been on policies that have been mainly a mix of extensification through increases in irrigated areas and intensification through fertiliser subsidies (Booth 1988). It has been suggested that there should be a greater emphasis on those policies orientated towards efficiency and productivity improvements through extension and research (World Bank 1992). The current emphasis especially on input subsidies, will tend to inhibit the achievement of efficiency. Some policies aimed at improving efficiency have been introduced: for example, the fertiliser subsidy has been applied differently to various types of fertilisers, and it has been stated that it will be phased out. However, the detailed future direction of agricultural policy for example that of irrigation development, is not clear, so it is worthwhile analysing policy options in more detail.

In terms of choosing future policies to achieve specific objectives, the past impacts of various policies are important. What relative influences have outward movements in the technology frontier, learning to apply new technology optimally (both in terms of farms relative to experimental stations and 'best' relative to 'worst' farms) and incentives to produce more within the same technology had on the observed increases in production? If these various influences are not distinguished, then estimates of relevant policy parameters such as those related to price responses and technology will be biased. There is also the question of the 'reversibility' of some of these influences, for example price effects compared to learning effects.

First a word of warning. It is often difficult with observed real world data to separate the convoluted influences of the various factors determining past impacts. A number of policies have operated as a package, complementing the effects of various separate policies (O'Brien 1992). Econometric estimates will often be affected by multicollinearity between the various influences. For example Booth (1988) estimated that urea alone explained 85 per cent of the observed variation between provinces in yields of padi sawah in 1983. However, similar analysis on irrigation ratios alone suggests that these explain 80 per cent of the observed variation. Taking the fertiliser applications and irrigation ratios together results in high explanation of 88 per cent of the observed variation but none of these explanatory factors are significant as a result of multicollinearity.

The situation is little better with time series data. Nutrient application alone explains 97 per cent of rice yields over the period 1969–85 whereas the irrigation ratio explains only 73 per cent. Taking these explanatory factors together hardly improves the best explanation and only nutrient application is a significant explanatory factor. However, the irrigation ratios are fairly aggregative representations of the influence of irrigation and basically just capture the underlying trend common to all inputs and outputs. Trend explains 96 per cent although nutrient application is still a more significant explanation of the increase in yields. More detailed

analysis of cross-sectional/time series data might shed more light on the factors behind the increase in yields. Overall, it is difficult with regression analysis of observed, real world data of complementary policies in action to separate the individual impacts. In addition, many of the influences, for example the impact of extension advice, cannot easily be represented in quantitative terms.

One means of separating the influences of the various factors and overcoming the lack of quantitative measures would be to carry out a survey of farmers to determine more directly the influences' importance and to ascertain farmers' intended responses if some of these factors were to change, due to policy changes, say. To date, no such survey has been published although one has recently been undertaken within the general project in which this research is being carried out. The following analysis will attempt to make the best use of available information to measure the various influences.

Steps in determining the best policy options

There are a number of steps in determining the best policy options. First, the potential benefits of the various means of increasing production need to be determined along with any constraints to achieving the increased production. What is the possible extent of irrigation? How close are levels of input use to physical and economic optima? And how large is the yield gap due to technical inefficiencies (currently, between both experimental stations and farms and 'best' and 'worst' farms and, in the future, as a result of research advances)?

The next step is to determine for specific policies what costs are associated with the achievement of the potential benefits. Even though there may be large apparent gains from extension advice in narrowing the yield gap, how cost-effective have past extension approaches been, and can these be improved? Implemented policies should not necessarily be aimed at where the largest gains can be made but rather where they can be most cost-effective.

Also, some policies may only be effective in conjunction with other policies, meaning that the best policy option may be a package of policies. In this case there would be no single superior policy, although the package of policies may have a common foundation, such as efficiency gains. In fact, a package of policies will generally be the chosen outcome for, as mentioned earlier, there are usually multiple policy objectives which generally require a package of policy instruments. However, some policies will have multiple benefits that may assist in achieving a multiple of policy objectives. For example, introducing a policy of user-pays fees in irrigation will assist in reducing budget costs as well as improving the efficiency of irrigation use, lowering environmental costs and releasing resources to other uses. A similar situation may apply with policies aimed at improvements in productivity.

A very general view needs to be taken of the costs of policies; for example, irrigation off Java could affect profit margins on Java, or could impose environmental costs. An economy-wide perspective needs to be taken and these costs incorporated into the analysis.

The final step is to weigh the realisable benefits against the associated costs.

These steps will now be dealt with in turn. The first step of estimating the potential benefits of and any constraints associated with the various means of increasing production is considered initially with regard to the main components of the current policies.

Potential benefits

There would appear to be few potential benefits and, as discussed earlier, large cost constraints from attempting to increase the intensity of fertiliser use through larger fertiliser subsidies. It is apparent that some fertiliser

inputs are being overused in parts of Java, in both an economic and physical sense, and that there is little to gain in the way of production responses from increases in fertiliser application (O'Brien 1992). Costs could be cut back by raising the price and decreasing the use of fertilisers. In terms of Figure 1, the majority of farmers are clustered near a point of maximum yield in terms of fertiliser application, M^*. Either the average production function currently facing farms is flat around this point, or the ratio of input to output prices is little changed by changes in fertiliser subsidies as output prices dominate, or both.

As pointed out earlier, credit subsidies can be represented similarly to the way fertiliser subsidies have been represented in Figure 1. There has been little analysis of the past benefits and future potential of credit subsidies. This is perhaps a function of the fact that credit subsidies have been applied in conjunction with other policies in the past, making it difficult to separate their individual impact in any analysis. Given the nature of past schemes, it is also difficult to determine whether any impact the schemes had was a consequence of the interest rate subsidy element or the provision of credit. The provision of credit would be a more direct way of addressing any credit market failure than subsidising interest rates. Credit policies should be such that they target the areas where greatest social benefit will be obtained. No doubt as the capital intensity of Indonesian agriculture increases and as structural adjustment accelerates, the demand for credit will increase and the impact of credit policies become more important. Much more analysis of this policy option is required .

Past irrigation developments were a fundamental component of the increase in rice yields that resulted in self-sufficiency in the 1980s. In a physical sense, there are ample opportunities for further irrigation developments. About 7 million hectares of land off Java has been identified by the Ministry of Public Works as suitable for irrigation development, with about 3 million hectares of this being so-called low-cost developments (World Bank 1992). In addition there is about 80 thousand hectares of land within existing irrigation schemes on Java that could be irrigated at minimum cost. It is not physical constraints that will limit the potential benefits of increased production from new irrigation developments but economic cost constraints.

There has been a rapid increase in the unit costs of new irrigation developments (Rosegrant and Pasandaran 1990) resulting in relatively low rates of return on such developments. This has been due both to the reduced physical suitability of new irrigation developments and a blow-out in construction times and costs. Thus it would appear that only lower cost operations, such as expansion within existing irrigation schemes and expenditures on improved operations and maintenance, would be economically justifiable, unless the delays and blow-out in costs for new developments can be overcome.

Increasing the efficiency of current irrigation schemes (the percentage of water released at the source that reaches production) from 30 per cent to the design efficiency of 50 per cent will result in an effective 40 per cent increase in the availability of water for irrigation or other uses. Thus effective irrigation could be increased at a lower cost by increasing the efficiency of current schemes rather than developing new schemes. This does not preclude the development of new irrigation schemes, especially if the costs of construction can be lowered through greater efficiencies in construction and the efficiency of irrigation itself increased. In terms of Figure 1, no movement from current rain-fed technology to the more advanced irrigation technology occurs because the benefits of increased production do not appear to justify the costs involved.

Another area related to irrigation development and offering potential benefits is rural infrastructure development in general. This category includes investments in roads, power, communications and the like. It has been proven in the past that such investments have been a major factor in the growth of Indonesian agriculture and the rural economy. This type of investment can reduce input costs and production losses, open up new opportunities such as in value adding and develop and integrate markets including input factor markets such as labour markets. These investments are strongly tied to the development of agri-business and agri-

industry. There would appear to be an underinvestment in such infrastructure in much of rural Indonesia at present. The benefits of such investments tend to be spread more widely across the rural community and have a more direct impact on the welfare, employment opportunities and general environment of more of the population. However, these investments could face the same difficulties as investments in irrigation development if delays and cost blow-outs make what in planning appear appropriate investments, inappropriate after the event.

One policy option, that of output price support, has been part of the current suite of policies, with the level of price support and fertiliser subsidy often being formally linked. It should be noted that at times prices to Indonesian farmers have been below world prices and that the net subsidy to farmers came through the fertiliser subsidy. However, price support, in the sense of always providing a benefit to farmers, and fertiliser subsidies are now being considered as alternatives. As mentioned earlier, as fertilisers' share of costs and demand and supply responses have shifted with development, fertiliser subsidies have become a less effective policy than output price support, in terms both of supply response and employment (Hedley and Tabor 1989). Questions have also been raised about the impact of fertiliser subsidies on the efficient allocation of resources, on the welfare of farmers and on the environment. Output price support could also have an adverse impact on these important aspects. Support would need to be designed to minimise any adverse impacts, for example by ensuring that prices follow world prices in the long run; that is, by providing stabilisation benefits rather than pure income transfers. In terms of Figure 1, output price support operates similarly to the fertiliser subsidy except that it would seem to have a relatively greater impact than fertiliser subsidies on the ratio of input to output prices.

As mentioned earlier, the benefits of research are difficult to predict, especially in the short term. However, the World Bank (1992) has estimated that the introduction of hybrid rice and the development of high-yielding varieties that are pest resistant could lead in the longer term to yield gains in Indonesia of at least 20–30 per cent, lifting maximum yields from around 10 t/ha to near the 15 t/ha goal set for China. Past agricultural research, both in developed and underdeveloped countries, has demonstrated high rates of return. This conclusion dates back to Griliches's pioneering cost–benefit study of hybrid corn research, which showed internal rates of return of between 35 and 40 per cent (Griliches 1958). In general, most of the benefits of these research advances will go to farmers if demand is more responsive to the research-induced price changes than supply, and to consumers if the opposite situation applies. The actual outcome will depend on the nature of any shift (for example, proportional or parallel) in the supply curve (Lindner and Jarrett 1978). Demand for internationally traded commodities tends to be more responsive than demand for commodities that are basically produced for internal consumption. In terms of Figure 1, the benefits of greater efficiencies from advancements in technology achieved as a result of research, in general and over the long term, would appear to justify the costs involved and would lead to more advanced technological production.

Some progressive farmers have achieved yields close to those achieved by experimental stations (Pingali et al. 1990). Adoption of new technology has been completed for these progressive farmers and future growth will be dependent on further advances in yields from research. However, there are still large yield differences, estimated by Pingali et al. to be in the order of 20 per cent, between these farmers and those at the other end of the yield spectrum. These differences appear to be due to better resource endowments, knowledge and use of inputs. Policies can address some of these factors. Effective extension advice is one means of closing the current and future gaps between farmers' yields and experimental maxima achieved by applying new technologies. There should be strong linkages between research and extension. Well-managed extension advice has delivered high rates of return in the past (Booth 1988, Pingali et al. 1990). However, as pointed out

by Israel (1990), many of the real problems with development programs lie in their implementation and are a consequence of institutional and managerial problems. Future extension will face even more difficulties as the required advice becomes more regional and more knowledge-intensive. This last aspect points to the full benefits of extension, which require a more highly educated farming community, being gained perhaps only over the longer term. In terms of Figure 1, well-managed extension advice will move farms' average production function towards the current technically efficient production function or frontier.

Associated costs

The next step is to determine what costs are associated with these potential benefits. As with earlier analysis of current policies, the costs of the policy options will be analysed in terms of budget costs, efficiency, welfare and environmental effects.

Proper operations and maintenance of irrigation schemes may increase budget costs as there has been underexpenditure in this area in the past. However, the budget costs will be nowhere near the high levels associated with new irrigation developments. Moreover, these expenditures will result in efficiency gains and, in turn, budget savings that can be used to benefit the welfare of the rural sector. However, if there are no new irrigation developments then the direct regional welfare benefits from irrigation development will be limited to those regions affected by current developments. The type of irrigation development is also an issue. There have been large losses in rice production recently as a result of drought. This suggests the need to assess the long-run returns from various forms of irrigation development, such as systems with larger catchment/ watershed components. A technically more efficient irrigation system is likely to have environmental benefits as well. Government has controlled irrigation developments in the past but there are moves to expand the user-pays principle in this area, which should ensure lower budget costs and more appropriate levels of expenditure on operations and maintenance in the future.

As Indonesian government spending on research has been below the levels of comparable countries, it would appear that budget costs should increase, especially if policies aimed at maintaining self-sufficiency through research are introduced. A perspective on this can be gained from noting that if the modest order of net savings obtained by phasing out the fertiliser subsidy were applied to research then there would be a doubling of government spending in this area. As mentioned earlier, self-sufficiency is not only about increased production but also about increased efficiency. In fact, given the potential benefits discussed in the beginning of this section, the largest immediate gains from research are likely to emerge from research into more efficient application of inputs.

Research need not be neutral in its impact. For example, many felt that the research that led to the 'green revolution' could result in greater income disparities, and although these worst fears do not appear to have eventuated, new technology can have welfare implications (Pearse 1980). However, this is really more a question of targeting the research effort than a question of its level. No one would seem to gain from trying to hinder technological progress as the rest of the world advances. The Agency for Agricultural Research and Development (AARD) has placed research priority on areas of political, economic and social strategic importance, areas with a high probability of generating a fair balance of growth and equity, and biotechnology and new product development. The question of targeting research also applies to the issue of the environment. Much of the research into improved methods of production such as deep siting of fertilisers, has been beneficial to the environment. Government has had a greater role in research in Indonesia than in neighbouring countries (World Bank 1992). There are a number of justifications for government involvement in research, such as government's ability to address information failures, high risks and difficulties in researchers appropriating

the benefits of their research. However, there are also strong reasons for applying the user-pays principle and having a significant private research involvement: focusing the research, providing a competitive alternative and achieving greater diversity, for example.

Appropriate levels of government extension advice are also likely to involve increases in budget costs, as this area has been underfunded in the past (World Bank 1992). Some past extension advice has resulted in large efficiency gains, especially to progressive farmers, from the introduction of new technology. Further targeted extension advice, aimed at the poorer and less educated farmers, could have significant welfare effects. Some extension advice could also have significant impacts on the environment. For example, given the emphasis placed on sustainable development by the World Bank and other international and Indonesian agencies it is likely that the environmental impacts of research will be a key component of any future extension advice. Governments have tended to play a dominant role in extension through the provision of free advice. This role has been justified on the basis of the need for independent advice, the relative isolation of farms, the poorer education of farmers and the societal nature of some extension advice. However, this does not negate the importance of private extension or of charging for services, especially if exclusive benefits are obtained from the advice. Charging for services in a competitive market ensures efficiency and that the services provided are those required. For example, charging would help extension personnel focus on their extension responsibilities, the efficient delivery of extension and the provision of the type of advice that many farmers are apparently seeking such as whole farm management advice. There is a danger with free services that internally set objectives will have little in common with farmers' requirements. On the other hand, government extension advice may be more economical due to linkages with other government institutions such as research agencies. The basis of free government extension advice will diminish over time as information technology and rural development progress, and should come under continual review.

Benefits versus costs

The final step in weighing up realisable benefits and the associated costs can only be done at a very general level at this stage because of the lack of hard information. The additional realisable benefits for the main component of the current package of policies – fertiliser subsidies — are small relative to the associated costs of this policy. Price support policies in which prices follow long-run world prices and offer farmers some stabilisation benefits would seem to be a better option than fertiliser subsidies. Little is known of the measurable benefits and costs associated with credit subsidies, except that if there were a credit market failure, the provision of unsubsidised credit would be preferred to subsidising interest rates. New irrigation developments currently have a rate of return of less than 10 per cent whereas more efficient operations and maintenance of current irrigation schemes would deliver at least the same returns but at lower cost, financially and probably environmentally. If the construction of new irrigation developments can be undertaken more efficiently then the resultant rates of return may justify the investment. If irrigation is to be restricted to current schemes, more efficient operations and maintenance may not have the same impact on specific welfare targets, for example certain isolated regions. Other infrastructure investment in roads, power and communications, for example, may offer better rates of return and address these regional welfare aspects better. The potential benefits from research and extension are large and the associated costs low relative to those for current policies.

Given the realisable benefits and associated costs, the key question is how these potential benefits can be most efficiently achieved, or perhaps how effective these alternatives have to be for them to be preferred over the current policies. The crux of the matter is what institutions and managerial systems need to be put in place to assist in achieving optimal efficiency. It should be noted that the existence of current institutions can

hinder the development of more efficient institutions, for example because of transaction costs, externalities or vested interests. Evidence from other countries would suggest that those institutions and managerial systems that make optimal use of whatever market processes can be developed in the economy are the more efficient. This does not mean that governments have no role to play. Governments can facilitate this process, and there will often be circumstances in which governments have to step in to overcome market failures when it is cost-effective to do so. Different institutions and management systems will be preferred depending on the country. There are lessons to be learned in terms of appropriate institutions and management systems from past successes, such as the high level of communication in the Integrated Pest Management scheme, and failures, such as some previous 'top down' approaches to extension.

The Australian experience in establishing research and development corporations is an interesting example of one institutional and managerial system aimed at maximising the potential benefits from efficient research and development. The key features of the Australian system are the establishment in legislation of clear objectives and functions, boards made up of broad and relevant expertise rather than interest groups, operations on a commercial basis including the raising of some funds, strategic and operational plans that are used to set priorities and evaluate programs, and accountability through annual general meetings and annual reports. Private research is encouraged in conjunction with public research, ensuring coverage of a variety of specific and general issues and introducing some competition to the process. Competition is also introduced through the various specific commodity and general research and development corporations commissioning research on, in some cases, similar core issues. There is a trade-off between the overlapping of public and private research interests and the lack of competition that would otherwise be the case.

The evolution of Australia's fertiliser policy also offers relevant institutional experience to Indonesia's self-sufficiency policy. Fertiliser subsidies existed in Australia up to the mid 1980s but were withdrawn following a sequence of Industry Commission inquiries. These public inquiries were called to investigate the justification for such subsidies and the appeal of alternative assistance measures. Little justification on the grounds of welfare or efficiency could be found for the subsidies but alternative forms of assistance could be justified on the grounds of compensation for the costs to agriculture of high manufacturing tariffs. Increased funding of research, directly addressing a market failure and offering high returns, was suggested as being a more beneficial form of assistance.

Much of the preceding discussion on cost-effectiveness is based on a theoretical position. However, as Timmer (1991) points out, the basis for such judgements should be empirical rather than theoretical. Evaluations of the cost-effectiveness of past research and extension relevant to Indonesian agriculture should be undertaken, as should similar evaluations of future efforts in these areas under various alternative institutional and management systems. The evaluations should include the transfer of the research to commercial application as this is fundamental to the realisation of the potential benefits. The framework for such evaluations is generally social cost–benefit analysis, although more specific equity and distributive criteria have often been included in the evaluations. Key information in such evaluations would be the costs and benefits (both internal and external to the specific research), the probability of success and the adoption rate.

Conclusion

The paper has analysed agricultural policy options to maintain rice self-sufficiency in Indonesia. It has been shown that self-sufficiency in the sense of production satisfying acceptable consumption levels with stable

prices was first achieved in Indonesia in 1984. However, without subsidies and other assistance, it is unlikely Indonesia would have achieved self-sufficiency at that time.

The achievement of self-sufficiency was the result of increases in production, mainly from higher yields but also from increases in irrigated area. The main components of the policy package used to achieve rice self-sufficiency were input subsidies and new irrigation developments, encouraging the use of inputs through subsidisation.

Other policy options to maintain rice self-sufficiency in Indonesia were a minor part of this package of policies. However, in the future far greater emphasis should be placed on research and extension at the expense of the fertiliser subsidy and new irrigation developments.

It was demonstrated diagrammatically in the paper how the various components of the current policy package operate in different ways to achieve the policy objective. The fertiliser subsidy diminishes the cost of fertiliser relative to the price of the product, encouraging greater use of this major input and increased production. Price support for the product operates similarly. New irrigation developments open up additional areas to the introduction of the high-yielding rice varieties, resulting in increased production. While efficient operations and maintenance of existing irrigation schemes may not have any direct effect on production within the schemes, the saved resources can be used to enhance production elsewhere. A similar situation applies in the case of research, which could result in a spectrum between more production from the same inputs, or the same production from fewer inputs as a result of the introduction of new technology. Extension is likewise about achieving efficiency gains through the application of current technologies.

Policy changes are being considered for various reasons. The growth in yields from the introduction of high-yielding varieties and the intensive use of inputs such as fertilisers is dissipating. The development of new irrigation schemes at low cost has been completed. Future gains in yields and efficiencies will have to come from more efficient operations and maintenance of current irrigation schemes, improved infrastructure, research and more effective extension to close the yield gap between the best and worst farmers.

Moreover, what justifications existed for the initial package of policies have tended to diminish over time as development has taken place. Even if the justifications are longer term then there would appear to be policies that could achieve these goals more directly than the current package. For example, lack of information could be addressed through more effective extension advice. Furthermore, the current policies have high budget costs, involve large inefficiencies, do not appear to be achieving any welfare goals and are associated with high environmental costs.

The suggested policy changes to greater emphasis on efficiency and productivity gains through better irrigation operations and maintenance, other infrastructure, research and extension will have costs, but these will be far below those of the current mix of policies. Proper management and targeting of the policy options can lead to low budget costs, efficiency gains and the achievement of welfare and environmental goals. Policy options appear to work against each other in some cases: for example the sugar acreage constraints work against the rice self-sufficiency policy.

Even if the policy options have large potential benefits and low associated costs, the key question is how effective these policy options will be. If the potential benefits of research and extension, for example, are not delivered by the policy approach then the resources spent in this area will be wasted.

The successful delivery of policy options depends fundamentally on putting appropriate institutional and managerial systems in place. Overseas evidence suggests that systems that draw heavily on market processes perform well. Governments still have a role to play in such systems, facilitating their development and addressing areas of market failure.

Indonesia will have to develop the systems that best suit its situation. This should involve analysis of the actual performance and cost-effectiveness of current systems and alternatives. Currently there is little such analysis around, and policy advice is being based more on theoretical positions. Relevant information needs to be collected and analysed before present systems are fully replaced.

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Table 1: Rice production, imports and consumption in Indonesia, 1969–89

Year	Gross area harvested (mha)	Irrigation & wet area harvested (mha)	Yield padi rice (kt/ha)	Production padi rice (mt)	Production milled rice (mt)	Net import milled rice (mt)	Bulog end of year stocks (mt)	Food/ capita milled rice (kg/y)	Consumption milled rice (mt)
1969	8.0	6.5	2.25	18.0	12.8	0.6	0.2	118.1	13.7
1970	8.1	6.7	2.38	19.3	12.2	1.0	0.4	108.5	12.9
1971	8.3	6.9	2 42	20.2	12.6	0.5	0.4	108.0	13.1
1972	7.9	6	2.45	19.4	12.3	0.7	0.2	108.3	13.4
1973	8 4	7.1	2.56	21.5	13.6	1.9	0.4	118.0	15.0
1974	8.5	7.3	2.64	22.5	14.2	1.1	0.8	115.6	15.1
1975	8.5	7.3	2.63	22.3	14.1	0.7	0.5	114.2	15.2
1976	8.4	7.2	2.78	23.3	14.7	1.3	0.6	116.2	15.8
1977	8.4	7.2	2.79	23.3	14.8	2.0	0.5	120.9	16.9
1978	8.9	7.7	2.89	25.8	16.3	1.8	0.7	123.4	17.6
1979	8.8	7.7	2.99	26.3	16.4	1.9	0.8	126.5	18.6
1980	9.0	7.8	3.29	30.0	18.4	2.0	1.2	130.7	19.6
1981	9.4	8.2	3.49	32 8	20.4	0.5	1.6	132.5	20.3
1982	9.0	7.9	3.74	33.6	20.9	0.3	1.0	138.8	21.8
1983	9.2	8.	3.85	35.3	22.0	1.2	1.4	145.2	23.3
1984	9.8	8 5	3 91	38.1	23.7	0.4	2.4	140.2	23.0
1985	9.8	9	3.97	39.0	24.3	-0.4	2.1	143.2	24.0
1986	10.0	8.8	4.08	40.8	24.7	-0.2	1.9	147.4	25.2
1987	9.9	8.8	4.04	40.1	25.0	0.0	0.8	143.2	25.0
1988	10.1	8.9	4 13	41.6	25.9	0.0	1.0	150.0	26.7
1989	10.2	9.3	4.23	43.0	26 7	0.2	1.5	140.9	25.6

Source. Sudaryanto et al 1992.

Table 2: Rice production inputs in Indonesia, 1969/70–1989/90

Year	Total fertiliser use (NPK) lowland harvested (kg/ha)	Intensification area (mha)	(%)
1969/70	54.5	2.1	(26.5)
1970/71	27.4	2.1	(25.6)
1971/72	66.8	2.9	(34.7)
1972/73	78.1	3.3	(41.3)
1973/74	112 1	4.1	(48.9)
1974/75	10[illegible] 1	3.7	(43 8)
1975/76	123.1	3.6	(42.8)
1976/77	120.8	3.6	(43.2)
1977/78	162.0	4.2	(50.8)
1978/79	161.2	4.8	(54.3)
1979/80	188.3	5.4	(61.8)
1980/81	278.8	5.5	(61.3)
1981/82	335.5	6.2	(55.3)
1982/83	377.7	6.3	(70.6)
1983/84	398.8	6.7	(73.1)
1984/85	415.0	7.4	(75.5)
1985/86	419.0	7.7	(77.4)
1986/87	450.4	8.0	(79.7)
1987/88	463.[illegible]	8.5	(82.3)
1988/89	483.7	8.3	(82.1)
1989/90	481.8	8.8	(94.5)

Source: Sudaryanto et al.1992.

Table 3: Price of rice production inputs in Indonesia, 1969/70–1990/91

Year	CIF rice price[1] ($US/t)	Ratio CIF to domestic rice price[2]	Implicit tariff on urea (%)	Ratio fertiliser to padi floor price
1969/70	176.0	1.32	na	0.78
1970/71	140.0	1.22	-28.7	0.78
1971/72	134.0	1.28	-28.1	0.78
1972/73	188.0	1.89	-37.9	0.78
1973/74	398.0	2.59	-37.3	0.78
1974/75	497.0	2.45	-74.0	1.04
1975/76	336.0	1.29	-53.2	0.97
1976/77	259.0	0.92	-0.9	0.97
1977/78	296.0	1.03	-21.9	1.01
1978/79	359.0	1.37	-47.3	1.07
1979/80	357.0	1.34	-58.3	1.35
1980/81	446.0	1.45	-54.9	1.50
1981/82	436.0	1.25	-57.1	1.71
1982/83	289.0	0.76	-52.0	1.92
1983/84	271.0	0.63	-40.6	1.61
1984/85	243.0	0.77	-46.3	1.83
1985/86	215.0	0.71	-42.8	1.75
1986/87	213.0	1.11	-32.7	1.40
1987/88	220.0	1.03	-38.5	1.52
1988/89	302.0	1.19	-50.1	1.55
1989/90	290.0	1.10	-45.3	1.47
1990/91	270.0	1.03	-38.6	1.29

Source: Sudaryanto et al. 1992.

[1] CIF rice price is 5 per cent brokens price in Bangkok

[2] Domestic price is an average of floor and ceiling prices