Improving the Lot of the Farmer: Development Challenges in Timor-Leste during the Second Decade of Independence*

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Abstract
Large segments of the rural Timorese population survive on subsistence farming characterized by simple production methods and low output. Broad-based improvements in Timorese living standards require increased agricultural output. This article discusses what determines agricultural development in Timor-Leste and how such development can be achieved. The main causes of low agricultural output are found to be scarcity of land and capital, poor technology and education, and lack of government support, such as extension services and provision of infrastructure. We construct a model of an agricultural household to examine how increased market incentives will affect agricultural output and incomes. The effects of different price changes on household production, consumption, sales, income, and leisure are investigated. We find that the objective of increasing the living standard of Timorese farmers may in part be achieved via increased earning opportunities outside agriculture.

1. Introduction

In 2012, Timor-Leste celebrated its tenth anniversary as an independent nation. Economically and socially, things have not turned out quite as envisaged at the dawn of independence. It is clear that the country has a long way to go before poverty will be eradicated. Disappointment with

the lack of development constitutes a source of political turbulence, most vividly demonstrated by the violence between different groups in 2006 and by the murder attempt on President José Ramos Horta in 2008.

To be fair, the expectations were hardly realistic. The Indonesians left behind a country with an essentially destroyed infrastructure, a country that was far poorer than it should have been. It is estimated that real GDP fell by one-third between 1998 and 1999 as a result of the violence and turmoil that accompanied the withdrawal (UNDP 2002, 57–58).

Another way of measuring the extent of destruction is by looking directly at the social and physical infrastructure. Regardless of which indicator we choose, the result is dismal (UNDP 2002). On average, peasant families lost 58 percent of their goats, 48 percent of their cattle, and 47 percent of their pigs (i.e., half their livestock was gone). All existing banks, including the regional branch office of the central bank, were either looted or destroyed and, as a result, all transactions in the economy had to be carried out on a cash or barter basis. One-third of the electricity-generating capacity in the capital was lost, and in the provinces the district capitals lost between 50 and 90 percent. The social infrastructure was more or less wiped out. No less than 80 percent of all schools and medical clinics were destroyed. The transport and communications network, including the markets, collapsed. Most of the fixed telephone lines were damaged and transportation was in extremely short supply. Finally, the entire public administration ceased to function. The civil service at the time consisted of some 28,000 officials. All the top-level officials, about one-fourth, were Indonesians who left East Timor (UNDP 2002).

Considering this turmoil, it should not come as a surprise that Timor-Leste is a very poor country. Income per capita is only about 14 percent of that of developing East Asia and the Pacific, or 41 percent of the incomes of developing sub-Saharan Africa (World Bank 2012). Poverty to a large extent is a rural phenomenon. Between 70 and 80 percent of the population is dependent on agriculture for its livelihood and three-quarters of the poor live in rural areas (Lundahl and Sjöholm 2007; UNDP 2011). Timor-Leste displays all the characteristics of a labor surplus economy as described by in the classic work of Arthur Lewis (1954). Most people are employed in subsistence farming where the marginal and average productivity of labor, and hence per capita output, is low. Few people work in the modern sector. Moreover, the situation may rapidly be getting worse due to the extraordinarily high fertility rate—close to 8 children per woman of child-bearing age in the early years of independence and almost 6 children per woman in recent years (Ministry of Health et al. 2004, 6; UNDP 2011). This means that the population is growing rapidly and that each year

about 17,000 young Timorese enter the labor force. As a result, unemployment and underemployment rates seem to be increasing.

Fortunately, there are signs of positive development during the last five years: Incomes have increased, and poverty seems to be declining from its high level. These improvements have been achieved by strong increases in public expenditures made possible by the oil revenues. Timor-Leste is often claimed to be the most oil-dependent country in the world, and oil and gas revenues account for around 90 percent of state revenue. Oil revenues have been spent on funding the return of around 150,000 refugees to their villages, on pensions to war veterans, on cash transfer programs to vulnerable households, and on various infrastructure projects (UNDP 2011, 17). In this respect it is a blessing but it also leaves the country at the risk of falling prey to the resource curse of low growth and social turbulence (Lundahl and Sjöholm 2008a).

Long-term development is likely to require modern sector development. For the foreseeable future, however, is it clear that the possibility of moving people out of agriculture so as to increase average productivity and income is limited. The only booming industry is oil production, which provides few jobs. There are no signs of an emerging manufacturing industry. Lundahl and Sjöholm (2009a) make a back-of-the-envelope calculation of the annual growth of output required in the modern sector just to keep the share of the labor force in agriculture constant: 21 percent if the public sector is included and a staggering 106 percent if not. It should also be noted that these figures are based on optimistic assumptions with regard to employment elasticities (equal to 1) in the modern sector (the change in modern sector employment when the output of this sector increases). More conservative assumptions make the required growth rates even higher.

The lack of a modern sector puts the poor rural population in a difficult position and leaves little room for per capita income growth other than through increased agricultural output. In other words, living standards will remain low for the rural population unless there is a substantial increase in farm production. In the short run, and until a modern sector begins to emerge, improvements in agriculture constitute the only way of improving livelihoods in Timor-Leste.

In the present article we discuss what determines agricultural development in Timor-Leste and how such development can be achieved. This is done in two steps. The first one takes the production function as its point of departure. Agricultural output is seen as a function of inputs (land, capital and labor) and technology, which in turn are influenced by the infrastructure and institutions of the economy.

Moreover, output is also affected by external factors that cannot be influenced by policy measures. The second part emphasizes the fact that Timor-Leste is a market economy. A model of an agricultural household is constructed. The static optimum of the household is derived and the effects on production, consumption, sales, income, and leisure of the household of different price incentives (changes in food prices, cash crop prices and prices of manufactured goods) are investigated.

2. The situation in agriculture

Large segments of the rural Timorese population survive on subsistence farming. Farmers tend to use simple production methods to grow food crops for their own consumption and the surplus sold in the market is small. Whatever cash incomes that are generated are used to buy essential food, kerosene, salt (Barlow 2001, 110) and also, increasingly, cheap Indonesian consumer goods (Conroy 2006, 21). The importance of subsistence farming differs between regions, however. About 80 percent of the rural households in the Eastern region are classified as subsistence farmers, compared to a mere 11 percent in central Timor-Leste, and 32 percent in the Western region (Ministry of Agriculture, Forestry, and Fisheries [MAFF] 2004, 2).

The main staple crops in Timor-Leste are rice and maize. Some 80 percent of the households grow the former and slightly more than 20 percent the latter (UNDP 2006, 27; UNDP 2011, 79). Almost all maize and about 75 percent of the rice are for own consumption; little agricultural produce is traded. Moreover, the land area used for maize is about three times as large as the land used for rice. The total area used for rice is actually substantially smaller than the corresponding area around 1975 (a peak period). Rice and maize are supplemented by cassava, which is grown by most rural households, often to be used as a reserve when the supply of rice and maize has run out. The same is true for sweet potatoes and taro.

The poverty of the farming population is of course caused by low productivity in agriculture. However, there are some indications that productivity may be increasing. Lundahl and Sjöholm (2007) compared agricultural productivity in Timor-Leste with other countries in the region in 2005. Productivity was substantially lower in Timor-Leste than in any other of the included Southeast Asian countries. For instance, it was on average 250 percent higher in rice production in other countries and about 310 percent higher in the production of maize. Figure 1 shows that productivity, measured as physical output per hectare, for rice and maize remains low in 2010, but not as low as in 2005. The production of rice per hectare is approximately the same as in Cambodia and Thailand, much higher than in Papua New Guinea, but substantially lower than in neighboring Indonesia. The progress in maize is slower and productivity remains lower than in all other countries. It is

Figure 1. Productivity in agriculture in 2010 in selected East Asian countries and Papua New Guinea (tons per hectare)
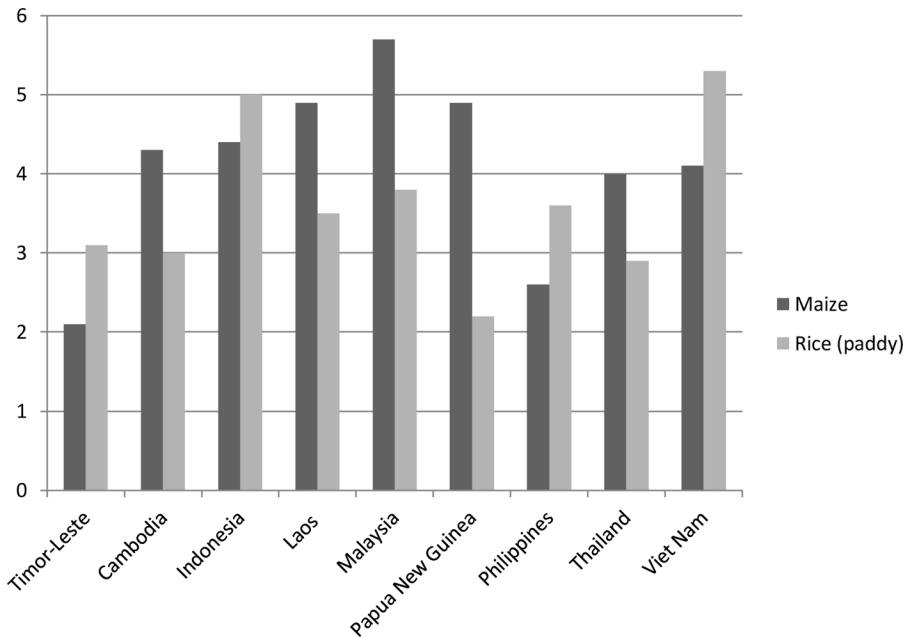
around half of that of Indonesia and even lower in comparison with two countries at a similar development level—Laos and Papua New Guinea. It should also be noted that the figures reported by the Food and Agricultural Organization (FAO) might be exaggerated. Other sources claim that the production of maize is 1.16 tons per hectare, 1.61 tons for rice, and 3.0 tons for the production of irrigated rice (MAFF 2009).

Coffee is the main cash crop in Timor-Leste and it is also the country's main export good. Production is concentrated to the highlands (Fox 2001, 164). Around 67,000 households grew coffee in 2009 (World Bank 2011a, 41). The quality of the Timorese coffee is good or has high potential. So far, exports have predominantly targeted high-quality niches in foreign markets. The decision by Starbucks to sell coffee from Timor-Leste has provided a major boost to the reputation of the product and has opened a large potential market.

The main problem with expanding coffee production is that little on-farm invest-ment has been made. Due to poor husbandry of the coffee trees, crops are small, and

delivery is irregular. For instance, yields are reported to be a mere 150–200 kilos of green beans per hectare (World Bank 2011a, 41). The irregularity and the small size of the coffee crops is a major obstacle when it comes to attracting foreign purchasers who require a high degree of predictability. Important improvements can also be made in the processing of the coffee.

Maize and rice are the dominant staple crops and coffee dominates cash cropping, but farmers in Timor-Leste grow a number of other crops as well. Fruit trees are common, there has been some success with soy beans, and legumes are important for conserving and increasing soil fertility. Farmers are often deliberately growing different crops to reduce risks and spread harvests across the year. Most of them also have animals, like chickens, goats, and cattle. Again, production is almost exclusively for subsistence.

3. Determinants of agricultural development

Figure 2 divides the factors affecting agricultural output into different categories. First, there are the external factors—that is, the factors that are beyond the control of farmers or policymakers but that could have an impact on agricultural output. Such factors could for instance include climate and world market prices of agricultural goods. Second, agricultural production is affected by the amount of inputs used in agriculture. Inputs include a range of factors, from labor and land to capital, like seeds, water, fertilizer and tools. Moreover, the better the technology, the more output will be produced with a given bundle of inputs. In practice, it can be difficult to separate inputs and technology in agriculture. New seeds are inputs but their proper use may require technological change (e.g., through extension services) and additional inputs (such as irrigation) to be effective, as in the case of the Green Revolution. Finally, investments in inputs and technology are affected by infrastructural and institutional factors. These include for instance transportation, markets, and property (land) rights.

3.1 External factors
Parts of Southeast Asia are among the most fertile areas on earth. Unfortunately, Timor-Leste is not one of those places. The fertile part of Southeast Asia ends somewhere after Bali, and the eastern part of the archipelago is characterized by a climate that is not ideal for agriculture. The problem is best described as one of too little or too irregular rain and land with steep slopes and low fertility.

The climate in Timor-Leste is a typical monsoon climate with a wet season extending from around December to March and a dry season from around May to October, but with local geographic variations. The annual rainfall ranges between 500 and

Figure 2. The determinants of agricultural output
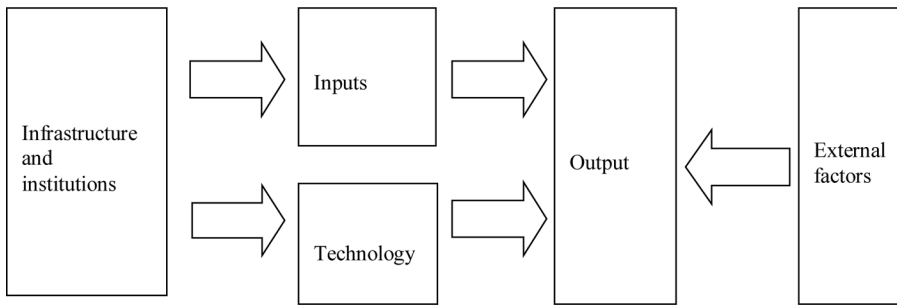
1,500 mm in the relatively dry north and over 2,000 mm in the relatively wet south. Local variations in rainfall are common as Timor-Leste is surprisingly ecologically diverse for being a relatively small country (Fox 2001, 155). The rainfall can be irregular. For example, Dili sometimes receives 30 percent of its annual rainfall in a single day (UNDP 2006, 19).

Moreover, there are regular droughts in Timor-Leste. Such droughts occur approximately every fourth year. Then the rainfall is not only reduced by as much as 50 percent but the drought also delays the wet season by two to three months, which causes further difficulties for agriculture. For example, the drought in 2002–03 reduced output by about 21 percent (UNDP 2006, 21) and in 2007, maize, rice, and cassava production (in cereal equivalents) was reported to be 25–30 percent lower than during the previous few years (FAO and World Food Programme 2007, 5).

Parts of the Southeast Asian archipelago are fertile because of a fortunate combination of large rivers and volcanic soil. Timor-Leste, however, has few rivers and, more importantly, the soil is not volcanic but instead consists of limestone and metamorphosed marine clays, a combination that is substantially less fertile (MAFF 2004, 1). An additional problem is that the country is mountainous. Around half of the land has a slope of 40 percent or more, which makes agricultural activities difficult to pursue.

3.2 Land
The combination of Timor-Leste's particular soil, the steep slope of the land, and the irregular and heavy rainfall makes the land fragile and prone to erode. Natural erosion rates are high, as is the rate of man-made deforestation. This is partly caused by "slash-and-burn" cultivation, which is still common in the country. Even more important is the effect of logging for firewood. The demand for firewood has

increased in recent years, partly as a consequence of the removal of kerosene subsi-dies. The increased demand has put pressure on the forests and aggravated land erosion, especially in areas close to towns and major villages. There are no recent figures on soil erosion in Timor-Leste, but the forest loss from 1972–99 was esti-mated at about 1.1 percent per year (UNDP 2006, 27), and the Ministry of Agricul-ture, Forestry and Fisheries (2007, 19) reports the same figure for 2000–05.

The reduction of arable land because of erosion in combination with the high fertil-ity rate means that little agricultural land is available in Timor-Leste, on average only around 0.4 hectares per capita (UNDP 2006, Table 2.1). The median area is even lower, 0.22 hectares per person and less than 5 percent of the landowning rural pop-ulation have more than 1 hectare per person (Ministry of Planning and Finance and World Bank 2003, 30). Most people, however, do have access to some land. Hence, there are few landless people in Timor-Leste, in stark contrast to the situation in many other countries in Southeast Asia. The share of irrigated land is only 22 per-cent of the total (UNDP 2006, 26).

3.3 Capital

Two types of capital are of interest in the discussion of agricultural development. The first is physical capital such as machinery and the second is financial capital, mainly credit. The use of machinery in agriculture, for example tractors, is ex-tremely limited in Timor-Leste, partly because of the inability of the poor farmer to pay for fuel. Cultivation is characterized by production methods that have changed little for several decades or perhaps even centuries.

Irrigation schemes are difficult to implement in Timor-Leste. Rainfall is irregular and most rivers are completely dry for large parts of the year. Even in those in-stances where some type of irrigation exists, it tends to be simple and unreliable. Irrigation systems are often crucially dependent on the water level in the rivers, which has to reach the level of the intake of the irrigation system. There are few in-stances where a pump can help farmers transferring water from its prime supply to the irrigation systems. As an example on the low quality of irrigation, it was re-ported that only a few hundred irrigation schemes existed in Timor-Leste around the time of independence and only around 20 of these could store water (MAFF 2004, 4). Maintenance is a major problem and irrigation schemes are often ruined by flooding rivers.

The lack of irrigation is a major problem when it comes to expanding agricultural output. The lack of water is particularly troublesome in the case of rice production. However, less than 20 percent of the irrigated land produces a second rice crop

(MAFF 2007). In other words, agricultural output is low even when water is not the binding constraint. Hence, there is a range of other problems explaining the low agricultural production level in Timor-Leste.

There are no up-to-date figures on the amounts of fertilizer and pesticides used in Timorese agriculture but the available indications point to small amounts. For instance, the Timor-Leste Suco Survey reported that only 3 percent of the households used such inputs in 2001 (Ministry of Planning and Finance and World Bank 2003, ix), and a 2003 survey in five districts revealed that only 29 percent of the farms used chemical fertilizer and that less than 35 percent used chemical pesticides because of lack of availability and high prices (Care International 2004, 19).

Investments in irrigation, new seeds, a plow, or a horse are expensive and require financial capital. Such capital is in scarce supply because farmer incomes are low, and also because the financial sector is rudimentary. There are only a few banks, which tend to be located in Dili where they target the international donor community and some service sector operators. No commercial banks are found in rural areas and even if they were, it is likely that low incomes and ill-defined land rights would prove to be serious obstacles to borrowing for most farmers. The credit situation in agriculture has been dismal during the entire independence period. Thus, in 2002, the Japan International Cooperation Agency (JICA 2002) reported that no farmers had access to credits from banks, 50 percent could borrow from traders, and 14 percent from relatives. An FAO-World Food Programme Study from 2007 bluntly stated that credit institutions were nonexistent, with minor exceptions (FAO and World Food Programme 2007, 12) and two years later an IFC survey reported that loans were typically not available for purchases of farm inputs or improvements or for trade in farm products, because credit institutions have a problem getting secure information about borrower risk and because land cannot be used as collateral (World Bank 2011a, 97–98). Micro finance may provide a useful alternative to banks and some initiatives have been taken by international donors, but it is unclear how extensive and successful these efforts have been.

3.4 Technology

Technology in agriculture is related to the use of the inputs described in the previous section. The choice of a new input, for example, a new variety of seeds, often requires a change in the whole bundle of inputs, such as water and pesticides. Barlow (2001, 119–120) describes how maize and rice harvests could increase by as much as 100 percent in Timor-Leste if new and better varieties were to be planted. He notes, however, that such varieties are typically more sensitive to droughts and pests and require more fertilizers and better storage facilities. This change in inputs could be described as a new technology package.

The UNDP (2006, 28) suggests that such changes in technology require a minimum of four to six years of education of good quality. Unfortunately, the level of education in Timor-Leste is low and the quality is poor (Lundahl and Sjöholm 2005). The implication is that improvements of the level of education have immediate relevance for the possibilities of introducing a new agricultural technology.

Another area where technology appears to be important is in the processing of crops like rice and coffee. The UNDP (2006, 30) claims that rice mills are using outdated technologies. Coffee quality in Timor-Leste suffers from poor processing, often carried out by the farmers themselves, where lack of water, necessary for the wet fermentation, is a major constraint (Barlow 2001, 120). It seems as if there is plenty of scope for technological improvement both in agriculture and animal husbandry, as concluded in a major World Bank (2011a) study on the scope for expansion of agricultural exports in Timor-Leste.

In the past, the Indonesian government took active part in agricultural production in Timor-Leste. During the occupation, inputs were provided by the government and output was purchased at set prices. The government also provided credits, storage facilities, and marketing assistance. Moreover, it developed an extension service that was modestly successful, both when it came to introducing new crops and increasing the productivity of the existing ones (World Bank 2011a, 77). The present government has not yet played any such active role. This is partly caused by an explicit intention to let the market forces and the private sector (including a number of nongovernmental organizations), rather than the government, shape agricultural production and development. There are, however, few agricultural extension workers in Timor-Leste. This is due both to a lack of trained personnel at the time of the Indonesian exodus (Timmer 2001, 105) and to the decision (until recently) to restrict the number of public servants (UNPD 2006, 41).

3.5 Infrastructure and institutions

One of the most important roles of infrastructure and institutions in an economy as undeveloped as that of Timor-Leste is to assist in the development of the market system. Farmers need access to markets if they are to abandon subsistence farming. Markets exist in towns and larger villages but a major problem is a lack of transportation to markets. Roads were developed reasonably well during the Indonesian occupation, partly to facilitate the movement of troops across the island, but maintenance has been poor since 1999. Due to the mountainous terrain the roads are narrow and the speed too slow, which in turn means that the utilization of the truck fleet is relatively low. The quality of the road network is bad and consequently traffic volumes outside Dili are low. The situation is particularly troublesome during

the rainy season when many roads are practically impossible to use (World Bank 2011b, Annex 10.1).

Walking is the most common way to move about for most people even when roads exist. Other means of transportation are either nonexistent or, more commonly, too expensive. Thus 80 percent of all farmers have to walk on foot to the nearest market, which is located two hours away on average (UNDP 2006, 29).

Selling in the market is also difficult. It is widely argued that farmers have problems getting access to price information for various crops. Improved communication networks including telephones and radios are necessary to facilitate the information gathering (Timmer 2001, 107). Inadequate or non-existent storage capacity is another problem. A large share of the harvest is regularly destroyed (UNDP 2006, 30). Another result of the poor access to markets is that many farmers only grow one crop of rice even where a second harvest would be possible.

Most farmers use land without clearly defined title. The attempt of the government to define land rights has been slow and progress has been limited. In the 2012 issue of the World Bank Doing Business report, Timor-Leste ranks 183 out of 183 countries when it comes to registering property (Doing Business 2012, 131). This comes as no surprise considering that several different, partly conflicting, law systems are involved, with land claims based on traditional rights, Portuguese titles, Indonesian titles, and occupation as a result of displacement of people voluntarily or by force by the Indonesian administration (Fitzpatrick 2001; International Crisis Group 2010). The situation is further complicated by the displacements that took place following the 1999 disturbances, when an estimated 250,000 people were driven across the border to West Timor, and the disturbances in Dili in 2006, when another 150,000 people were displaced. This means that many landholdings have several claimants. Work has begun on a cadastral survey and a draft land law exists, but it has not yet been approved by Parliament.

Lack of clear title makes land transactions difficult and makes it impossible to use land as collateral for credit, but not only that. Coffee provides an example of how the lack of clear land rights leads to poor harvests. Low coffee production is to a large extent caused by neglect in pruning the coffee trees. Pruning increases the crops but only after a few years, while yields decline for the first two years. Farmers who are not certain that they will have the right to the crops in the future will therefore behave rationally and avoid pruning the trees.[1] The lack of other agricultural

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1 Another reason for not pruning the trees is that many farmers are so poor that they cannot

investment is also partly caused by the failure of the government to provide land titles. Such failure leads to lower investment both because of the insecurity when it comes to enjoying the fruits of the investment and because of the difficulty of obtaining loans without clearly titled land as collateral.

4. The role of market incentives in agricultural development

It is clear that the government has a role to play when it comes to increasing agricultural production. The most obvious example is the provision of the infrastructure that will make it possible for farmers to get their products to the market. Another, much more difficult, task is the allocation of land rights. It is likely that the lack of clearly defined land rights has a detrimental effect on investments in agriculture. A third obvious area for government action is extension services.

Timor-Leste is, however, not a planned economy but a market economy, although admittedly an embryonic one, since subsistence activities dominate in agriculture. The question that then arises is whether market incentives can be used to make Timorese farmers increase their production and sales and use more and better inputs. Increasing productivity and output in agriculture is one of the most important tasks of economic policy in Timor-Leste, because, as we have already dealt with, the agricultural sector in the foreseeable future will have to serve as a "sink" for the growing labor force. Conroy (2006) argues that the discussion of "private sector development" in Timor-Leste has to take this as its point of departure and suggests that increased demand for either cash crops or food crops may serve to increase agricultural production, notably, production for the market. Moreover, as in many other peasant societies, according to Conroy, peasants will not bother to produce for the market unless they can get access to industrial or other consumer goods that they cannot produce themselves.

Conroy's argument implies that the subsistence sector resembles the vent-for-surplus economy portrayed by Hla Myint (1958), where both labor and land are unemployed for lack of demand. The economy is producing at some point inside its production possibility curve, to use a textbook term, and if and when the demand for its goods increases, combining land and labor in the prevailing fixed proportions may serve to bring it quickly to the curve, where production becomes efficient in the sense that it will no longer be possible to increase the output of any given commodity without simultaneously reducing that of some other good. There are no longer any unused resources in the sector.

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afford two years of declining production. A better functioning credit system could help farmers to smooth incomes between years (UNDP 2006, 29).

Whether such a process will materialize is, however, doubtful. In the first place the land frontier that exists in the economy must be put under the plow, as it were. The frontier must be "cleared" before it can be used for production and this is costly in itself (Findlay and Lundahl 1994). Second, in practice it is unlikely that a hand-in-hand expansion of labor and land can take place. The confused situation with respect to property rights makes it probable that when the agricultural labor force grows, most of the absorption of this growth will take place on land already under cultivation. Then, labor absorption in agriculture will be subject to diminishing returns (i.e., to falling income per head). Third, even if land and labor can be combined in fixed proportions, diminishing returns to labor are likely to set in, because the land added to cultivation is likely to be either of lower and lower productivity or of more and more distant location, in the Ricardian fashion.

5. A model of the agricultural household in Timor-Leste

With the given proviso, we may shed some light on the question of whether agricultural "entrepreneurs" will seize the opportunities offered by the market with the aid of a simple model of farm household behavior (Lundahl and Ndulu 1990). In this model, households produce food and a cash crop (which they do not consume themselves) on a given land area. The consumption and production decisions are hence interdependent. The households maximize their utility given the relative prices of cash crops, food crops, and purchased goods.[2] (The price of purchased goods is used as the *numéraire,* i.e., the prices of other goods can be measured in terms of the number of units of purchased goods they can buy.) Utility maximization yields an equilibrium in which the households distribute the available time between production and leisure, the time devoted to production between cash crops and food production, and the resulting income between the consumption of food and purchased goods, all according to their preferences and the prevailing relative prices. It also determines how much food is sold on the market.

The utility function of the agricultural household is

$$U = U(F, M, L_e) \, , \tag{1}$$

where F denotes food, M purchased goods, and L_e leisure.[3] Utility is positive and diminishing for all arguments of the function.

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2 An alternative formulation would be to assume that the household maximizes expected utility subject to a survival constraint. The present formulation does not take uncertainty into account.

3 Possibly, the household is not interested in leisure. This simplifies the utility maximization to a choice between the consumption of food and manufactured goods.

Food and cash crops are produced using labor and a fixed quantity of land according to

$$q_f = q_f(L_f) \,, \tag{2}$$

$$q_c = q_c(L_c) \,. \tag{3}$$

These production functions display diminishing returns to labor. The total quantity of labor (time) is divided between leisure, food and cash crop production:

$$\bar{L} = L_e + L_f + L_c \,. \tag{4}$$

Households maximize their utility subject to equation (4) and to

$$p_m M = p_f[q_f(L_f) - F] + p_c q_c(L_c) \,, \tag{5}$$

where the p's denote prices. What is available for spending on purchased goods is the sum of the value of food production, minus what is consumed by the household itself, and the value of cash crop production.

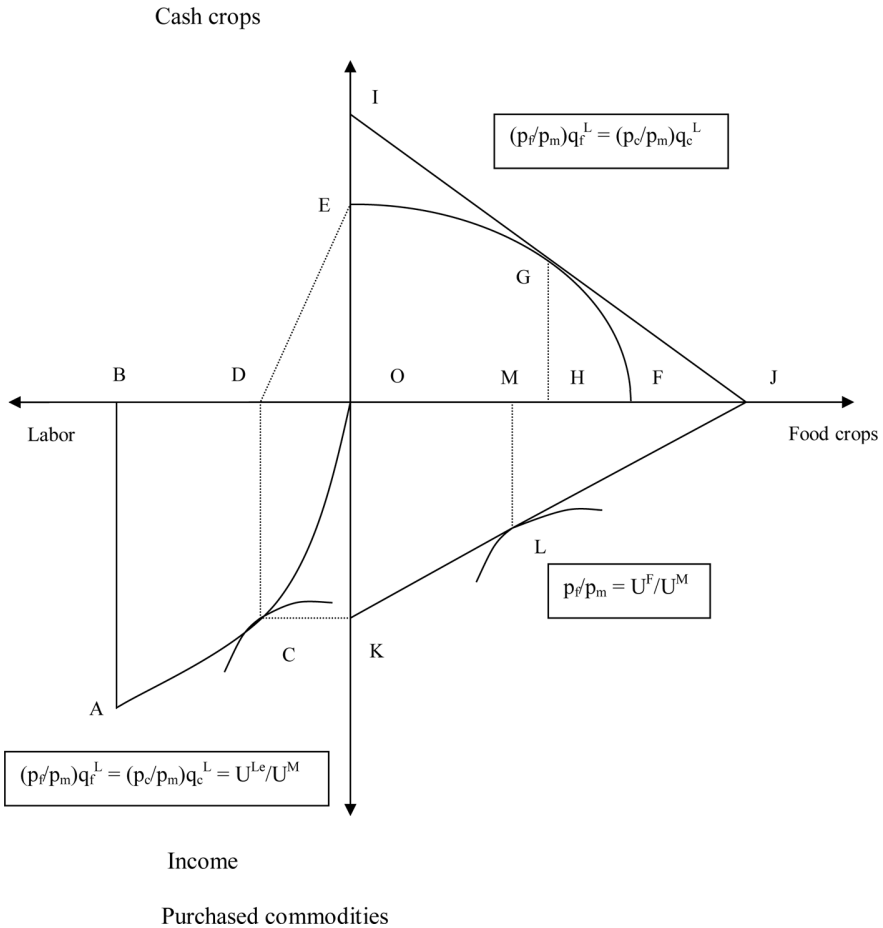Utility maximization yields the following first-order conditions:

$$U^M(p_f/p_m) = U^F \,, \tag{6}$$

$$U^{Le} = U^M(p_f/p_m)q_f^L = U^M(p_c/p_m)q_c^L \,, \tag{7}$$

where the superscripts denote first derivatives. In equilibrium, the valuation of a unit of food must be the same at the margin regardless of whether the household chooses to sell it to buy purchased goods or to consume it in the household. Also, at the margin the household must obtain the same satisfaction of a unit of time egardless of whether it is dedicated to leisure, food production, or cash crop production.

The situation is illustrated in Figure 3. Beginning with the OA curve, this shows the income-leisure tradeoff for the household. The number of hours available is OB. Work (as opposed to leisure) is measured leftwards in the diagram, and income downwards. The more hours the household works, the higher is its income, which increases at a decreasing rate. Given the preferences of the household for income and leisure, respectively, it chooses point C on the tradeoff, working OD hours and taking out DB hours of free time. This yields a total income of OK, measured in terms of purchased goods.

Figure 3. The equilibrium of the farm household

Cash crops

$(p_f/p_m)q_f^L = (p_c/p_m)q_c^L$

$p_f/p_m = U^F/U^M$

$(p_f/p_m)q_f^L = (p_c/p_m)q_c^L = U^{Le}/U^M$

Labor

Food crops

Income

Purchased commodities

The OD hours worked must be distributed between food and cash crop production. If only the latter is chosen, the maximum output will be OE, one of the two end-points on the household's production possibility curve. If the household specializes in food production instead, the maximum output is given by the other endpoint of the curve, OF. The production possibility curve is drawn on the assumption of a given factor (labor) endowment, and shows the different possible combinations of food and cash crops that can be obtained with the aid of this endowment. The actual choice of production is determined by the relative price of the two crops, as given by the price line IJ. This line is tangent to the production possibility curve at G, which is where the value of output is maximized at the given prices.

The output combination given by G gives a farm household income of OI, measured in terms of cash crops, or OJ, if we choose to measure in terms of food instead. Given the relative price prevailing between food and purchased goods, this translates into an income of OK, in terms of the latter, our *numéraire.* The only thing that remains to be determined is the consumption of the household, given this income, represented by the budget line JK. Given the preferences of the household for the two goods, the consumption point is L, where ML units of the purchased goods and OM units of food are consumed. This, in turn, leaves a food surplus of MH, which is sold in the market.

5.1 Farm household response to market incentives

Next, we will use our model to examine the proposition offered by John Conroy (2006, 20): that Timorese farmers may be expected to increase production for any of the following three reasons:

1. Increased prices on cash crops;
2. Increased prices on food crops; and
3. Reduced prices (increased availability) on goods not manufactured by the farmers but purchased from outside.

In the present work, we do not make any assumptions as to where the price changes come from, but they are likely to be intimately connected with, for example, infrastructural development. For example, better roads are likely to increase the net price fetched by the farmers both for cash and food crops while at the same time they should have to pay less for what they buy from the outside.

We will next examine the probable effects of each one of these price changes with the aid of our model.

5.2 Increased prices of cash or food crops

Let us begin with what happens when the price of cash crops increases ($dp_c > 0$) while the other two prices are kept constant. The price increase serves to rotate the income–leisure tradeoff in Figure 3 counterclockwise, since the value of the marginal product of labor in the production of cash crops increases. For any given labor effort in agriculture, household income will increase. At the same time, leisure will become more expensive in terms of income forgone. We have an income effect and a substitution effect, and it will not be possible to reach a general conclusion of whether more hours will be devoted to agriculture than before, or the number of leisure hours will increase. If, however, leisure is an inferior good, as hinted by Conroy, the number of hours worked will increase. This is a quite realistic case in a

poor economy. Households have plenty of idle time. Should income possibilities improve, it is quite likely that the farm household prefers to work more and not less. Leisure does not even have to be inferior. It is enough that the substitution effect is strong enough to swamp the increased demand for leisure at given prices.

What will happen to the production of the two goods? The first-order condition (equation (7)) may be rewritten as:

$$(p_f/p_m)q_f^L = (p_c/p_m)q_c^L . \tag{8}$$

Differentiating equation (4) yields:

$$dL_f = -(dL_c + dL_e) , \tag{9}$$

and from equation (8), allowing p_c to change and keeping p_m and p_f constant (normalizing all three prices = 1, at the outset), we obtain

$$q_f^{LL}dL_f = q_c^{LL}dL_c + q_c^L dp_c . \tag{10}$$

Combining equations (9) and (10) gives us

$$-(q_f^{LL} + q_c^{LL})dL_c = q_c^L dp_c + q_f^{LL}dL_e > 0 , \tag{11}$$

provided that $dL_e < 0$, because $dp_c > 0$ and the second derivatives of the production functions are negative. By the same token it must be that $dL_c > 0$. If the rise in the price of cash crops leads to less leisure, the production of these crops must increase. Even if dL_e is positive, the production of cash crops may increase, if the price rise is large. The production of food crops may increase as well, in the case where the reduction of the hours devoted to leisure exceeds the increase in the number of hours devoted to cash crop production. Finally, what happens to the marketed surplus of food crops is uncertain. The on-farm demand for food will increase if the production of cash crops, and hence income, increases, because the relative price of food and purchased goods remains constant, but food production may also increase.

In the same way, it may be demonstrated that an increase in the price of food will lead to increased food production, provided that leisure is reduced or provided that the increase in the price of food is large. What will happen to on-farm consumption and the marketed surplus of food is not clear. When incomes rise in terms of the purchased goods the farm households will demand more of both these goods and food at given relative prices. There is also a substitution effect due to the increase of

the relative price of food, however. This serves to reduce the consumption of food and increase that of purchased goods. The net outcome of this is unclear and will depend on the income elasticity of demand for food products among the farm households themselves.

Normally, we should expect Engel's Law to operate—namely, when incomes rise, less and less of the income increase will be devoted to food consumption, so that the share of the household budget spent on food will decrease as income increases. In Timor-Leste, however, this is not necessarily the case. Various empirical investigations have shown that households experience a shortage of food between November and April (i.e., for some four months every year; Lundahl and Sjöholm 2005, 15–16; 2008b, 20). Hence, given the low income level and the large share of the population living in poverty, it is far from certain that Engel's Law is operative. It is not possible to rule out the possibility that an increase in the price of food will lead to a reduction of the marketed surplus.

5.3 Cheaper purchased goods

Finally, we investigate whether a cheapening of the goods that the farm households purchase from the outside will serve as a stimulus to increased production and sales (in the case of food). Again, we differentiate equation (8), but this time holding p_f and p_c constant, while allowing p_m to fall. This yields

$$q_f^{LL}dL_f - q_f^L dp_m = q_c^{LL}dL_c - q_c^L dp_m . \tag{12}$$

In equilibrium the value of the marginal product of labor in food production must equal that in cash crop production (remembering that we have normalized all prices = 1 at the outset). Hence the second terms on both sides of the equality sign in equation (12) are equal. What remains is

$$q_f^{LL}dL_f = q_c^{LL}dL_c . \tag{13}$$

Either the production of food and cash crops will both increase, or both decrease. Rewriting equation (9) as

$$dL_e = -(dL_f + dL_c) \tag{14}$$

shows that the crucial determinant here is what happens to leisure as purchased goods become cheaper. Because we have chosen the price of purchased goods as our *numéraire,* making these goods cheaper amounts to increasing farm household in-

come. The income–leisure tradeoff in Figure 3 will rotate counterclockwise, exactly as when the price of cash crops or food increased. Once more, we have an income effect and a substitution effect, and if the net outcome of these is to reduce leisure, the production possibility curve will shift outwards and the production of both cash and food crops will increase. In the opposite case, it will fall. Again, what will happen to the marketed surplus of food crops is not certain. The same considerations as before apply.
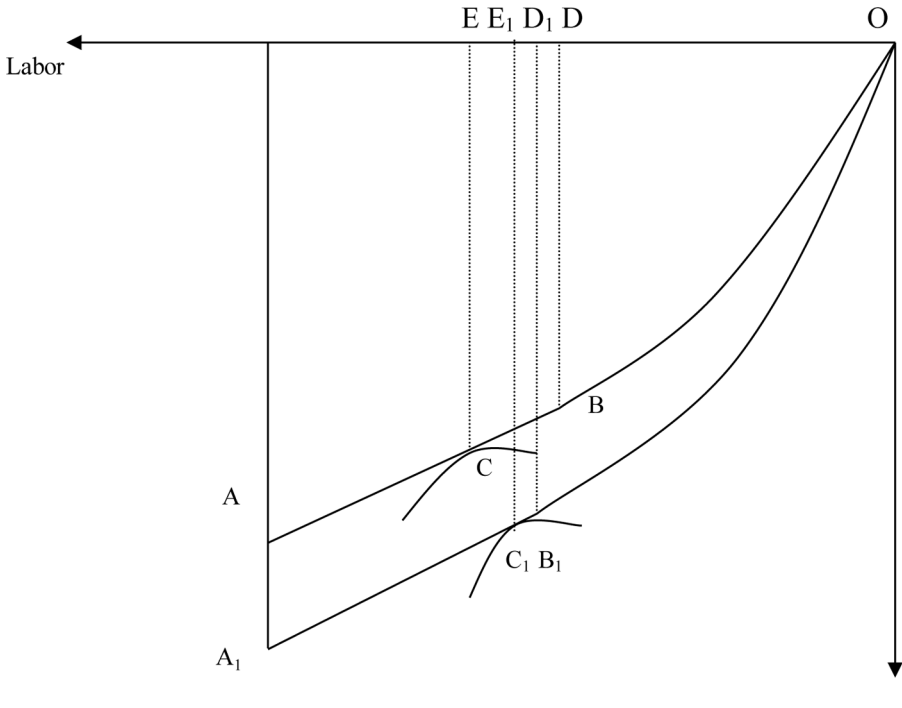
5.4 The importance of outside alternatives

So far, we have considered farm households with no options to work outside of agriculture. The Household Survey carried out in 2001 (see Lundahl and Sjöholm 2005, 14) reported two significant findings: (1) Among those individuals who were in the labor force, those belonging to households whose heads were limited to farm employment were considerably poorer than when the heads worked in wage employment, household business, or other outside ventures; (2) almost 70 percent of all Timorese belonged to families with no or only small possibilities of obtaining income from outside agriculture.

This clearly points to desirability of creating employment outside the agricultural sector. In the short run, this could for example take the form of public works during the off-peak season in agriculture. In the longer run, a private sector will develop. Smallholders in the developing countries often derive their income from a variety of sources, and this serves to increase their standard of living. This finding can easily be incorporated into our model. In Figure 4, the possibility of earning a given outside wage equal to w/p_m, when measured in terms of purchased goods, has been incorporated. The household keeps working in agriculture until the value of the marginal product of labor there falls to the level given by the constant outside wage. At this point (B), the income–leisure curve becomes a straight line. Thereafter the remaining hours worked are spent in wage employment, up to point C. The income from this must be added to that from farm work. Hence the total income line will lie outside IJ and outside the budget line JK. The incorporation of outside employment changes our conclusions.

Let us begin with the case of increased prices of cash crops. When p_c increases, as before, the income–leisure tradeoff rotates counterclockwise, from OA to OA_1. The value of the marginal product increases in agriculture, and more hours will be worked there. Outside work will no longer begin at B (or D), but at B_1 or (D_1). The total number of hours worked will, however, decrease. Provided that leisure is not

Figure 4. An increase in the relative price of cash crops

an inferior good, points C_1 and E_1 lie to the right of C and E, respectively, as long as some outside work takes place both before and after the price increase. The reason is that the substitution effect disappears. Leisure is no more expensive at the margin after the price increase than before, because the marginal valuation is given by the wage rate and not by the price of cash crops, and the wage rate does not change. All that remains is the income effect, and this makes for increased leisure. Income increases as well, but as a result of the reallocation of work hours between wage labor and farm work. On the other hand, should leisure be inferior, C_1 will be to the left of C and E_1 to the left of E. Work will increase both inside and outside of agriculture at the expense of leisure.

Turning to the allocation of work hours between cash and food crop production, equation (12) may now be rewritten as

$$(p_f/p_m)q_f^L = (p_c/p_m)q_c^L = w/p_m, \tag{15}$$

where the wage rate is given in terms of purchased goods. Also, the available labor time has to be distributed among leisure, crop production, and outside work. This changes equation (4) to

$$L = L_e + L_f + L_c + L_m \tag{16}$$

Differentiating equation (15) when p_c changes and the other two prices and the wage rate in terms of purchased goods (w/p_m) are held constant (with $p_f = p_c = p_m = 1$ at the outset) yields

$$q_f^{LL}dL_f = q_c^{LL}dL_c + q_c^L dp_c = 0 \tag{17}$$

or

$$dL_c = -(q_c^L/q_c^{LL})dp_c > 0 \tag{18}$$

and

$$dL_f = 0. \tag{19}$$

The output of cash crops increases and that of food remains constant. Here, price incentives work unequivocally, and because all cash crops are sold in the market, outside sales will increase as well. The marketed surplus of foodstuffs, on the other hand, will be reduced. Farm household income has increased, and both food prices and the price of purchased goods remain constant. Hence there is only the income effect. The demand for both food and purchased goods among farm households will increase, but food output remains constant. The marketed surplus of food must therefore shrink.

The analysis is analogous for the case of increased food prices. There will be more leisure and larger food production and cash crop production will remain constant. In this case, however, we don't know with certainty what will happen to the marketed surplus of food. The price of the latter good increases and the substitution effect will be reintroduced. Possibly, on-farm consumption will be reduced and more food will be sold outside.

The conclusions will change also when the price of purchased goods is reduced (but w/p_m remains constant). The income–leisure tradeoff again rotates counterclockwise, more leisure is enjoyed, and less work takes place outside the farm and more inside. Equation (12), in turn, becomes

$$q_f^{LL}dL_f - q_f^L dp_m = q_c^{LL}dL_c - q_c^L dp_m = 0 \qquad (20)$$

and

$$dL_c = (q_c^L/q_c^{LL})dp_m > 0 \qquad (21)$$

$$dL_f = (q_f^L/q_f^{LL})dp_m > 0 . \qquad (22)$$

$dp_m < 0$, so the production of both cash crops and food will increase. The farm households will increase their consumption of purchased goods, and possibly, but not with certainty, that of food as well, because food becomes more expensive in terms of purchased goods. However, because the production of foodstuffs increases as well, the net result of the cheapening of purchased goods may be both increased leisure, at the expense of outside work (provided that leisure is a superior good), increased on-farm consumption of food, and increased sales not only of cash crops but also of food.

5.5 Policy implications
The model analysis has some policy implications. The first one is that we cannot be certain that price incentives will necessarily work for farm households that have no outside opportunities. The increased income opportunities may be converted to more leisure instead of increased output. On the other hand, given the widespread poverty in the countryside, this is perhaps less likely. Then, in the case of higher cash crop prices, more output will be put on the market. The case of food crops is different, because these are consumed also by the farmers themselves, and, given the regular periodic food scarcity, an increased output is likely to be absorbed to a certain (unknown) extent by increased on-farm consumption. Access to cheaper purchased goods will increase the production of both types of crops, provided that it reduces leisure, but we don't not know with certainty whether this will result in more food in the marketplace or not.

The second policy implication is that once farm households get access to outside income opportunities, agricultural production is likely to increase as a result of price incentives. As long as leisure is not an inferior good, all three price changes will result in more leisure, but at the expense of outside work. The increases of the value of the marginal product of labor in agriculture that are due to the price changes will ensure that the output of the crop whose price increases will increase as well, and when purchased goods become cheaper, the production of both types of crops will expand. The marketed surplus of food will shrink when the price of cash crops increases, but not necessarily in the other two cases, where not only the on-farm con-

sumption but also the production of food increases. (If leisure is inferior, both out-side work and work in agriculture will increase. The effects on agricultural production will be the same.)

Thus, altogether, it appears likely that price incentives stand a better chance to work once the farmers have access to outside income earning opportunities as well. Also, in that case, improved access to purchased consumer goods may serve as an impor-tant stimulus to agricultural production. This, in turn, may be important for non-agricultural enterprises, which often perceive that their operations are constrained by insufficient demand. The situation to a certain extent resembles that of the chicken and the egg. If outside goods are available, farmers may produce more, and this may provide a market for domestic modern enterprises, but unless the latter provide outside goods in the first place, there may be no response from the farmers. The analogy is not perfect, however. The initial stimulus could come from imported goods, and once domestic entrepreneurs see this, they may develop substitutes for imports. But then, on the other hand, a business environment conducive to entrepre-neurship must be created, and here, Timor-Leste has some way to go (Lundahl and Sjöholm 2009b).

The Timorese government seems to be aware of the importance of job creation and has tried to increase publicly funded employment since 2007. The number of jobs in the public sector is increasing, which represents a change from a previous deliberate attempt to keep public employment below 20,000 people. The most visible employ-ment effects have come from government-funded infrastructure projects, which have benefited 40,000–60,000 Timorese annually since 2007, often through short-term employment for the rural population (UNDP 2011).

6. Conclusions

This article has dealt with the problem of how to achieve a higher future income and living standard in Timor-Leste. In the longer run, that will presumably be the task mainly of a modern industry or service sector, but at the present time four-fifths of all Timorese are subsistence peasant farmers, and in the absence of a modern sector, in the short and medium term, agriculture will have to continue to act as a sink in terms of employment.

This fact makes it natural to focus on what determines production and incomes in agriculture. In the first part of our discussion we used a "production function ap-proach," which allowed us to focus on the inputs used in agriculture. Land is a scarce production factor and little capital is used, among other things due to a gen-

eralized lack of credit. The technological level is low, not only because of the lack of capital, but also because of the low educational standard of the farmers and the lack of government support in such areas as extension and transportation.

The agricultural sector in Timor-Leste is to a large extent a subsistence sector, where the agricultural households consume most of what they produce. In the future, however, the market orientation of the sector is likely to increase. Timor-Leste will presumably undergo the same process of rural–urban migration and urbanization as the rest of the developing countries. This, in turn, means that change, for better or for worse, will presumably have to come via the market mechanism.

In the second part of our analysis we hence developed a model of an agricultural household, which allowed us to find out the likely effects of changes in the prices of food and cash crops and industrial goods on agricultural production and incomes, crop mix, leisure, farm household consumption of food and industrial goods, and sales of food crops and cash crops not consumed by the farm households. Incentives may come from increased prices of farm products and reduced prices of industrial goods. The effects of these changes are not altogether clear-cut. Much depends on how the farmers value leisure and on whether the farm household has access to outside earning opportunities as well. Introducing wage-earning opportunities may be important, because in this case, whatever increased leisure farm households may want to enjoy will take place though a reduction in outside work rather than farm production. The production of at least one agricultural commodity will increase (both in the case of a cheapening of manufactured goods). Thus the objective of increasing the living standard of Timorese farmers may in part be achieved via increased earning opportunities outside agriculture.

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