AGRICULTURAL TRANSFORMATION & FOOD SECURITY 2040

ASEAN Region with a Focus on Vietnam, Indonesia, and Philippines

Indonesia Country Report

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Table of Contents

List of Figures, Tables, and Boxes

Figures

Chapter 2

Chapter 3

Annex 1

Annex 3

Tables

Chapter 2

Annex 5

Box A5.1: Climate Field Schools in Indonesia

Abbreviations

AAHRD	Agency of Agricultural Human Resource Development
AIAT	Assessment Institutes for Agricultural Technologies
ASEAN	Association of Southeast Asian Nations
AUSAID	Australian Agency for International Development
AVRDC	Asia Vegetable Research and Development Center
BAL	Basic Agrarian Law
BIPP	Balai Informasi dan Penyuluhan Pertanian—Agriculture Extension Field Office
BPN	Badan Pertanahan Nasional- Land Agency
BPS	Badan Pusat Statistik—Central Agency on Statistics
BRI	Bank Rakyat Indonesia
BTPN	Bank Tabungan Pensiunan Nasional Tbk
BULOG	Badan Urusan Logistik—Logustics Affairs Agency
CC	Climate Change
CBS	Central Bureau of Statistics
CPO	crude palm oil
DAFEP	District Agricultural and Forestry Extension Project
EEZ	Exclusive Economic Zone
FAOSTAT	FAO Statistical Database
FEATI	The Farmer Empowerment Through Agricultural Technology and Information Project
FMD	Foot and Mouth Disease
FMPI	Forum Masyarakat Perunggassan Indonesia
FPPM	Fisheries Product Processing and Marketing
GAPPI	Gabungan Perusahaan Perunggassan Indonesia—Indonesian Poultry Association
GCM	General Circulation Models
GERNAS	Gerakan Nasional Cacao- National Cocoa Replanting Program
GDP	Gross domestic product
GGP	Great Giant Pineapple
GHG	Green House Gas FPPM
GMO	Genetically modified organisms
GOPAN	Gabungan Organisasi Peternak Ayam Nasional- National Chicken Producers of 550 Ciation
GPMT	Gabungan Perusahaan Makanan Ternak—Indonesian Feedmill Association
GPS	Grand Parent Stock

GSL	Global Sea Level
GMP	Global Mean Precipitation
GOI	Government of Indonesia
HACCP	Hazard Analysis and Critical Control Points
IAARD	Indonesian Agency for Agricultural Research and Development
ICT	Information and communication technology
IFC	International Finance Corporation
KADIN	the Indonesian Chamber of Commerce
KPPOD	Komite Pemantauan Pelaksanaan Otonomi Daerah (Committee Monitoring the Implementation of Regional Autonomy)
KUD	Kooperasi Unit Desa—Village Cooperative
MCS	Monitoring Control and Surveillance
MHOA	Ministry of Home Affairs
MMAF	Ministry of Marine Affairs and Fisheries
MOF	Ministry of Finance
MP3EI	Masterplan Percepatan dan Perluasan Pembangunan Ekonomi Indonesia—Strategy for Accelerated Regional Development
MSY	Maximum Sustainable Yield
NES	Nucleus Estates and Smallholder Schemes
NIFA	National Institute of Food and Agriculture
PBS	Program for Biosafety System
PDSR	Participatory Disease Surveillance and Response
PEER	Partnerships for Enhanced Engagement in Research
PIN	Production Index Number
PINSAR	Pusat Informasi Pasar- Center for Market Information
PPP	Public-private Partnerships Purchsing power parity
OECD	Organisation for Economic Co-operation and Development
RASKIN	Rice for the Poor
REDD	Reduced Emissions for Deforestation and Degradation
RFMO	Regional Fisheries Management Organizations
RSS	ribbed smoked sheet
SMS	Short message service
SUSENAS	The National Socioeconomic Survey
TFP	Total factor productivity
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WTO	World Trade Organization

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Executive Summary

Major findings

Two parallel stories of agricultural performance, one of unrelieved consistent success, year after year and decade after decade, the other of early success and later stagnation, emerge from our study. The first story revolves around tree crops and is concentrated on the key Outer Islands of Sumatra, Kalimantan, and Sulawesi. The second, mainly focused on Java, revolves around rice, the ostensible center of food security concerns, as well as presumed future highly profitable production of horticulture, aquaculture, and animal products.

The drivers of Indonesian agriculture

While rubber was the early dominant export crop, the dominant growth crops of the 1980–2011 period were oil palm on a grand scale, especially on Sumatra and Kalimantan, where Indonesia eventually surpassed its technical and commercial leader and prime foreign investor (Malaysia) and became world leader, and cocoa on a smaller scale, especially prevalent in Sulawesi. Indonesia's oil palm exports alone (the country is also a large consumer) already exceed in value the entire world rice trade and over the next few years production is expected to further increase merely based on immature hectares already planted. Yields of commercial nurseries of oil palm are much higher still, implying that the position of this oil as the most abundant and cheapest edible oil in the world, that preferred by the new, poorer consumers of India, China, and much of the rest of the developing world, will not be challenged within the study period. The crop also produces a very large by-product (palm kernel oil), much finer in quality and higher in world price, indeed very similar to coconut oil, for the more affluent markets. It is also increasingly smallholder in origin (now about 40 percent), and given huge areas of degraded forest (already logged over for timber) will not need any new rainforest land to further consolidate its premier position in world edible oil markets by 2040. It will, however, need a serious and effective replanting program, like all tree crops, which does not exist yet (see below).

Poverty reduction: The past 30 years saw two major reductions in general and rural poverty in Indonesia, essentially from near 62.8 percent incidence in 1984 to 18 percent in 2011 (at US $ 1.25 a day PPP);the latter very close to current levels in Philippines and Vietnam. The initial decline in poverty was largely based on the Green Revolution in rice, mainly on Java, and was supported by large government programs in irrigation, adaptive research, production credit, and agricultural extension in a fairly coordinated manner. However, as government saw self-sufficiency in rice achieved in 1984–85, and rapid (if fragile) increases in employment in manufacturing and services, it gradually withdrew support to agricultural programs to very low levels, until the financial crisis of 1998 put an end to much of the import-substituting manufacturing capacity and employment, threw tens of millions of people back into poverty for many years, and forced agriculture to once again serve as the safety net for the nation. Here, the robust growth of tree crop exports carried the revival of the rural economy (and enlarged workforce), e.g., enabling otherwise poor and neglected regions like Kalimantan to achieve the fastest agricultural growth rates and lowest levels of rural poverty in the country. Other segments, like fisheries, livestock, and horticulture, helped feed and employ the millions displaced from manufacturing and services, while significantly slowing the eventual transformation of Indonesia from an agricultural to an industrial and commercial nation, but the consistent driver has been the development and expansion of tree crops—despite the lack of government-sponsored credit, research in the field (there was considerable private sector research in the major tree crops, much of it brought over from Malaysia), extension, or efficient land titling programs.

Thus pure comparative advantage can triumph over most of the so-called obstacles to development—if government does not explicitly hinder it, a powerful lesson for the next 30 years of agricultural development.

Replanting programs: While oil palm now dominates export crops in Indonesia, the crop where a government-sponsored replanting program is most urgently needed is, however, rubber. Replanting in general is harder to encourage than initial conversion of former forest to plantation, in that there is now an (albeit dwindling) income which must be sacrificed from the aging trees. Rubber replanting is most critical however, because a) the average age of the rubber stock is much closer to senility (or beyond) than is the case in oil palm; b) rubber is now much more a smallholder crop (85 percent) than oil palm, and it is smallholders who need the assistance of government; c) due to the possibility of self-processing (smoking) of latex by smallholders, and hence avoidance of the "nucleus estate" mills which may extend replanting credit, government is not even currently experimenting with credit schemes for rubber replanting; fresh fruit bunches of oil palm offer no such escape route from credit repayment, as they must be delivered and processed by a nearby mill within hours of harvest. Thus 3 million ha of rubber, and millions of people largely dependent on them, are currently at risk of gradual loss of income from rubber. It is thus strongly recommended that a government financed, grant-based replanting program for smallholder rubber, financed largely if not exclusively by a small export tax ("cess") as pioneered in Malaysia over 50 years ago, be designed and implemented as soon as possible to ensure continued long-term rubber income streams for Sumatra and Kalimantan. The smaller replanting program for cocoa begun in recent years under government auspices may be an example here that Indonesia can indeed design and execute such a program without destructive levels of corruption. Based on success here, other programs may be devised for smallholders in oil palm, coffee, and perhaps even coconuts.

Replanting programs need to be based on the following: a) planting materials supplied by nurseries, whether public or private, must be only of the highest quality—these are investments of 20–30 years, which must not be crippled by short-term considerations of minor savings or personal profits; b) effective anti-corruption mechanisms to ensure the integrity of field and managerial staff in awarding the grants to smallholders is extremely important—wages and rewards for good work in the replanting service must be high, punishments and penalties for criminal staff must be onerous and well-publicized; and c) the grant system is so much less complex than credit schemes for this purpose, that only the former has hopes of reaching the great majority of the smallholders and plantings. The temptation to once again try the credit approach as the main approach to smallholder replanting, if only to protect the government's balance sheet, should be avoided. The cess approach will ensure that as the programs grow larger, so will the self-financing.

Food security and self-sufficiency: A major confusion in Indonesian agricultural policy-making, or perhaps a substitution of short-term political gains (e.g. safety of agricultural jobs) for true food security, has been the emphasis on self-sufficiency in production (especially of rice) as the definition of food security. Indeed, in rhetorical terms four other products—beef, corn, soybeans, and sugar—are also officially designated for domestic self-sufficiency. What they all share is that in none of them does Indonesia have agro-economic comparative advantage, which means the probability is extremely low that self-sufficiency will ever be achieved (nor should it) for any of them. Indeed, in recent years despite the rhetoric, beef production has actually declined. In the case of the four smaller commodities, there is little actual welfare loss for the mass of Indonesians from the policy, except perhaps for excessively expensive beef (and hence extremely low domestic consumption) due to repeated interference in imports at various stages in the value chain. For rice, however, welfare losses are extremely high, due mainly to restrictions on imports and high final output prices borne by all consumers. For 2010 OECD calculated the "consumer support estimate" for agriculture, the great bulk of which for rice, at 215 trillion Rp (about $24 billion), equivalent to a $US 100 tax on every Indonesian citizen, representing the transfer of this income from consumers to producers of rice. By comparison, all "general services support" to agricul-

ture (all development expenditure including infrastructure, research and development, agricultural schools, inspection services, etc.) summed to only 13 trillion Rp.[1]

Even if one accepted that self-sufficiency in production (at any cost) represents the most rational approach to food security, it is doubtful that one would approach production maximization mainly by charging consumers (poor as well as prosperous) rice prices far above world prices, which is the main pillar of current food policy. The main production-oriented program to back up the price incentive is fertilizer subsidies costing the equivalent of US$ 1–3 billion per year (depending on world prices for petroleum products), which mainly subsidize the use of nitrogen. Nitrogen may well be overused in Indonesia today, but it is certainly well-known by now to all Indonesian farmers, and hence needs no educational or extension campaign to introduce it to the farm community. A much smaller program tailored only to phosphorous, potassium, and important trace elements in specific places probably would be much more effective in stimulating production of rice at much lower cost. More effective still would be a revival of investment in the most basic of production aids, such as irrigation, where in recent years government expenditure has been only about US$ 500 million/year, covering new investment, rehabilitation, and operation and maintenance of a system officially rated at 7.2 million hectares, but now probably hardly more than about 6.4 million hectares. As can be noted, this real production base for paddy is depending on only a fraction of the budgetary amount allocated to fertilizer subsidies, while compared to the welfare cost of excessive prices, it is negligible.

Meanwhile, banning private rice imports to hold up domestic prices would seem to have two very negative consequences. First, it reduces food security, by putting rice imports (which seem to be necessary year after year even with the "self-sufficiency" policies) in the hands of a single agency (BULOG) which could after all make large errors in estimation of domestic and world crops, or in the management of trade flows. With private participants entitled to import shiploads of rice at will, at ports throughout Indonesia, and store rice where and how they thought best, there would be a constant stream of rice arriving at all times, competition to increase efficiency and keep prices down, and little chance of shortage anywhere. The second negative consequence of artificially restricting rice supplies to the Indonesian population is the impact on increasing poverty, although poverty alleviation is sometimes claimed as a goal of the restrictive policy. A recent article demonstrates that 3/4 of Indonesians plant no rice at all and hence must purchase in all their rice from the market.[2] Those with surplus rice to sell are the larger rice farmers—who may not be "wealthy" in general, but on the other hand are not the absolute poor.

In part to compensate Indonesia's poor and near-poor for extremely high rice prices, the above-mentioned RASKIN (Rice for the Poor) program was developed to distribute subsidized rice (mainly imported) to poor consumers, but by now targeting has degenerated to the extent that 90 million people (nearly 40 percent of Indonesia) receive a few kg of rice every month, meaning that here is one more highly expensive program which does not serve well those who need it most, serves many who do not need it, and contributes little to real food security. Facing the decades to the year 2040, Indonesia instead needs different programs that will ensure: lower food prices—including imported meats as well as grains—for the entire population, and more agents (firms) involved in constant rice imports and storage; higher domestic production at lower cost through investments in real production capacity—irrigation, effective research and extension, new breeds and seeds (some imported) with real potential to increase yields or overcome losses to pests, diseases, and climate change; and poverty programs which better target their recipients, and which are more efficient than hauling bags of rice around Indonesia, likely more dependent on cash transfers.

Other concerns for the next 30 years

Management of marine fisheries resources must improve substantially if this main source of protein (aside from rice

1 OECD, OECD Agricultural Policy Reviews: Indonesia. 1 February 2012. Chapter 2, page 65

2 Neil McCullough: Rice Prices and Poverty in Indonesia, Bulletin of Indonesian Economic Studies, No. 1, 2008, pages 45–65.

itself) of the Indonesian populace is to remain strong. It must also be augmented by mass aquaculture developments available to smallholders, or at least villages, perhaps on the technical leadership model demonstrated by oil palm. But there needs to be a more welcoming attitude of government to foreign investment if major foreign and domestic investments are going to be made in Indonesian aquaculture or for that matter in horticulture and animal industries also. Foreign investments in such fields typically bring with them foreign markets, in addition to cutting edge technologies, and it is difficult to duplicate the value of such packages in any other way. Thus, the government needs to work much harder to ensure that such investments are made in Indonesia, as against her many competitors. New laws like the Horticulture Law of 2010, with an attitude harshly negative to foreign investment (indeed with requirements for foreign investors to reduce their investment) are not the way Indonesia might become a strong factor in high-value agriculture industries by 2040. Thus in aquaculture as well as in land-based industries, a positive approach to foreign investment in such industries must permeate the Indonesian bureaucracies as soon as possible.

While it was noted above that even lack of an efficient land titling and registration system could not long delay the development of oil palm in Indonesia, few crops will carry that overwhelming vista of profitability. For the other crops, it will be necessary to improve the ease of access to land for development. In order for the country's land administration system to be seen as a facilitating, rather than hindering, force in land management, procedures will have to be simplified to the extent that simple, uncontested transactions like sale of a plot of land can be consummated within one day.

Rehabilitation of irrigation systems needs to once again be seen as an urgent national priority, even if rice self-sufficiency is rejected as an impractical and inefficient goal. The imbalance between high prices for consumers and enormous subsidies on items like fertilizer, as against public goods (like irrigation), which are absolute necessities for rice production, argues for a return once again to a robust irrigation program with heavy central funding. Without this, domestic rice production will simply get weaker and weaker over the decades to 2040.

Strategies for agricultural transformation

Conceptually, it will not be a simple task to design in detail and then to implement, strategies to ensure the revival of Indonesian agriculture, and then to facilitate its continued rapid growth over the next 30 years. One reason for this is that many of the preferred courses of institution-building and actions have been proposed in the past and for various reasons rejected. An example is the grant-executed tree-crop replanting program for smallholders, proposed in the past but rejected in part because of a pessimistic attitude to the country's ability to enforce honesty and integrity on a large scale, in meeting high agronomic standards, inspection of field work, and then funding the required smallholder actions phased over several years. In other cases, for example the organization of large-scale irrigation rehabilitation and maintenance programs, or the coordination of food crops adaptive research, disciplined agricultural extension, and production credit, the programs were actually implemented successfully (in the 1970s and early 1980s); the problem here is to return, at least to some extent, to "old fashioned", quite centralized modes of government programming, with hierarchical control, considerable discipline, and responsibility for results. In other cases, such as reliance on private sector rice traders to fulfill the import segment of the nation's staple food needs, there is some genuine fear of the unknown, though in part this was tried in 1999–2004. Given these difficulties, here are the most important long-term strategies for the next 30 years.

Replanting programs: A series of smallholder replanting programs, starting with rubber, must be planned and implemented shortly, before Indonesia loses her major export crop assets in rubber, smallholder oil palm, cocoa, coffee, and tea. For coconuts, a diversified program of tree (and varietal) renewal, intercropping (including with cocoa), and livestock keeping might markedly upgrade incomes on millions of relatively unproductive hectares.

Irrigation: Without "gold-plating" systems, it is time to complete existing systems that were never fully built—especially in Outer Island locations where social assessments show strong willingness and expertise of local populations in paddy production. Where there is strong farmer interest, on both Java and Outer Islands, smaller irrigation systems where rice production is faltering, may be redeveloped for low-cost, low-pressure pipe and drip irrigation systems suitable for horticulture, where on-farm costs would be borne by individual farmers, farmer groups, or entrepreneurs trying to secure supplies for processing and marketing. The general program would be, however, to rehabilitate about a half million ha per year, while instituting a standardized maintenance program designed to reduce rehabilitation frequency to about 20 years.

- Coordinated research and extension. A new major effort is required to collect, develop, and disseminate technical and agro-economic knowledge for Indonesia's millions of farmers. The "bottom-end" of this new system should not rely primarily on routine visits to farmer groups to impart such knowledge, but should utilize media preferred by today's farmers, such as TV, radio, internet, and social networking, as well as demonstration plots, to communicate new packages and concepts. Livestock and aquaculture should be much more integrated with cropping than heretofore. It is obvious that this type of research/extension communication must be executed by higher level units than those of the decentralized kabupatens, though it is possible that provincial units may be able to play this role, along with central ones

- Focusing input subsidies. Reducing costs of standard fertilizers forever is neither sustainable nor useful. All input subsidies, at levels much lower than current ones, should be based on introducing new practices and inputs in areas where they may be extremely beneficial—in part as determined by the revived research/extension system. Subsidy programs must be seen as large-scale experiments, with periodic analysis, comparison of outcomes, and redesign of subsidy programs on this basis.

- Liberalization of rice imports. The rice trade should be opened up to the maximum number of competitors, with a view to lowering retail prices throughout Indonesia. Those who lose by declining farm gate prices, e.g., the larger rice farmers, may be compensated in part by improved irrigation and rice varieties, with higher yields and cropping intensities, and indeed organizational assistance by Ministry of Agriculture to shift to higher return activities (e.g., livestock, aquaculture, horticulture) perhaps on a cooperative basis. BULOG should be made explicitly responsible for preventing local shortages, panics, hoarding behavior and price spikes through its reserve stocks and its network of warehouses and logistics to handle them, and constant market intelligence.

- Land titling. The National Land Agency must be specifically mandated to cover the great bulk of alienated land plots within a specific time frame (e.g., 10 years may be sufficient with the recommended sporadic (transactional) approach), while reducing the time for uncontested land transactions (sales, leases, mortgages) to a single day.

- Coastal fisheries co-management. All coastal fisheries should be placed under the overview of cooperative management by the local fishermen themselves, guided by fisheries extension officers who can advise the associations on the relationships among average and marginal catches and the volume of fishing effort. The cooperatives themselves should then be given a strong say in managing local effort, including protected zones, seasonal limits, banned practices (dynamite fishing, trawling of spawning beds, etc.).

- With these strategies, the sector could be placed well on the way to superior performance, with both higher levels of food security, and higher farm incomes than at present.

Chapter 1. Introduction

Indonesia, the largest southeast Asian nation, not surprisingly presents the most varied agricultural history over the past three decades, and thus presents a difficult case for prediction over the coming three decades also. The well-known dichotomy between densely populated and extremely fertile Java, and the relatively sparsely populated and still largely forested islands of Sumatra, Kalimantan (Borneo), Sulawesi (Celebes), Papua, and many others, still prevails, and explains much of agricultural development today. The commodity analyses which are an important part of this entire study is used here to demonstrate the ability of world markets to supplement the feeding of Java, and on the other hand to provide offtake of the tree crops of the Outer Islands. These differing political economies also lead us to highlight different issues, of widely differing regions: decentralization, the major innovation in governance of the rural areas of the past decade, has had much different impacts on Java and the Outer Islands, due to differences in needs for public infrastructure and in the quality and capabilities of the local bureaucracies which try to meet those needs across the archipelago. Weaknesses in agricultural research and extension which are not very relelvant for tree crops, due to the presence and interests of the private sector in the Outer Islands, are quite critical for food crops and horticulture on Java. In regions like Kalimantan, poverty elimination has moved farther and faster than on Java, related to very rapid increases in tree crop incomes. On the other hand, a new generation of more productive rubber and cocoa trees will require a serious and workable smallholder replanting program, perhaps the major agricultural issue for the Outer Islands over the next 30 years. It is hoped that for every important issue, where there are major differences in impact or importance in the major regions of Indonesia, these are duly recognized and clarified.

Chapter 2. Macroeconomic Economic Performance of Indonesia

Macro Economic Performance

1980–2011

Indonesia has made impressive economic and social advances during the past thirty years, despite the 1997–8 financial crisis. During the 1980–2011 period it achieved average annual GDP growth rate of 4.9 percent. Its total GDP grew from US$170 billion to US$754 billion. The more recent growth rate (between 2006–2011) of 5.9 percent has made it one of the fastest growing large economies, after China and India. Indonesia's growth has been driven by its above average high investment and total factor productivity growth rates. Like Vietnam, its declining population growth has allowed per capita income to rise impressively from US$1,125 per year in 1980 to US$3,112 in 2011. And, its poverty rate (percent below US$1.25/day) fell from 62.8 percent in 1984 to 18 percent in 2011. Agriculture's share in GDP declined gradually from 24 percent in 1980 to 15 percent in 2011. Key economic and social data are summarized in Table 2.1 below.

Centennial Group's projections for per capita food consumption are given in Table 6, and show where Indonesia eating habits may move in the future. As Indonesians get wealthier, they are likely to consume less rice and more meat, as indicated in the table. Under the optimistic GDP scenario, poultry consumption more than doubles, while beef consumption increases from 0.4 to 2.2 kg per year.

Country Background and Context

Recent economic developments

From 1990 to 1996 Indonesia experienced rapid economic growth across the board, with GDP growing between 6% and 8% every year (Indonesia Economic Quarterly, World Bank, December 2011, pg. 28, fig. 21). The growth of the manufacturing sector hovered around 12% per annum—in-

Table 2.1: Key Economic Data 1980–2011

	1980	1990	2000	2011	1980–2011
GDP (constant 2010 billion US$)	170	289	425	754	4.9%
GDP per capita (constant 2010 US$)	1,125	1,566	1,994	3,112	3.3%
Average ten-year GDP growth rate (ending in given year)	-	5.5%	4.0%	5.5%	-
Average ten-year population growth rate	-	2.0%	1.4%	1.5%	-
% of population in poverty (below $2/day)	-	85%	82%	46%	-
% of population in poverty (below $1.25/day)	62.8%	54%	48%	18%	-
Gini index		29.2	29.0	34.0	
Average ten-year TFP growth rate	-	0.0%	0.1%	2.8%	1.0%
Agriculture as % of GDP	24%	19%	16%	15%	–1.5%

Sources: IMF WEO, World Bank WDI, Centennial Group estimates

Note: 1980 poverty numbers are from 1984 and 2000 from 1999

deed from the mid-1980s to the mid-1990s manufacturing grew as fast as in Malaysia and Thailand. This trend coincided with a marked slowdown in government investment in agriculture and agricultural growth in general, but the authorities perhaps were justifiably convinced that the country had reached and turned the corner (perhaps the most universal phenomenon in economic development worldwide) where the burden of both economic growth and employment generation decisively shifts from agriculture to industry and services. However, the financial crisis of 1997/98 hit Indonesia particularly hard, and especially its manufacturing and formal sectors, with an astounding drop of 14% in GDP in the single year of 1998. This was soon followed by the fall of the three-decade Soeharto regime, which had a conspicuous impact on investment, finance, commercial arrangements, and the modern economy in general.

Since the establishment of democratic governance of the country at the start of the millennium, the management of the macro-economy by the Government of Indonesia has been subject to widespread approbation over the years. One of its first major tasks was to assume the debts, take over the management of, and restructure the overstretched commercial banking system, a major and extended bailout operation which eventually cost $50 billion. This has resulted in a largely state-owned but highly profitable, professional, and financially healthy commercial banking system at present. Inflation, long a weakness of Indonesian economic management, was reduced to manageable levels, as low as 3.8% in 2011. Government deficits and debt burdens have been reduced far below OECD levels, and last year rating services placed the government's debt at investment grade levels. Still, it took the country until 2004 for true "recovery" to be said to have been achieved, and manufacturing could not be said to have resumed its warranted growth path until perhaps 2008, lagging behind its East Asian neighbors.

On the other hand, Indonesia has weathered the recent extended global economic crisis (2008 to date) much better than most developed and developing countries with GDP growth recovering to 4.5% in 2009 and 6% in 2010. This is often ascribed to the very large element of domestic consumption in its GDP, but this may miss the point of Indonesia's ability to capitalize on the commodity boom of recent years, in much the same manner as Australia and Canada. In these years, Indonesia became the largest coal exporter in the world (with the production center shifting from Sumatra to Kalimantan, to fields whose existence were barely suspected a decade or two before), as well as the world's largest palm oil producer and exporter. With each of these products contributing about $20 billion, total exports doubled in five years to over $200 billion in 2011, providing Indonesia with a large balance-of-payments cushion beyond its import needs. The oil palm (and to a smaller extent, cocoa) boom, and continuing large receipts for millions of smallholders in the Outer Islands from rubber, were particularly valuable as the import content of such export crops is so low, unlike mining and other resource based industries.

The tree crop boom, and agricultural performance in general, may also be behind two other beneficent macroeconomic trends over these years, the dramatic reduction in poverty incidence (both rural and aggregate), and a reduction in income inequality. The reduction in the proportion of the population below the poverty line from 29% in 1980 to 11% in 1996, is a tribute to earlier development programs; after the savage rise in that rate to 25% in 1998 with the associated economic collapse, the resulting long gradual struggle back down to 13% in 2010, largely due again to agriculture (see below), shows the resilience of the rural economy.1 Regarding inequality, the already fairly low measured GINI coefficient of 39.4 in 2005 reduced to 36.8 in 2009, bucking a trend in both developing and developed countries where rapidly rising incomes are associated with rising inequality. The fact that poorer regions like Kalimantan have led the way in many branches of agricultural production, combined with the overwhelming prevalence of smallholder agriculture in Indonesia, may be strong factors behind this good outcome for income equality.

There are perhaps three main points to derive regarding agriculture and its role in the aggregate economy. The first is the inevitable decline in agriculture's position in GDP, though

1 Estimates of poverty and inequality rates in this and following paragraphs are based on government figures and studies by Indonesia and international scholars, and may differ slightly from those reported by UN sources.

this was arrested at about 15% during the crisis years of 1997–2004, indeed rising to over 16% in 2000–2002,[2] but now again down to 15%. The second is the recurrent role of agriculture as the main socio-economic safety valve, in crisis after crisis. Thus 41% of the labor force was in agriculture in 1997—this parameter was still as high as 44.5% in 2006,[3] and is reportedly 38% today. Some experts point to this high ratio of workers in the agricultural sector as a justification for pursuing a policy of self-sufficiency but it is difficult to see how this advances the wellbeing of farmers, let alone urban consumers. It is possible that the extreme population density of Java, which may place a trishaw driver or workshop worker in a typical Java city only a bicycle ride from his family farm, contributes to this strong continuing link to agricultural employment. Finally, it seems impossible that agriculture can continue to carry this heavy employment burden much further and certainly not through the study period to 2040. The business climate will simply have to improve to the point where foreign and domestic manufacturing, commerce, and services takes up this role in a prominent way.

Indonesia too has made impressive economic and social advances during the past thirty years, despite the 1997–98 financial crisis. During the 1980–2011 period it achieved average annual GDP growth rate of 4.9 percent. Its total GDP grew from US$170 billion to US$754 billion. The more recent growth rate (between 2006–2011) of 5.9 percent has made it one of the fastest growing large economies, after China and India. Indonesia's growth has been driven by its above average high investment and TFP growth rates. Like Vietnam, its declining population growth has allowed per capita income to rise impressive from US$1,125 per year in 1980 to US$3,112 in 2011. Its poverty rate fell from 62.8 percent in 1984 to 18 percent in 2011. Agriculture's share in GDP declined gradually from 24 percent in 1980 to 15 percent in 2011. Key economic and social data are summarized in Table 2.2.

Demographic changes, urbanization, rural population

As in many countries, rapid urbanization has been a feature of Indonesian development for a long time, in her case at least since Independence in 1945, when 10% of the population was urban. The three drivers of the rise in the urban population to about 50% of the 2010 population (according to final census numbers) were natural increase, migration from the countryside, and reclassification of rural places to urban status, with the three factors surprisingly close in size to each other.

The overall population growth rate, which had declined to 1.35% p.a. from 1990 to 2000, increased to 1.49% p.a. between 2000 and 2010, while the urban population growth rate, which had reached 4.4% p.a. in 1990–2000, reduced to 3.3% in 2000–2010. One explanation for this development is that large middle-class populations began leaving old urban cores for suburbs and fringe areas (Firman, op. cit) with impacts on consumption of food and other items (e.g. via the rise of supermarkets) much like those in modernizing regions in many other countries. Regarding functions of cities, in Java many cities and towns other than the mega-cities seem to be losing their economic functions to the largest ones, with resulting slower population growth. However, in the Outer Islands this is not the case, with all sizes of cities growing rapidly and playing key roles in agricultural commerce and development of natural resources.

According to Indexmundi, rural population may have peaked in Indonesia in 1994 at about 128.5 million, but has since then declined at about half a million people per year to 119.3 million[4] but it must be recalled that much of this was not due to true loss of population from rural places, rather the reclassification of those places to urban status due to increased density. Where out-migration has actually taken place, this has been a key cause of increased partial (labor) and total factor productivity increase in agriculture; where

2 Wayan Rusastra et al, Food Security and Poverty in the Era of Decentralization in Indonesia, UNESCAP-CAPSA (Centre for Alleviation of Poverty through Secondary Crops Development in Asia and the Pacific), Bogor, 2008, Table 2.2, pg. 81
3 op.cit, table 2.1, pg. 80

4 World Bank sources indicate a reduction of rural population from 124 million in 2000 to 111 million in 2010, but the trend is confirmed.

Table 2.2: Key Social Data 1980–2011

	1980	1990	2000	2011	1980–2011 growth rate
population (millions)	151	184	213	242	1.5%
urban population (millions)	33	56	90	123	4.3%
rural population (millions)	117	128	124	119	0.1%

Source: IMF WEO, World Bank WDI, Centennial Group estimates
Note: 1990 poverty numbers are from 1984 and 2000 from 1999

due to reclassification there is no impact on real production at all.

Socioeconomic Trends

Key economic and social data

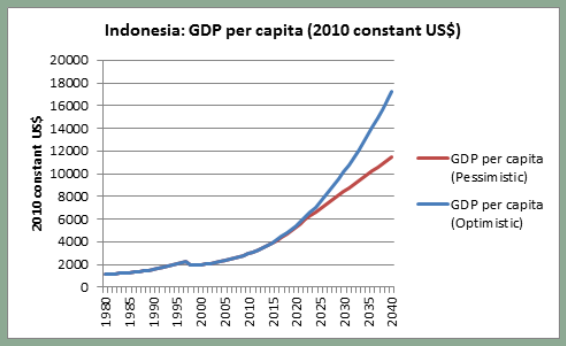
One final remark may be made regarding rural-urban movements in Indonesia, against the backdrop of the largest such movement, in China. In Indonesia such movements are free, entirely up to the concerned individuals and families. In China, they are illegal, though with weak enforcement since all know they are positive factors in the overall economy. But in Indonesia a migrant's children (if he should bring them) may go to schools, clinics, other services such as they are, like all other urban residents. In China, without an urban residency permit the migrant and his family is non-persons, cannot access such services in the cities and even suffer consequences back in the home villages. Thus the welfare changes for migrants in Indonesia are likely much more positive than in China—if work can be found for the migrant.

Table 2.3: Urban Population Growth 1980–2006

	Java	Outer Islands	Indonesia
1980 Total Population (000)	91 269.5	55 665.4	146 934.9
Urban Population (000)	22 929.4	9 916.4	32 845.8
Proportion of Urban Population	0.251	0.177	0.224
Share of Urban Population (%)	69.8	30.2	100
1990 Total Population (000)	107 581.3	71 049.9	178 631.2
Annual Rate of Population Growth 1980-1990 (%)	1.65	2.47	1.97
Urban Population (000)	38 341.5	17 092.3	55 433.8
Proportion of Urban Population	0.357	0.238	0.31
Share of Urban Population (%)	69.2	30.8	100
Annual Rate of urban Population Growth 1980-1990 (%)	5.28	5.95	5.37
2000 Total Population (000)	120 429.3	83 026.7	203 456.0
Annual Rate of Population Growth, 1990-2000(%)	1.11	1.56	1.35
Urban Population (000)	58 874.4	26 369.8	85 244.2
Proportion of Urban Population	0.487	0.328	0.419
Share of Urban Population (%)	69.1	30.9	100
Annual rate of Urban Population Growth, 1990-2000 (%)	4.38	4.43	4.4
2006 (Estimate) Total Population (000)	-	-	225.500.0
Annual Rate of Population (%)			1.4
Urban Population	-	-	94.710.0
Proportion of Urban Population			0.42

Source: Central Bureau Of Statistics, 1990 and 2001 in Firman (2004), and Population Reference Bureau (2006)

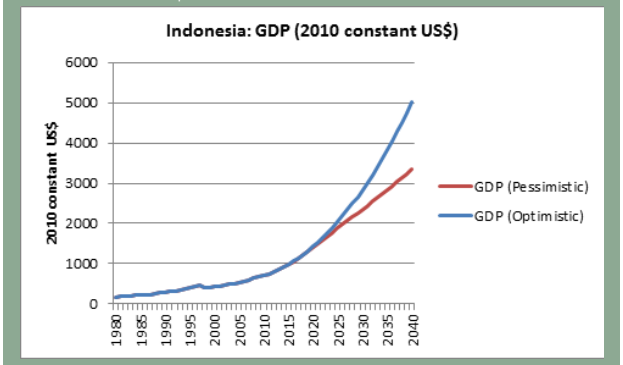
Figure 2.1: Indonesia: GDP per capita



Source: Centennial Group estimates

Figure 2.2: Indonesia: GDP

Source: Centennial Group estimates



Macro Economic Scenarios 2012–2040

The Centennial Group model was used to investigate possible economic scenarios for the 2012–2040 period. Two scenarios were selected for detailed analysis based on past performance of Indonesia, an optimistic scenario based essentially on a continuation of the current high growth, and a pessimistic scenario based on a poorer performance.

Under the desirable scenario, Indonesia will sustain a high average annual growth rate (6.7 percent) during the next thirty years. This will dramatically transform the economy and Indonesian society. At US$5 trillion, Indonesia will boast one of the top ten economies in the world, with its per capita income rising more than six fold to exceed US$17,000 (Figure 2.1).

Indonesia's GDP growth rate of 6.7 percent will keep it amongst the fastest growing economies of the world, as it reaps the benefits of the demographic dividend, high investment rates and impressive productivity growth for an economy of its development level. Almost all Indonesians will be classified as middle income by today's classifications. Agriculture's share of GDP will have fallen to 7%. Compared to 1980, the country will have been truly transformed in all aspects of the economy and society.

Table 2.4: Yearly Consumption Range (2010 PPP $)

		Country Average 2010	Country Average 2040 (Pessimistic)	Country Average 2040 (Optimistic)
Rice	Kg	114.3	100.2	87.2
Maize	Kg	1.6	0.3	0.2
Fish	Kg	21.5	32.7	36.7
Beef Meat	Kg	0.4	1.5	2.2
Poultry Meat	Kg	4.2	8.2	10.0
Eggs	Kg	6.7	9.9	10.1
Vegetables	Kg	26.9	32.7	37.5
Fruit	Kg	9.7	20.7	30.8
Casava	Kg	5.4	3.4	2.1
Sugar	Kg	7.7	9.1	9.5
Cooking Oil	Liter	10.2	12.6	13.1

Source: Centennial Group projections

As expected, under the pessimistic scenario Indonesia will be considerably less well off. Its total GDP and GDP per capita will be only two-thirds of the optimistic levels (figure 2.2). And, 13% of the population will be classified as below middle class by today's global standards. The driver of this lower growth is that Indonesia's TFP is no longer converging with the global best practice, and thus is growing slower than it would if converging. Average TFP growth in the non-converging scenario is 2.7%, while it is 3.9% in the converging scenario (see figure 2.3 below). While compared to the rest of the world—particularly when compared to South Asia and much of Africa—Indonesia will be better off, given its resource base and its potential, this outcome must be considered unacceptable.

Figure 2.3: Indonesia: TFP Growth Rate

Source: Centennial Group estimates

Table 2.5: Indonesia Macro Economic Scenarios

Indonesia	2011	2040 (Optimistic)	2040 (Pessimistic)
GDP	754	5,016	3,341
GDP per capita	3,112	17,283	11,513
Average GDP growth rate (2011-2040)		6.7%	5.3%
Average TFP growth rate (2011-2040)		3.9%	2.7%
% of population at least middle class	17%	100%	87%
Population (millions)	242	290	290
Urban population (millions)	123	197	197
Rural population (millions)	119	94	94
% of population in poverty (below $1.25/day)	18%	0%	0%
Agriculture as % of GDP (high TFP)	15%	7%	10%
Agriculture as % of GDP (high TFP)	15%	5%	7%

Source: Centennial Group estimates

Box 2.1: Centennial Growth Model

Productivity Convergence

A wide body of research has shown that some growth differences between emerging market countries can be successfully modeled by dividing them into two groups: 'converging' countries with rapid growth and 'non-convergers' stuck in the middle income trap.

The 'convergence' idea is this: It has been observed that the convergers' incomes catch up to those of global best practice over time, and that convergers with lower incomes converge more quickly. Three main forces drive convergence: First, open economy forces yield convergent growth if poorer countries focus on their comparative and factor advantages and then trade with nations lacking those factors, e.g., cheap labor. This leads to more equal cross-country factor prices. Second, capital deepening boosts growth more in countries with lower ratios of capital to skilled labor (usually the poorer ones) due to the nature of diminishing returns.

The third force is productivity convergence. Here it is the TFP of convergers that catches up to that of best practice, with those further behind in TFP converging faster. This phenomenon reflects technology leap-frogging, technology transfers, shifting underemployed agriculture workers to efficient export-led manufacturing, transferring child laborers into schools, a steady increase in the average level of literacy, building roads to connect the unconnected to markets, and the diffusion of management and operational research from more advanced countries. It appears that countries can shortcut productivity-improvement processes by learning from economies that are already at the productivity frontier.

Middle Income Trap

However, as suggested by the records of many middle-income countries around the world, it is difficult (but possible) to avoid a stagnation in growth after a fast-growing economy reaches middle-income status. This stagnation has been termed the 'middle income trap' and results from an inability to make some difficult—yet critical—structural adjustments to the growing economy. Once the rural workers have been shifted, the labor-capital ratio approaches that of developed nations, educational attainment reaches higher levels, the old-age dependency ratio increases, everyone is connected by physical infrastructure, and productivity approaches best practice levels—so that importing foreign technology offers only small benefits—the strategies above no longer reap rewards. For example, moving from a BA to MA offers a smaller boost than moving from illiteracy to literacy.

Chapter 3. Agricultural Sector Performance 1980–2011

Recent Agricultural Developments

After decades of successful agricultural development following the end of the Sukarno era (1966), there was a period of stagnation in the rate of agricultural progress in the 1990s. Several major studies of Indonesia's agriculture produced at the end of this period (early 2000's) are thus relatively pessimistic; agricultural yields of many crops, including rice, had virtually stalled, and what growth was occurring seemed entirely due to greater inputs, including land in the Outer Islands converted from forest. Table 3.1 below (FAOSTAT) shows actual declines in food and agricultural production per capita over 1994–99, based on 1% annual production growth rates over the period. Crop production per hectare (ha) was virtually static.

A remarkable change occurred in the following years, also visible in Table 10. Already over 1999–2004, decline or stasis was replaced by rapid growth in production, of 5% annually and about 4% on a per capita basis. This was based on both increases in inputs and of productivity. The stock of utilized arable land was rising from 20 million ha in 2000 to nearly 22 million in 2005, while crop production per ha grew slowly (0.34% per annum). The break point may have occurred thereafter. While aggregate growth continued at a pace near 5% (through 2009), crop production per ha now represented a major part of the increase, growing at 3.52% per annum.

This history, based on FAO statistics, is largely confirmed by the findings of Keith Fuglie (Table 3.4), who presents Indonesian agricultural growth over the past half century as a series of stages. The stagnant stage (1993–2001), marked by slow growth of total output, total inputs, output per worker, and even land per worker, is replaced by a liberalization stage (2002–2006) where output grew at 4.3%, more than three times the growth of inputs, while Total Factor Productivity grew at the highest rate in history (2.95% per annum). In this period, even land/worker increased, due to the actual subtraction of workers from agriculture. Indeed, several sources indicate a continuing reduction of rural population which would agree with a reduction of workers in the field. This is a major trend development, possibly representing

1. an end to "agricultural involution" in Java, the cultural feature mentioned earlier emphasizing sharing of a fixed amount of work rather than productivity increase and release of redundant workers to other sectors: and

2. both a path and a symptom of further productivity increases in agriculture. Note in Table 3.3 an increase in land/worker in the latest period that is considerably higher than any other in previous history. This would imply that this productivity-enhancing result is not just due to the development of forestlands in the Outer Islands, since the

Table 3.1: Crop Production on Cultivated Lands

	Value (2004–2006 US$)			
	1994	1999	2004	2009
Crop production per ha of land in use	998	1002	1019	1235
Growth rate since prior year (%)		.08	.34	3.52

Source: FAOSTAT

Table 3.2: Evolution of the value of total agriculture production and food production

	Value (2004–2006 US$ Millions)				Growth rate (%)		
	1994	1999	2004	2009	1994–1999	1999–2004	2004–2009
Total Agricultural production	34704	36624	47082	58981	1.08	5.15	4.61
Food production	32119	33756	43500	54505	1.0	5.2	4.61

Sources: FAOSTAT

Table 3.3: Index of per capita production

	Gross Production Index Number (base 2004–2006)				Growth rate (%)		
	1994	1999	2004	2009	1994–1999	1999–2004	2004–2009
Food production per capita	83	81	98	116	–.049	3.88	3.43
Agricultural production per capita	82	81	98	116	–.025	3.88	3.43
Agricultural production per agricultural worker	78	78	96	120	–0.52	4.78	4.56

Source: FAOSTAT

Table 3.4: Sources of growth during episodes of agricultural development

	(annual percentage growth in value terms)				
Growth Measures	Instability 1961–1967	Green Revolution 1968–1992	Stagnation 1993–2001	Liberalization 2002–2006	Whole Period 1961–2006
Total Output	1.24	4.82	1.51	4.31	3.62
Total Inputs	0.71	2.47	0.93	1.36	1.80
Total Factors (TFP)	0.54	2.35	0.58	2.9	1.82
Workers*	0.02	0.29	0.01	–0.28	0.13
Output/worker*	1.23	4.53	1.51	4.5	3.49
Land/worker*	0.15	0.21	0.24	0.6	0.26
Other inputs/worker*	0.35	1.62	0.37	0.62	1.09
Education	0.19	0.35	0.31	0.41	0.33

Source: Fuglie's estimates.
* Note: The number of agricultural workers is measured in constant-quality units after adjusting for changes in the average schooling level of the agricultural labor force. Land includes land in crops and ponds, quality-weighted by type of land resource. "Other inputs" include all other measured inputs: animals, machinery, seed, feed, and fertilizer.

latter is an old story marking previous periods. The increase in the land/man ratio is more likely due to the actual withdrawal of workers from agriculture on Java.

Table 3.5, from the Ministry of Agriculture and FAO's Rice Market Monitor of April 2011, is an attempt to bring the review of recent developments, at least regarding rice production, further up to date. Note that areas given there represent cropped areas, so that a double-cropped hectare is counted as two hectares. This is based on official figures, which are in some aspects (e.g., cropping intensity) highly doubtful (see below), but the focus here is on changes, not absolute values. A growth rate of over 4% per annum in

Table 3.5: Paddy Production 2007–2011

	2007	2008	2009	2010	2011*
Area Harvested ('000 ha)	12,148	12,327	12,883	13,244	13,259
Dryland Paddy (000'ha)	1,106	1,070	1,086	1,133	1,047
Wetland Paddy ('000ha)	11,041	11,258	11,797	12,111	12,211
Average Yields (Mt/ha)	4.71	4.89	4.99	5.01	5.08
Dryland Paddy	2.67	2.95	2.97	2.98	3.1
Wetland Paddy	4.91	5.08	5.18	5.23	5.25
Production ('000 tons)	57,157	60,326	64,399	66,411	67,307
Dryland Paddy	2,958	3,156	3,221	3,448	3,244
Wetland Paddy	54,200	51,170	61,108	62,963	64,063

Source: Ministry of Agriculture
* Note: First Forecasting Figures

production of rice (18% in the last four years), from 2007–2011, emerges here. This in turn is based on a total of 9% growth in area and 8% growth in yield of paddy over the four years, or about 2% annual growth of each. On a global basis, this is rather good performance.

Regional Diversity of Agriculture

The tables below, while some years old, portray the regional diversity of agriculture in the country. While much rice is planted in the Outer Islands, yields are lower than Java. Java is thus able to produce 60% of the national rice crop on 1/2 of the total cropped area. Some observers propose shifting rice production from Java, where extreme density of population (and urbanization) may suggest other land uses, to the Outer Islands, especially relatively under-populated Kalimantan and Irian (Papua). Here there is a serious question of soil suitability. A World Bank study (Adapting to Climate Change: The Case of Rice in Indonesia, 2008) summarizes Ministry of Agriculture land capability studies to the effect that only 3% of Kalimantan and 4.4% of Irian are suitable for food crops. Of course in these large regions even small proportions represent sizable hectarages, but it does mean that sites must be selected extremely carefully and designed carefully also. There are many good reasons for the concentration of rice-cropping on Java.

The other data shown are indicative of the diversity of the Outer Islands. The growth of oil palm is notable, especially in Sumatra and Kalimantan. This trend has continued, making Indonesia the leading producer and exporter of palm oil in the world. An encouraging trend is the rapid growth of both smallholder and private company plantations, and the beginnings of their rise in yields towards those of the mature government-owned estates, which often have been operating since pre-Independence. These trends have continued to date, with commercial plantations (with high proportions of immature trees in the past) growing faster than smallholders in terms of average yields.

Meanwhile, in response to market forces, areas of traditional tree crops like rubber and coconut virtually stagnated. Growth of another boom tree-crop, cocoa, has focused largely on the island of Sulawesi. It is possible that much of

Table 3.6: Recent Crop Developments

	Production (million tons)		Yield (tons/ha)	
	2006	2010	2006	2010
Rice (Paddy)	54.5	66.0	4.62	5.03
Maize	11.6	17.8	3.47	4.32
Rubber	2.64	2.59	0.97	0.93
Palm Oil	17.35	19.76	3.49	3.55
Cocoa	0.77	0.91	0.85	0.91
Coconut	3.13	3.27	1.12	1.18

Source: Ministry of Agriculture official statistics
(Yield based on mature ha)

that was under-cropping with old coconuts in areas such as Central Sulawesi, long known for the latter crop.

Table 3.6 gives recent official production statistics for several important crops. The numbers are odd in a major respect: two grains critical for food security, rice for direct human consumption and maize increasingly for animal and fish production, here are shown as experiencing rapid growth, both in yields and in area. The general expert view is the opposite, that there has been stagnation in yields of those crops hence the high imports. Meanwhile the export tree crops are showing slow yield growth, or even yield decline (rubber), which of course can be true without replanting and aging stands, and despite generally good export performance. In general, statistical work especially on annual crops (rice and maize) needs to be improved and made less political.

Public-Private Partnerships

Much has been said and written about the potential for public-private partnerships (PPP) in agriculture but there are few examples of such schemes. Agricultural research and development is an exception in this regard[1] as there are a number of successful examples of PPP largely because these activities can: (i) reduce the costs and risks entailed in research; (ii) improve the quality and relevancy of research results due to synergies among the partners; (iii) ensure greater adoption by user groups; (iv) lead to the accumulation of complementary abilities, skills, and resources; (v) lead to higher competitiveness and better market positioning as a result of improved competencies; and (vi) promote development and poverty reduction by providing small-scale farmers with access to knowledge and technologies[2]. Unlike other sectors of the economy such as telecommunication, transport, and industry where PPP schemes are common, their use in addressing agricultural and value chains development, as well as tackling food security issues, remains largely untapped. The few examples of PPP that exist are largely experimental and often rely on subsidies from donors and governments that essentially remove the commercial risk from the private partner.

The scope for potential success of the PPP channel in agriculture in Indonesia is limited by the prevalence of state-owned companies in areas normally occupied by the private sector, e.g. BULOG (grain logistics), PUSRI Holding (fertilizer production), and a large segment of state-owned plantation companies. The "nucleus estate" (now "plasma") concept for developing smallholder tree crop production near the processing facilities of these government-owned plantations has now been spread widely by law or national or local regulation to the private sector, and the very high share of smallholder rubber in total cropping, and increasing share of smallholder oil palm, is in part due to such PPP-type policies. Entrusting oil palm research and breeding largely to the private sector may be an implicit recognition of interests and competency by the government, a hallmark of good PPP policy. Given such successes and the presence of public enterprises in other important fields, the scope for formal PPP development seems limited.

Successful PPP are contingent upon (i) efficient strategic planning, namely, their ability to deliver outcomes that contribute to the government's strategy in the sector (e.g. food security, improved productivity, diversification of farming activities; employment generation, etc); (ii) conducive conditions for transparent and interference free operations; and (iii) the right regulatory framework[3]. As indicated in the Overview Report (see for example Box 4 Ease of Doing Business and page 47), governments wishing to elicit a positive response from private investors will have to improve governance in the sector, predictability of the rules of law, and a better business enabling environment. Until these basic frameworks are addressed there is limited potential for increased role of PPP in Indonesia's agricultural sector.

1 Marco Ferroni and Paul Castle—Open Access Sustainability 2011, 3, 1064–1073; doi:10.3390/su3071064—Public-Private Partnerships and Sustainable Agricultural Development

2 Frank Hartwich, Jaime Tola, Alejandra Engler, Carolina González, Graciela Ghezan, Jorge M. P. Vázquez-Alvarado, José Antonio Silva,José de Jesús Espinoza, and María Verónica Gottret in IFPRIs—Food Security in Practice: Building Public–Private Partnerships—FOOD SECURITY IN PRACTICE for Agricultural Innovation (2008).

3 Michael Warner and David Kahan: Project Briefing No 9 (January 2008)—Market-oriented agricultural infrastructure: Appraisal of public–private partnerships.

Legacies of the Past

Diversity of lands, peoples, and agricultures

Indonesia is an empire, no longer politically as in the eras of the Majapahit or the Netherlands East Indies, but in terms of geography and all that entails. This was always recognized whether by the empire builders or those who struggled against them for independence, mainly in the 20th Century. Thus, in 1928 agreement was reached within the independence movement on a national language, Malay, not the home language of the majority of the people (which would have been Javanese), but the lingua franca of sailors and merchants throughout the archipelago (and beyond) which all the many peoples (including the Javanese) would adopt and learn as Bahasa Indonesia. The need for cohesion and integration was always there and always recognized.

In foreign policy, independent governments of Indonesia have always followed the principle of succession to the Dutch Empire. There were ideological conflicts (Konfrontasi) with Malaysia under the Sukarno regime in the 1960's, and actual conflict in the former Portuguese territory (East Timor) embedded in the Eastern Islands,. But they never were actual territorial claims to non-Dutch territories, and there has been in its history virtually no conflict on territorial claims, whether regarding large territories on the periphery—such as the British-influenced areas on Borneo (Kalimantan) of Sarawak, Sabah, and Brunei, and Papua New Guinea on Irian, or the Portuguese one (East Timor) sharing an island in the interior of the archipelago. The propaganda conflict (Konfrontasi) with Malaysia in the 1960s, this was really unconnected to territory, non-violent, and of rather short duration. This general external peace, and internal peace after the 1965–66 civil strife which ended the Sukarno regime and the Communist Party of Indonesia and installed a military and technocratic regime under Suharto, probably served the purposes of continuing development, at least until the financial crisis of 1998 stimulated democratization.

Beneath all this, extreme geographic differences persist, and determine the obvious extreme differences in population density, agriculture, and many other social, economic, and even cultural differences. There is no comparing the volcanic soils of Java with the peats of Sumatra or the swamps of Kalimantan, and indeed only for the most general uses should statistics for all Indonesia be read together: even the conventional Java/Outer Islands dichotomy masks more variation among those Outer Islands than we might see among the nations of Europe. Indeed one issue which requires investigation (see below) is whether the noted stagnation of Indonesian rice yields in the 1990s was a true phenomenon; or was only a statistical artifact composed of declining rice hectarage on high-yielding Java and rapid expansion of hectarage on the low-yielding fields in the Outer Islands.

Due to her extremely fertile soils, high rainfall, and mountainous topography which gave her early engineers gravity command to irrigate virtually anywhere, Java was always relatively heavily cultivated with rice, and in turn heavily populated. In other areas with fortunate configuration of rivers, large populations developed based on rice culture, but in many the function of rivers evolved mainly as transport routes, and the chokepoints to tax and control that transportation became, in a more Malay tradition, the centers of population, culture, and commerce, such as around Palembang in Sumatra and perhaps Pontianak in West Kalimantan. There even arose a complex culture of migration to riverine areas of eastern Sumatra by Bugis tribes from far off Sulawesi, based on a technology they developed for tidal irrigation. In the 1980s the Bugis sailing junks could still be witnessed in the middle of the night, using only lanterns, poles, the rising tide, and wood slot sails to ascend the rivers around the Batang Hari.

While the spices of the Moluccas and other eastern islands are what drew the Portuguese and then the Dutch to Indonesia in the first place, it was likely entirely the Europeans who brought tobacco to North Sumatra and later the oil palm and rubber. When these spread from the estates (plantations) to the smallholders, and were augmented by cocoa and in southern Sumatra, pepper, the basis for a fairly prosperous rural society was laid.

Rice, sugar, and irrigation on Java

Though primarily oriented to the field crops (e.g. rice) necessary to human survival, Java was not devoid of commercial estate crops. Plantations were developed for tea, coffee, and oddly enough, teak and other valuable hardwoods, many of which still exist today due largely to bureaucratic inertia. But perhaps the dominant commercial crop has been sugar cane, the real reason the Dutch early on became interested in expanding irrigation systems there. The history of sugar on Java is not a pretty one, socially. Since the colonials and later on their inheritors, the state, owned the mills, they were interested in the cheapest sugar cane possible, and thus from early on, long through the decades of independence, there was a considerable element of coercion in forcing farmers to grow sugar. The farmers knew that rice, grown on the same land, was the more profitable, especially after the development of shorter term varieties and hence double-cropping in the 1960s. Indeed, many of them needed the rice for family subsistence. Thus they had to be forced, by all instruments of state power, to grow the sugar cane on a rotational basis, where eventually the turn came to every irrigated village and farmer.

At least to the end of the 20th Century, supervising this rotational burden downwards, to kecamatans and irrigation blocks, was one of the more distasteful tasks of many Java bupatis, the civil administrators of the kebupaten, one that most of them would gladly have forsaken. Thus the inertia of colonialism, reinforcing the interests of the sugar factories, carried into the decades of independence, when these factories were operated by state enterprises. One important step to prepare Java agriculturally for the next three decades of development would be to eliminate such vestiges of the distant past, now carried on by state enterprises with narrow interests but on balance creating no value added for Indonesian welfare. Several foreign advisory reports on long-term Indonesia development have recommended shifting sugar cane production from Java to the Outer Island, a process which will be fraught with socio-economic difficulty. It is far higher priority to end coerced sugar cultivation on Java, to be replaced if farmers so wished with double-cropped (or even more frequent) rice crops. If commercially viable without the current excessive import protection on sugar (which only stimulates greater rice imports) sugar plantations may be developed on several outer islands. This should be a purely commercial program. Unlike rice, a critical element of subsistence and subject to a notoriously thin world rice market, sugar carries no such strategic need or threat.

Such timber plantations as remain on Java, particularly in flatlands suitable for rice, should also be harvested and terminated as quickly as possible, with land again reallocated to small farmers. It does not require highly sophisticated calculations to prove that timber rotations of 40 years or longer cannot compete economically (or socially) for prime agricultural land with double-cropping of a high-yielding staple food, now imported at high world prices. Other estate crops, such as coffee and tea, may be more concentrated in hilly and mountainous locations, and may provide more employment, but they should also be investigated as to their socio-economic relevance to Java's agricultural future. All of these are relics of a past which may not have valued Indonesian welfare as a prime criterion, perpetuated by bureaucratic structures with similarly narrow objectives.

Agricultural involution in Java

One of the best known specific theories of economic anthropology, associated with the writings of Prof. Clifford Geertz, is based on a long and close study of Javanese agriculture. Geertz' theory was based on a conclusion that many centuries ago productivity of food crops (especially rice) on Java had reached extremely high levels, levels that the population itself had deemed close to the maximum potential. Faced with the prospect of increasing social conflict over distribution of this fixed income, Javanese society set about enforcing increasing degrees of inefficiency (in usage of labor) in paddy cultivation and harvesting, socially mandating greater and greater labor intensity per hectare—apparently despairing of ever achieving population control. Geertz demonstrated the actual shrinking size of various types of farm implements on Java, with sickles used for harvesting paddy (already much more labor-intensive than scythes) shrinking over the centuries down to tiny knife-blades hidden in the

Table 3.7: Harvested Area of Paddy (hectares) by Province, 2007–2011

Province	2007	2008	2009	2010	2011
Aceh	360,717	329,109	359,375	352,281	375,312
North Sumatra	750,232	748,540	768,407	754,674	757,194
West Sumatra	423,655	421,902	439,542	460,497	461,659
Riau	147,167	147,796	149,423	156,088	141,179
Riau Archipelago	117	134	144	396	399
Jambi	149,888	143,034	155,802	153,897	161,533
South Sumatra	691,467	718,797	746,465	769,478	772,803
Bangka Belitung Islands	9,010	6,266	8,063	8,180	3,703
Bengkulu	123,853	127,506	132,975	133,629	130,659
Lampung	524,955	506,547	570,417	590,608	614,450
Sumatra (total)	3,181,061	3,149,631	3,330,613	3,379,728	3,418,891
Jakarta Special District	1,544	1,640	1,974	2,015	1,812
West Java	1,829,085	1,803,628	1,950,203	2,037,657	1,959,686
Banten	356,803	362,637	366,138	406,411	388,990
Central Java	1,614,098	1,659,314	1,725,034	1,801,397	1,748,611
Yogyakarta Special District	133,369	140,167	145,424	147,058	147,738
East Java	1,736,048	1,774,884	1,904,603	1,963,983	1,945,712
Java (total)	5,670,947	5,742,270	6,093,603	6,358,521	6,192,549
Bali	145,030	143,999	150,283	152,190	151,095
West Nusa Tenggara	331,916	359,714	374,279	374,284	416,079
East Nusa Tenggara	166,753	187,907	194,219	174,674	190,692
Bali andNusa Tenggara (total)	643,699	691,620	718,781	701,148	757,866
West Kalimantan	399,832	423,601	418,929	428,461	441,920
Central Kalimantan	229,665	205,684	214,480	247,577	215,369
South Kalimantan	505,846	507,319	490,069	471,166	490,528
East Kalimantan	155,484	157,341	146,177	150,031	142,100
Kalimantan (total)	1,290,827	1,293,945	1,269,655	1,297,235	1,289,917
North Sulawesi	103,189	109,961	114,745	119,771	122,084
Gorontalo	44,548	46,942	48,042	45,937	56,201
Central Sulawesi	204,342	211,876	211,232	208,628	216,174
South Sulawesi	770,733	836,298	862,017	886,354	907,555
West Sulawesi	66,630	72,471	64,973	75,923	73,973
Southeast Sulawesi	110,498	102,520	98,130	107,751	115,493
Sulawesi (total)	1,299,940	1,380,058	1,399,139	1,444,364	1,491,480
Moluccas	15,352	19,142	21,252	20,233	18,237
North Moluccas	14,497	14,831	13,711	16,071	16,692
Papua	22,957	24,461	26,336	26,686	28,784
West Papua	8,357	11,467	10,486	9,464	9,963
Moluccas and Papua (total)	61,163	69,901	71,785	72,454	73,676
Java	5,670,947	5,742,270	6,093,603	6,358,521	6,192,549
Outer Islands	6,476,690	6,585,155	6,789,973	6,894,929	7,031,830
Indonesia	12,147,637	12,327,425	12,883,576	13,253,450	13,224,379

Source: Ministry of Agriculture

fingers of the female harvesters. Cultural explanations, in some places citing the need to approach the rice plant by stealth, so as not to alarm the fertility goddesses, masked the simple truth of the overwhelming need to create jobs and thereby share the income.

Whether completely true or not, Geertz' theory of agricultural involution seemed to many observers to explain much about Javanese agriculture; indeed in a feedback loop the sharing of work and income seemed to permit even higher levels of population density, in a strong demonstration of Malthusian axioms, in particularly fertile and well-watered areas. Links were also drawn to other aspects of Indonesian culture, society, and politics. The slow development of the industrial and services sectors on Java may have extended the involution phenomenon a generation or two beyond independence in 1945, but the latest data do finally indicate a reduction in the rural population and workforce on Java, a declining man-land ratio there, and perhaps some indication of rising farm wages. It is still too early to advocate widespread mechanization on Java, but selective mechanization of certain operations may make sense already. On the other side of the coin, Egyptian paddy yields now average 9.5 tons/ha twice per year over a million hectares. This rice is also much higher quality than Chinese hybrid rice—some is exported to Italy, while much of Chinese hybrid rice is used as animal feed. Java, with about 6 tons/ha, is used to looking to Japan, China, South Korea for leadership in this area, but Egypt's world-leading performance (built on very small farms, like East Asia), aided greatly by enormous USAID investments in Egyptian agricultural research and plant breeding over the decades, may provide more specific lessons on increasing returns per farmer-day of labor.

The recent past: success or failure?

Indonesia suffered substantially from the Asian financial crisis of 1997–98, and the years thereafter, exacerbated by the political upheavals which followed and the introduction of democratic politics. National budgets were slashed to regain macroeconomic balance and this of course impacted agriculture. These fiscal cutbacks and political instability, seemingly exacerbated by a particularly fierce El Nino drought in 1997, ushered in a period of agricultural stagnation. Thus in rice "national average yields and production have been largely stagnant from 1990–2006" (IRRI 2006 rice statistics, quoted in Adapting to Climate Change: The Case of Rice in Indonesia, hereafter abbreviated ACC, pg. 12). The same report refers to 1961–80 as the period of "rice production expansion", and 1980 to the present (2008) as that of "rice production stagnation". Indeed, older FAO statistics (Table 3.4, pg. 21 of ACC) indicate a national average paddy yield of 4.3 tons/ha in 1990, 4.25 tons/ha in 1999 (on 1.5 million ha more land), and 4.39 tons/ha in 2001. As noted above, no one seems to have queried whether average yields were reduced by substitution of Java rice fields by Outer Island rice fields, with no actual yield stagnation or decline taking place.

For 1994–99 more broadly, FAO STAT reports growth of total agricultural production of 1.08% p.a., of food production of 1%, of crop production per ha of land in use of 0.08% p.a., and negative numbers for food production per capita, agricultural production per capita, and agricultural production per worker. National production of meat declined by 2.29% per annum over 1995–2000. However most of these numbers turned around fairly radically during 1999–2004, including gains of over 5% p.a. in total agricultural production, food production, and meat, about 4% for per capita production of both food and agricultural products in general, and 4.78% for agricultural production per worker. A continued low positive number (0.34%) for crop production per ha used, is the only caveat here, indicating perhaps that production increase depended on more use of formerly forested lands in the Outer Islands. Still, most reports and analyses emphasized negative future scenarios based on the results of these years, with considerable criticism of Indonesian government programs and calls for change.

Whether or not the Indonesian government heeded the advice of outsiders, the most recent half-decade has seen agricultural performance in some respects even greater than the previous half-decade. Over 2004–2009 total agricultural production and food production both grew at 4.61% p.a. But this time the growth seems more due to yields than to area expansion: crop production per ha of land in use,

Table 3.8: Harvested Area of Corn (hectares) by Province, 2007–2011

Province	2007	2008	2009	2010	2011
Aceh	36,774	34,164	39,731	43,885	41,334
North Sumatra	229,882	240,413	247,782	274,822	243,770
West Sumatra	43,182	63,219	70,882	59,801	69,239
Riau	18,379	21,397	25,016	18,044	15,221
Riau Archipelago	439	531	502	454	434
Jambi	8,655	9,520	10,112	8,280	7,301
South Sumatra	25,908	31,716	31,693	33,769	33,295
Bangka Belitung Islands	904	393	458	341	351
Bengkulu	27,117	35,661	28,205	20,516	23,644
Lampung	369,871	387,549	434,542	447,509	391,637
Sumatra (total)	761,211	824,563	888,923	907,421	826,226
Jakarta Special District	20	20	16	15	9
West Java	113,373	118,976	136,707	153,778	151,046
Banten	6,736	6,288	8,425	8,697	4,563
Central Java	571,013	639,354	661,706	631,816	536,373
Yogyakarta Special District	70,216	71,164	74,563	86,837	70,632
East Java	1,153,496	1,235,933	1,295,070	1,257,721	1,198,159
Java (total)	1,914,854	2,071,735	2,176,487	2,138,864	1,980,782
Bali	24,021	27,251	32,305	26,706	22,529
West Nusa Tenggara	42,955	59,078	81,543	61,593	89,706
East Nusa Tenggara	217,478	270,717	250,536	244,583	247,687
Bali andNusa Tenggara (total)	284,454	357,046	364,384	332,882	359,622
West Kalimantan	36,295	42,834	41,302	45,014	42,658
Central Kalimantan	1,385	2,104	2,821	3,247	2,999
South Kalimantan	22,241	20,116	22,979	22,584	19,551
East Kalimantan	4,919	5,375	5,141	4,693	3,369
Kalimantan (total)	64,840	70,429	72,243	75,538	68,577
North Sulawesi	115,664	131,791	126,349	121,930	119,872
Gorontalo	119,027	156,436	124,798	143,833	145,236
Central Sulawesi	40,516	38,209	46,245	42,747	37,128
South Sulawesi	262,436	285,094	299,669	303,375	287,369
West Sulawesi	7,359	9,110	11,694	13,308	13,910
Southeast Sulawesi	40,975	37,249	27,214	29,607	28,660
Sulawesi (total)	585,977	657,889	635,969	654,800	632,175
Moluccas	6,761	8,045	6,749	6,293	5,073
North Moluccas	6,568	6,834	10,984	10,813	12,111
Papua	4,141	4,113	3,955	3,903	3,835
West Papua	1,518	1,070	965	1,162	1,454
Moluccas and Papua (total)	18,988	20,062	22,653	22,171	22,473
Java	1,914,854	2,071,735	2,176,487	2,138,864	1,960,782
Outer Islands	1,715,470	1,929,989	1,984,172	1,992,812	1,909,073
Indonesia	3,630,324	4,001,724	4,160,659	4,131,676	3,869,855

Source: Ministry of Agriculture

TABLE 3.9: STATUS OF ESTATE CROPS, 2010

	Thousand hectares	% smallholder	Thousand tons	% smallholder
Rubber	3,445	85	2,592	80
Coconut	3,808	98	3,266	97
Oil Palm	8,110	38	21,958 (crude palm oil) 4,864 (palm kernel oil)	35 33
Coffee	1,269	96	684	96
Cocoa	1,652	94	845	92
Tea	131	43	146	24
Cloves	470	98	111	98
Pepper	186	100	84	100
Sugarcane	429	56	2,278	54
Tobacco	194	98	122	97
Kapok	171	97	55	96

Source: Ministry of Agriculture

grew at 3.92% annually, accounting for the great bulk (over 85%) of the growth in production. Still there were substantial increases in arable land, the great bulk of it (9.8%, or 2.1 million ha) between 2006 and 2009.According to World Bank statistics based on GOI data, In the last half-decade, paddy and corn production finally took off, growing only 7% between 2000 and 2006, but then 24% in the next three years., The pattern for cereal yield was the same—slow growth (from 4 tons/ha to 4.37 tons) between 2000 and 2006 and then an acceleration to 4.8 tons/ha by 2009. Meat production continued to grow rapidly through 2010 (5.61% annual rate) as did export crops like coffee, cocoa, palm oil (oil crops grew at 7.6%). Fish exports rose from $1.6 billion in 2003, a more or less constant value over the next five years, then rising to $2.6 billion in 2008. Exports of palm oil and palm kernel oil in 2009 reached $13.8 billion.

All this took place while the rural population was declining in absolute terms to below half the population. Most of this drop was on Java, signaling the end of whatever agricultural involution remains. Indeed, increasing productivity—both of land and of labor—is now the key to the future competitiveness of Indonesian agriculture.

While there are of course many problems, as is natural for agriculture in any large country, there is no escaping the fact that the sector has been booming for many years now, and has obviously emerged from whatever stagnation it endured at the turn of the millennium. This is the baseline for the 30-year period we must now anticipate.

CROPPING PATTERNS AND THEIR RECENT CHANGES

FIELD CROPS

RICE

Rice is the main crop of Indonesian agriculture. It was reportedly cropped on about 13 million ha consisting of about 12 million ha of wet paddy (sawah) and 1 million ha of dry paddy (ladang), i.e. grown without bunds and ponding. The actual physical hectarage of wet paddy conforms closely to the 7.2 million ha of irrigation systems, but with a cropping intensity of over 100% on those hectares, the cropped hectarage is much larger. There is considerable agreement among experts that paddy production in Indonesia is overestimated, and this may be attributed to overestimation, of cropping intensity. The major objective indicator of this overestimation in Indonesia is fairly careful estimates of consumption, which are far lower than reported production, yet imports are frequently required. Official statistics would require an average cropping intensity of about 170% over 7 million ha of sawah, which seems impossibly high given current conditions. Thus true sawah cropping intensity may

be only about 140 %, and cropped ha only about 10 million ha.

Given these caveats, official data for cropped ha, 2007–2011, are given in Table 3.7. To be noted is that there was reportedly an increase in cropped ha of about 9% over the last four years, including a small reduction in Java in 2011. There was also reportedly an overall increase of yield over the period of 5%, summing to an increase in production of 14%. If we accept the past increase in yield as more certain than that in cropped ha, and also more sustainable (less constrained) in a long-term future, then we may be looking at long-term increases in rice production of about 1% per annum.

Also to be noted is the total stagnation of cropped ha in Kalimantan over the period. The modest increase in production on the island was due only to a 6% increase in yield. Kalimantan is often mentioned with Papua as a prime future area for paddy production, but if so, this had not even begun to manifest itself. Reported large increases in area were in West Java, East Java, South Sulawesi, Lampung, and South and North Sumatra. Despite many changes, Java in 2011 still held more than half (52%) of cropped paddy hectares in Indonesia.

Reported paddy yields in Indonesia (4.9 tons/ha) and Java (5.5 tons/ha) are high by world standards, particularly given that unlike China (6.6 tons/ha) they do not include large volumes of hybrid rice, which is often considered low quality for human consumption. A model for Indonesian breeders in future may better be Egypt, with world-leading yields now approaching 10 tons/ha (on average, for the country), with qualities capable of export to Europe. The latter benefitted from decades and billions of dollars of U.S. agricultural research assistance, and may have genetic materials which could markedly advance Indonesian production.

Corn

Indonesia's secondary food crops, called palawidja, are led by corn. Corn occupied 3.9 million ha in 2011 (Table 3.8), half in Java, half in Outer Islands. This hectarage was actually slightly lower than in previous years. The 30% growth in corn production over 2007–2011 was largely led by enormous (22% cumulative) yield increases. This was probably due to a massive shift by smallholders to hybrid varieties and seeds. By 2011, average national yield had reached 4.45 tons/ha, and interestingly enough Sumatra's average (4.83 tons/ha) was higher than Java's (4.66 tons/ha). Despite this, East Java still dominates national production, with about 30% of national hectarage and 5 million of the 17 million tons produced. This increase in production occurred in parallel with increases in poultry production.

Soybeans

Production has hovered below the million ton level for several years. East Java with 40% of total production again dominates. For this crop, average yields (1.3–1.4 tons/ha) are low by international standards, and are not growing fast, perhaps limited by geographical factors such as unvarying day length near the equator. The priority of retaining soybeans in the Indonesian cropping pattern therefore may be questioned. On the other hand, it does fulfill a cultural norm (several traditional dishes) not primarily connected to animal feed, it may fit well into small niches of the cropping calendar, and if inoculated, as a legume it can supply free nitrogen to the soil, all of which likely explains its continuing presence. Unless yields can be substantially increased, however, it should not be promoted more broadly.

Peanuts

The recent production of peanuts, another legume among the palawidja crops, is much like that of soybeans, with areas slightly declining, yields growing little, and about 30% of national production in East Java. Average yields, at about 1.2–1.3 tons/ha, are again low by world standards. [However, in all these palawidja crops certain provinces stand out for higher yields—West Sumatra leads that island, West Java is also a regional leader, and the island of Sulawesi is better than others. If a careful review indicated there are reproducible factors involved here—e.g. organization of agricultural extension, varieties used, adaptive research—then perhaps there is something here to transfer to the rest

of the country. If it is rather mainly due to the fortunes of geography—soils, climate, rainfall patterns—there is little to be done.

Other field crops

Mungbean and sweet potato areas and yields have also been rather stable in recent years. The interesting story is in cassava, which has seen 17% growth over the last four years, all of it based on yields, from 16.6 tons/ha to 19.5 tons/ha. The overwhelming leader here has been the province of Lampung in southernmost Sumatra, which at 9 million tons in 2011 (based on a yield of 24.9 tons/ha) rivals the production of all of Java. On 30% of the national cropped hectarage of this crop, Lampung produces 38% of the national tonnage. Two other Sumatran provinces achieve even higher yields—West Sumatra at 36 tons/ha and North Sumatra at nearly 29 tons—but on much smaller areas.

Horticultural Crops

Vegetables

Vegetables (like fruit) never occupy a large portion of cropland. The estimated total area in 2009 was 1,078,000 ha, 14% higher than in 2005. The largest portions of that were devoted to chili (22%) and shallots or "red onions" (10%), followed by potatoes (6.6%). Increases in production in recent years are ascribed more to area increases than to yields, according to the official statistics. Vegetables, like corn, are usually a prime target of commercial seed companies (because many of the best are hybrids, and need new seeds for every crop) in new markets, and the lack of obvious yield increase in vegetables to date is possibly a sign this development has not yet occurred in Indonesia. It is overdue.

Fruit

Fruit reportedly occupies a total of 826,000 ha in Indonesia, with the major ones being mango, banana, durian, and citrus. East Java leads in mango production, with Central Java rising fast. In citrus, North Sumatra leads the country by far (789,000 tons in 2010), while East Java is in second place. West Java leads in banana production, where the other large Java provinces are also productive, as is Lampung, probably more for commercial sales than for own consumption.

Anecdotally, the imposition of taxes and other charges at every kabupaten boundary, a consequence of the decentralization policies of the last 10 years, hurt horticulture (and other perishables like meat, fish, milk, and eggs) more than field crops. Numerous studies have shown the high number of stops and charges produce trucks must endure, and the killing impact this has on horticulture in general.

Estate Crops

There are some critical points to note about the recent history of estate or plantation crops in Indonesia. Perhaps the first is that, except for oil palm, tea, and the atypical case of sugarcane, these crops are now overwhelmingly owned and produced by smallholders.

The reason for this efflorescence of smallholder tree crops was partly due to far-sighted policies of encouragement, including promulgating the concept of "nucleus estate" development, where the government plantations which had run the expropriated properties of Dutch colonial era firms, were made responsible for developing and assisting neighboring smallholders' production as well as processing their production. This obviously expanded beyond original intent, so that the Outer Islands are among the most concentrated export agriculture producers in the world. Vast areas of rubber are found in Sumatra and Kalimantan, while oil palm is now even more prevalent on both these islands. Coconuts are everywhere, including large areas on Java. While coffee is also widespread, the largest areas are in southern Sumatra. Lampung Province (also in southernmost Sumatra) is the center of pepper production, while tea is very concentrated in West Java Province. Sulawesi leads the nation in cloves and cocoa, producing half of the former, and 2/3 of the cocoa.

Table 3.10: Production of key crops in VIP countries

	Vietnam			Indonesia		
crops	1990	2000	2010	1990	2000	2010
coconuts	894,419	884,800	1,179,900	12,120,000	15,240,000	18,000,000
coconut (copra) oil	119,936	144,000	163,217	759,780	778,000	861,000
cacao beans	0	0	0	142,347	421,142	844,626
coffee (green)	92,000	802,500	1,105,700	412,767	554,574	684,076
maize	671,000	2,005,900	4,606,800	6,734,030	9,677,000	18,327,600
palm kernel oil	0	0	0	305,000	717,800	2,358,000
palm kernels	0		0	660,000	1,660,000	5,380,000
palm oil	0	0	0	2,412,610	7,000,510	19,760,000
rice	19,225,100	32,529,500	39,988,900	45,178,800	51,898,000	66,469,400
rubber	57,939	290,800	754,482	1,275,300	1,501,430	2,591,940
soybean oil	1,645	2,858	9,967	297,131	339,518	441,250
soybean	86,600	149,300	296,900	1,487,430	1,017,630	907,031
		Philippines			world	
crops	1990	2000	2010	1990	2000	2010
coconuts	11,942,000	12,994,700	15,540,000	43,468,941	51,194,357	59,421,273
coconut (copra) oil	1,462,870	1,358,240	1,913,350	3,358,837	3,381,717	3,987,563
cacao beans	9,848	6,628	5,019	2,532,151	3,373,727	4,187,587
coffee (green)	125,659	107,557	94,569	6,063,100	7,564,401	8,228,018
maize	4,853,890	4,511,100	6,376,800	483,372,614	592,479,279	840,308,214
palm kernel oil	5,133	7,266	10,963	1,675,875	2,767,441	5,688,559
palm kernels	11,406	16,000	23,800	3,717,219	6,479,122	12,594,756
palm oil	45,100	54,000	92,000	11,449,101	22,227,777	43,573,470
rice	9,885,000	12,389,400	15,771,700	518,568,263	599,355,455	696,324,394
rubber	179	71,382	130,430	5,225,369	6,947,472	10,004,206
soybean oil	4,585	38,280	17,575	15,922,935	25,573,310	39,840,137
soybean	4,937	953	812	108,456,438	161,289,911	264,991,580

Source: FAOSTAT

Table 3.11: Food Budget Shares for 9 Countries (%)

	Beverage/ Tobacco	Breads/Cereals	Dairy	Fats/Oils	Fish	Fruits/Vegetables	Meat	Total Food Expenditure
Indonesia	11.3	33.5	5.7	4.7	8.7	23.7	5.1	54.6
Philippines	11.9	29.7	6.7	1.8	14.5	11.1	14.5	48.4
Thailand	28.6	16.1	5.2	2.8	3.3	16.4	18.6	28.6
UK	47.5	8.3	6.9	1.3	2.3	12	12.6	16.4
Australia	25.2	13.5	9.7	1.7	3.1	18.3	16.9	15.1
Japan	23.1	22.3	4.8	0.7	17	12.8	7.8	14.9
Singapore	25.2	10.3	5	1.8	15	18.1	13.3	13
Hong Kong	17.9	9	3.4	3.3	19.7	11.8	22.7	10.3
USA	28.7	11.4	8.6	1.8	1.2	14.7	19.6	9.7

Source: prepared by USDA, reproduced in Morey, Phillip, Report on the Indonesian Investment Market for Horticultural Produce, for International Finance Corporation, 2009, pg. 15

It may be argued that the estate crops which are now heavily (or even purely) smallholder, are those in which smallholders can process the output to a standardized and stable product, such as ribbed smoked sheet (RSS) for rubber. But this would not explain the continuation of the plantation form for tea, which can be processed to a preliminary form by small groups of smallholders, and indeed even oil palm which has a particularly tight schedule between harvest and processing plant, is 38% smallholder-owned at present. This percentage may have been kept down mainly by the huge volume of foreign (mainly Malaysian) investment in new oil palm development in recent years. Thus in the four years from 2006 through 2010, smallholder oil palm area increased by 500,000 ha, a truly impressive development. But in the same four years, oil palm plantation area increased by an enormous 1.8 million ha, which meant that the smallholder proportion of oil palm was smaller at the end of the period than at the beginning. The range of investment costs for new commercial oil palm plantations is $3750–4350/ha (Rp 35–40 million equivalent), and for smallholders about $1750–2000/ha, about 10–20% less if the latter do not use high-yielding hybrid seedlings. The immature period is 3 years for estates, 4 for most smallholders. This means the largely foreign investments in oil palm in those four years amounted to about $7.2 billion, which dwarfs amounts recorded in registers of foreign direct investment in agriculture. Even the smallholder investments for this crop amounted to about $1 billion. Whatever the problems in Indonesia's rural business climate, and they are many, high profitability seems to be able to overcome them.

A second critical point to note, regarding the boom in the tree crop sector, is that virtually the entire driving force in this sector has been the expansion of oil palm in Sumatra and Kalimantan, and indeed that this expansion has been the major growth factor in Indonesia's agricultural sector in general, over the past decade. The only other truly dynamic element has been cocoa's expansion by 330,000 ha, largely in Sulawesi, in this case entirely smallholder-driven. Given that new land taken from Indonesia's forests is not infinite, and that much environmental damage may already be attributed to the forest conversion which has already taken place, a main task in projecting future agricultural growth in Indonesia, is to determine how much new land will still be developed for perennial crops, and when that forest frontier will close. A second major task will be to project how the average yield profile will develop in areas already developed, through replanting and rehabilitation, and for new areas developed from logged-over, degraded forest. These factors, together with market demand, will shape this side of Indonesia's agriculture over the next 30 years. They are discussed as part of the 2040 Vision of this report.

The preceding section of the report provided a snapshot of recent development of field crops, horticultural crops, and estate crops. Given the great similarity between Indonesia and the other two countries (Vietnam and Philippines) being examined in this study, it is interesting to compare the recent developments in the area and production of their major crops as well as to put their output in the perspective of global production. Table 3.4 provides the comparative data from the VIP countries.

Horticulture

Overview

In Indonesia, this subsector is typically broken down into two large areas, fruit and vegetables, and two small ones, medicinal and ornamental plants. It is a large subsector in terms of participants—8.4 million households according to the 2003 Agricultural Census—but fairly small in terms of aggregate value, about US$ 10 billion equivalent in 2010 ($5.5 billion of fruit and $3.3 billion of vegetables), or 6% of agricultural GDP. It unfortunately has not been growing very rapidly in recent years, compared to other agricultural subsectors, and shows a negative and indeed declining balance of trade. For the first 9 months of 2009, horticultural exports were $368 million while imports were well over $1 billion. This deficit has been increasing at a rapid pace (57% per annum) since Indonesia's recovery from the economic crisis years commenced (i.e. since 2005), which means it may well be a continuing trend with rapid economic growth. There is a strong Indonesian demand for temperate climate fruits in particular (apples, citrus, etc.), fulfillment of which is facilitated by increasing incomes. There is perhaps another

trend, also ominous for future high value product development in the country but quite common internationally, which is the early failure of traditional agriculture to enter the burgeoning supermarket sector. Domestic fruits and vegetables at present make up only 21% and 16% of those products on the shelves of the country's modern markets, now composed of hundreds of supermarkets and thousands of convenience stores, with those totals growing at about 20% per year. If this trend continues, it may cap the growth of domestic horticultural production, which must be sold as well as produced, although it is possible that the slow-growing segment of traditional tropical fruits and vegetables will remain a niche for domestic producers, whether sold through traditional markets or supermarkets.

The Strategic Plan for Horticulture (2010–2014), was not overly ambitious regarding production growth (about 4–5% per annum) with fruits projected for much more rapid growth than vegetables. This has changed with a new Long-Term Plan for 2011–2025, which if anything is over-ambitious. This plan envisages increases in production of about 200% for both vegetables and fruits by 2025, a growth rate of over 8% per annum. This in turn would require an increase in cropped area for horticulture from the current 1.53 million ha to about 4.5 million ha; this would involve a competitive struggle for paddy land and the urban development that is encroaching on that land use. Most serious might be the demand constraint. In both cases, per capita demand would nearly double (to FAO nutritional guidelines) while in actuality recent years have seen little growth in at least vegetable demand. Given the statistics and scenario presented above, there is no obvious reason for this rapid growth to occur, which likely removes concerns about this particular pressure on paddy land. In the end, it is not the task of Indonesia's farmers or indeed its Ministry of Agriculture to balance any particular trade balance—these should be determined by comparative advantage. More relevant would be to give the small farmers the means to realize their own comparative advantages and increase their income possibilities.

What needs to be made more effective are the operational programs to advance the horticultural subsector, through technology development (research), various sorts of extension systems including in particular the Farmers' Field School approach also applied to horticulture, assurance of easy access to good seeds, effective crop protection (against pests and diseases) programs, and assisting in the organization of appropriate types of farmers' organizations (cooperatives) which seems an absolute necessity in a country of farms of less than 1 hectare. Without such organizations, it appears that any group of small farmers will have great difficulty in ever accessing the new market and supermarkets for offloading purposes. One large issue is occasional policies and legislation, which actively work against foreign investment in this field. This is a field where such investment is the key to the entire future development of the subsector, perhaps to bring in technology and capital for greenhouses, agro processing plants, refrigeration plants and cold chain links, and finally, to bring in foreign home markets to which domestic production might be shipped back.

A major example of a rather harsh attempt to force foreign investors into arbitrary patterns of involvement in horticulture is the recent Horticulture Law 13/2010, which was drafted and passed by Parliament with little consultation and discussion. There are several positive aspects of this law that any progressive foreign agri-business would accept and implement without complaint—such as use of local apprentices and cooperation with local institutes in research and development. But the main thrust is actually to reduce foreign ownership in the sector. The limit to foreign equity previously set at 49% or 95% (depending on the crop) is now reduced to 30%, and this ex post facto result must be met in 4 years.[4] There are bans on small and medium investments by foreigners, even though when entering new countries or regions of countries prudent investors may wish to start various investments on pilot scales. There are mandates for joint ventures with local firms, and to deposit all investible capital up front in a domestic bank. All in all, sudden moves like this law, which seems to treat foreign investment in horticulture production as a threat rather than a great boost to a domestic industry, will mean a stagnant

4 OECD; OECD Agricultural Policy Reviews: Indonesia, 1 February 2012; Chapter 3, pg. 16.

horticultural subsector in decades to come, rather than a dynamic engine of growth.

According to some data sources, Indonesia's consumption of horticultural products (essentially fruit and vegetables) is among the highest in the world (see table below). On the other hand, contrary to expectations, demand is not growing fast except for a limited series of temperate zone (largely now produced in China) fruits and vegetables. Exports of fresh fruits and vegetables are extremely small, so rapid growth rates in that area mean little, and there is but one (extremely) successful case of large scale integrated fruit production and processing development, in Lampung Province for pineapple, to report on (see paras below). In sum, whatever has been written about processing potentials for rapid horticultural growth (statistics before 2004 should probably be discounted) is probably mainly overly optimistic and one of the tasks here, before looking to the long-term future, is to explain why.

Table 2.4 was developed in 2004, as Indonesia finally emerged from the economic stagnation following the financial crisis and revolutionary regime change of 1998, and the disruption of the "big-bang" decentralization of 2000 and the following years. Still, the Indonesian food consumption scene presented there seems to have held up in many particulars over the intervening years, as confirmed by numerous surveys and common observation, viz.

1. Expenditure on food is an extremely large part of total expenditure.

2. Expenditure on meat is extraordinarily low. However, here Japan, with much higher incomes, is also very low.

3. The "breads and cereals" category was exceptionally high due to heavy Indonesian reliance on rice for nutrition.

4. Relatively high expenditure on fish in this survey may yet be somewhat lower than expected from very high physical volumes consumed (20–30 kg/capita/year), but this may be because of high consumption of cheap species.

5. It is not obvious why consumption of fats and oils is so proportionally high; perhaps the consumption of large volumes of coconut meat (santan) in the making of curries (actually an alternative to drying copra and crushing it to coconut oil) is counted under this heading.

6. Finally, it should be noted that according to this survey, Indonesians spend a far higher proportion of their income on fruits and vegetables than any other East Asian comparator (including high-income ones) or the US or UK. This may not indicate a high domestic market demand for commercial horticulture production (with imputed market values), however, since the great bulk may be handled by subsistence and near-subsistence production, in the form of self-consumption and gifts of urban-periphery residents with a few fruit trees and vegetable plots to urban relatives.

Indonesian policy-makers do not consider national horticultural consumption as adequate, as they compare it to theoretical target volumes prepared by the UN, which however may be irrelevant in many ways to Indonesian conditions. The true directions of future consumption are more likely to be found in the marketplace. The great marketplace breakthrough in recent years, as in so many other middle-income and developing countries, has been the rise of supermarkets in Indonesia, growing astronomically (high double-digit growth rates) in number and sales. This boom reportedly originated in a Presidential Decree in 1998/99 permitting the French chain Carrefour to increase its number of supermarkets in Jakarta. Removal of restraints on foreign direct investment in this field, laid atop patterns of rapid urban growth, increases in per capita income (Morey estimates there are now 30 million "middle-income shoppers"), and investment in property development, have led to a fleet of at least 251 major supermarkets and hypermarkets (half in Jakarta) in 2009, or by other counts/definitions 485, and 6,757 minimarkets and chain convenience stores with sales passing Rp. 80 trillion (US$ 9 billion) already

in 2007. It is odd that this easy attitude towards foreign merchandising is accompanied by such a negative reaction to primary production by foreign firms.

Supermarket development has not led to a large growth in off take for high quality local produce, however. The latter has occurred but only on a small scale, with too few entrepreneurs organizing chains of small growers. Instead, modern retailing has mainly served as a portal for an extremely rapid growth (albeit from a small base) of imported fruits and vegetables, with well over $1 billion in 2008. Over 70% of both fruits and vegetables in that year came from China, in each case temperate zone products, apples, pears, and mandarins among the fruits, and one single product—garlic—among the vegetables. More disappointing perhaps was the import in that year of $30 million worth of durian (the classic king of Indonesian fruits) and $50 million of other tropical fruits, areas where a competitive marketing system should be exporting.

For classic tropical fruits, this could occur either through efficient collection/harvesting systems of natural or smallholder stands, or, with more investment, through plantation development. The only crop where this has occurred even in a small way has been mangosteens, with exports (mainly to China through Hong Kong) hovering about 9000 tons over the past decade but declining in value to $5 million per year. Here the complaint of the trading community is insufficient regularity of export quality, but this would appear to be the task of serious traders, to establish inexpensive sorting/grading facilities, if necessary establishing their own grades with their own pricing. With an annual production of mangosteens of 113,000 tons, and export below 10,000 tons, complaints of "only 15–30% meeting export quality essentially means the sorting/grading function is not being done. A great deal of government/NGO training money could be spent trying to upgrade production standards of thousands of smallholders. Perhaps it would be better to focus training and maybe credit on dozens of traders, to better play their role between the primary producers and the broad world market.

In general, many of the commonly listed constraints to horticultural development are not likely to improve much over the coming decades—prevalence of very small farms scattered over mountainous terrain, and poor condition of country roads—though this was once before greatly improved with government investment over 1970–90. Under decentralization, indeed, rural roads seem to have suffered rather than improved, and it is possible that central allocations to the districts need to be tied more tightly to performance in rural road investment—although this alone will not produce increased and improved horticultural supply to cities and export outlets.

An increasingly common mentioned constraint, which also will be difficult to alter, is high price levels (by international standards) for Indonesian produce in the field. In part this could be a simple amalgamation of the costs of inefficient transport (e.g. poor roads), over-regulation (e.g. premature imposition of developed-country standards on poor peasants), corruption (constant stopping of perishable products by police and officials).[5] But another factor here may be an Indonesian version of the "Dutch disease", whereby extremely successful export performance in enclave or semi-enclave sectors drives up the value of the currency to an extent that exporting becomes difficult and importing becomes inexpensive. The enclave sectors in Indonesia were once petroleum, rubber, timber, tin and various other agricultural commodities—none of which have disappeared, but which have been dwarfed by fast rising exports like palm oil and coal, in both of which Indonesia is now the world export leader. Given the explosive growth of total exports, this factor alone may have imposed a severe constraint on horticultural export development.

Finally, any attempt to strengthen the production of horticulture in Indonesia will require the development (primarily by private investors and farmers cooperatives) of effective value chains to support processing, marketing, cold storage

5 Examples of the current huge incremental costs of inefficient logistics/corruption in transport of agricultural goods from Jakarta, as quoted by active businessmen, include the following comparisons: Shipping a 20-foot container to Malaysian ports, $300. The same container to Kalimantan ports is $1000. The problems also afflict the airports: Air cargo rates for paprika, Netherlands-Hong Kong, are less than the same rates for paprika, Jakarta-Hong Kong, a fraction of the first distance.

and transporting goods to market. Improving the business environment and the ease of doing business will be critical steps to be adopted by government in supporting this development.

Pineapple processing, a success story. There is one very large horticultural success story in Indonesia, Great Giant Pineapple (GGP), but with 33 years of development it is not clear that it is a model which can be quickly replicated. Situated in Lampung Province in southernmost Sumatra, GGP is reputed to be the world's largest fully integrated pineapple plantation (33,000 ha) and processing facility (Morey, op. cit., pg. 58). It is separately the third largest producer of canned pineapple and of pineapple juice concentrate, all based on primary production of 500,000 tons of pineapple per year. Facilities are ISO 9002 certified and export to 30 countries. The company has now started growing and packing bananas under a brand name. Thus with good enough management none of the above-mentioned constraints can nullify the chances of successful horticultural business development. Nevertheless, a more welcoming attitude to foreign investment in the field might shorten the development period of various large-scale horticultural projects.

Tree Crops

Oil Palm

Overview. Oil palm has been the main dynamic force in Indonesian agriculture for the past two decades, and this trend is projected by this study to continue for at least the next 20 years, and probably to the end of the study period, nearly 30 years from now. The reasons for this are:

- the extremely high oil productivity of the crop, giving roughly 10 times the oil per hectare as any oilseed. This translates into very low unit costs of production in the proper agro-environment, which is present in Sumatra, Kalimantan, and other Indonesian regions. Thus Indonesia is on the low end of the world edible oil cost curve, and will likely always out-compete other oils on price;
- the historical and now policy and legal structure of the industry, where large, well-organized plantation companies (many of them foreign) lead the breeding, planting, and processing programs, followed by large populations of nearby smallholders, many of whom double as laborers on the estates. This ensures continuing rapid increases in yield potentials of the tree stock, good processing, and smooth marketing of output, while smallholder production allows usage of larger mills than could be expected for the estate hectarage alone;
- an enormous area of land suitable for oil palm remains to be planted. Most of this land may once have been rainforest, but is not today, due to two long-standing trends that have nothing to do with oil palm: (i) particularly on Kalimantan, slash-and-burn agriculture (on shorter and shorter cycles) by indigenous tribes has created large areas of degraded forest or bush; and (ii) on Sumatra commercial logging itself has created much the same conditions. The smoke and ash of the seasonal burning in Kalimantan were a negative fact of life in Malaysia and Singapore as far back as the 1970s, when there was essentially no oil palm planting in Indonesia.

A USDA study of 2010 reports that of the 5.5 million ha of land in Kalimantan currently legally permitted for palm plantation development, only 1.7 million ha is on known forested land. Degraded lands alone will permit continued rapid expansion of oil palm planting for the next 20 years, with perhaps 60–65 million tons of oil produced per year, without undue additional damage to remaining forest reserves. This would represent a 140% increase in current production, based on less than a doubling of current land area, due to the fact that much current hectarage is still immature, while clones being planted now are higher yielding than the existing stands.

Demand for Palm Oil. There seems to be no true market constraint for palm oil. There is opposition from environmental groups in developed countries to certifying palm oil as a legitimate fuel base for biofuels, due to its production

in what was formerly forest. But palm oil is still too high in value as a food to make use as fuel commercially viable, today by a factor of two. Its price at present is over $920/ton, the most pessimistic long-range forecast now is about $600/ton, while USDA reports cost of production in Indonesia at $250–300/ton. About 10 biofuel plants have been built in Indonesia with government encouragement and subsidy, but all are apparently doing poorly commercially and slipping into bankruptcy. Thus certification as biofuel is not foreseeable as a binding constraint on oil palm development in Indonesia.

Table 3.12: Estimated Areas and Yields of Palm Oil (2011)

	mature hectares (million ha)	tons oil per ha	total output millions of tons
Estates (including state-owned)	4.2	4.2	17.6
Smallholders	2.7	3.6	9.7
Aggregate	7.0	3.9	27.3

Source: Centennial Group estimates

The low price (as a food) noted above is the key to palm oil's explosive recent growth, and to its future. Price is the key driver in its expansion in huge emerging markets like China, India, Pakistan, Africa, and the Middle East. Thanks to emerging markets, global edible oil demand has increased at a rate of 5.5 million tons per annum over the past 10 years, of which 2.5 million tons per year has been palm oil's share (growing at 9.5% per year). The latter has consisted of 1.47 million tons annual increase from Indonesia, 0.82 million tons from Malaysia, and 0.27 million tons from the rest of the world. Meeting the future rapidly rising edible oil demands of the billions of people in the developing countries, can only be accomplished by palm oil, and indeed according to the USDA study referred to, by Indonesian palm oil, since the other giant in the field, Malaysia, is increasingly constrained by land and labor limits. Regarding other oils, it should be noted that at average oilseed yields of about 0.5 tons/ha, a global increment of 25 million tons would require 50 million ha to produce (an area larger than France), as against 5 million ha of today's Indonesian oil palm, and probably much less given rapidly rising yields already being proven (see below). It is certainly unclear where such a vast area of fertile land is to come from, not to mention the environmental costs of bringing such a vast area into production in the temperate or subtropical zones. Thus even purely environmentally, if the edible oil demands of the additional inhabitants of the planet are to be met, oil palm has a claim to be the best choice.

The Role of Oil Palm in the Indonesia Economy. As of 2010, oil palm activities employed 3 million people and contributed about 4.5 % of GDP, with exports of oil palm products reaching about $18 billion. Expansion of this industry seems to be associated with strong reductions in rural poverty in recent years in Kalimantan and Sumatra, in part because, as with earlier tree crop expansions, a wave of smallholder plantings has followed estate development—by 2010 38% of the 8.1 million ha were already in smallholder hands, as was 35% of the crude palm oil and 33% of the palm kernel oil. This process was the result of a deliberate policy by government (with strong World Bank encouragement in the 1980s) to force or encourage plantation and processing companies to assist nearby smallholders to plant tree crops on the margins of the estates, sending their rubber or oil palm fruit to the processing plants of the estates. This was meant to guarantee smallholders (often connected to the estates by labor contracts) some sort of standards of planting material, agronomic advice, and most important, markets for their produce, when they delivered to the estate processing plants. Originally called Nucleus Estate and Smallholder (NES) schemes, the arrangement is now generally known as plasma schemes, and is mandated by Ministry of Agriculture regulations, typically at a minimum of 20% of the area the estate wishes to develop for itself, though often more is given. Actually, in the early 1980's the NES/Transmigration program mandated 60% of planted area for smallholders, 40% for private estates. Jambi Province in eastern Sumatra, one of the main focal points of oil palm development, has now mandated that future plantation allocations must reserve 50% of the area for smallholders. Given the profitability of current plantings, this bold

Table 3.13: Historical Oil Palm Areas

Year	Smallholder Hectares	Private Estate Hectares	State-Owned Estate Hectares	Total Oil Palm Hectares
1993	502,300	750,100	380,700	1,633,100
2000	1,166,750	2,542,460	609,950	4,319,160
2008	2,882,000	3,879,000	698,670	7,459,670

Source: Ministry of Agriculture

step may prove feasible, and further advance smallholder interests.

Breeding and Future Yields of Oil Palm. Current Indonesian production is about 22 million tons of crude palm oil (CPO) and 5 million tons of palm kernel oil, the latter a much finer oil with most of the characteristics (and the price) of coconut oil. It is thus erroneous to assume that the oil palm has only the lower end of the edible oils spectrum for its market. These products were produced on about 8.1 million ha, but only about 7 million ha were mature. While precise statistics are not available on the breakdown of areas and yields, the mission estimates of the generation of 2011 output from mature hectares are as follows:
These existing yields are however only the beginning of what promises to be a long history of dramatic yield improvements for this crop. Industry experts report that recent estate plantings are already averaging 5 tons/ha, achieved much earlier in tree life than ever before—with initial production in less than two years and substantial production in 3.5 years. Reports from large commercial seed gardens in Indonesia, Papua New Guinea, and South America all indicate clones already producing 8 tons/ha. These same sources indicate commercial yields of 12 tons/ha oil are achievable, with 17 tons/ha the maximum physiological yield. As a crop, oil palm is thus still in an early phase of development, with genetic potentials still only partially achieved.

Here is a brief summary of the breeding strategy of a major Papua New Guinea research station, whose stands are now producing 8.2 tons of oil/ha:

Approach genetic potential of 17 tons oil/ha with priority given to i) high extraction rates at no extra harvesting costs, and high early yields, for early cash flow returns; ii) reduction in height for longer planting cycles—but not at the expense of yield; iii) tolerant to disease, particularly Ganoderma (bud rot) which is severely damaging Colombian plantings. To shorten the extremely long normal breeding cycle of 16–17 years for this crop, the station is creating new seed gardens of cloned parents of existing well-performing stock to transmit the best characteristics to their progenies.

Even discounting the normal enthusiasm of technical sales people, it is rare in agriculture to be considering new releases with fairly certain yield increments of 50% over the currently planted best material. Given that precocity (i.e. production within 18 months of planting) is also being bred for, and may thereby provide earlier markers of superior progeny performance than ever before, we may envisage very rapid increases in Indonesian palm oil production far beyond 2020, indeed most of the way until 2040, even with radical slowing of new land conversion. The point in achieving this result may be to shift some investment and attention to replanting in situ, more or less at the same pace as new plantings were done in the past.

Replanting of Smallholder Oil Palm. One potential threat to any tree crop-based industry is a failure to replant. This is more a threat among the smallholder segment of any tree crop, than in the commercial plantations, since the former will have to sacrifice part of their livelihoods as they destroy producing older trees. Given that farmers age along with their trees, there may also be incentive concerns in replanting, tied to inheritance, migration of offspring to cities, etc. As will be seen below, all these issues are more urgent regarding rubber, a much older crop historically in Indonesia, than for oil palm. But in the context of the long-term horizon adopted in this study, the time for large-scale replanting of oil palm will arrive soon enough, so it is best to consider seriously the choice of modalities now. These will be among the largest decisions the agriculture sector will face in the coming years.

While many different numbers are proposed for hectares of oil palm which need replanting, perhaps the most conservative may be taken from historical figures for areas planted, minus an estimate for areas already replanted, which will likely be almost entirely in commercial estates, given the relative youth of the crop. Thus in 1981 there were 314,000 ha of oil palm planted, almost all in Sumatra, likely almost all in government or private estates, and probably largely replanted by now since 25 years has long been a commonly accepted economic length of life for oil palm.

At the end of the NES program in 1993, areas of oil palm were roughly as follows, according to one set of official figures. The crops were still overwhelmingly on Sumatra. Growth over the next 15 years was extremely fast, averaging just under 400,000 ha of new plantings per year, but one may notice an interesting shift around the year 2000: for the seven years before the millennium, private estates grew in area three times faster than smallholder areas. For the eight years thereafter, smallholder areas grew faster than private estates. This likely indicates that there are increasing numbers of "stand-alone" smallholder palm farmers not connected to parent estates, delivering fruit to any mill within the 6–7 hour radius of fruit viability—which in turn will have implications for replanting approaches. Regarding smallholder replanting volumes, the 500,000 ha of smallholder palm standing in 1993 should probably commence replanting about 2015 (perhaps at a rate increasing to 70,000 ha/year) rising to 100,000 ha/year by 2025 (the rate of new planting over 1993–2000), and then scaling up to over 200,000 ha/year after 2025. This may seem a bit early, but reports are that many smallholders received inferior quality planting material in the early years, with low yield potentials, and it is thus probably best to upgrade those stands as soon as the owners can be convinced to do so.

Choice of Modality for Financing of Smallholder Oil Palm Replanting. There appear to be two main choices for financing and managing a program which could actually handle replanting of over 100,000 ha/annum of smallholder oil palm, initially focusing on Sumatra and eventually turning to aging stands on Kalimantan. One is based on commercial bank credit, and is largely focused on the NES and plasma schemes which introduced oil palm planting to smallholders in the first place. Here we have an actual scheme in operation today (see below) to consider. The second is an earmarked government fund approach, largely based on the Malaysian experience with rubber going back to the 1950s, where financing derives from an export tax (in Malaysia then called a "cess"), which is paid out to all (smallholders and estates) who replant old stands according to the rules of the program. Many different features are possible in such a cess-and-grant system, but almost all involve:

1. phased payments to growers, year by year, covering removal of old trees, digging of new holes, planting material and fertilizer for the planting (often specified by the authority), planting material for inter-cropping in the early years of the new crop (for smallholders). Some or all of this work may be executed by contractors. Payments are also frequently made for labor and subsistence of (smallholder) growers, at least in part covering calculated needs, leaving some room for growers' own incentive to work and invest for their own future; and

2. an inspectorate, which must approve all the above payments based on work actually done, which inspectors must certify.

The Current Credit-Based Smallholder Oil Palm Replanting Program. The on-going oil palm replanting program is one organized and financed by Mandiri Bank (a state-owned commercial bank, and largest bank in the country), working with various estate companies as clients, probably to fulfill various social responsibility mandates required by government. In each case, good smallholder performance is guaranteed by the plasma corporation (nucleus estate). The total program covers 100,000 farmers (with 176,000 ha of oil palm) nationwide, which is both large enough to take seriously but perhaps not large enough to truly fulfill national needs. One estimate is that up to 74,000 ha should be replanted each year, rising to much higher numbers later on. The factual question to be answered is thus whether the program can be expanded with appropriate quality in time for the aging trees, and whether enough of the nearly 3 mil-

lion ha of smallholder oil palm are close enough to estates to be effectively supervised by them.

The current credit program is indeed paternalistic. For example, the Palm Oil Research Institute of Medan (North Sumatra) oversees both implementation and quality of inputs and work for the plantation companies and the bank, audit firms are constantly involved to prevent corruption, farmers' cooperatives are entrusted with inputs to distribute but not with money, and all management expenses are borne by the estates for a 5% management fee. A sinking fund for replanting is accumulating through deductions from value of fresh fruit bunches at the mill. There is a 13-year term to the replanting credit—with 4 years grace and 9 years of repayment. During all these years the "farmer" is also a salaried estate worker, so there are few problems of subsistence, generally one of the biggest issues in replanting. Perhaps the most paternalistic element of all is, that until the credit is fully repaid, the "farmer "does not know where his land (generally nearly 2 ha) is. He knows how many hectare shares he "owns" in the whole scheme, but the land titles stay with the bank until the credit is repaid. So the farmers learn the actual location of their land only after 13 years. In a sense, one may say this is a profit-sharing scheme for plantation workers, but one is forced to wonder if it can be the basis for a national smallholder replanting program, given the existence of more and more stand-alone oil palm farmers.

All the safeguards mentioned above are no doubt markers, from past failures to repay credit, which killed every previous government scheme, in part due to corrupt practices of inspectorate and control staff. So far, this paternalistic program seems to have started well, with Bank Mandiri insisting it has not lost a rupiah. But there seem to be several strong reasons why a larger, stronger program with more government involvement will be needed to fully handle rejuvenation of tree crops in Indonesia. These include:

1. for oil palm, smallholder replanting in the Bank Mandiri scheme seems to rest heavily on the fact that the "farmers" are actually staff of the client corporations. Thus they have assured incomes throughout the new crops' immaturity period, they tolerate easily imposition of many types of controls (including not knowing where their new land is), they are fairly easily served by experts based on the plantations nearby, etc. But for how many smallholders will this approach be feasible? Given recent rates of new planting, there may now be almost 2 million oil palm smallholders in the country. This largest and most successful credit scheme handles only 5% of that. It does not seem likely it can be scaled up 20 times with a high degree of technical, financial, and fiduciary success.

2. even Bank Mandiri states that its credit approach cannot be used successfully for rubber and other important crops where smallholders can semi-process the primary output to a point where biological deterioration is stabilized and arrested: in rubber's case, this involves drying and smoking the latex to a grade of ribbed smoked sheet (RSS). This processing allows the farmer to transport (typically on the back of a bicycle) his output to more distant dealers or factories, other than those who provided him the investment and production credit to produce the output—and hence to avoid repayment of replanting credit. Indeed this was a major cause of failure of past replanting schemes. Yet if anything, replanting of non-productive old rubber (to high-yielding rubber, oil palm, or other crops) is today more urgent than in oil palm. Recent rapid start-up of a fairly large program for cocoa indicates that

TABLE 3.14: EXPORTS OF COCOA PRODUCTS

	2009		2011	
	tons	$ million	tons	$ million
Beans	438,200	1,083	214,740	617
Fully Processed (powder, chocolate)	39,700	75	58,010	209
Semi-Processed	85,912	251	137,460	519
Total	563,812	1,409	410,210	1,345

Source: International Finance Corporation, project preparation documents, May 2011.

TABLE 3.15: COCOA SUPPORT PROGRAM

	2011 target
Rejuvenation	49,500 ha
Rehabilitation	74,200 ha
Intensification	62,800 ha

Source: Ministry of Agriculture

arguments about feasibility of new government-financed replanting schemes are exaggerated.

3. The main Indonesian argument against a Malaysian-style tax-and-grant scheme is the common perception of pervasive corruption in Indonesia, whereas the success of such schemes depends largely on the integrity of the inspectorate which approves payments for each step of replanting. The response to this really needs to be to start systematically reducing the level of corruption in the civil service, perhaps starting with a specialized replanting agency. Looking towards the year 2040, Indonesia cannot simply accept the fact that a critical function like renewing one of the major assets of the country (its tree crops) cannot be done due to an untrustworthy civil service.

4. As noted above, while planning and design of an export cess-grant system for replanting smallholder oil palm should begin soon, the more urgent goal would be to finance rubber replanting, given a much older and less productive stock. We will first follow here with a review of cocoa developments, since the country has started a program for this crop, and then briefly describethe rubber situation.

Cocoa

The second smallholder boom crop of the past 15 years has been cocoa, with output (900,000 tons in 2011) and area planted (1.7 million ha) tripling over that period. Indeed, yields have increased little over those years, from 0.5–0.6 tons/ha (compared to a 1.5 ton/ha international standard), which likely indicates insufficient government assistance to the subsector. In this heavily smallholder (94%) crop, there are too few plantations to provide real private sector leadership in terms of breeding, provision of planting material, agronomy, etc. so a large part of the NES/plasma model applicable to oil palm is absent here. Indeed government has tried to use the chocolate processing industry as its technical partner to the smallholders instead, but without the network of breeding stations and nurseries provided by oil palm estates, effectiveness in raising smallholder cocoa productivity has been much less. Some technical support has been garnered from the Indonesia Coffee and Cacao Research Institute in Jember, East Java.

The crop's strong geographical focus has been Sulawesi, site of 62% of the nation's cocoa planted thus far. In an effort to pursue value-added processing in country up the value chain, the government has imposed policies similar to those imposed on logging in the 1970s and thereafter, and nowadays on a wide range of primary products, such as metallic ores. These generally include an export tax on primary products (in this case, cocoa beans) and favorable treatment of processing investments. It is not clear whether resulting private investment patterns are optimal (e.g. see the failing fleet of biofuel plant investments) or if the policy actually drives investors away from primary production in Indonesia in general; with a proper business climate and natural advantages (e.g. industrious labor at relatively low wage rates) it is also not clear why businesses need to be "forced" to invest in processing in the country. The following statistics, reconstructed from an article in the Jakarta Post (9 May, 2012) indicate ambivalent results from a progressive export tax on cocoa beans levied in 2010.

Due to developmental interest by senior government leaders from Sulawesi, a government replanting program based on grants has started up for cocoa, known as Gerakan Nasional Cacao, or GERNAS. The program for 2011 was quite ambitious in scope and size, as follows:

In GERNAS, rejuvenation is essentially replanting, rehabilitation is essentially various types of grafting onto existing rootstocks, while intensification covers mainly infilling of failed trees. Actual realization performance against these targets is not known, nor is budget expenditure. Accord-

Table 3.16: Natural Rubber Area and Production

Natural Rubber Area and Production				
	1980	1990	2000	2010
Area (ha)	1,612,190	1,865,610	2,400,000	3,445,120
Production (tons)	1,020,000	1,275,300	1,501,430	2,591,940
Yield (t/ha)	0.633	0.684	0.626	0.752

Source: FAOSTAT

Table 3.17: World Rubber Consumption 2008–2015

	(Million MT)	%
2008	22.8	–2.4
2009	21.3	–4.4
2010	24.6	15.3
2011	25.7	4.5
2012	27.6	7.5
2013	31.0	4.2
2014	33.8	0.4
2015	35.9	3.6

Source: Gapkindo—Rubber Association of Indonesia

ing to official statistics, in 2011 300,000 ha of smallholder cocoa were at least 20 years old (i.e. ready for replanting), thus the numbers above, if realized, amounting to 60% of this area, would be a good start on a serious national rejuvenation program for smallholder cocoa—indeed, the program outlined above would seem to be a multi-year one, in that it would take a long time to gear up professional organizations to execute anything close to such a program in one year.

Meanwhile, and apparently unrelated to this new government grant program, the International Finance Corporation (IFC) is working with the BTPN Bank and the Armajaro Cocoa Company to develop an intensive microcredit-based scheme, also on Sulawesi, with a heavy emphasis on technical upgrading, aiming at raising yields by 60–100%. Spacing of trees is specified in detail, as is fertilizer (NPK) application per tree. Before extension and credit are provided to farmers, these treatments are first performed on demonstration plots, which are taken as a basic tool of program development. Indeed this program is restricted at this point to cocoa and Arabica coffee, since these two crops show visible response to fertilizer applications within three months. Robusta coffee will require 1 1/2 years to show first results, and hence will need development of a separate program.

While Bank Rakyat Indonesia (BRI) would likely finance such investments at current interest rates of 16–17% they would need land titles as collateral, which would severely restrict the volume and clientele served. BTPN would not require titles, but would have to lend at their standard microcredit rate of (currently) 27%. BTPN reports its overall planned microcredit program at $75 million, with 2400 farmers now enrolled (mainly in West Sulawesi) but aiming at a total of 10,000 eventually. Again, as with oil palm, while this credit program may be seen as a technology leader for smallholder perennial crops, it is difficult to envisage it fully answering the needs of Indonesia's smallholder cocoa farmers. With 1.6 million ha of smallholder cocoa, at about 2 ha per family, we may have 800,000 families to serve. Perhaps only a GERNAS type program geared up to accepting 40,000 "new candidates" each year, would be sufficiently large to accomplish the task of raising Indonesian cocoa to high international levels, and with that, farm incomes also.

Rubber

Rubber, long the major estate crop in Indonesia, has experienced limited growth in the 1980's and 1990's but as Table 3.16 shows, the rate has accelerated in recent years.

At present Indonesia has the largest rubber planted area in the world, though it trails far behind Thailand in terms of total production. Factors contributing to Indonesia's failure to capitalize on its advantages in rubber may include:

Relatively low profitability, especially compared with oil palm, due to low yields imposed by the originally planted (uncontrolled) and unselected clones used by the smallholders;Rubber is relatively labor-intensive, i.e. traditionally considered twice as labor-intensive as oil palm;Due to the above labor-intensity, actual production of rubber (i.e. tapping) is often dependent on rural wage rates in the various rubber regions; in the short term more prosperous

Table 3.18: Indonesia's Rubber Exports by Destination (tons)

	2006	2007	2008	2009	2010	2011
Asia	1,041,090	1,105,013	1,058,584	1,122,113	1,110,492	1,156,760
Africa	37,064	39,578	36,340	32,124	36,995	35,540
Australia	18,562	18,928	15,735	9,932	6,285	4,907
North America	809,197	845,067	830,161	555,080	791,632	847,663
Europe	380,084	398,190	354,636	272,014	406,511	510,849
Total	2,285,997	2,406,776	2,295,456	1,991,263	2,351,915	2,555,719

Source: Gapkindo—Rubber Association of Indonesia

Table 3.19: Development of Smallholder Rubber

	1960	1970	1980	1989	1998
Cultivated areas ('000 ha)					
Malaysia	772	1,289	1,493	1,488	1,373
Thailand	482	1,276	1,538	1,747	1,972
Indonesia	1,430	1,813	1,947	2,589	2,795
India	72	145	182	354	484
% high-yielding materials					
Malaysia		75			90
Thailand			21	48	52
Indonesia				15	17
India	29			89	92

Source: Colin Barlow, The Role of Institutions in Planting Improved Smallholder Rubber, pg. 16, Australia National University, 2000.

farmers simply ceasing to tap (such semi-abandoned rubber areas are known as "sleeping rubber"), and often in the longer term replanting to other crops, notably oil palm.

Although tapping of mature rubber trees began to phase out in less productive areas in Malaysia in the 1980s, average yields continued to decline as did the planted area. By contrast, yields in Thailand rose rapidly between 1990 and 2000 and have since remained at that level while the planted area and total production increased rapidly between 2000 and 2010. During the same period Indonesia's planted area rose steadily as did production but yields remained mostly stagnant. By contrast, Vietnam's rubber production rose rapidly both in terms of planted areas and yields. Details for these four countries, which together account for about 73% of the world natural rubber production in 2010 are presented in Annex 8 of the Overview Report and in Table 3.11.

It is worth noting that the decline in production in Malaysia did not occur due to failure of replanting program design, but due to a dramatic change (and a very positive one) in the rural and macro-economies of the country; although Thailand experienced similar economic growth, it managed to consistently increase total production. . While in the 1980s a typical rural wage of about US$2/day may have been enough to slow tapping in lower yield areas like Trengganu State of Malaysia, it would take very detailed calculations to project when this would occur in the various rubber regions of Indonesia. The issue is, at current smallholder yields that are about half of those in Thailand, the feasible imputed wage rate of rubber smallholders will obviously be

much lower than with higher yields. The target yield for any government replanting program thus will have to consider this major factor to ensure that the fiscal returns from an export tax (which should also be applied to estate production) cover the costs of the program.

Indonesia is currently the world's second largest rubber producer, after Thailand, but it has plans to expand production and become the number one producer by 2020[6]. Annual production is forecasted to reach 4 million tons or 31% of the world's total natural rubber production. The government plans to utilize the increased revenue to revitalize the rubber processing industry and maximize added value within Indonesia, stimulating the demand for processing technology and production machinery. However, as previously pointed out, these plans could only materialize if the government introduces an appropriate replanting scheme for smallholders' aging trees.

According to Ministry of Agriculture data, total rubber hectarage increased steadily from 1.6 million ha in 1980 to about 3.4 million ha in 2010.. With about 2.6 million tons of exports (Table 3.18) and small domestic consumption, current average yields of about 750 kg/ha are a reasonable estimate, with a good smallholder target of about 1,500 kg/ha. It is the possibility of achieving a large part of those potential gains for smallholders, which should stimulate government interest in mounting a national rubber replanting program.

A breakdown of tree crop area by producer category is presented in Table 3.19. Indonesia has actually done quite poorly in stimulating and supporting high-quality smallholder rubber production. The main indicator here is the extremely low proportion of trees (17%) derived from high-yielding clones. This is critical since this one decision or action will impact productivity for the next 30 or more years, no matter what else is done. Indonesia has tried numerous schemes to assist small numbers of smallholders through credit schemes to replant. While some have done better than others in terms of coverage, few have managed to enforce widespread planting with certified high-yielding planting material.

It is likely that almost all of the high-yield clones in Indonesia are from the Nucleus Estate for Small holding program, and the relatively low dispersion of such material is perhaps a sign of the limits of NES approaches to developing high-quality smallholder tree crops in Indonesia. An additional factor limiting the NES approach to rubber planting and replanting derives from the fact that smallholders can semi-process their own rubber (rolling and smoking), creating a stable product which they can store and transport (by bicycle or motorcycle) to fairly distant rubber factories—thus avoiding the automatic checkoff of credit repayments from payments for the raw output. Oil palm smallholders do not have this option—they must get their output to the nearest (NES) oil palm mill in a matter of hours, and thus typically cannot avoid automatic repayment. This is one reason for the persistent failure of credit-based rubber replanting in Indonesia.

Under the Malaysian cess and grant system the smallholder will simply not receive his grants unless he follows the standards imposed by the replanting authority—which in turn will help guarantee him and his family and heirs higher yields and returns over three decades. Aside from sheer higher average yields, the selected clones provided under the tightly managed Malaysian and Thai programs reached maturity (in terms of full production) much faster than the unselected ones in Indonesia, which often took 8–10 years to produce reasonable amounts of latex, and an additional task of the inspectors in Malaysia and Thailand was to prevent smallholders from various types of "slaughter tapping", where in an effort to maximize early returns some smallholders try to tap trees every day rather than follow prescribed 2-day or 3-day regimens, which allow the trees to fulfill their lifetime potential rather than suffer early death. The Thai system followed the Malaysian in most aspects, but could not achieve as high a coverage for managed replanting since much of the initial planting was in official forestry areas, hence many of the smallholders had no titles. This was a requirement for the Thai program—but

6 Jakarta Post (August 27 2012)

Table 3.20: Fish production in Indonesia 2002–2009

	2002 ('000 tons)	2009[12] ('000 tons)	% annual growth 2002–2009
Marine Capture	4,073	4,789	2.10%
Inland Capture	305	310	0.10%
Total Fish Capture	4,378	5,099	2.20%
Inland Culture	903	1,721	9.60%
Marine Culture	n.a.	13	-
Total Fish Culture	903	1,733	9.60%

Source: 2002: Statistics Indonesia; 2009: FAO Fisheries Statistics Yearbook

it need not be for an Indonesian one, since without credit arrangements there is no real need for such collateral.

Fisheries

After rice, fish is an essential source of protein in the Indonesian diet and fish production is thus an important aspect of food security. Exploitation of 5.8 million square kilometers of Indonesia's territorial waters, 5.4 million ha of inland waters and 1.1 million ha of ponds contributed about 3.34% to Gross National Product (GNP—without oil and gas) in 2011[7] or almost 20% of agricultural GNP. In constant prices, the fisheries sector growth since 2004 has been consistently 2% higher than that of the agricultural sector.

Past pro-growth sector policies particularly benefited from the (declining) availability of under-exploited marine resources inside and outside the EEZ, from the mostly free access to these resources, from newly developed or improved technologies (seaweed, marine cage culture, shrimp, tilapia), abundant areas for fish culture expansion and the availability of cheap labor and land/water. Investment in the sector—notably for supporting infrastructure—has been mostly public and well below what would be expected to maintain growth.

Coastal, traditional fisheries have historically been an 'unemployment sink'; many of the 6.21 million full- and part-time fisherman and fish culturists originate from agriculture.

The volume and value of Indonesia's fish exports show substantial differences between local and international statistics. Local statistics[8] suggest exports, excluding seaweed, totaled about 1 million tons in 2009, and did not change much since 2004 (0.9 million tons) while seaweed exports (reported separately) reflected the explosive production growth. Total export value increased by 8% annually to US$ 3.2 billion in 2009. Exports (mostly tuna, shrimp and crab) increasingly targeted new markets (China, the Middle East) in addition to traditional ones: Japan, EU and the USA.

Between 2004 and 2009 fish imports (notably fishmeal and frozen fish) expanded 21% annually in terms of volume (0.33 million tons in 2009) and 18% in value to US$ 300 million in 2009.

Future domestic demand for fish may almost double by 2040. As marine fish production has mostly reached sustainability limits, local aquaculture production growth of food-fish will be the key source of future incremental supply to satisfy demand. The national average protein consumption from fish well exceeded the combined protein consumption from beef, chicken and eggs in 2011.[9] National Socio-economic Survey (Susenas) estimates that consumers in Indonesia in 2011 annually individually consumed an average of 21.5 kg of fish. Since 2002 (16.3 kg) fish consumption increased by 3%/year.

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7 Sources: Indonesian Fisheries Yearbook 2011; Ministry of Marine Affairs and Fisheries, and Japan International Cooperation Agency, Jakarta 2011. MMAF; Capaian Dan Target Indikator Kinerja KKP Tahun 2010–2012. Ministry of Marine Affairs and Fisheries, Jakarta 2012.

8 Indonesian Fisheries Yearbook 2011; Ministry of Marine Affairs and Fisheries, and Japan International Cooperation Agency, Jakarta, 2011. By comparison, FAO (Fisheries and Aquculture Statistics, FAO, Rome 2009) reports Indonesia exporting fish and fish products worth US$ 2.247 billion and importing US$ 229 million in 2009.

9 Buro Pusat Statistik (Central Bureau of Statistics, BPS): Konsumsi Kalori dan Protein Penduduk Indonesia dan Provinsi, book 2, 2011; table 3.2.

Table 3.21: Annual fish consumption (2010)

	Consumption of fish: (Kg/head/year) (a)	National annual consumption (Million tons) (a) * 245 million (b)	Total national fish production less seaweed and net trade (Million tons) (c)	Total loss between production and consumption (c) – (b)/(c)*100 (d)
Susenas 2010 Survey	21.5	5.3	7.7	31%

Source: Centennial Group estimates.

Table 3.22: Annual fish consumption of urban and rural consumers by monthly income group ('000Rp) in kg/head/year (2011)

Income	>100	100–149	150–199	200–299	300–499	500–749	750–999	>1000	Average
Urban	-	6.7	9.8	13.2	18.3	22.0	26.1	27.3	20.6
Rural	7.1	12.1	13.5	17.5	22.9	28.3	33.6	37.3	22.5
Average	7.1	11.1	12.5	16.0	20.7	25.1	28.7	29.3	21.5

Source: BPS, Konsumsi Kalori dan Protein Penduduk Indonesia dan Provinsi, book 2, 2011.

availability of cheap labor and land/water. Investment in the sector—notably for supporting infrastructure—has been mostly public and well below what would be expected to maintain growth.

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The national average protein consumption from fish well exceeded the combined protein consumption from beef, chicken and eggs in 2011.[11] National Socio-economic Survey (Susenas) estimates that consumers in Indonesia in 2011 annually individually consumed an average of 21.5 kg

10 Indonesian Fisheries Yearbook 2011; Ministry of Marine Affairs and Fisheries, and Japan International Cooperation Agency, Jakarta, 2011. By comparison, FAO (Fisheries and Aquculture Statistics, FAO, Rome 2009) reports Indonesia exporting fish and fish products worth US$ 2.247 billion and importing US$ 229 million in 2009.

11 Buro Pusat Statistik (Central Bureau of Statistics, BPS): Konsumsi Kalori dan Protein Penduduk Indonesia dan Provinsi, book 2, 2011; table 3.2.

TABLE 3.23: PROJECTED DEMAND FOR FISH PRODUCTS IN INDONESIA (2010–2040)

	Consumption per capita 2010 (Kg/year)	Projected consumption per capita in 2040 (Kg/year)	Consumption per capita growth (2010–2040) (%)	Assumed losses between production and consumption (%)	Projected production required to satisfy demand (Million tons)
Low value food fish	12.5	15.5	24	25	6.7
High value finfish	7.3	13.1	80	20	5.4
Mollusks	0.1	0.2	100	15	0.1
Crustaceans	1.6	2.7	69	40	1.3
Total	21.5	31.5	47		13.5

Source: Centennial Group estimates

of fish. Since 2002 (16.3 kg) fish consumption increased by 3%/year.

The single heading 'fish' does no justice to the variety and complexity of fish consumption of dozens of fish products; Consumers currently annually eat an average of 4 kg in rural areas around Yogyakarta and 53kg in the Riau Archipelago. Consumption levels in Java, with over 60% of all consumers, are a third below average, notably in the cities. Since 1999 the percentage of monthly average per capita expenditure for fish declined from 5.6% to 4.3% in 2009; the poor (those earning less than $1.25/day) spend about 7.5%.[12] Producer prices for fish (2011 = 140, 2007 = 100) increased slightly faster than the general Consumer Price Index (2011 = 130, 2007 = 100). Fish consumption still does increase substantially with wealth.

As future population growth will be largely concentrated in urban areas, and average income growth in real terms will remain moderate, two conclusions can be drawn. Fish consumption growth over time will decline in relative terms—urban consumers eat less fish, have access to more alternative foods, while demand for higher value fish will relatively increase. In terms of future national food security policies, production location, growth and distribution may be seen as critical, linked, parameters.Public policies should not only focus on growth but also on fish distribution, notably on availability of low priced fish. Policies defining the future location of incremental fish production and fish imports and related logistics requirements should in part be driven by national and regional nutrition policies.

In terms of future consumption projections this report assumes total demand in volume terms will plateau, but not before 2040. Indonesia will still have quite a few poor people by 2040, and while the middle and upper income consumers may well limit the growth of the physical consumption of fish, the less affluent may still wish to consume more; particularly in rural areas with lower income growth, demand for fish is likely to remain strong.[13]

Compared to current production levels of food fish (7.7 million tons in 2010), domestic demand may about double by 2040. Aquaculture food fish production, currently about 1.7 million tons, would need to more than triple by 2040 to satisfy projected domestic demand assuming no changes in external trade, prices and consumption preferences.

Fish trade will assist mitigating short-term demand and supply imbalances of food-fish; its long-term structural role will depend on the competitiveness of the Indonesian industry and international fish prices. The volume and value of Indonesia's fish exports are modest compared to local

12 David A. Raizer et al; Prioritzing the agricultural research agenda for South-East Asia; refocusing the research agenda to benefit the poor; Global Conference on Agricultural Research and Development (APAARI, AsDB, GFAR); 2010.

13 In China in the period 1973–97 consumption/capita of low-value fish increased very rapidly until it reached about 15 kg, after which growth slowed considerably. In SE Asia the 15kg level of consumption was already reached a decade earlier, and per capita consumption growth has been quite modest since then, despite relatively high-income growth levels. For high-value fish China showed consumption/capita growth of about 9% annually during an era that constraints on fish supplies were limited.

production. Indonesia's current trade tariffs are relatively benign, reflecting ASEAN efforts to reduce regional trade impediments. The country may consider (temporary) reducing existing constraints on 'low value' imports as part of its food safety policy, while in the short- to medium term it may issue temporary volume limits on exports of fish products that appeal to low- and middle-income consumers in situations where China and other countries in the region suffer major declines in production. Given its exposure to developments in the region, an active fish products trade policy—within the limits of ASEAN and WTO agreements—will remain necessary as part of food security strategies.

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The complex domestic logistic network of traders, processors and retailers mostly comprise small- or medium-sized enterprises; employment in processing, trade and sector services is substantial (0.85 million in 2009). A few companies are large, such as vertically integrated shrimp farms. In fish production, culture, processing and marketing, size matters, notably when firms operate in highly competitive foreign markets (shrimp, tuna), when activities require cutting edge research (shrimp) or involve substantial operational risks, or when solutions are needed for ingrained logistical issues. Small-scale, traditional, extensive fish culture does flourish near consumption centers, but farmers often have difficulty satisfying stringent sanitary and quality standards.

Efforts are being made to link active interested buyers with small-holders; the DG of Fisheries Product Processing and Marketing (FPPM) has linked buyers to centers of small-scale production for a range of higher value products under its Fisheries One Village One Product Project, applying a cluster-based approach. A healthy mix of larger and small scale enterprises involved in fish catching, aquaculture and trade will be critical for sustainable production growth.

Indonesia's ability to satisfy demand for fish will above all depend on its ability to transform the current administrative sector control into active resources and sector management, in which the public and private sectors cooperate more closely. Indonesia's sector policies have historically focused on development, less on management. During the 1970s and 1980s strong centralist and statist development policies maintained the principle of open access to the marine resources. Starting in 1998, policy switched from a top-down to a bottom-up approach, as part of a broader process of devolution, giving much wider powers to local administrations and created administrative competition and overlap. The current multi-layered structure is unable to match financial and human resources with obligations that have been devolved. Most important, the culture of sector administration didn't transform into a focus on effective sector management.

Following the Presidential Degree no 5 and as part of the long-term Masterplan Percepatan dan Perluasan Pembangunan Ekonomi Indonesia 2011–2025: MP3EI, adopted in May 201114, Indonesia adopted a National Medium Term Development Plan. Its four pillar development strategy—pro growth, pro-job, pro-poor and pro-environment—focuses on infrastructure spending to increase economic growth, fiscal incentives to encourage export industries, social

14 MP3EI particularly targets fisheries development in two of the six ' economic corridors': Sulawesi and Maluku/Papua. It also suggests regional coordination in such areas as research, processing and logistics, which may particularly affect cooperation with Philippines in aquaculture research, tuna processing and fish logistics.

programs—which includes specific improvement of fishermen's livelihoods—and on enhancing mitigation against climate change. The relative importance of public investment in the sector reflects the precedent of multiple five-year plans. Compared to current and future requirements, public—and private—investment levels have been modest in the past compared to future, long-term requirements to develop a sustainable and competitive industry. In the future, the level and focus of public and private investments—at all levels, including logistics, infrastructure and supporting services—will need balance towards the private sector, and increase substantially compared to historic levels.

The prevailing developmental role of the public sector compared to the relatively limited private sector investment levels is partly the result of the nature of the fish resources, the small-scale character of most fisheries related activities, and partly of the private sector perception of the poor investment climate for the sector. High bank loan interest rates (between 12 and 13.5%, almost double those in neighboring countries) counterproductive employment policies, uncertain multiple layer public licensing practices, and the impact of devolution—creating additional layers of regulation, bureaucracy, multiple levels of taxes and fees, and corruption—are listed by the industry as key factors that constrain operations and limit private sector interest in expanding investment. Uncertain land legislation and title registration affects investment in aquaculture. Administrative deregulation and improvement of the business climate will be critical conditions for further sustainable development of the fisheries sector.

Maintaining marine fish production at current levels will critically depend on more effective resources management. The de-facto free-access principle of past resources management strategies particularly affected the large army of small-scale, traditional fishermen, ever more dependent on declining catches[15] for income and food, while their share of total production has declined over time. Research suggests that on average marine resources are exploited close to their Maximum Sustainable Yield (MSY), estimated at about 6 million ton. However, current catch statistics and survey methods may not capture the true state of stocks, or the requirements of future management. Modest potential may exist to increase production from a few resources, but the size of (assumed) under-exploited small-pelagic resources in Eastern Indonesia is subject to debate. Tuna resources in the Indian and Pacific Oceans are mostly moderately exploited, but ongoing efforts to control exploitation by Regional Fisheries Management Organizations (RFMOs) responsible for these oceans and major competition for access to the resources from other countries are likely to limit unrestricted future access[16]. Over the next three decades, no substantial expansion of total marine fish production can be reasonably expected; production in selected over-exploited areas may well decline. Sustainable exploitation of all marine resources in Indonesia will require adjustment of fishing effort towards balanced harvesting—distributing moderate fishing efforts more evenly across species—and to increase catches per unit effort to enhance the financial viability of fishing operations.

Decentralization currently severely constrains critical research and private sector inputs being effectively integrated into sensible resource management decisions. A number of pilot projects demonstrated that community-based approaches can be established in coastal resource management, but the record is far from conclusive. The chances of community management succeeding may be highest if they are part of a broader program covering contiguous areas, focus on resource rich areas that are not severely over-exploited and satisfy critical requirements of political support, leadership, funding, technical support and services, adequate infrastructure and potential for alternative livelihoods. Unfortunately, few areas in Indonesia currently satisfy all those criteria. The record of Japan and of Philippines suggests optimism about the feasibility of rapid introduction of such systems nationwide is misplaced.

15 About 2.6 million fishermen engage in marine fisheries of which 40% operate full time, located in over six thousand coastal villages located along a 95 000 km long coast line bordering about 500 districts.

16 Long-term access to these tuna resources will require political coordination between the public and private sectors, whereby Indonesia may obtain additional resource access in exchange for supporting local Pacific or Indian Ocean Island fisheries and improved local and regional participation of these Island countries in the value chain. Indonesia may also benefit from closer regional coordination with Philippines in international tuna matters.

Under the current regulatory structure District/Municipal, Province and central government resources management responsibilities are linked to vessel size and area, but have no relationship to migrating fish resources and related complex multiple fisheries. An alternative strategy would give priority to effectively regulating industrial and commercial fisheries, which currently catch about 50–60% of the marine fish production. Under this strategy currently planned efforts to expand fish culture and other alternative income generating activities at the district and municipal level should remain priority activities. Since adjustment of the current devolution principles appears politically unlikely, an institutional solution is required within the current legal framework to adjust the resources management paradigm. Rather than maintaining the separation of the responsibilities of Ministry of Marine Affairs and Fisheries (MMAF), the provinces and municipalities/districts, the future management framework could aim to combine their prerogatives into a single process in each of the eleven marine zones already defined for research purposes. Such regional approach would: (i) give priority to better controlling—and selectively reducing—industrial and commercial fishing, while (ii) expanding research and monitoring, control and surveillance coverage and effectiveness, (iii) restructuring the institutional framework for fisheries management, and (iv) addressing the issue of managing traditional fishing and coastal fish resources initially mainly through indirect means. While such strategy would not be without risks—effective implementation would require substantial political commitment—it would create the institutional framework and build capacity to manage and control all fisheries before it tackles the most difficult part—actively managing coastal small-scale fisheries.

Maintaining sustained high growth of food-fish aquaculture production—projected by the Government to be concentrated in Eastern Indonesia—will require a multitude of 'internal' structural adjustments, focusing on research, extension, logistics, quality control, fish-health and investment. MMAF estimated in 2005 that the country has substantial marine areas where fish culture and seaweed potentially can be expanded. The brackish water culture area could also be increased (by 80%) but such expansion could raise environmental risks (mangrove destruction, coastal erosion, and further loss of coastal environment for fish spawning). A 1997 assessment suggested the area of freshwater ponds could potentially be doubled, while the area of open inland waters and rice fields that could be used for fish-culture could increase manifold. However, no detailed recent assessments have been made of the technical feasibility, required public and private investment levels and potential risks—climate change, disease, markets, logistics and competitiveness—of developing these areas, or the ability and willingness of the private sector to invest in such expansion.

From a nutrition point of view future low-value fish production may lag. The projected production growth to satisfy long-term demand infers that aquaculture will be able to produce low value products that would augment marine fish supplies in local markets, notably in the main market: Java. Past aquaculture growth was particularly driven by the expansion of seaweed culture and high-value fish, enjoying strong local and foreign demand; current farmer incentives still encourage investment in high priced products. Demand from developed markets and possibly China will cause global prices to continue to increase compared to other sources of protein and Indonesia may benefit from such demand if it can improve local competitiveness. This focus on high priced products may however limit investment in the production of cheaper products for the local market, mainly Java, and may impair another public objective: long-term future domestic demand for fish being satisfied mainly from domestic resources. This in turn will increase domestic fish prices for cheaper fish and encourage imports of cheaper fish. Indonesia does have the potential to substantially increase future production of cultured fish and seaweed, but if current investment incentives prevail it may not be able to satisfy domestic demand for low value products in the more distant future.

To ensure future productivity growth, many aspects of the aquaculture value chains need to be strengthened. Aquaculture requires drivers to ensure effective research, technology transfer and capacity building. It also requires a complex combination of human and institutional resource

capacity building to satisfy specific technical disciplines and services. It requires a coherent set of policies and regulations, an efficient transport network, a functioning land market, improved water management and effective downstream distribution and marketing. It also requires effective spatial planning, an allocation process to locate viable areas for expansion or define where restructuring of production is necessary. Integration of these multiple requirements into a coherent development strategy is the most critical requirement facing the sector, and failure to satisfy these requirements may impair sustained production growth.

To maintain high aquaculture production growth, research budgets and the research agenda will require substantial expansion. For critical research subjects listed below truly international rather than predominantly national networks should be organized and maintained. Exceptional and wide-ranging research will be critical to maintain future aquaculture production growth.

1. Brood stock quality. Maintaining high quality brood stock and ensuring effective hatchery operations will require sustained back-up research, training, experimentation and investment, both public and private. Maintaining high quality hatchery products and the genetic integrity of wild stocks from the impact of artificial propagation and genetic manipulation will be essential. National strategies to deal with these risks remain to be fully implemented.

2. Disease control remains only partly effective and satisfactory solutions—in the region and globally—for existing and newly emerging diseases need to be vigorously pursued. Several universities and institutes have programs dealing with fish diseases; better coordination of these programs within a national and international research strategy will be necessary.

3. Many cultured species require specialized high-protein feeds; currently available feeds are critically dependent on (mostly imported) fishmeal and oil. Global demand for fishmeal has substantially increased over the past 15 years while fish resources supplying meal[17] are limited and mostly fully exploited. Substitutes exist, but the cost of production and extraction remain high. Development of alternatives to fishmeal and oil and production of herbivores or filter feeders to reduce future demand for high protein feeds will be critical, and may be best pursued through regionally and internationally coordinated research.

Multiple extension efforts will be required. Extension has been a factor in transforming aquaculture from a subsistence food system to an important sub-sector. Improved hatchery technology, genetic manipulation, feed improvements and disease control also played a positive role, but their impact could have been higher. Indonesia requires markets, education systems and extension services particularly tailored to highly disperse small-holder activities. Large operators have access to international research and technology developments—small operators don't. Devolution has reduced the effectiveness of traditional aquaculture extension activities. Alternative systems have been successfully tested (UPT's, nucleus estate, activities by Universities) but these separate activities may not satisfy all local conditions and requirements. Alternative approaches tried in the SE Asia region (pooling of resources, public private partnerships, private extension services linked to feed providers, One-stop service centers, and producer associations) all have strengths and weaknesses. Indonesia needs an effective aquaculture extension function; testing various approaches and selecting the most effective (combination) will be essential for future production growth and farmer income.

Success in satisfying long-term local demand for fish will depend in part on 'external' parameters such as China's ability to maintain high fish production growth. Global fish production growth during the past 20 years has been largely generated by China; it produces almost 70% of global aquaculture production and an increasing share of the marine catch. The impact on world market prices and fish trade would be major if China's production growth was to sub-

17 About 22–26 million tons globally + 5–7 million tons of fish processing waste), producing about 6–7 million tons of fishmeal and 1 million tons of fish oil.

stantially decline or increase compared to currently projected levels. Fundamentally, the fish consumption fate of the countries in the region is directly linked to their joint ability to develop and maintain an efficient and highly productive aquaculture sector, and jointly and individually solve critical technological, disease, feed, environmental, institutional, regulatory and logistical issues. While China may be able to continue to import fish from across the globe to satisfy gaps in local demand, Indonesia may have greater difficulty pursuing the same strategy facing a combination of limited local appeal of imported fish and having few industrial groups operating globally catching fish, while current import restrictions also limit the appeal of imports. The ability to pay higher prices for fish will increasingly determine global trade flows and global demand. For lower-income countries like Indonesia this implies limits on their long-term access to external supplies of cheap fish.

Regional diversification of aquaculture production towards species less prone to disease. Intensive aquaculture already had its share of national or global pandemics—shrimp, salmon, carp—and the risk of a new disease seriously affecting a globally important fish is not negligible. That may affect global fish supplies and prices, but may also affect Indonesian production. While it may be impossible to eliminate this risk, the country can reduce it by diversification, having a strict regulatory framework and quality controls, top-level researchers, and effective extension services.

Effective management of global resources of small-pelagic species. Like the rest of the world, Indonesia will need to depend on global markets to satisfy large gaps between demand and local supply of fish, or absorb price hikes for (imported) fish and alternative products. Markets for high-value species are well developed globally and fish imports in Indonesia may only be constrained on account of prices and consumer preferences. Dependence on imports of cheap fish in the future will be riskier. At present sufficient supplies of 'small-pelagic' fishes are available in global markets. However, future demand for these fish may increase substantially, notably in Africa and Asia, while sustainable production is not unlimited. Supplies of cheaper fish species may cost much more in the longer-term future; this may limit the effectiveness of fish imports as a tool to control domestic fish prices for poorer segments of the population or to substitute imports for slower than expected aquaculture production growth.

The likely impact of the projected effects of climate change will probably be manageable. Climate change may create four threats: a temperature and precipitation increase, a sea level rise, and an increase in frequency of extreme events. The impact of these threats on fisheries activities by 2040 is likely to be moderate to modest. Temperature increases may affect spawning and migration of wild stocks, but the impact on Indonesian resources remains to be clarified; severely over-exploited fish resources may run the highest risks of being affected by 2040. Aquaculture has several means to easily mitigate high temperatures—deepening of ponds, higher water exchange rates etc. Similarly higher levels of precipitation may affect spawning and migration of wild stocks—again the impact is likely to be modest, and marine systems under stress may run the highest risks. Low intensity aquaculture may also be affected, as infrastructure may be unable to cope, but is unlikely to affect other production except through flooding. Careful site selection of aquaculture operations can minimize such risks. Sea level rises may still be moderate by 2040 and would mostly affect brackish

TABLE 3.24: AVERAGE CONSUMER PRICES (USD/KG) FOR BEEF AND POULTRY AND PRICE RATIO

	2005	2006	2007	2008	2009	2010	2011	2012*
Beef	4.85	5.42	5.47	5.79	5.89	6.92	7.58	7.53
Poultry	1.38	1.59	2.51	2.75	2.94	3.06	3.3	3.28
Ratio B/P	3.51	3.41	2.17	2.1	2	2.26	2.3	2.3

Source: CBS (Central Agency for Statistic of Indonesia) Monthly Socio-Economic Data of Indonesia 2007–2012; Data Base—Ministry of Agriculture of Indonesia. Prices in USD, converted with average exchange rate for the year
*Average of the first four months of 2012.

water ponds in coastal areas. In selected areas the impact may well be mitigated by restoration of mangrove forests, which can trap silt and 'grow with the rise'. If such option is not available, man-made structures may protect low-lying ponds. In selected areas mitigation costs may become too high, and ponds may be abandoned.

The threat of extreme climatic events is probably the most pressing, as it could affect large coastal areas used for marine culture of fish and sea-weeds. While submerged line cultures for seaweed and mussels may be less prone to storm damage, floating cages are. In sea areas with limited natural protection from waves and currents these may particularly be prone to losses, leading to the escape of the crop. While technical solutions exist to limit storm damage—submerged cages, heavier anchors etc—the costs are high, and may not yet be feasible for most current culture practices and intensities. Site selection will be the critical variable determining future losses of cage culture due to extreme climatic events.

Livestock

Introduction

A comprehensive review of Indonesia's livestock sector is presented in Annex; only highlights are provided in this section of the report. Historically livestock played a minor role in the agricultural production systems of Indonesia, where plantation crops and rice were the mainstay. Water buffalo and cattle were and still are used for animal traction. Traditionally all species play important roles in religious and socio-cultural events, such as Madura cow races, pigs in social exchanges in Papua and chicken in ceremonies.

The green revolution of the seventies had a major impact on rice, wheat and maize production but bypassed the livestock sector. The current much heralded livestock revolution, largely driven from the demand side with population growth, urbanization and increasing affluence as the major drivers, caused a strong demand for and price increase of most products of animal origin. Table 1 gives an overview of the price developments for beef and poultry. The effect of the increase in grain prices can be seen in the narrowing price ratio between beef, largely fed on roughage, and poultry, fed on grain. The producer price increases formed a strong incentive to increase livestock production by those who had the means to do so.

It is however questionable whether in a traditional livestock production system as found in Indonesia, in which livestock played many roles not directly of a commercial nature and with the availability of land as a limiting factor, smallholders were/ are and will be capable and able to take advantage of this market driven opportunity to expand their livestock business without outside support. It seems that corporate agriculture did make good use of this opportunity, explaining the exponential growth of the highly industrialized poultry sector with vast investments in feed milling, breeding farms, hatcheries and grower and layer facilities. Also the beef feed-lotting industry largely based on imported weaners is an example of a production system originating from corporate investments, not from expanding smallholders. Besides the dairy small-holder farms linked to a milk processing company there have been several recent developments of large-scale dairy farms, where thousands of cows produce a quality controlled and guaranteed range of dairy products for export and the high-end supermarket trade.

The above-mentioned developments have led to the existence of three distinct modes of livestock production in all species in the country:

1. Corporate vertically integrated production system: by making use of own production facilities or contracting and controlling third party production facilities, these units produce, process and market the produce, often through modern retail outlets such as supermarkets and through the fast food and restaurant industry

2. Commercial production systems: largely making use of similar genetic resources, feed and methods as the first group, some working as outgrowers for the first group, others remaining independent in their marketing, usually preferring to work through middlemen and wet markets

Table 3.25: Per Capita Livestock Products Consumption (Kilograms)

	2009
Beef	1.18
Buffalo	0.09
Goat	0.15
Mutton	0.12
Pork	0.55
Chicken	2.97
Other poultry	0.08
Other meat	1.33
Eggs	5.61
Local dairy products	2.50
Imported dairy products	7.03
Total dairy products	9.53

Source: Directorate General of Livestock Services

Table 3.26: Livestock Production 1983–2009 ('000 tons)

	1983	1990	2000	2009
Cattle meet	208.77	258.51	339.94	408.36
Sheep Meat	22.31	31.55	33.38	53.80
Goat Meat	66.22	57.46	44.89	72.57
Buffaloes Meat	44.27	43.97	45.83	33.71

Source: Ministry of Agriculture

Table 3.27: Chickens Imports

	Quantity (heads)	Value (USD)
1980	2,864,000	2,622,000
1990	7,126,000	426,000
2000	10,185,000	1,959,000
2009	253,000	93,000

Source: FAOSTAT

3. Family farming/traditional production systems: within a family household livestock production is in symbiosis with the family's crop production and serves in the first place the family needs followed by sale of surplus on local markets or to middlemen.

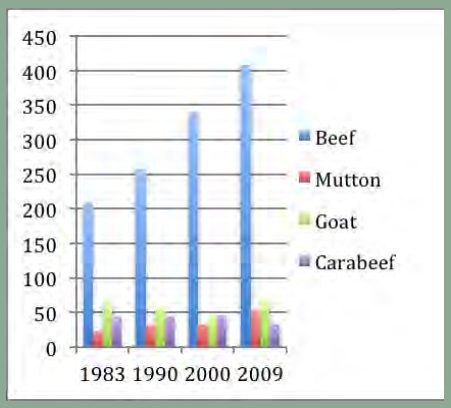
Over the last 20 years the contribution of corporate farming towards aggregate production has steadily increased to the point where currently some 80% of urban poultry consumption is now derived from corporate farming. Feed lotting in the beef sector has not reached a similar level throughout the country except for the main population centers due to the fact that it is difficult to link the traditional cattle keeping areas with the end markets, which can be readily served from the feed lots or imported beef. If small-holders can participate in this development it will assist them to escape the poverty trap, but this would require a radical change in their livestock production system from subsistence to commercial, for which they would have to gain access to more land and finance and to be incorporated in a value chain system that would guarantee the right veterinary and extension services, quality assured inputs and a fair marketing of their produce. Value-chain financing is a powerful credit tool to link producers to suppliers of inputs and the processing industry. In many countries with commercial broiler production, financing of day old chicks and feed is done through the integrator, who takes responsibility for slaughter, processing and marketing and in this way is guaranteed repayment of the value chain credit, usually in kind. Such schemes could be powerful instruments to modernize the kampong (village) poultry production systems, both for eggs and broiler production. In the following sections a picture of current status and expected developments for poultry, piggery, dairy and beef cattle farming will be given.

Consumption pattern

The overall meat consumption in Indonesia is still extremely low in comparison with neighboring countries. The following table gives an overview of the consumption of products of animal origin in 2009.

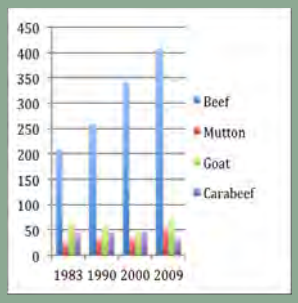
From this table it can be seen that poultry with meat and eggs are and will remain the most important source of animal protein for Indonesian consumers. Dairy consumption has grown and local production can cover only a fraction of the overall consumption so that import is necessary. While with poultry it is possible to increase the local production through the import of feed, this is far more difficult in the

Figure 3.1: Livestock meat production (1000 ton)



Source: Ministry of Agriculture

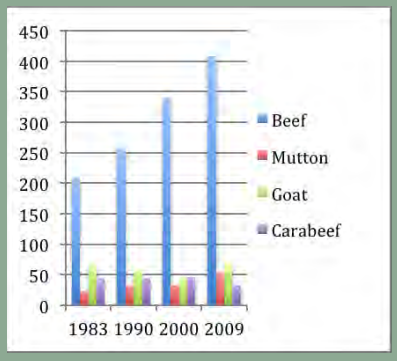
Figure 3.2: Broiler Meat Production (1000 ton)



Source: Ministry of Agriculture

case of cattle as more land is required. The current practice of importing feeder cattle from Australia for feedlotting on mainly locally available byproducts and maize seems a sensible compromise to increase local beef production without having to maintain additional breeding cows that require scarce grazing land. , which is scarce. Milk production is best done near the areas of consumption, especially when the market exists for fresh dairy products. Besides smallholder schemes actively supported by the various dairy plants there is an increasing number of large-scale dairy enterprises, corporate owned, which besides the urban market target lucrative export markets, such as Singapore.

Figure 3.3: Number of imported broilers



Source: FAOSTAT

Production

Annual livestock production levels are presented in Figure 3.1. It shows a nearly doubling in the production of cattle meat, a more than doubling in sheep meat (albeit much of the increase occurring in the past ten years), little change in the production of goat meat, and an actual decline in the production of buffaloes meat.

Figure 3.2 gives an overview of the rapid increase in broiler production, especially during the last 10 years.

This increase in domestic broiler production has led to a rapid decline in the number of imported chicken, which in light of the increased consumption attest to the rapid expansion of domestic production.

Outstanding Issues

Strategic decisions for livestock development

Indonesia has had three policy initiatives for beef self-sufficiency of up to 90% in 2005, 2010 and the current policy which is in effect until 2014. The government will have to make critical decisions whether self sufficiency in beef, poultry meat, pork and dairy can and should be achieved; in the process the costs of such choices should be measured against the benefits and the opportunity costs of alternative land use of lands dedicated to achieve the self-sufficiency

policy. The drastic reduction of maize production in Lampung over the last years from 3 million to 0.5 million tons, whereby the freed land is now under cassava proves the point that if import is cheaper than local production it is better to import and go for the alternative crop giving higher returns. The current strategy in the poultry sector of reduction in the cost of and increasing the scale of production will work as long as there is a demand for the product and not an alternative cheaper supply. It is therefore important to monitor production, consumption and prices in neighboring countries to be prepared for the moment that the increased production will no longer be "absorbed" by the local market. For this type of analysis, prediction and action it will be important to have close public-private collaboration, which is developing in Indonesia between the Ministry of Agriculture and the various sector organizations.

Future of the small-holder sector

With the drives to reduce cost of production and increase the scale of production in especially the poultry and pig sectors it will be increasingly difficult for smallholders to remain competitive on the market for conventional products. The capital needed to keep up with the required technology goes beyond the smallholders' capacity. It is therefore important to further develop and strengthen the niche markets for specialty poultry and pork products. The kampong chicken holder organizations will increase their chick production and will have to get involved in the organization of processing and marketing of the birds. The non-chicken poultry can provide other niche market products. In the case of ruminants the expansion of smallholder cattle keeping would depend upon increased availability of land and credit. It is probably more realistic to increase the smallholders' role and participation in the goat and sheep value chains. Goat milk production in particular fits better in the smallholder farming system than dairy cattle: it requires less capital, space, fodder and feed. Smallholders will have to work together to create collective economies of scale. The KUDs in the current form are no longer able to respond effectively to today's requirements of farmers.

Animal health and food safety

It is internationally accepted that veterinary services should have a single line of command from the Chief Veterinary Officer to the field veterinarians. Veterinary services are not only responsible to keep animals healthy, but also to prevent animals from infecting people with zoonoses. Only under such a structure could the Veterinary Services correspond to "the competent authority" as described in OIE's terrestrial animal health manual. In Indonesia the Veterinary Service is a department of the Livestock Production Services, with a director under the Director General of the Livestock Production Services. This position makes it difficult for the head of the Veterinary Service to interact with the Director General of Health. The decentralization has jeopardized the effective response to animal disease threats, the quality of vaccines has been compromised as the purchase changed from Western companies providing all guarantees to Chinese and Indian manufacturers because they are cheaper. The badly needed centralized system of decision-making and control in veterinary affairs has been broken. The right balance between centralized and decentralized system has to be determined. Only with a veterinary service with standard operational procedures and having one line of command can a country effectively and efficiently respond to animal disease outbreaks or threats.

The veterinary service will have to develop its capacity to address and respond to food safety issues related to products of animal origin. Especially with the ever-increasing role of corporations and the larger share of processed products this role is of great importance. Although big corporations maintain that they can work under a self-control system to assure food safety (HACCP) as well as controlling the health status of their animals, international experience shows that there is still a need for external control. The OIE through its PVS and GAP analysis and investment plan tools can assist member states in assessing and reorganizing their veterinary services.

Environment and animal welfare

With the increase in livestock production not being land-linked, the issue of responsibly storing for recycling or disposing of manure and other wastes (e.g. from slaughter houses) becomes an issue. The ban of no live birds in urban areas will have to be reinforced to make sure that birds will be slaughtered in future in poultry slaughterhouses under veterinary supervision and with appropriate systems for the disposal of offal.

Large-scale livestock farming enterprises in particular will have to make provisions for the handling of manure. Biogas production is one step to convert potentially very harmful GHG Methane into less harmful Carbondioxide. When manure becomes a tradable commodity from livestock farmers to (tree) crop farmers there is less risk for pollution of soil and/or water.

Animal welfare issues brought major quarrels to the beef cattle sector in 2011. This incident should be used as a driver to improve the situation. Within the livestock research institutions it is important for people to follow developments in Europe and America in the field of animal welfare and pick out what is applicable in Indonesia to avoid a growing gap in welfare standards. It is likely that more poultry meat will be exported from Asia to Europe in direct competition with the Americas. For this to happen (Thailand is currently already exporting both processed and fresh product), both animal welfare and environmental protection systems will have to be in place, applied and audited.

Chapter 4. Key Issues in the Agricultural Sector

Link between Agriculture and Poverty

Despite agriculture's declining role in the aggregate Indonesian economy, it is still the primary sector to look to in terms of the locus of poverty, and paths to poverty alleviation. This is made clear by an important recent (February 2012) paper by Roland Rajah and Neil McCulloch, "Agricultural Growth and Poverty Reduction in Indonesia—a synthesis of Recent Evidence". The first point to note from the paper is the long gradual decline of poverty incidence from about 40% in 1976 to about 12.5% today, with a severe relapse following the international financial crisis of 1997–98. The impact of the crisis on poverty was quite overwhelming. From an estimated headcount of the poor of 22.5 million (11.3% of the population) in 1996, the number ballooned to 49.5 million or 24.7% of the population in 1998.[1] A large share of the weight of labor absorption fell on the agricultural sector, not just immediately but for years to come. "In absolute terms, the number of poor employed in the industrial sector decreased drastically from 5.4 million in 2000 to 2.0 million in 2004…the industrial sector suffered paralysis leading to severe inability to absorb laborers (especially unskilled laborers)."[2]

It has required most of the years since 2004 for the various sectors (agriculture, industry, services) to regain the lower levels of poverty achieved before the crisis. Before that crisis, most of the progress in poverty alleviation was on Java. After the crisis, it has been on the Outer Islands, where there were both higher initial rates of poverty and faster agricultural growth.

Poverty in Indonesia is still a predominantly rural and agricultural phenomenon, and Rajah and McCulloch note that it shows very stable traits. In 1984, 84% of the poor were in rural areas; 18 years later this measure was 83%. In 1984, 86% of the poor worked in agriculture. In 2002 this was 68%. In 2010 this same measure was 64%. Of course this measure was higher among those living in rural areas—75%. The surprising point is that 36% of poor urban workers also primarily work in agriculture—the largest single employment category among the urban poor.

While agriculture is most important among varied income sources for the poorer it is a significant source of income for as much as 80% of all Indonesians, as per chart 4.1.

There are strong regional dimensions to the links between agriculture and poverty, and one of the big motivators here after the financial crisis has been the tree crop expansion in the Outer Islands. In the decade between 1993 and 2002, the major change nationally in sources of rural household income was an increase in income from estate crops (often purely in smallholder hands) from 6.8% to 11.5% of total rural household income. A 2005 study of Central Sulawesi indicated that agriculture provided 89% of income for poor households, as against 69% for all rural households. (Based on data presented elsewhere in this study, probably much of the agricultural growth in this province was due to smallholder cocoa planting). Kalimantan, home to much oil palm

Table 4.1: Income and Agricultural Dependency

	Income Quintile	Agriculture's Share as % of Household Income
Lowest	1	36.0
	2	28.7
	3	21.8
	4	13.6
Highest	5	4.3

Source: Rajah and Mculloch, op. cit.

1 Rusastra, I. Wayan et al, Food Security and Poverty in the Era of Decentralization in Indonesia, U.N. ESCAP, Bogor, 2008, pg. 84
2 op. cit., pg. 88

Table 4.2: Annual Percentage Growth in the Quantity of Agricultural Production 1999–2005

	Food crops	Horticulture	Estate crops	Livestock	Fish
Java	0.3	11.3	3.5	5.8	5.0
Sulawesi	0.8	15.2	9.0	1.6	6.3
Sumatra	0.6	13.7	6.5	3.9	7.1
Kalimantan	4.3	25.2	13.1	9.4	1.1
E. Indonesia	–0.5	9.6	6.2	6.8	5.6
National	0.5	12.4	7.1	5.4	6.0

Source: Rada & Fuglie (forthcoming)

planting, went from an agricultural growth rate of below 3% in 1985–98, to 7.6% over 1999–2005.

Indeed, as the following table indicates, Kalimantan has led by far Indonesia's major island regions in growth of agricultural production, at least in the 1999–2005 period, in every major category (including food crops) but fisheries. It is tempting to ascribe this purely to an abundance of untapped forest and swamp land to be developed, but Sumatra,

Sulawesi, and Papua in Eastern Indonesia also had abundant unused land. It is thus more likely the combination of that land and competent labor and capital that led to the impressive growth rates. In turn, this growth was associated with Kalimantan's reduction in poverty rates from 20% in 1999 (below the national average but the same as Sumatra's), to about 11% in 2005 and about 7% in 2010, lowest in the country and a little more than half of Sumatra's. In these years, rural poverty on that island declined from 25% in 1999 to 13% in 2005 and 9% in 2010.

Econometric estimates through the year 2002 found a rural poverty elasticity of –0.07, i.e. a 1 percentage increase within a year of agricultural production, results in a 0.07% decrease in the rural poverty rate. This seems rather small but over some years yields substantial reductions in the poverty rate. Later researchers working with later data (1996–2008) find the elasticity to be greater, –0.12. Generally, agriculture growth seemed to statistically explain about half the reduction in rural poverty over 1999–2005, though in absolute terms this was rather small, only about a 2.8 point reduction in the rural poverty rate. Thus the link to poverty alleviation is strong, but the rate is slow. Perhaps three decades of agricultural growth of about 5% per year would be needed to achieve another 10 point reduction in rural poverty, i.e. from about 16% in 2010 to about 6% in 2040, if current relationships continue to hold.

Lumbung Desa

These "revived" institutions are currently serving the dual role of food security and a social safety net. The "Lumbung Desa" or village barns, serve as community food reserve storage. These local institutions have existed for many years and played an important role in addressing food insecurity during periods of food shortages and natural calamities. With the widespread adoption of the Green Revolution technologies and the concomitant decline in food shortages, as well as the reduction in seasonal variability of food prices, the utility of the Lumbung Desa declined. Furthermore, the introduction of BULOG as a national food reserve institution with nationwide responsibility for managing food storage facilities, primarily for rice, has successfully stabilized the domestic price of rice.

Introduction of economic deregulation measures in 1993 restricted BULOG's role to the handling of rice and sugar; following the economic crisis of 1997/1998 and reformation of government, BULOG no longer has a monopoly on the trade in rice and sugar. With the exception of rice, the private sector is now free to import the food commodities needed.

Table 4.3: Newly Constructed Lumbung Desa 2009–2011

Sumatra	280
Java	278
Kalimantan	108
Sulawesi	191
Bali and Nusa Tenggara	137
Maluku and Papua	52

Source: Agency for Food Security Ministry of Agriculture

Following the food crisis of 2007/2008, a new plan was introduced to revitalize the Lumbung Desa as an institution for food security purposes in rural areas. The central government (Ministry of Agriculture), provincial, and district governments are currently providing budgets for construction and operating capital for the Lumbung Desa. Priority is assigned to regions with deficit food production (rice and maize). The central government allocates Rp 30.0 million for construction of each barn and provides an additional Rp 320.0 million per village for purchasing and storing rice that serves as a village food reserve. Storage capacity of the barns ranges from 60 ton–100 ton of rice or maize. In line with traditional practices, villagers are encouraged to donate rice or maize to be stored for emergency purposes. Between 2009 and 2011 a total of 1046 new Lumbung Desa were constructed:

The overall number of these facilities is much higher than the total above because additional ones are being built by local governments and farmers' associations and cooperatives.

The Lumbung Desa are managed and operated by famers' institutions such as Farmers' Associations. Initially the function of the Lumbung Desa was limited to emergency and social purposes with villagers able to borrow rice during shortages or emergency and pay back after the harvest with some interest agreed upon by the members of the association. Once the institutional and management capabilities of the Lumbung Desa have improved, they can transform itself into an economic or business unit of the farmers' institution.

Local governments currently provide facilitators and training to the local managers of the Lumbung Desa that are managed by three persons (a head, a secretary, and a treasurer). The managers are democratically elected by the members of the famers' institution.

Examples of the revival of these institutions can be seen from the case of the province of East Java. By December 2011 about 12 % of the 8,000 villages in the province had a Lumbung Desa and the provincial government plans to continue revitalizing the Lumbung Desa in the remaining villages. Currently the function of the Lumbung Desa is to purchase rice during the harvest season, process the rice and sell it in the market or directly to consumers. The plan is to have about 10 % of the rice production earmarked for emergency and social purposes in each village.

In villages where the Lumbung Desa are already established, villagers participate actively by storing rice or maize after the harvest and borrowing food commodities for home consumption during shortages, especially for low income households. Some high income households are willing to donate food commodities for reserve and social purposes. Therefore the Lumbung Desa is able to play as safety net for food security especially in regions with acute food insecurity. In the longer run it is expected that these local associations will also operate and manage the business activities of the Famers' Association in the respective village.

While food security is the underlying reason for reviving the Lumbung Desa program, the activities are more relevant to a "social safety net" than food security. It would thus be worth considering to integrate these units with the RASKIN (Rice for the Poor) program, since the Lumbung Desa are closely related to the poverty eradication program.

The Evolution of the Indonesian Diet

Official statistics on food consumption in Indonesia are generally treated with much more respect by expert observers than production statistics, simply because of the care and professionalism with which they are collected by SUSENAS, the national social survey, and have been for a long time. In 2011 for the first time the surveys were done quarterly,

Table 4.4: Average Weekly Major Food Consumption of Indonesia 1999-2011

No.	Commodity	Unit	1999	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	In Home Consumption												
1	Rice including rice flour	Kg	1.995	1.937	1.941	1.912	1.862	1.849	1.747	1.799	1.761	1.74	1.728
2	Fresh Maize	Kg	0.014	0.023	0.02	0.026	0.018	0.015	0.046	0.024	0.012	0.018	0.012
3	Dried shelled maize	Kg	0.057	0.054	0.044	0.048	0.047	0.05	0.06	0.044	0.035	0.03	0.023
4	Cassava	Kg	0.187	0.163	0.162	0.169	0.162	0.141	0.134	0.147	0.106	0.097	0.111
5	Sweep Potatoes	Kg	0.054	0.052	0.062	0.102	0.061	0.058	0.046	0.051	0.043	0.044	0.055
6	Fresh Fish and Shrimp	Kg	0.21	0.252	0.281	0.267	0.29	0.266	0.26	0.263	0.249	0.271	0.282
7	Canned Fish and Shrimp	Kg	0.038	0.044	0.048	0.047	0.05	0.052	0.052	0.054	0.046	0.045	0.049
8	Beef And Buffalo Meat	Kg	0.01	0.011	0.012	0.013	0.011	0.007	0.008	0.007	0.006	0.007	0.009
9	Poultry Meat	Kg	0.033	0.063	0.075	0.07	0.077	0.058	0.079	0.073	0.069	0.08	0.083
10	Eggs	Kg	0.06	0.095	0.094	0.1	0.11	0.103	0.122	0.115	0.116	0.2	0.199
11	Condensed Milk	397 gr	0.029	0.044	0.047	0.047	0.048	0.046	0.068	0.061	0.058	0.064	0.063
12	Powder Milk	Kg	0.006	0.014	0.012	0.013	0.018	0.016	0.026	0.025	0.023	0.023	0.04
13	Red Onion (Shallot)	Kg	0.029	0.042	0.043	0.042	0.042	0.04	0.058	0.053	0.048	0.049	0.045
14	Garlic	Kg	0.014	0.021	0.022	0.022	0.023	0.021	0.029	0.033	0.026	0.026	0.026
15	Chillies	Kg	0.021	0.032	0.03	0.031	0.034	0.031	0.057	0.057	0.054	0.054	0.034
16	Tofu	Kg	0.117	0.148	0.143	0.129	0.153	0.138	0.163	0.137	0.135	0.132	0.142
17	Tempeh (Fermented Soybean)	Kg	0.13	0.159	0.158	0.14	0.159	0.167	0.153	0.139	0.135	0.133	0.14
18	Cooking Oil	Litre	0.167	0.197	0.19	0.189	0.196	0.19	0.198	0.196	0.189	0.195	0.195
19	Sugar	Kg	0.159	0.177	0.174	0.153	0.17	0.154	0.047	0.162	0.152	0.148	0.142
20	Brown Sugar	Kg	0.018	0.021	0.019	0.019	0.005	0.005	0.006	0.019	0.015	0.014	0.014
	Out of Home Consumption (Prepared Food)												
21	Rice	Kg	0.257	0.298	0.319	0.329	0.35	0.326	0.37	0.436	0.418	0.412	0.457
22	Fish	Kg	0.005	0.004	0.006	0.005	0.006	0.006	0.006	0.009	0.01	0.01	0.01
23	Beef And Buffalo Meat	Kg	0.003	0.002	0.003	0.005	0.006	0.004	0.007	0.008	0.008	0.008	0.01
24	Poultry Meat	Kg	0.005	0.004	0.003	0.004	0.006	0.003	0.007	0.009	0.008	0.009	0.01
25	Eggs	Kg	0.002	0.002	0.0022	0.002	0.003	0.002	0.003	0.003	0.003	0.003	0.004
	Total Consumption of Major Food Items												
26	Rice	Kg	2.252	2.235	2.26	2.241	2.212	2.175	2.117	2.235	2.179	2.152	2.185
27	Fish	Kg	0.253	0.3	0.335	0.318	0.346	0.324	0.319	0.326	0.305	0.326	0.34
28	Beef and Buffalo Meat	Kg	0.013	0.013	0.015	0.018	0.017	0.011	0.015	0.015	0.014	0.015	0.019
29	Poultry Meat	Kg	0.046	0.076	0.09	0.088	0.094	0.069	0.094	0.088	0.083	0.095	0.102
30	Eggs	Kg	0.062	0.097	0.096	0.102	0.113	0.105	0.125	0.118	0.119	0.203	0.203

Source: National Socio-Economic Survey (SUSENAS) Consumption Module 1999, 2002 and 2005 (SUSENAS data 2003, 2004, 2006, 2007,2008,2009, 2010, and 2011).

Table 4.5: Breakdown of Rice Consumption in Indonesia 2011

Items	Rice Consumption		
	Yearly Per Capita (Kg)	Total Consumption (Ton)	Share (%)
1. Direct Home consumption	90.1	21,659,172.90	79.43
2. Restaurant	0.12	29,073.20	0.11
3. Hotel	0.1	23,118.10	0.09
4. Food Vendors and Small Restaurant	20.51	4,931,114.30	18.08
5. Food Processing Industries	1.02	245,362.30	0.9
6. Other Services	1.58	379,805.60	1.39
Total	113.43	27,267,646.40	100

Sources: 1. Direct Home consumption from SUSENAS 2011; 2. Other Items from Special Study on National Rice Consumption and Stocks 2011 Conducted by the Central Bureau of Statistics (CBS) and Agency for Food Security, Ministry of Agriculture, Indonesia, 2011; and 3. Total population in 2011 was 240,383,298 people.

Table 4.6: Fish and Meat 2011 Annual Consumption

Province	Meat (kg)	Fish (kg)
North Sulawesi	3.6	36
East Java	4.4	17.6
South Sumatra	5.9	25.2

Source: Ministry of Agriculture

rather than annually, with over 75,000 households interviewed each time. With such enormous, statistically rigorous sampling, results are significant not only nationally but at the provincial level as well. The reliability of the results does not make them always easy to interpret as will be noted below—but they do make them important to interpret. A summary table with consumption given for different food sources is provided below.

One interesting story which emerges from the survey results is a slow reduction in overall per capita rice consumption, composed of a rapid decline in at home consumption (1.5% per annum, greater than the rate of population growth), and an increase in consumption of rice outside the home (e.g., kiosks) or as processed food (see below). The resulting decline (0.3%) is rather slow. This study projects slightly accelerated decline in per capita rice consumption based on rapidly increasing incomes and similar patterns observed in other East Asian countries.

The nutrition standards Indonesia sets itself are 2000 calories and 52 grams of protein per day. The actual for the nation in 2011 was 1952 calories, and 56 grams of protein. The rural population consumed more calories (by about 10%), the urban more protein. (Thus even the Special District of Jakarta was “inadequate” for calories.) From 2010 to 2011 the biggest change was in prepared foods, where there was an 11% increase in calories and 12% in protein. Prepared foods are generally described as food consumed in “restaurants and cafes, “this category now provides 15% of all calories and 16% of all protein, and 20% of all rice by volume. To capture out-of-home consumption of rice more accurately, a special survey was conducted in 2011 in 100 districts of 11 provinces (Table 5.2), confirming these results, and giving a total national consumption of about 113 kg per capita. The largest recent increased were registered in poultry meat and eggs, while direct consumption of inferior starches like maize and cassava declined fairly substantially.

Table 4.7: Yearly Consumption Range

		Country Average 2010	Country Average 2040 (Pessimistic)	Country Average 2040 (Optimistic)
Rice	Kg	114.3	100.2	87.2
Maize	Kg	1.6	0.3	0.2
Fish	Kg	21.5	32.7	36.7
Beef Meat	Kg	0.4	1.5	2.2
Poultry Meat	Kg	4.2	8.2	10.0
Eggs	Kg	6.7	9.9	10.1
Vegetables	Kg	26.9	32.7	37.5
Fruit	Kg	9.7	20.7	30.8
Casava	Kg	5.4	3.4	2.1
Sugar	Kg	7.7	9.1	9.5
Cooking Oil	Liter	10.2	12.6	13.1

Source: Centennial Group projections

Indonesia seems still largely a vegetarian society, with its animal protein demands largely filled by fish. On average for the country 6.3 kg of meat were consumed per capita in 2011, and 17.8 kg of fish. Of course there was some regional variation in this, but perhaps not as much as one would expect. Even Jakarta apparently consumed only 11.9 kg of meat per capita. Here are consumption figures for three widely-spread provinces, calculated on a slightly different basis.

These numbers were calculated in reverse from statistics for protein, and from extremely detailed parameters given in SUSENAS reports themselves for numerous types of fish and meat.

While only 8 provinces (none on Java) surpassed the calorie standard, all but Papua, West Papua, and North Maluku surpassed the protein standard. It should be noted that only in Papua do calories from tubers exceed calories from cereals (this is a rural phenomenon in Papua, not an urban one.). Everywhere else cereals are by far the largest source, not only of calories, but of protein also.

The remark about a vegetarian society is not mere hyperbole. In 2010, "vegetables" provided virtually the same amount of protein to the Indonesian diet, as meat, and this does not include legumes, which are a separate category. Indeed, legumes provided nearly twice the protein as meat. In 2011 there was a slight advance in the proteins from meat, and a slight decline in the protein from vegetables, though the point remains.

The implications of this starting point for developments over the next 30 years are not entirely clear. Perhaps the most important revolve around the role of fish. In the absence of pork (due to religious reasons), and given that the humid tropics are not especially conducive to cattle and sheep, fish have played a major role in the Indonesian diet. If overfishing of Indonesian waters continues, and more coastal resources are depleted in the fairly near term, this role may not be sustainable. If, on the other hand, an expansion of farmed fish can counteract any stagnation/decline of marine fisheries, the protein situation may ease somewhat. The two sources of replacement for any lost high-value fish protein would seem to be poultry meat and eggs, given the efficiency of poultry production in terms of space and feed needs, and this is already observed in Table 4.4. Finally, for the approximately 36 million non-Muslims, pork may provide a very large share of increased protein consumption.

If indeed Indonesian policy-makers agree that in the long run meat and animal products (milk and eggs) will have to at least partially replace fish in the Indonesian diet, it behooves them to facilitate a mixture of import, domestic finishing/fattening of weaner cattle, and domestic poultry production if feed materials can be imported/transported easily and cheaply. Current statistics regarding a large increase in the national cattle herd are dubious to most experts in the field, which explains large increases in domestic beef prices whenever imports of weaners from Australia are arbitrarily reduced: This does no good for Indonesian consumers. Indonesia has no comparative advantage in complete cycle beef-breeding, although the fattening of imported weaners (mainly with imported corn and other materials, near large cities) does provide considerable employment and could provide more in future, if quantity of beef demanded increases with stable pricing.

Regarding poultry, other parts of this report provide recommendations on what will be required to develop and

maintain viable industries (industrial and peasant) in this field, which will not require perpetual subsidies or protection from cheaper imports at the expense of the Indonesian consumer.

Centennial Group's projections for per capita food consumption are given in Table 4.7, and show where Indonesia eating habits may move in the future. As Indonesians get wealthier, they are likely to consume less rice and more meat, as indicated in the table. Under the optimistic GDP scenario, poultry consumption more than doubles, while beef consumption increases from 0.4 to 2.2 kg per year.

Decentralization and Rural Development

In 2001, Indonesia embarked on an idealistic and fairly radical change in governance of the country. Two laws (Laws 22 and 25/1999) set the stage for the transfer in 2001 of a great deal of governance from the center to local governments. In one "big bang", as it was often called, one of the most highly centralized polities in the world became one of the most decentralized. Responsibility for many types of technical services was shifted to several hundred districts (kabupaten, or "regencies") and municipalities,[3] and some (though rarely enough) central budget resources were also shifted to cover them. Thus while in 1998 the central government spent 72% of government spending, today this number is down to 55%. Local governments now manage 38% of the public resources, with the fairly small remainder belonging to the 33 provincial governments.

Not all domestic functions of government were decentralized. For example the police are still a central function. More relevant to agriculture, the National Land Agency (Badan Pertanahan Nasional—BPN) is still centralized, though apparently there is considerable local influence on its performance in the field.

But most functions bearing on agriculture and rural development are now shared among the various levels of government. This sharing has not always been well and carefully specified, so there is little integration among the programs financed, for example links are weak between national agricultural research centers, the 32 Assessment Institutes for Agricultural Technologies (AIATs), one at each province, and agricultural extension teams in the districts. More will be said of agricultural research and extension below.

Impact of Decentralization on Irrigation

One field where fairly clear divisions of responsibility among levels of jurisdiction have been made is irrigation and water resources. In this more engineering-oriented field, quantitative distinctions can be easily made, and thus we have national responsibility for schemes with more than 3,000 ha irrigated (quite small in the world of irrigation), and for other schemes straddling two or more provinces. Provincial governments handle schemes of 1,000–3,000 ha, and other schemes straddling two or more districts, and districts handle the rest. In practice, out of the 7.23 million ha or irrigation, nearly half (3.49 million ha) fall under district management, 2.3 million ha come under the national government, and 1.44 million ha under the provincial governments.

There is considerable disparity in judgments of the condition and effectiveness of these schemes. The usual anecdotal judgment, including by many Indonesians and foreigners of long-term residence, is that the irrigation systems are generally in poor shape, indeed this is one of the main reasons given for the stagnation of rice production over several long periods in the recent past. In addition, the poor condition is often ascribed at least partially, to decentralization: When 32% of all local government expenditure is now spent on "core government administration", in part due to constant subdivision of districts and hence their expanded number, there will obviously be less funding for infrastructure spending, such as operation and maintenance (O&M) of irrigation systems. This is the common description of the current state of irrigation in Indonesia, especially at the local level.

However, there is also evidence for a better picture. In 2010 the Department of Irrigation commissioned a technical audit of all of Indonesia's irrigation, which seems to

3 Since that time the number of districts and municipalities has nearly doubled to 491, in the 33 provinces (this number has also increased) including the Special District of Jakarta.

have been professionally and honestly done. Nearly half of the system (3.48 million ha) was judged in good condition, i.e. with a level of service over 90%, while less than 10% (706,000 ha) were judged heavily damaged, i.e. with a service level below 60%, capable of a cropping intensity of only 120%. Another interesting finding was that the half of the system delegated to the districts under decentralization, were in almost as good condition as those larger schemes still under the central government. The largest proportion of poor and mediocre schemes was among those under the provinces. Thus it is not at all clear that decentralization has materially harmed irrigation at the local levels.

It is quite possible that the dichotomy of judgments on the state of irrigation infrastructure is a question of timing. Until about 2006, funding for irrigation O&M and development had been at historically low levels for a long time, nearly 15 years. From that year onward, funding of this subsector from the center increased substantially year after year. It is quite possible that several influential reports written around 2006 faithfully recorded the depressed state of the system at that time, which has created the ruling image, whereas four years later an accurate technical audit may have simply recorded large and widespread systemic improvements. It still appears, however, that:

1. The long period of disinvestment has left many systems in the Outer Islands incomplete;

2. Decentralization has left much of the old field service depleted and deprofessionalized; and

3. Even today, too little money and staff are being devoted to irrigation operation and maintenance.

4. All these need to change if cropping intensity of rice, and hence rice production, is going to increase significantly over the next 30 years.

Impact of Decentralization on Agricultural Services

Given the small role of districts in agricultural research, the main decentralization issues regarding this field lie between the provinces and the center. Here the major question concerns the advisability of each province having its own provincial assessment technology institutions (AIATs). This is an important question, because the AIATs consume 30% of the total national budget for agricultural research. A system by which AIAT centers are positioned with agro-economic zone specializations, serving all provinces concerned, would foster cross-province cooperation, lead to less fragmentation, and reduce the potential for duplication of efforts and functions at the provincial level.

Secondly, many AIATs are highly insulated with few linkages to other partners such as the private sector, universities, and NGOs. Successful agribusiness development will demand that these linkages be made. AIAT staff tends to be isolated from technical information, not only from international literature, but also other IAARD institutes and other AIATs. Most importantly, research is not demand driven due to the limited contact with farmers.

Thirdly, some well-endowed provinces have expressed an interest in taking over the O&M of the AIATs in the respective provinces, while the poorer ones are not willing to engage as far as funding is concerned. More broadly, local governments particularly at the Kabupaten level now wield considerable authority over the working relationship with the central government agencies, and therefore on financing and budget allocation and utilization. This is particularly affecting the extension services.

The institutional arrangements for agricultural extension have undergone significant changes in the last three decades. As with public extension systems in many countries, Indonesia faces a major challenge to develop an effective institutional mechanism for disseminating technology relevant for small scale producers. With decentralization in 2001, a new chapter began, and local governments got the authority to choose the extension organization for their districts. Regional autonomy has changed not only the relationship among levels of government (central-province-district/city), but also the format of the accountability of local government; a lack of accountability of local governments has influenced the attention given to different public services at the district level, including extension.

It appears that agricultural extension is one of the program areas most deeply hurt by decentralization. Despite increased district income as a result of central government grants, the structure of the extension system built up over 20 years had been undermined. Management, professionalism, mobility, and administration of the agricultural extension system, as well as respect among farmers, have almost disappeared in many districts. In November 2006, the Government promulgated a new Extension Law (Law No. 16/2006) aimed at revamping the extension services with increased coordination between the district, provincial and central levels, establishment of clear norms and standards for agricultural extension institutions at all levels of government, and most significantly, recognition of the importance of a multi-provider extension system. As of 2011, 333 out of the 497 districts/municipalities and 29 of the 33 provinces had established unified extension agencies.

The establishment of the Rural Extension and Information Centers at district (Balai Informasi dan Penyuluhan Pertanian BIPP) and sub-district (Balai Penyuluhan Pertanian BPP) levels were meant to consolidate extension programs and staff of isolated district agricultural service units for provision of sub-sector advice (food crops, estate crops, livestock, fisheries, and forestry). An earlier World Bank project (the District Agricultural and Forestry Extension Project, or DAFEP) had aimed to strengthen this process by facilitating team-building within and between sectors and encouraging staff to develop an integrated extension program using farming systems approaches including agro-forestry.

At district level, the institutionalization of integrated extension services remains tenuous. Some districts, recognizing potential benefits from farmer-led approaches to extension using the DAFEP model, which had used a system of farmer managed grants for sourcing and paying for technical advice from providers of their choice, have supported integrated extension centers through guaranteed on-going finances and Bupati decree. In districts where decentralized, farmer-led extension is working well (which are relatively few in number), there has been strong support from the head of the district (Bupati) and district parliaments in institutionalization of BIPP's (for example, Magelang district Central Java and Maros District in South Sulawesi). Elsewhere support is weaker and in some cases BIPPs have either been abolished (Banyumas, Kotabaru, Tanah Laut, Timor Tengah Selatan Districts), or their echelon level downgraded in effect restricting the career path and status of extension staff. In many cases BIPPs/KIPPs are seen simply as cost centers and their potential contribution to poverty alleviation is not recognized.

Against the above background, spending on agriculture extension in Indonesia doubled over 2006–09 as a share of agricultural GDP. Despite the extension services being highly decentralized, all three levels of government are executing a component of the budget, which is largely funding salaries and operational funds. Central government spending for extension services increased by 62 percent in real terms driven primarily by two big pushes in 2006 and 2009. These large increases mostly went to finance salaries (27 to 46 percent of total central extension budget), the result of MoA hiring a large number of contractors to be trained as extension workers and based at the district level. It also financed increasing transfers to cover operational costs from the MoA to provinces and districts for the operational expenses of extension workers. The districts are executing a large share of the extension budget as a result of decentralization, but as noted above, those that have established unified extension agencies are delivering better quality services and reflecting stronger linkages between planning and budgeting.

It is quite clear that meeting the national objectives, in as far as delivery of technical services is concerned will require greater investment and efficiency gains from public spending.

Decentralization has created a lack of clarity over funding responsibilities across different levels of government, undermining the provision of extension services. The MoA has assumed an increasing share of this expense and encroached into the districts' mandate. This is setting a perverse incentive for greater under-funding of services at the local level over the upcoming years. Instead of complementing public spending, the increasing transfers are substituting for subnational spending for extension because the districts do not

bear the cost and welcome this intervention. At the district level, there are now two types of extension workers, the regular extension staff, which are paid by the district budget, and contractor workers that have been deployed and funded and are under the mandate of the MOA. In some districts, the MoA's involvement has generated conflicting directions in the advice provided, for the agriculture priorities set by the central government sometimes differ from the planning objectives of districts.

Research outcomes are not reaching farmers effectively and being fully disseminated at the local level. While the AIATs are supposed to be the link between research at the central level and extension agents in the districts, there is weak coordination across agencies providing extension and R&D at all tiers of government. A study of the services found that information and services that are given by the provincial assessment technology institutions (AIATs) are sometimes not in line with those given by extension workers; AIATs provide advice based on the research outputs, while extension workers give services based on the technical guidance from the MoA. Moreover, extension workers are spread thinly to cover many farmers, and are often poorly qualified. Of the total extension workers, there are only 2,560 PPLs (around 6 percent) who hold bachelor degrees, while the rest (37,450 PPLs) hold associate degrees or lower qualifications, mainly training from agricultural high schools.

As is quite clear from the above, the institutional and management changes to the agricultural extension system have led to a lack of direction and clarity of roles. The implementation of decentralization has created different interpretations of extension service delivery and led to uncertainty with regards to institutional affiliation and staff management. Overall, the key message is that there are still no effective means of dealing with the constraints faced by small farmers in the adoption of new technologies. While some improvements have been made, research and extension agencies continue to suffer from weak (and sometimes confusing) budgetary support, an incomplete reform agenda and the confusion caused by decentralization. Reform in the delivery of technical services will require an increased reliance on farmer/producer organizations, and a greater role for non-governmental provision (universities, agribusinesses, NGOs, farmer organizations, and other private sector providers) of agricultural services who have been active in many areas but which have remained at the periphery of driving the government's agenda on agricultural modernization due to the lack of a conducive policy environment.

Recommendations for improved delivery of useful agricultural technology to the masses of village farmers include: Local Economic Governance

Beyond the technical fields of irrigation and agricultural services, what is the general state of economic governance at the local level across Indonesia, in the decentralized era? A valuable window on this question is provided by a series of surveys of business operators in a large sample of districts and municipalities. The latest of these (2011) is an impressive study by the Asia Foundation and the Indonesian NGO KPPOD (Regional Autonomy Watch), with financial support from Australian Aid. It surveyed 245 districts and municipalities (half of Indonesia) in 19 provinces. The results, like those of the irrigation audit, are perhaps surprisingly positive in general, and may bode rather well for the future of Indonesian development. They are based on a sample of 12,391 firms.

The first point of interest are the weights assigned by these thousands of mainly small, local firms, to the various aspects of local governance, in terms of which aspects are major constraints for business activities. The dominant choice here was infrastructure, with a 38% weight, compared to which frequently discussed aspects like land access (9%), transactions costs (7%), capacity and integrity of bupatis/mayors, local level regulations, and security and resolution of business conflicts (all less than 5%) that were seen as distinctly secondary, or indeed minor issues. Instead, the second and third choices were business development programs (i.e. did the district have them—14%), and local government and business interaction (13%), while business licensing received an 8% weight. Perhaps the point here is that there are ways around corruption and low competence of agencies and individuals, but there may be no way around the lack of a passable road to one's

town. Regarding infrastructure, the survey did not merely enquire about the quality of district infrastructure, but included the time needed to repair damaged infrastructure in number of days for roads, water supply, street lighting, and non-district-provided electricity and telephone; frequency of loss of water supply and power, level of private generator ownership, and finally, the impact of all such deficiencies on business.

The second major point is the high variability of the results, especially at the district level. There are some districts in remote provinces which score excellently in aspect after aspect which are obviously under the control of honest, committed, and competent leadership, and which may only fall in the overall rankings through lack of funds for infrastructure or business development programs. One such example is Kolaka Utara District in Southeast Sulawesi Province, which scores first in the country in access to land, first again in transaction costs (with a perfect score of 100), and is among the leaders in security and conflict resolution. Its overall rank of 103 in the sample derives from a mediocre score for infrastructure and a near-zero score for business development programs. But it does show that even at the far end of Sulawesi, a determined local administration can make a vast difference in whether government is on balance a supporter or a hindrance to economic development.

In general, western Indonesia does better than eastern, with East Java's jurisdictions leading the way, the highest ranked one overall in Indonesia being Kota Blitar Municipality (with a very high score for infrastructure); rural Blitar district is also high-ranked (14)—and in between those two rank six other East Java jurisdictions. Even here, however, good leadership trumps geography: Two West Papua (this province is generally among the weakest) districts rank among the top 16 in the survey.

In anecdotal reporting on the (poor) consequences of decentralization, it often seems that the district governments are out of control, and that there are no limits to the regulations they can impose on the productive sectors. This study makes clear that this is, in the end, untrue. Law No. 22/1999 on Local Government and Law No. 34/2000 on Local Taxes and Local User Charges do grant greater authority than previously to districts to impose, increase, or reduce various types of taxes and charges. Various districts have used these in widely differing ways—for short-term increases in local revenue, to long-term easing of burdens on business, hoping to attract and create more economic activity. But all these regulations (peraturan daerah or district regulations, now abbreviated to "perda" in Indonesian) must be sent to the provincial and central governments for approval. Reduction of scope for perda already started in Law 32/2004 on Local Government, no doubt given early excesses. Law 28/2009 now requires that local governments may only issue perda on local taxes and user charges that are included in a "closed list" stipulated in the Law, while certain levies that had previously been under the authority of central government were decentralized to the regions.[4] This is not a situation of uncontrolled legislation.

It is true that the same section of the study is concerned with the slow progress of revoking local legislation where problems have been found. Through end-2010 13,622 perda were received by the central government, 13,252 of them reviewed by the Ministry of Finance (MOF) of which 4,885 were recommended by MOF to the Ministry of Home Affairs (MOHA) for revocation. The study is concerned that as of that date, only 1,843 perda had actually been revoked. However the rest of the chapter makes clear that the very process of review itself both establishes basic good governance principles, and chills local legislative urges towards irresponsible but populist actions. The very fact that these principles exist at least provides the platform on which new legislation will be made and reviewed. For example, in their own review of perda issued by Kotabaru District of South Kalimantan Province (the lowest ranking in the survey on Local Level Regulations), the study team remarks "levies on plantation products that are being taken out of the district also create obstacles to trade between regions and thus violate the principle of free internal trade, thereby reducing the competitiveness of products."[5]

Studies at the micro-level, such as the qualitative part of the current study done in East Java in 2011, show the immedi-

4 "Local Economic Governance", KPPOD and Asia Foundation, Jakarta, 2011, pg. 39
5 Op. cit., pg. 45

Table 4.8: Rice Milling Rates

milling rate	total paddy production (million tons)
63	47.5
61	49.0
59	50.7
57	52.5

Source: Centennial Group estimates

Table 4.9: Cropping Intensity

cropping intensity	tons of paddy
1.2	42.681 million
1.3	46.238 million
1.4	49.795 million
1.5	53.352 million

Source: Centennial Group Estimates

ate good effect of Law 28/2009 on Local Taxes and Local User Charges. "In Jombang District of East Java, 30 types of permits have been exempted from user charges since 2009. As a result, the proportion of types of permits in this district that have no user charges is now greater than those with user charges. In 2010, the Bupati of Tuban District issued a decree exempting 32 objects from taxes.[6] Finally across the whole survey, only 4% of respondent firms felt that transaction costs (often a code phrase for corruption) were a major impediment to their businesses.

Thus the conclusion of this study on the impact of decentralization on Indonesia's rural development is this: The initial impact was poor across the board, in terms of agricultural services, infrastructure provision (including irrigation O&M), and local economic governance. Agricultural services are still in a poor state, though by now the problem is largely in the hands of the MOA to ameliorate (see last section of this report and Annex 3); it is possible that issues such as the better placement, tasking, and management of AIATs will require legal changes at the central level, while local governments may have to be presented a choice of either funding agricultural extension adequately, or losing control over the function entirely back to MOA: the competency level of whole districts of farmers cannot be left to shifting local politics. Regarding local economic governance, the central government, probably goaded by NGO-sponsored studies such as those referred to here, and indeed activism by central government agencies (not to mention democratic politics itself), has responded over the past decade with a series of laws designed to ameliorate the situations uncovered, and judging from the review of survey results, the results have improved, perhaps more so than the study authors fully realize. For example, in one section of the survey (on Business Development Programs), the major complaints of business operators in remote parts of Kalimantan, Papua, Maluku, and others are distances to sources of raw material supply and product distribution, and perhaps related to this, volatility of prices. Complaints about quality of roads (something local governments can actually do something about) are much fewer and less severe. But the reality is that such districts are among the most remote in the world, and distant from most busy trade routes, and it is not clear in many cases what even the most dedicated administrations, either local or central, could do about such geographical realities except at the most exorbitant, unsustainable expense.

What has been proven in the survey, however, is that the right personnel in the right positions can make a great difference in the prospects of local economic development, at those points where government officers meet, interact with, and hopefully serve the public, including farmers and the traders who serve them. Granted that bupatis and mayors are now elected through local elections, there is still much that the center can do to improve the quality and performance of local administrators, and it appears from this study that heavy emphasis should be placed on selection and training of officers in Eastern Indonesia. Otherwise, a pattern of responsive legislation has been set and should continue, and the final recommendation would be persistent attention to enforcing implementation of these improved laws.

6 Op. cit., pg. 51

Rice Demand and Supply: A Major Data Issue for Indonesia

Any analysis of long-term supply and demand of any commodity, in this case rice, should naturally begin with a fairly sure estimate of the current situation. This presents us with the first major issue in assessing Indonesia's future food security, often defined largely in terms of the degree of self-sufficiency in rice. This issue is, that the official estimates of current consumption and production of rice are so far apart, that if they were both true there would be a surplus of about 15 million tons of paddy per year, or about 9 million tons of rice, enough to make Indonesia the largest rice exporter in the world. As this is patently not the case (Indonesia imported 2.7 million tons of rice in 2011), at least one of the sets of numbers is definitely highly inaccurate, and possibly more than that are.

Let us begin with consumption. Food consumption has been independently monitored for more than 30 years through national social surveys, abbreviated as SUSENAS. SUSENAS methodology and surveys are generally highly respected, both internationally and domestically. They report a constant and fairly steady decline (about 1.1% per annum) in per capita rice consumption at least since 1990. Thus per capita consumption in the home was reported as 118 kg in 1990, 101 kg in 2002, 97 kg in 2005, and 90 kg in 2011. As consumption outside the home has become more important with the passing years, a special survey of rice consumption outside the home (e.g. in restaurants, hotels, from food vendors and kiosks, etc.) was mounted over the years by MOA and CBS, which for 2011 gave an aggregate estimate for rice consumed outside the home of 23.72 kg. Thus the final overall per capita consumption of rice in 2011 is officially estimated at 113.72 kg.

As a proportion of overall household expenditure, expenditures on cereals (of which more than 95% is rice) fell from 18% in 1990 to 12.5% in 2002, 8.5% in 2005, and 7.5% in 2011. There is some volatility in the results from year to year, including in recent years, for both physical consumption and expenditure, but the general downward trend is apparent, if perhaps slowing. While direct rice purchases were declining as above, general purchases of "prepared food", from restaurant meals to packets of instant noodles (or loaves of bread) were rising from 5% of the household budget in 1990 to nearly 14% in 2011. Modernization of eating habits in Indonesia is thus an undeniable trend, as patronization of prepared food replaces purchase and cooking of raw food such as rice.

This volume of per capita rice consumption in 2011, coupled with an estimated population of 242 million, yields an aggregate consumption of 27.52 million tons of milled rice in that year. Given imports of 2.7 million tons (10% of total supply on this basis), national rice production consumed as food may be estimated at about 24.82 million tons, assuming no change in stocks. But considerable rice (or paddy) production is consumed as seed, animal feed, industrial raw material, or simply lost as waste. A conservative (high) estimate of their non-food uses is 17% of rice produced. This number applied to consumption of domestic rice yields a total domestic production of 29.9 million tons of rice. Estimating paddy production from this production estimate requires adopting a national average milling rate from paddy to rice. The operational range for this milling parameter in rice-growing regions is generally taken to be 55% to 70%. The table below gives estimates of paddy production for three milling rates which may describe Indonesia's current average, applied to the 29.9 million tons of rice derived above.

As can be noted, the range of estimates of possible domestic paddy production varies by only about 10%, over a range of milling rates from quite good to quite poor. A good general estimate of paddy production in Indonesia today, based on the most accurate (consumption) source available, is thus about 50 million tons.

The official MOA estimate of paddy production is nowhere near these numbers. For 2011 it is 65.385 million tons, based on an estimated cropped area of 13.224 million ha and an average estimated yield of 4.94 tons/ha per crop, very good by world standards. This number is over 15 million tons higher than the higher estimates based on consumption, and as noted above this surplus is greater than

Thailand's world-leading exports. Instead, Indonesia imported 8% of total world market supply at the end of 2011.

Aside from the sudden large rice import of late 2011, there are other indications that official rice production figures for Indonesia are far too high to be accurate. One is that based on the Ministry of Agriculture estimates they translate into an annual per capita consumption of 139 kg/capita (the Centennial team's estimates of these production figures translate into a much higher consumption level of 170 kg per capita), which is far outside any surveyed result in recent years. A second has to do with cropping intensity, or the number of crops per year on a single plot of land. We may assume that the 7.2 million ha generally accepted as the irrigated land resource of Indonesia, is devoted to rice production for at least one crop per year. There are actually substantial areas of dry land also planted to paddy (usually to lower yields and a single crop), while some irrigated land is taken up for other crops throughout any given year (e.g. sugarcane, horticulture), and these may largely balance out. Then, in order to achieve the reported 65 million tons of paddy at an average yield of 4.94 tons/ha, the entire irrigated land area would have to achieve a 184% cropping intensity. In practice, this is a very high level of rice double-cropping, even for a single, well-managed irrigation scheme. As an average for an entire country, with wide variations in rainfall (only 11% of Indonesia's irrigation areas have reservoir storage), this seems impossible to achieve, and with it, the reported paddy production.

One explanation for the production over-estimation is that the reported yields are largely correct, but that cropping intensity estimates are fairly casual ones, done by irrigation engineers with interests in better service and higher intensities. On the following small chart, we maintain the assumptions of 7.2 million ha for rice-land, and average paddy yield of 4.94 tons/ha, varying only the cropping intensity, from 1.2 (120%) to 1.5 (150%).

As can be seen, a cropping intensity of 1.4 (140%) gives a production value roughly equal to the one derived above from consumption surveys, assuming an average milling in the 59%–61% range, which seems a good conservative estimate. Thus, technical routes for cropping intensity (slightly above 140%), for milling rates (59–61%), and for non-food uses of rice (17%), combine to yield an estimated paddy harvest (50 million tons) well in accord with carefully surveyed national rice consumption. These technical rates are generally acceptable to large numbers of independent engineers with local field experience.

Land Administration

Land administration is one of the most heavily conflicted areas of Indonesian agricultural, rural, natural resource, and urban policy. In some respects idealistic, in others chauvinistic, on paper the panoply of laws on land seem so cumbersome as to make it impossible to move virgin land to operational use, or to transfer land among uses, e.g. from agriculture to housing or commercial development. In practice, recent decades have seen millions of hectares (ha) of forest first logged and then turned to tree crop agriculture on the Outer Islands, and hundreds of thousands of ha of paddy land on Java and other islands turned to modern housing, commercial complexes, roads, and other infrastructure. Thus commercial pragmatism triumphs in land administration as in other aspects of Indonesian development—indeed "doing business" surveys indicate that the larger the business, the less the felt burden of land administration issues in the development process. It is small business and individuals for whom land administration presents serious hindrances to development.

The most important piece of legislation regulating land rights is Law 5/1960, known as the Basic Agrarian Law (BAL), which initially applied to all land in the country.[7] This changed in 1967 when the Basic Forestry Law (Law 5/1967) was adopted, which placed over 65% of the country under the jurisdiction of the Ministry of Forestry. The developed areas of the country, however, mainly come under the BAL.

It is generally considered that the BAL tried to combine two radically different approaches to land tenure inherited from the past, the Western, commercial one imposed by

7 OECD; OECD Agriculture Policy Reviews: Indonesia; 1 February 2012. Chapter 1, pg. 47.

the Dutch colonial authorities in regions where agricultural, commercial, and industrial development was taking place, where some sort of certification of land ownership was necessary, and the more extensive traditional ownership of large blocks of land by tribes and princely states, governed by "adat" (the Malay word for tradition or custom), with the term "hak ulayat" specifically applying to land rights. Both sources are still considered legitimate bases for recognition of land ownership, with the former activated by private conveyancing and the latter by registration of deeds. It has long been a goal of both domestic and donor professionals in this field, to increase the proportion of actual plots of alienated land included in the latter formal system, but this has been an elusive goal. One reason for this has been the continuing creation of new plots of land from former forests in the Outer Islands; another is the continuing subdivision of plots in more developed regions such as Java. For these reasons, registered plots still number no more than 30% of all plots, or about 30 million plots out of 100 million identified in the fiscal cadastre as owned by individuals, entities, or communities with tenure sufficient to attract tax liabilities and willingness of "owners" to meet their payment obligations.

There are five basic types of land tenure in Indonesia, with one ("hak milik", or right of ownership) close to Western freehold. This type of tenure is denied to foreign individuals and firms. Other forms permit cultivation only, building only (one may have title to a building without ownership of the land beneath), use only ("hak pakai", a typical form for foreign investments), and land management only. Banks are not enthusiastic about taking any form but hak milik as collateral.

A National Land Agency (Badan Pertanahan Nasional, BPN) was created in 1988, responsible to administer all non-forest land in the country. Its four specific mandates cover land titling, land survey and registration, land use, and land reform.[8]It is possible that under "normal" circumstances, given revolutionary technological advances such as GIS, wireless transmission of textual and graphical information, etc., BPN could have made substantial progress in reducing the backlog of unregistered properties, while keeping up with new plot formation, but various major developments intervened, chief among which the financial crisis and regime change of 1998, and then the decentralization reform of 2000 and subsequent years. The first thrust of that legislation was to devolve all responsibility for land administration to the lowest level jurisdictions—kabupaten and municipalities. This would have essentially destroyed modern land administration in Indonesia. This was subsequently (and sensibly) modified to maintain BPN as a central agency, but with a role limited to legislation, performance standards, uniform land registration procedures, training, and the provision of some services.[9]

Even before the major disruptions of the turn of the millennium, several independent expert observers commented that it would take BPN 100 years to complete the cadastre of Indonesian real estate. Usually the same observers also took the line that the main work approach should remain "systematic registration", whereby land blocks are selected for focused campaigns, during which all properties in the blocks are registered in detail, complete with physical survey and mapping of plots and index maps. This approach was popular among the public, partly because the rationale of doing this work in this comprehensive fashion seems obvious. But it is a slow process, and decentralization obviously made it slower.

Thus there has been a change in recommended approach relevant to Indonesia's situation over the coming decades, which is to shift the major emphasis of Indonesia's land titling from the systematic to the "sporadic" approach, whereby properties are formally entered into the registry "on demand", typically when a transaction needs to occur, such as an inheritance, sale/purchase, mortgage, etc. The sporadic approach thus focuses effort and manpower where it is truly needed, and should be aimed to streamline the registration process as much as possible. The opposition to sporadic registration has always been on cost per plot—sending teams out to the field for a sprinkling of registrations here and there, will obviously cost more per plot than

8 Heryani, Erna, and Chris Grant, Land Administration in Indonesia, 3rd FIG Regional Conference, Jakarta, 2004, pg. 5.

9 Op. cit, pg. 11

registering all land in a village. But the point then arises, that if the great bulk of plots (especially agricultural ones, which in traditional societies like Indonesia do not often change ownership) will not have to register transactions for years to come, why do the preparatory work for those transactions now? Indeed, historically the large nations of North America, Western Europe, and recently Russia have seen most of their titling done by sporadic approaches, so shifting emphasis to this in Indonesia will not be anamolous at all, while markedly increasing the value of the registration work itself.

In addition, the same technical breakthroughs which have reduced the cost of systematic registration have also reduced the cost of sporadic registration. Perhaps more important under each approach is to escape irrationally strict technical standards (e.g. millimeters deviation for plot boundaries) typically imposed by the photogrammetric engineering profession, which add nothing to the land titling process. With this change in emphasis, it is possible that deficiencies and backlogs in land titling may not materially delay agricultural investment and results through the year 2040. Without it, a different picture may emerge of investment in a high value agriculture substantially reducing, and with that serious drops in agricultural growth.

A second major question then arises as to the differentiation of roles between BPN and the kabupaten/municipal governments in land administration. This was actually addressed by Presidential Decree No. 34 of 2003, which assigned the following land functions to local governments:

1. Location permit issue
2. Provision of land for public interest
3. Resolution of cultivated land dispute
4. Resolution of compensation for land allocated for development
5. Determination and resolution of ulayat/communal land problems
6. Handling of abandoned land problems
7. Land opening permit provision
8. Planning of land use within kabupaten/municipality areas

To complement the handling of these essentially local land issues, by the closest government to those issues, various experts have proposed a significant strengthening of land administration functions at the higher levels of government, including the provincial level which was largely ignored throughout decentralization planning. Some of the main concepts are as follows:

1. All land policy and standards to be set by central government (BPN Pusat (HQ))
2. All monitoring and supervision activities to be carried out by central government
3. Provincial spatial planning and the issue of major land grants to be delegated to Provincial Land Offices Services
4. Regional (local government) spatial planning, land use management, permits, expropriation, minor land grants and systematic adjudication to be delegated to Regional Land Services offices
5. Land registration to be carried out within BPN Land Offices at Regional level
6. Technical services associated with land registration (base mapping, geodetic control, licensing of surveyors, etc to be supplied by BPN Technical Services Units based in provinces.
7. Much of this will be somewhat controversial; in terms of reestablishing higher level technical competence at higher level nodes of government, but most of these steps may be necessary to help provide the physical base for the agricultural expansion hoped for over the next three decades.

Lessons in land administration from other countries. In the past two decades the World Bank has been more active in

the land administration field in Europe and Central Asia (the formerly Communist nations of Eastern Europe and the Former Soviet Union, plus Turkey), than in any other region of the world. About 40 projects were done in 21 countries, of which 21 projects in the last 13 years were "stand-alone", i.e. pure land projects. There was a very good reason for this concentration of land projects—this was the part of the world where there was no real private ownership of land and real estate, for as long as the Communist system ruled. In any commercial society, family ownership of land and real estate is the basis for agriculture, for all housing and commercial development, for much of the financial system through mortgage markets. Thus it was felt imperative to create secure tenure in land and real estate as early as possible in the transition of all these countries to capitalism and free enterprise, not to mention to the personal and family freedom and independence involved in home (and family farm) ownership.

Technical staff of the IBRD's Europe and Central Asia Region have done a series of studies attempting to distill lessons from this great body of practical work, before too many staff move on and the institutional memory of 1995–2010 fades. We have here attempted to capture as briefly as possible some ideas which may be relevant at this point to Indonesia's future land administration program.[10]

Some of the main lessons are not immediately operational to Indonesia because her system already avoids the problems, or on the other hand, are so basic to Indonesia's history and culture that they will not change soon. Thus, systems requiring more than one agency to process a transaction in land, especially if one of those agencies involves the courts, which are quite common in Eastern Europe (the former Austrian Empire), create many problems avoided by single-agency systems. Indonesia was largely blessed with a single-agency system when BPN was created. It may be argued that decentralization created in every kabupaten and municipality a second land agency, and this has probably slowed progress; but if the local services can be kept within the tasks enumerated above, it is possible clients can avoid too much extra effort and cost.

Other lessons include the need to have clarified land laws and regulations before embarking on mass land titling, and the need to have a strong political champion behind a land registration campaign, who will leave an effective manager of the land agency in place long enough to essentially complete the job (in Russia this has actually been Vladimir Putin). These are all good aspects which will make work easier, but it is not clear that Indonesia has the luxury to wait until these aspects prevail.

Information and communication technology (ICT). Land administration is one of the most information and data-intensive professions in the world, indeed it consists of little else. Thus ICT has quickly moved to the heart of land programs, as activities moved from manual recording of facts and analog surveying and mapping to digitization, automation, data-linking, and sharing through the Internet in real time. The first approach of many national programs was to engage large international firms (sometimes offshoots of cadastre agencies in developed countries) to develop the software and hardware configurations to run these programs. Many of these programs failed, either from a purely technical point of view (it is more difficult to create working systems from scratch than as a series of incremental improvements as they did back home), or in terms of staff and client understanding, effective use, and acceptance. Even those systems that succeeded required much more time, effort, and cost than estimated.

Much more effective has been in-house ICT system development (perhaps with the help of a few individual technical advisors): "Incremental approaches, which have started with automatization of alphanumeric data and systems, and proceeded to include graphical data only after the alphanumeric solution worked, have been the best... in the past decade. They have enabled quick automatization of the rights and mortgage registration functions, which were able to serve the market very soon after their introduction. The more challenging graphical functions and more

10 Torhown, Mika, and Gavin Adlington. Twenty Years of Land Management and Administration Projects in Europe and Central Asia Region: Key Lessons Learned. Presented at annual World Bank conference on land and poverty in Washington, DC. April 23–26, 2012.

complex system features have been added later."[11] It does stand to reason that an agency may better use a system it has largely developed itself—even it is somewhat less sophisticated than in more highly developed locations.

Cadastral systems and surveying methodologies. There are two main lessons under this heading, both mentioned above. The first is the shift of the main emphasis of the titling program to the sporadic approach, to make sure that the land administration system itself does not hold up development by causing delays in transactions, or generate yet more corruption through those delays providing incentives for bribes, or both. The performance of sporadic registration may be measured in time required to process a simple transaction, say an uncontested sale: Kyrgyzstan now manages this in one day, and this should be the goal for Indonesia. Later on, the goal may be lowered to numbers of hours. Given the current state of ICT, there is no longer an excuse for weeks, months, or worse to register an uncontested transaction.

There will still be occasions and places where systematic registration will be necessary, e.g. for larger-scale public works like highways or irrigation schemes where (generally) small parts of large numbers of plots will be required, and accurate and fast work is needed to avoid cheating numerous poor rural people of their just compensation payments. The same is true for large private-sector developments, more likely to be commercial or housing sites in urban and peri-urban settings. Thus BPN needs to develop and maintain strong systematic registration teams even while streamlining sporadic registration down to a one-day performance standard.

The second major lesson under this heading is to avoid the trap of excessive technical precision in surveying for land administration purposes. It is extremely common for the survey engineers to demand equipment and operational systems, and indeed performance standards and time allowances (and costs) conducive to accuracies within fractions of a millimeter. Such costs per plot are often the major factor preventing the completion of national cadastres. This must be strongly resisted, if necessary by calling in external engineers with real experience in accelerated (and low-cost) mass titling. One World Bank study ends this discussion by stating: "The level of accuracy of cadastral survey work does not appear to have any bearing on real estate market activity or instances of dispute."

Improving service delivery. The first step here is the streamlining of transactions and sporadic registration down to a one-day standard. This alone will markedly reduce corruption in this service by removing its incentive, and simply by ensuring there is no time in the work schedules for such activities. However, beyond this there is the creation of transparency, both literal and electronic. In Armenia, the agency itself created an office design whereby all internal walls and barriers were of glass, so that any actual payments or other unusual actions were visible to others, including the clients. More common is to put the maximum proportion of the business on the Internet, so that all can compare what they were asked to pay, to published rates and to what others paid.

Another major element of service delivery is to serve the poorer and less educated groups—especially important in rural areas when dealing with the farming community. Many projects in eastern Europe instituted legal aid programs for such groups (these may be advertised on television and radio), sometimes with the legal aid officer sitting right in the lobby of the courthouse or land office—which is where the poor or illiterate person often gets frightened away from pursuing his claims. If not done yet in Indonesia, this may be a worthwhile and low-cost program to pursue, especially in rural areas; indeed, NGOs may be interested to sponsor this program.

Business orientation. All land administration programs should earn back some of their budgeted costs through fees, and if well-managed, like businesses, should entirely finance themselves. This has happened in Georgia, Moldova, Kyrgyzstan, Romania, and Turkey, with the latter earning more than its costs, but according to law handing over revenues to the state and requesting budgets from it. The point here is to charge little or nothing for services of value to the state, like initial registration (entry of property into

11 Gavin Adlington, personal communication.

the registry), and relatively high for services of high private value, such as registration of leases on property, or use of property as collateral. Self-financing should probably be a goal for any well-run land administration program.

Agricultural Research

Given the extreme importance of agricultural research and extension to sector performance, the following detailed strategy for these fields (research is also covered in Annex 3) is proposed.

Creating a Successful Strategy for Agricultural Research. Domestic agricultural research has played a very weak role in Indonesian agriculture over the past two decades. This has primarily reduced the impact of new technology on the country's predominantly smallholder agriculture, but opportunities have also been missed on improving the policy-making front in that some of the agro-economics researchers also under the MOA/IAARD system have been wary of opposing populist political programs including the banning of imports, high subsidies on inputs, hostility to foreign agri-business investment, official goals of self-sufficiency in many commodities in which there is no hope of this, and the like; while some careful micro-economic studies of smaller agricultural issues have been done, there has not been sustained criticism of some of the most negative and dangerous ideas in Indonesia's agricultural policy.

The greatest weakness however, has been a paucity of breeding releases usable by the smallholder farmers, and clear strong recommendations on technical packages such as economic rates of fertilizer applications for specific soils and sub-regions. For Indonesia's remaining small farmers to reach the year 2040 in a prosperous state, not only will they need proven, highly-productive technical packages for field and tree crops, animal husbandry (especially small animals), and fisheries, they will need proven farming systems packages which combine all these aspects of agriculture—such as new varieties of soybeans which could effectively replace increasingly expensive fishmeal in animal and fish feed rations, with higher yields of soybean per hectare than produced by the predominantly temperate-zone varieties now in use.

Thus Annex 3 was written to try to spell out a strategy to markedly upgrade Indonesia's agriculture research in the years to come. The strategy starts with a plan (or "Roadmap") for agricultural development, whose formulation is already underway with the help of KADIN (the Indonesian Chamber of Commerce). Before finalization, this Roadmap should be discussed in detail and approved by independent representatives of two critical groups who are not always involved in such discussions—the smallholder farmers who must produce most of the food, and the consumers who must often pay excessively high prices for food thanks to various government policies. These are the people, the majority of Indonesians, who do not get most the subsidies; indeed, they often finance them in one way or another.

It is then recommended that a "coordinating ministry" of the several involved in agriculture, education, science, etc.) be appointed and empowered to push through the long-term program, including the education and training of a new generation of scientific researchers, required to make Indonesia increasingly self-reliant in agricultural innovation and development. One process that is stressed is collaboration with world-class institutions in each specific field important to Indonesian agriculture, wherever they may be found.

Annex 3 makes clear that many of the next generation of agricultural scientists will not be fully or largely occupied in abstract research, but will be using the new generation of laboratories proposed there for operational purposes also—testing for animal and plant diseases, and of inputs, outputs, residues and other pollutants, trials and experiments needed for operational guidance in fisheries and other fields, etc. Thus higher-technology development per se will require a major upgrading of the agricultural research system.

One fundamental scientific area where Indonesia must move forward rapidly is genomics research, where advances in capabilities of organisms are tied to and based on effects of genetic changes. Leaving aside political controversies on commercial treatment of genetically modified crops, the basic contemporary science must become a known and

used tool of Indonesian scientists. One effective approach to achieve this, and to advance Indonesian agricultural science generally, would be to institute various competitive grant schemes, as practiced in developed and emerging countries around the world.

Educating and training (including in overseas venues) the experts who will guide the sector, and equipping the laboratories where they will do their work, will cost money. Indonesia now provides one of the lowest budgets in the world for agricultural science, roughly 0.02% of agricultural GDP, whereas a standard rule of thumb (0.5% of agricultural GDP) would provide 25 times as much. Obviously, well before reaching such a standard rule, there would be plenty of funds for competitive grant schemes as well as overseas education. Another recommended initiative would be organization of proven researchers into strategy teams for major product groups and for critical issues such as climate change adaptation and response, more effective agricultural extension methods, operationalization of genomics methods, etc. For these research coordination and oversight teams to work well, funding will also be needed, but the quid pro quo would be accountability for measurable results.

Specific recommendations for more effective (and cost-effective) agricultural research include:

1. the coordinating ministry for agricultural research and development, whether it is the MOA or another, should establish and adhere to clearer approval processes for import, trials of, commercialization of, newly developed varieties and breeds of plants, animals, and inputs. These processes should be transparent, and decisions should be well-explained to all concerned;

2. to an extent which would not hurt the quality of the research, facilities, funds, and leading staff should be allocated to locations outside Jakarta and West Java (Bogor): many crops, animal species and fisheries are already concentrated far from the capital region, for good reasons of climate, soils, and physical geography, and it is best that research facilities also follow such determinants of comparative advantage; and

3. tariffs and duties should be removed from research equipment and materials, imports of which should be specifically expedited through Customs. This would both practically help accelerate the research effort proposed here, and also signify a new overarching government commitment to agricultural technology enhancement.

Delivery of Improved Agricultural Technology to Small Farmers. Recommendations for improved delivery of useful agricultural technology to the masses of village farmers, i.e., a modernized agricultural extension system, include:

1. Local governments need additional resources to implement the national policy on extension—to ensure one extension worker per village, and to provide IT solutions to strengthen linkages to new technologies. Utilization of the internet by extension workers and farmers should be encouraged to access agricultural technology information.

2. Improve the efficiency in spending by reallocating resources away from administration towards training, technology enhancement, and an incentive system at the district level. A matching grant approach can be used to foster reforms.

3. With the aim of unifying extension services at the district level, the funding responsibility, accountability and direction of contractor extension workers should be fully transferred to the districts. Establish fiscal incentives for these transfers in the form of matching grants for operational costs.

4. The quality of extension services depends greatly on the linkage to new technology and to innovative agricultural research, as well as the quality of extension staff. To facilitate this, in the first instance, promote internet connectivity and better upstream linkages to the R&D institutions and their outputs,

to improve the adoption of new technologies and crop-management techniques.

5. The Agency of Agricultural Human Resource Development (AAHRD), which is the agency within MOA responsible for extension, needs to take the leadership in providing training for all extension workers as part of an overall HR development strategy for extension workers. This needs to be done in close coordination with districts and provinces effectively utilizing the six central-level agricultural extension colleges, the sixteen provincial training centers, universities, as well as the private sector. AAHRD needs to establish sound policy guidelines for a clear career development path that is based on continual training and refresher courses for extension workers. From a medium-term perspective, districts in consultation with AAHRD can set incentives (scholarships, performance assessments by farmers) to recruit and retain better-qualified staff.

6. Finally, the World Bank is funding FEATI to help implement the core part of the above program—it will be important that this gets wider support from the donor community, and a common framework for bringing on a multi-provider model for extension is adopted.

Finally, one finding of research into impacts of decentralization on local economic performance (including agricultural), has been the extremely large impact of the competence and integrity of the local administrators. Thus very heavy emphasis should be placed on the selection of quality local administrators, especially for Eastern Indonesia, their intensive and recurrent training, and their retention through promotions and salary premia for difficult locations.

Climate Change and Food Security

Indonesia is already witnessing the early impacts of Climate Change (CC). Changes in key climate variables in Indonesia are generally in line with global trends and predictions. Temperature rise to 2050 is projected to be modest (around 1 °C) but by 2100 it is projected to be from 2.1 °C to 3.4 °C. Total rainfall is expected on average to increase by 2–3% in the first half of the century and then decrease in the 2nd half. Sea level is projected to rise, with considerable local variations, by up to 70 cm by 2100.

Climate variables affect yield potential of crops and livestock differently in different regions. Projections are that yield potential of most crops and pastures will increase in the mid to high latitudes but decrease in the low latitudes. Thus, overall global supplies of food are not likely to be affected at least to 2050.The impact from these climate threats are likely to intensify. The likelihood of exceeding a 30-day delay in the onset of the monsoon will increase, affecting yields. Production of cereal food crops is projected to decline on average by 0.5%, livestock by 0.6% and fishery by 0.2 % while that of fruits and vegetables is projected to increase by 1%.It is estimated that a 10–15% increase in crop productivity by 2050, would overcome any negative climate change impacts, using known adaptation techniques. Autonomous adaptation measures typically are of the "no-regrets" type: they are good for the sector with or without climate change. They include changes in cropping patterns, dates, varieties, farm and crop management, more efficient irrigation methods, raising walls of fish ponds or changing fresh water intake to deal with salinity.

Government support for autonomous adaptation starts from the timely availability of climate information and strengthening the ability of farmers to use it. This in turn calls for a strong extension system that can effectively promote agricultural adaptive activities to mitigate the impact of climate change. Indonesia's Climate Schools would play a vital role as would increase in investment in agricultural R&D. Change in the design standards of rural roads, irrigation systems, dykes and market infrastructure can help make the sector more climate proof. Adaptation against sea level rise would call for restoring mangroves and for raising dykes.

Some hard investment options can be quite wasteful should the climate risk not materialize. Notably, sea dykes and river embankments cost about $ 0.7–1.5 million per kilometer and can lead to huge expenditures. Cost effective alternatives need to be considered and above all, investment

decisions have to be timed well based on careful monitoring of actual sea level rise.

Estimated potential costs of adaptation for agriculture are simply indicative figures and come to about $5 billion per yea. But risks in agriculture will certainly increase in the form of crop failure and livestock /fishery losses due to increased floods and disease and programs of crop and livestock insurance would be needed to increase resilience of rural communities. Household food insecurity among the poorer populations will increase with delays in the onset of the monsoon and a longer hunger season. Price increase could push more people below the poverty line and there would be a need to strengthen the social safety net.

Systems are needed for prioritizing adaptation options which can take into account the severity, probability, immediacy of the climate threat as well as the costs, cost recovery options and social impact of the adaptation response. Indonesia's newly established Climate Change Trust Fund is establishing criteria and processes for allocating resources for climate protection projects including a system of fiscal transfers to local governments.

Institutional capacity for combating climate change (CC) is being steadily developed, with leadership coming from the President and involving all sectors. Given the heavy emphasis on decentralization, there is an attempt to replicate the national CC architecture at the provincial and district levels. There is still room to better harness national scientific talent into policy making effort and for clarifying the role of different agencies for gathering, analysis, dissemination and actual use of CC data. Similarly, mechanisms for engaging with key sectors at the local government level would need to be strengthened as systems for fiscal transfers to local governments to manage climate change are put into place.

With virtually no progress, especially in developed countries, to reduce Green House Gas (GHG) emissions since Kyoto, the world may well be on the way to a 4–7 °C warming by 2100. With a 3 °C or higher rise, prospects for food production become unfavorable even in the high latitude regions and disastrous in the low latitudes. Indonesia's GHG emissions make it the 3rd largest emitter of GHGs from all sources .Thus, what Indonesia does now to reduce GHG emissions is critical to its own as well as global food security in the 2nd half of the 21st century.

In 2009, Indonesia announced a voluntary commitment to reduce its GHG emissions by 26% by 2020. Nearly 51% of the planned reduction is to come from the forestry sector. Indonesia's forest cover has declined from 162 m ha in 1950 to less than 90M ha now and is being lost at about 1–1.5 M ha per year. Primary cause is planned land conversion to plantations, a sector viewed favorably for its contribution to employment, food security and exports. Global effort is underway to assist Indonesia to create a system for providing incentives to concessionaires and communities to preserve forest carbon through Reduced Emissions for Deforestation and Degradation (REDD). Norway has recently pledged a $1 billion grant to implement REDD. In addition, compliance with EU's timber import rules and US Lacey Act are changing behaviors of large Western markets for Indonesia's timber.

Summary and Conclusion

Primary conclusion of this review is that Indonesia needs to complete unfinished sector reforms and accelerate the uptake of known adaptation technologies to achieve an additional 10–15% increase in agricultural productivity by 2050 to counter projected threats from climate change. Most adaptation can be done autonomously by farmers. However, Government support for planned adaptation is needed in the form of strengthened agricultural research and development and continued support to its Climate Schools. Crop and livestock insurance needs to be considered in view of increased variability and risks. Hard options to build costly dykes and embankments to protect against projected, slow, and long term sea level rise need to be taken at the right time after thorough analysis of options. As institutional capacity is further strengthened, focus needs to be on a system of prioritization of climate related expenditures and on strengthening the technical support to local governments. Finally, ensuring success in Indonesia's efforts to control its GHG emissions, primarily those coming from

deforestation and land use changes will be vital to ensure global food security in the 2nd half of the 21st century.

Chapter 5. Agriculture Vision for 2040: Strategies to Achieve it

Domestic Market Outlook for Selected Commodities

In developing the 2040 vision we considered the global prospects for Indonesia's key commodities. A brief analysis of the 2040 global markets supply and demand conditions for key commodities of interest to Indonesia is included as an annex 8 to the Overview Report. In this section we examine likely responses from local producers to increased demand for food crops and opportunities to increase the exports of tree crops. We started the analysis by using the SUSENAS household survey results for 2010 to prepare data showing per capita annual consumption levels of six key commodities.

We next examined the likely per capita consumption levels (Table 5.1) of these six commodities in 2040 with the aid of the Centennial Group Growth Model.

Specific data taken into account when analyzing future demand consist of: population projections (derived from UN and Government of Indonesia statistics and projections); 2010 per capita consumption of selected commodities that were obtained from SUSENAS data; 2040 per capita consumption of these same commodities shown in Table 5.1 that were derived from the Centennial model; and 2010 cropped areas for these selected commodities obtained from FAOSTAT (Table 5.2). We next translated this per capita demand into a total demand using two different population growth scenarios for 2040, one derived from UN population forecasts that anticipate a continued decline in birth rates culminating in a total population of 290 million, and the second by GOI, which are based on a more gradual decline in population growth and projecting a population of 344 million. These forecasts in turn gave rise to two different total consumption estimates.

The next step was to compute the amount of land currently being used to produce these food items and to calculate the future land requirement to meet the growth in demand. For the purpose of this analysis we assumed that all incremental demand would be produced locally, that there will be no change in agricultural productivity and that there will be no further loss of cropped land to non-agricultural uses. One further important assumption concerned maize production. Indonesia produced about 18.3 million tons in 2010 (4.4 tons/ha) of which only about 400,000 tons is used for human consumption and the balance for animal feed and ethanol. Consumption of maize is expected to decline even further but in light of the expected increase in demand for animal feed and ethanol, we are projecting that the area devoted to maize will remain constant.

FAOSTAT data indicate a total cropped area in 2010 of 20.54 million ha (table 5.2). Over 90% of this area is accounted for by three crops: rice, maize and cassava. Vegetables are the other important crop (nearly 1.0 million ha) but there would seem to be no major issues in finding another 1.0 million ha to satisfy projected demand under GOI's population projections (this could be achieved through higher crop intensity and incremental production on the Outer Islands). Results from the analysis presented in Table 5.2 ndicate a need to increase the total cropped area by 14% and 31%, respectively, under the UN and GOI population projections. As these calculations explicitly show, future population growth rates are going to have a decisive impact on food security in Indonesia. No major issues are anticipated in meeting future demand for food items under the lower population growth rate but the higher one could exert pressures on land resources.

The following paragraphs present a brief summary of the likely outlook for the key food crops in Indonesia.

Table 5.1: Per capita and total consumption

	Consumption (Kg/per capita)			Consumption (million mt)			
	2010	2040	2040	2010	2040	2040	
	Act.	Pessimist	Optimist	Act.	UN	GOI	
Rice	114.3	100.2	87.2	27.7	29.1	34.5	(Pessimistic)
Maize	1.6	0.3	0.2	0.387	0.087	0.103	(Pessimistic)
Vegetables	26.9	32.7	37.5	6.51	10.88	12.90	(Optimistic)
Fruit	9.7	20.7	30.8	2.35	8.93	10.59	(Optimistic)
Cassava	5.4	3.4	2.1	1.31	0.99	1.17	(Pessimistic)
Sugar	7.7	9.1	9.5	1.86	2.76	3.27	(Optimistic)

Source: Centennial Group Estimates

Table 5.2: Required Cropping Area (HA)

	2010	2040 UN-Population	2040 GOI-Population
Rice	13,253,500	13,971,594	16,507,067
Maize	4,234,980	4,236,980	4,234,980
Vegetables	950,000	1,587,710	1,882,490
Fruit	580,000	2,204,000	2,613,700
Cassava	1,183,050	894,060	1,056,620
Sugar	336,000	498,580	590,710
Total	20,537,530	23,390,924	26,885,567

Source: 2010 FAOSTAT; 2040—Centennial Group Estimates

Rice—Forecasts of global rice production and those by ASEAN members point to fairly stable supply conditions (for details see Overview Report Anne 8). In 2010 Indonesian farmers devoted a total of 13.25 million cropped hectares to rice cultivation. Employing Centennial's pessimistic per capita consumption in 2040 (i.e. a slower decline in per capita consumption to 100.2 kg/person), the required crop area will be 13.97 million hectares (assuming no change in yields or cropping intensity) based on the UN population projections (290 million) and 16.56 million hectares based on GOI's population projections (344 million). Indonesia should have no difficulties in meeting its requirements from local production at the lower population projections. However, even assuming that yield increases and intensified cropping intensities will offset the diminishing land on Java, converting some 3.3 million ha additional cropping areas to rice cultivation may not be feasible.

Unlike the analysis of future demand for rice provided above, the government's own analysis assumes a constant per capita consumption level of 139.15 kg/year. When combining this higher consumption level with the higher population projections, the total demand for rice increases from 33.7 million tons in 2011 to 47.9 million tons in 2040 (see Table 5.3). Meeting this level of demand from strictly local production is highly unlikely and the need to rely on imports becomes inexorable. This is yet another factor in favor of abandoning the rice self-sufficiency policy.

Actual conditions may even be worse than the scenario described above since the potential for opening up new rice lands is mostly outside Java where yield levels are

TABLE 5.3: GOVERNMENT OF INDONESIA RICE DEMAND PROJECTIONS 2005–2040

Years	Population Growth (%),	Population (millions)	Consumption (kg/cap/yr)	Rice Demand (million tons)
2005–2010	1.3	233.48	139.15	32.49
2010–2015	1.18	247.57	139.15	34.45
2015–2020	1.06	261.01	139.15	36.32
2020–2025	0.92	273.22	139.15	38.02
2025–2030	0.92	286.02	139.15	39.8
2030–2040	0.92	344	139.15	47.9

Source: BPS Badan Pusat Statistik- Central Agency on Statistics
Note: The BPS figures are only through 2030 and the 2030–2040 projections are Centennial team's extrapolation of the BPS data.

lower. This raises serious doubts about the country's ability to achieve self sufficiency in rice and there may indeed be no option but to rely on imports for part of the production. Fortunately current global projections imply this would be feasible. As for the level of self sufficiencyto strive for, there is no magical number to underpin such a strategy but a possible target will be 90–95% self sufficiency.

Maize—Latest 2010 crop data indicate 4.23 million hectares dedicated to maize production. Considering the projected decline in consumption (from 1.6 to 0.3 kg/person by 2040 under the pessimistic forecast), most of this area could be used for animal feed rather than human consumption. At today's average yield of 4.5 ton/ha, total maize production is around 19 million tons. Only a small fraction (and this is projected to decline sharply) of this total is being consumed by humans and the bulk is (and will continue to be) available as feed for fish, poultry and livestock.

Cassava—Cropping area in 2010 was 1.18 million hectares; with consumption projected to decline from 5.4 to 3.4 kg/person (pessimistic scenario), total demand will decline from 1.2 million ton in 2010 to just under 1.0 million in 2040 under the UN population projection and 1.17 million ton under GOI's population forecast. Thus unless more of it is going to be used for commercial purposes, from a food security point of view there will be no issue in meeting this level of demand from existing crop areas.

Soybean—Indonesia's soybean situation is similar to that of several other major crops in the country (corn, peanuts, even rice). This is a traditional important crop in the country (soybeans consumption is presently around 907,000 tons/year) that is employed in producing common regional foods (tempe in Java, tofu and soy sauce and soybean milk throughout the archipelago). Yields have been fairly stagnant for various reasons that will not be easy to overcome or compensate for. Soybean is also important for indirect uses (animal feed) and as a source of edible oil. The world market in the commodity is huge—(265 million tons in 2010) but concentrated in few countries; the USA, Brazil, and Argentina produce 150.3 million tons or 57% of global supply, which does introduce some element of drought and disease risk, but the probability that there would ever be insufficient world supplies to fulfill an Indonesian deficit (probably no more than one million tons) at a reasonable price would be very small. This is an argument against expensive special programs promoting local production.

Japan is a case of a large and advanced East Asian nation, in which soybeans traditionally played the same role as they do now in Indonesia. Today, Japan produces only 220,000 tons of soybeans, or 3–5% of all soybean needs, at quite low yields, little higher than Indonesia's. U.S. soybeans, typically genetically modified, supply the 2/3 of Japan's market represented by animal feed, while China and Canada have supplied the non-biotech beans for human food use. It is recommended that Indonesia follow the same route as Japan has, and it is assumed that the same level of non-rice food security will thereby be achieved.

2040 Vision

An optimistic vision of Indonesian agriculture in 2040 will include a smaller agricultural labor force than at present, perhaps involving 15 percent of the total labor force, older than in the urban areas, which by then will likely claim 68 percent of the population. Given major simplification, improvement, and coverage of the national land service some consolidation in ownership (through sales) and operation (through leases, especially among family members and village neighbors) will have taken place through market transactions; however, smallholdings will still be the dominant ownership pattern, with typical Javanese holdings between 0.4 and 0.8 ha, and Outer Island holdings in the 3–6 ha range. One reason for the persistence of this pattern is the relatively slow development of alternative residential options for older citizens; the small homestead will serve this function, as well as the home of one offspring electing to carry on farming (and elder care) and the family center for "pilgrimage holidays" such as Hari Raya Puasa (Id ul Fitri), when all family members are expected to return home.

Agricultural growth in the Outer Islands will have been largely carried by tree crops for export, with oil palm overwhelmingly dominant, with over 15 million ha producing nearly 90 million tons of crude palm and kernel oil, or about half the world's edible oil. This result would be directly due to a government managed replanting program for smallholders. Based on grants to planters at appropriate stages of tree life, and financed by an export "cess," the program would preserve the impressive base established by 2010, and permit continued expansion. By 2040 some of this land should also be devoted to intercropping, including to leguminous forage for cattle, as well as some of the 10 million ha under rubber, coconuts, and smaller trees like coffee and cocoa. Each of these crops will have an individually tailored replanting program, based on grants to smallholders from earmarked fiscal financing, mainly through export taxes of various sorts.

Agriculture on Java will continue to be more complex than on the Outer Islands, but will also be more complex than at present due to continued development of food tastes among the population. First, rice consumption will have declined to about 87 kg/capita; thus even with GOI's population projections (344 million), about 30 million tons of rice will be needed, which is just 10 percent more than today. Thus, even with loss of paddy land to other crops and other uses, the average yearly production may be closer to consumption than today (with slow increases in yield), and may even reach or exceed self-sufficiency in some years.

The goal of rice self-sufficiency has been abandoned for decades, and with it the extremely high domestic prices that cause considerable welfare loss today. The main support by government has resulted in markedly improved irrigation facilities over the 7 million ha that also provide, where possible, municipal and industrial water and flood control to the general population.

The rice import monopoly has been replaced by dozens of certified private importers franchised to import rice (and purchase domestically) in any quantity.[1] As per other transport reforms, imports of rice are possible in every port in Indonesia, with no mandates to transship via Jakarta or Surabaja. This in turn reduced prices to consumers throughout the country, and improved food security in more remote locations (e.g., the Eastern Islands). A smaller BULOG will serve as a buffer stock agency holding 1–2 million tons at all times as an emergency reserve. The larger reserves will be maintained by the trading community and the farmers themselves. BULOG would handle many of the government's own institutional needs for rice through the normal turnover practiced by any stockholding entity, but in general would function as one more competitor in the rice trade. The stock mentioned is well distributed around the country, and is more than sufficient to break any hoarding strategy of any market players, or unintentional panic behavior.

A considerable area of irrigation, especially on Java, is in very small schemes (smaller than 100 ha, averaging about 30 ha in size) that total about 500,000 ha. Many of these areas will not be viable in the long run for rice production due to the limited scope for economies of scale in mechanization, harvesting, marketing. On the other hand, for horti-

1 This is the Centennial team's vision that may not necessarily correspond to the vision of the Indonesian Government.

culture such areas are large, providing both efficient scales of production and good water control that is required by most horticulture crops. These "pocket irrigation schemes" have become highly effective bases for horticultural cooperatives at the village level, with a natural grouping of production; it is here where government programs promoting such organization and investment, and the entry of private joint venture partners, will be focused in the decades to come.

Fish production and consumption is considerably greater than today, averaging about 28 kg/capita. While marine catches have leveled off at 2010 levels, due to careful conservation management of various coastal resources, growth was provided by aquaculture. This was carried forward by investments by large international and smaller domestic firms, often in joint venture with coastal villages with implied rights to stretches of coastline, important for development of high-value mariculture species.

Further protein diversity is being provided by rapid development of both industrial and advanced village poultry production systems, which will underpin continued growth in egg and layer meat production. Beef production, focused on finishing imported weaners, has risen to levels several times the very low 1–2 kg/capita of 2010, with little government interference. However, beef is still not a major element in the Indonesian diet.

This optimistic scenario, would not only result in positive welfare outcomes for the general population and the rural community, but would also cost the government much less money than now, due to today's confused policies.

Annex 1—Centennial Group Growth Model

Concepts Underlying the Macro Model and Scenarios[1]

Productivity Convergence

A wide body of research has shown that some growth differences between emerging market countries can be successfully modeled by dividing them into two groups: 'converging' countries with rapid growth and 'non-convergers' stuck in the middle income trap.

The 'convergence' idea is this: It has been observed that the convergers' incomes catch up to those of global best practice over time, and that convergers with lower incomes converge more quickly. Three main forces drive convergence: First, open economy forces yield convergent growth if poorer countries focus on their comparative and factor advantages and then trade with nations lacking those factors, e.g., cheap labor. This leads to more equal cross-country factor prices. Second, capital deepening boosts growth more in countries with lower ratios of capital to skilled labor (usually the poorer ones) due to the nature of diminishing returns.

The third force is productivity convergence. Here it is the TFP of convergers that catches up to that of best practice, with those further behind in TFP converging faster. This phenomenon reflects technology leap-frogging, technology transfers, shifting underemployed agriculture workers to efficient export-led manufacturing, transferring child laborers into schools, a steady increase in the average level of literacy, building roads to connect the unconnected to markets, and the diffusion of management and operational research from more advanced countries. It appears that countries can shortcut productivity-improvement processes by learning from economies that are already at the productivity frontier.

Middle Income Trap

However, as suggested by the records of many middle-income countries around the world, it is difficult (but possible) to avoid a stagnation in growth after a fast-growing economy reaches middle-income status. This stagnation has been termed the 'middle income trap' and results from an inability to make some difficult—yet critical—structural adjustments to the growing economy. Once the rural workers have been shifted, the labor-capital ratio approaches that of developed nations, educational attainment reaches higher levels, the old-age dependency ratio increases, everyone is connected by physical infrastructure, and productivity approaches best practice levels—so that importing foreign technology offers only small benefits—the strategies above no longer reap rewards. For example, moving from a BA to MA offers a smaller boost than moving from illiteracy to literacy.

The critical question in this context becomes the following: how have some countries managed to avoid the middle income trap?

Across the world, maintaining high growth after reaching middle-income status has required a change in approach, shifting focus from low-wage, export-led manufacturing to a knowledge-based society with strong domestic demand and a large middle class. Once a fast-growing country's citizens reach middle-income status, they will no longer accept wages low enough for low-wage manufacturing to be internationally competitive. The economy must become more dependent on innovation and differentiation, transitioning from input-driven growth to productivity-driven growth, but this cannot happen without developing advanced educa-

1 This subsection is taken from Kohli, Szyf, and Arnold (2012).

tional institutions, efficient financial systems to allocate resources, reliable public safety and pleasant living areas to attract mobile skilled workers and prevent a 'brain drain', skill-training programs and social safety nets, affordable housing, sufficient and wise investment, elimination of corruption and inappropriate regulations, and free information flows. If countries cannot change their economic strategies and move up the value chain, they find themselves stuck in the middle—between rich countries that have the legal and financial base to allow for economic growth through high-value innovations and poor countries that are globally competitive because labor and other input costs are low.

These concepts of convergence and the middle income trap drive the productivity component of the model and form the basis for our alternate growth scenarios for Indonesia, the Philippines, and Vietnam.

Estimating Future GDP[2]

To estimate the total GDP of each country through 2040, the model uses the following Cobb-Douglas function, with α equal to 2/3:

$$GDP = TFP \times L^{\alpha} \times K^{1-\alpha}$$

GDP figures are generated for three different measures: real GDP (constant 2010 dollars); PPP GDP (constant 2010 PPP dollars); and GDP at market exchange rates (explained in Section 1.4).

Our units to measure labor force are the number of workers economically active each year. Labor force growth stems from population growth and from changes in labor force participation rates. Labor force participation rates are projected separately, by gender, for seven age cohorts (15–19, 20–24, 25–29, 30–49, 50–59, 60–64, and 65+), using a separate auto-regression for each cohort. The labor force in each of the fourteen age-gender cohorts equals the number of individuals in that cohort times the participation rate for that cohort. Male rates are projected directly; female rates are derived by projecting the difference between male and female rates.

For the Philippines and Vietnam, population estimates are taken from the United Nations. For Indonesia, we have two different population scenarios: one from the UN, and the other from a country source.

Capital stock is projected by applying yearly investment and depreciation to each year's stock, beginning with an initial stock derived using the Caselli method. For each country, a quota is set so that its investment rate (over historical years and projected years combined) cannot remain above 30 percent (as a share of GDP) for more than 35 years. Once it reaches its quota, its rate linearly decreases to 30 percent over 10 years. And for countries with rates below 20 percent, the rate tapers up over time, reaching 20 percent in 2020.

Finally, TFP is estimated using the following equation:

$$TFPGrowth_{i,t} = DefaultRate + CB_{i,t} - FP_{i,t}$$

where i is the country, t is the year, DefaultRate represents the expansion of the global productivity frontier (1 percent), CB is the convergence boost benefiting 'converging' countries, and FP is the penalty suffered by fragile states (–1.8 percent).

The convergence boost is defined as follows:

$$CB_{i,t} = c_{i,t} \times BoostCoefficient \times ln\left(\frac{TFP_{USA,t-1}}{TFP_{i,t-1}}\right)$$

where i is the country, t is the year, BoostCoefficient is the convergence coefficient (0.0269), TFP is the total factor productivity, and c takes a value between 0 and 1 and identifies whether the country is treated as a converger (c=1), as a non-converger or fragile state (c=0), or as in an intermediate position (0<c<1), wherein the country is experiencing some, but not all, of the convergence boost.

For non–developing-ASEAN countries, the classification of whether the model treats them as convergers, non-converg-

2 Subsections 1.2, 1.4, and the middle of 1.5 are taken from or based on Kohli, Szyf, and Arnold (2012), where further details may be found, and Kohli (2011). Kohli, Harpaul Alberto. (2011). Model for Developing Global Growth Scenarios. In Harinder Kohli, Ashok Sharma & Anil Sood (Eds.), Asia 2050: Realizing the Asian Century. New Delhi: SAGE.

ers, or failed states may be found in Annex 1 of Kohli, Szyf, and Arnold (2012).

For developing ASEAN countries, their classification as convergers or non-convergers constitutes the most important difference between the optimistic and pessimistic scenarios.

The Macro Scenarios: Optimistic and pessimistic

In all cases, the differences between the scenarios consists in the values chosen for c in equation 3.5.1 (which affects productivity growth) and the investment rate. The precise definitions for each scenario for country are as follows:

Indonesia: In both scenarios, Indonesia starts out as a converger, continuing its overall success over the past two decades. In the optimistic scenario, this status remains unchanged through 2040, which corresponds to the c n Equation 3.5.1 remaining 1 for all years. But in the pessimistic scenario, beginning in 2017, it gradually begins to lose most of its convergent status, reaching a minimum c of 20 percent (meaning it is treated as in an intermediate position between convergence and non-convergence, in this case reaping just 20 percent of the convergence boost) in 2024 and continuing at that level through 2040.

As we also have two population scenarios, this yields four macro scenarios (identified in §1.8).

Table A1.1 provides the full details of Indoesnia's secario specifications. All other parameter values are as given earlier in this annex and Kohli, Szyf, and Arnold (2012), which is also the source of the investment rate given in the table.

Philippines: In both scenarios, the Philippines starts out as a non-converger. In the pessimistic scenario, it maintains this status through the end of the time period, and its investment rate gradually falls, reaching 15 percent in 2025 and through 2040. But in the optimistic case, it begins to experience increasing portions of the convergence boost beginning in 2014, reaching a c of 40 percent by 2022 and through 2040. In addition, in this optimistic case it enjoys the new-converger investment boost described in Kohli,

Table A1.1: Indonesia's scenario specifications

year	c (opt)	inv (opt)	c (pess)	inv (pess)
<=2016	1	25.45%	1	25.45%
2017	1	25.45%	0.97	25.45%
2018	1	25.45%	0.84	25.45%
2019	1	25.45%	0.72	25.45%
2020	1	25.45%	0.59	25.45%
2021	1	25.45%	0.47	25.45%
2022	1	25.45%	0.36	25.45%
2023	1	25.45%	0.25	25.45%
2024+	1	25.45%	0.2	25.45%

Source: These are the scenario definitions being presented in this section of this annex.

Szyf, and Arnold (2012),[3] rising to 24 percent by 2020 and then falling back down to a plateau of 20.12 percent by 2035. This investment boost is needed in order for the country to transition from being a non-converger to being a converger.

Table A1.2 provides the full details of the Philippines' scenario specifications. All other parameter values are as given

Table A1.2: Philippines' scenario specifications

year	c (opt)	inv (opt)	c (pess)	inv (pess)
2013	0	20.68%	0	20%
2014	0.35	21.71%	0	19.5%
2015	0.4	22.75%	0	19%
2016	0.45	23.79%	0	18.5%
2017	0.5	23.84%	0	18%
2018	0.6	23.89%	0	17.5%
2019	0.6	23.95%	0	17%
2020	0.6	24%	0	16.5%
2021	0.6	23.74%	0	16%
2022–2024	0.6	23.48%	0	15.5%
2025–2034	0.6	declines each year	0	15%
2035+	0.6	20.12%	0	15%

Source: These are the scenario definitions being presented in this section of this annex.

3 Kohli, Harpaul Alberto, Szyf, Y. Aaron, & Arnold, Drew. (2012). Construction and Analysis of a Global GDP Growth Model for 185 Countries through 2050. Global Journal of Emerging Market Economies, 4(2), 91–153.

earlier in this annex and Kohli, Szyf, and Arnold (2012), which is also the source of the optimistic scenario's investment rate, based on the invstment boost for newly converging countries.

Vietnam: Although Vietnam has traditionally been considered a converger, in the past few years its TFP growth has slowed. Therefore, in both scenarios, for 2014 Vietnam is made to benefit from only 70 percent of its convergence boost (a c of 70 percent). In the optimistic scenario, it gradually increases the share of its convergence boost it enjoys from 70 percent to 100 percent, regaining its fully convergent status in 2027. But in the pessimistic case, it gradually loses more and more of its convergence boost, reaching a thereafter-permanent low of a c of 20 percent in 2021. In addition, in the pessimistic case, its investment rate falls much faster than in the optimistic case (wherein it decreases after reaching the 35-year quota described above). As a point of comparison, in the optimistic scenario it does not fall to 35 percent until 2040 but in the pessimistic scenario it has already fallen to 35 percent by 2022.

Table A1.3 provides the full details of Vietnam's scenario specifications, except for the post-2027 investment rates, which equal the lower of 33.5% and the rate determined by the methodology in Kohli, Szyf, and Arnold (2012), which is also the source of the investment rate given for the optimistic scenario and pre-2020 for the pessimistic one.

Rest of Developing ASEAN: n the optimistic scenario, Cambodia, Malaysia, and Thailand are convergers throughout the entire time period; Laos and Myanmar begin as non-convergers but gradually begin converging, with an investment boost, in 2015 and 2017, respectively, according to the process detailed in Kohli, Szyf, and Arnold (2012).[4] In the pessimistic scenario, Malaysia (given its high income) remains a converger and Myanmar and Laos remain non-convergers throughout the time period; Cambodia and Thailand fall into the middle income trap according to the timetable explained in Kohli, Szyf, and Arnold (2012).[5]

Table A1.3: Vietnam's scenario specifications

year	c (opt)	inv (opt)	c (pess)	inv (pess)
2013	1	38.14%	1	38.14%
2014	0.7	38.14%	0.7	38.14%
2015	0.715	38.14%	0.63	38.14%
2016	0.72	38.14%	0.56	38.14%
2017	0.725	38.14%	0.5	38.14%
2018	0.7	38.14%	0.44	38.14%
2019	0.82	38.14%	0.38	38.14%
2020	0.83	38.14%	0.3	37%
2021	0.85	38.14%	0.2	36%
2022	0.85	38.14%	0.2	35%
2023	0.88	38.14%	0.2	34%
2024	0.9	38.14%	0.2	33.5%
2025	0.93	38.14%	0.2	33.5%
2026	0.99	38.14%	0.2	33.5%
2027–2036	1	38.14%	0.2	33.5%
2037	1	37.32%	0.2	33.5%
2038	1	36.51%	0.2	33.5%
2039	1	35.70%	0.2	33.5%
2040	1	34.88%	0.2	33.5%

Source: These are the scenario definitions being presented in this section of this annex.

GDP at Market Exchange Rates

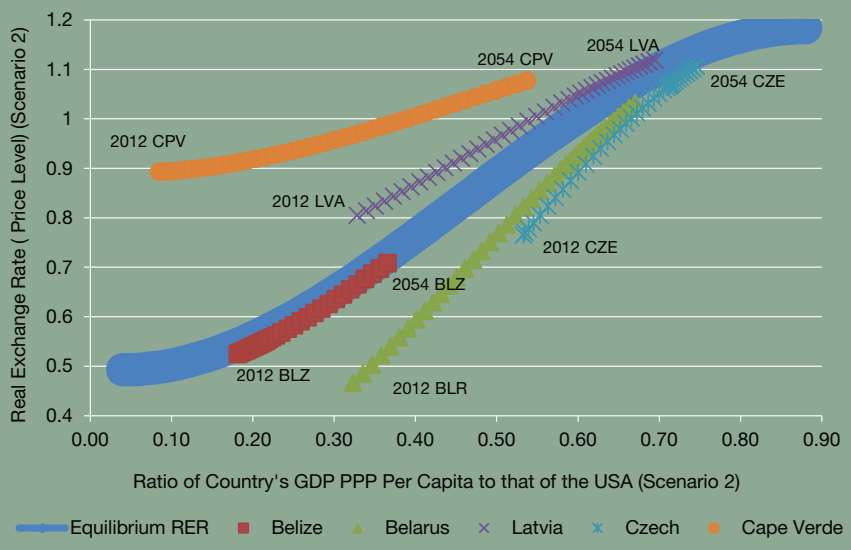
As countries grow richer, over time periods of 10 years or more, their real exchange rates (RERs) tend to appreciate. This gives them an even larger share of the global economy, increases their weight in trade, and increases the international purchasing power of their citizens. To capture this effect we generate a measure of GDP at market exchange rates, which serves as our proxy for nominal GDP.

For the historical observations we create the GDP at MER measure by taking away US inflation relative to 2010 from each country's nominal GDP and leaving in exchange rate differences. But for the future we project this indicator by inflating a country's estimated real GDP (at constant 2010 dollars) by its expected real exchange rate appreciation.

Our first step in estimating future RERs is to derive the following equation to establish a theoretical equilibrium relationship between a country's RER and its PPP income relative to that of the US:

4 Ibid.
5 Ibid.

FIGURE A1.1: EQUILIBRIUM RELATIONSHIP AND MOVEMENT OVER TIME



Source: Kohli, Szyf, and Arnold (2012)

$$RER_{i,t}^{EQ} = \frac{PPP_{i,t}}{e_{i,t}} = .498 - .255\left(\frac{GDPPC_{i,t}}{GDPPC_{US,t}}\right) + 3.23\left(\frac{GDPPC_{i,t}}{GDPPC_{US,t}}\right)^2 - 2.34\left(\frac{GDPPC_{i,t}}{GDPPC_{US,t}}\right)^3$$

where i represents the country, t the year, PPPi the country's PPP conversion factor relative to the US (US$=1), ei its exchange rate relative to that of the US, GDPPCi its GDP PPP per capita, and GDPPCUS the US's GDP PC. Then, using the following equation, each country's modeled exchange rate converges (see figure) towards the value that corresponds to its income in this equilibrium equation:

$$\ln(C_{i,t}) = \beta_1 \times \ln(C_{i,t-1}) + \beta_2 \times \ln(CappedGDPPC_{i,t}) + \beta_0 + \varepsilon_{i,t}$$

where RERi,t is the modeled value of country i's real exchange rate at time t and RERi,tEQ is the equilibrium RER of country i at time t predicted by the previous equation.

Figure A1.1from Kohli, Szyf, and Arnold[6] illustrates both the equilibrium relationship and the movement over time of example countries' rates.

MEASURES RELATED TO INCOME DISTRIBUTIONS

The final aspect of the macro model used in this study is estimates of income classes and median and percentile consumption. The first step in this process is to estimate per capita total consumption.

We calculate consumption in constant PPP international dollars (both for base year 2010 and base year 2005) as the GDP PPP PC times the share of GDP spent on consumption. To estimate the latter, we begin with the historical series of the ratio of consumption to GDP from the Penn World Table (Heston, Summers, & Aten, 2009).7 We then estimate future consumption using the following autoregression across all countries and years:

$$RER_{i,t} = RER_{i,t-1} + \left(1.184 - RER_{i,t-1}\right) \times \left(\frac{RER_{i,t}^{EQ} - RER_{i,t-1}^{EQ}}{1.184 - RER_{i,t-1}^{EQ}}\right)$$

where i is the country, t is the year, C is the share of GDP spent on consumption, CappedGDPPC is the minimum of $50,000 and the GDP PPP PC in constant 2010 PPP dollars, the βs are the coefficients, and ε is the error term.

6 Kohli, Harpaul Alberto, Szyf, Y. Aaron, & Arnold, Drew. (2012). Construction and Analysis of a Global GDP Growth Model for 185 Countries through 2050. Global Journal of Emerging Market Economies, 4(2), 91–153.

7 Heston, Alan, Summers, Robert, & Aten, Bettina. (2009). Penn World Table Version 6.3. Retrieved 8/10/2010, from Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania.

To estimate the sizes of the lower, middle, and upper classes, the model calculates what share of the population is between certain income cutoffs (middle class is $10.80 to $100 of consumption a day using constant 2010 PPP dollars). As a country's total income increases, more people with small shares of the country's total will attain higher living standards. We use a type of income distribution curve called a GQ Lorenz curve (Kohli, Szyf, & Arnold, 2012). We calculate these shares using the following GQ-Lorenz-based headcount function (the share of the country's population below per capita income level z in a given year):

$$H(z) = -\frac{1}{2m}\left(n + r \times \frac{\left(b+\frac{2z}{\mu}\right)}{\sqrt{\left(b+\frac{2z}{\mu}\right)^2 - m}}\right)$$

where H(z) is the headcount index, μ is the country's mean consumption level per capita in 2010 PPP dollars, and the other letters are parameters that describe the shape of the income distribution (Kohli, Szyf, & Arnold, 2012), with values taken from Povcal (World Bank Development Research Group, 2011).[8]

For our food consumption model, we will also need to calculate percentile incomes, that is, what is the income (or consumption level) so that a given percentage of the population lives under that level. For percentile pct, the following equation identifies below which income level it is that pct% of the population lives:

$$\theta \times H(z) \times (1 - H(z)) \times \left(\frac{\gamma}{H(z)} - \frac{\delta}{(1-H(z))}\right) = 1 - \frac{z}{\mu}$$

where GDPPC is either the income or consumption level per capita, pct% is the percentage of the population, and the other terms are the same as in the previous equation.

The model also generates poverty measures for all ASEAN countries except Myanmar. However, the GQ Lorenz curve (and hence the headcount formula above) is not as accurate for extremely low incomes (Kohli, Szyf, & Arnold, 2012), and so we must use the Betz Lorenz curve. Using the Beta Lorenz, the poverty headcount ratio (what percent of the population lives below the poverty line) is the value of H(z) that makes the following equation true (Datt, 1998):[9]

$$\theta \times H(z) \times (1 - H(z)) \times \left(\frac{\gamma}{H(z)} - \frac{\delta}{(1-H(z))}\right) = 1 - \frac{z}{\mu}$$

where Θ, γ, and δ are the parameters that characterize the income distribution (with values taken from Povcal (2012)), z is the poverty line ($1.25 per day, measured in constant 2005 PPP dollars), and μ is the country's mean consumption level per capita in constant 2005 PPP dollars.

This headcount index tells us how many poor there are, but not how poor they are. A country with all the poor living just below the poverty line would get the same score as a country with the same rate of poverty but with most of the poor living on incomes below half the poverty level.

To estimate the magnitude of poverty, we use the poverty gap. This takes into account how far below the poverty line the average poor person is. More precisely, it measures what share of the society's resources would have to be transferred to the poor to eliminate poverty. The poverty gap equals

$$PG = H - \frac{\mu}{z} \times \left(H - \theta \times H^{\gamma} \times (1 - H)^{\delta}\right)$$

where z is the poverty line and H is the H(z) defined in the previous equation (Datt, 1998).

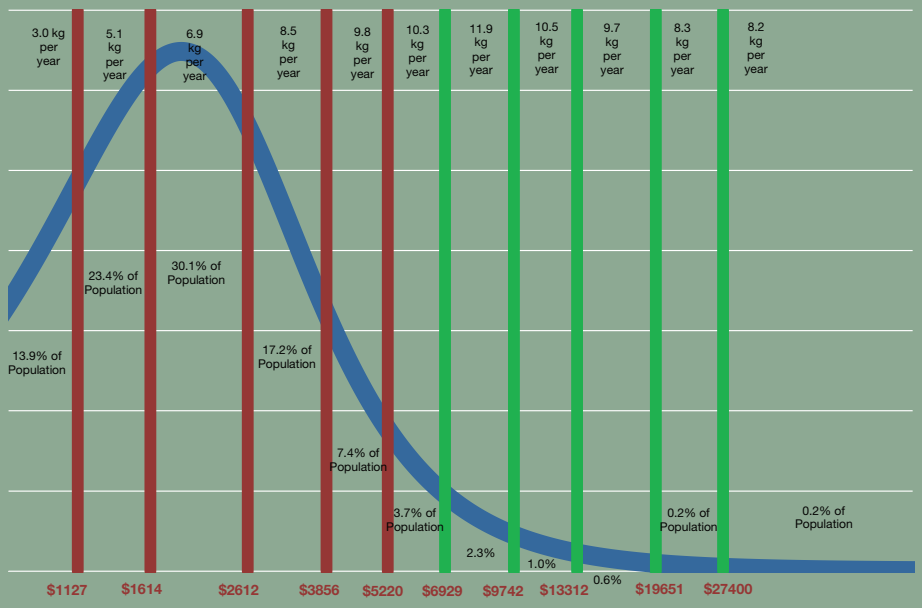
However, for the Philippines 2040 estimates, we do not use the above equations for the poverty gap and headcount because its Beta Lorenz curve is not valid (Povcal, 2012). Instead, we use the GQ-Lorenz headcount function above and the poverty gap equation given in Kohli, Szyf, and Arnold (2012).[10]

8 World Bank Development Research Group. (2011). PovcalNet. Retrieved 12/13/2010 http://go.worldbank.org/WE8P1I8250

9 Datt, Gaurav. (1998). Computational Tools for Poverty Measurement and Analysis. FCND Discussion Papers, 50. Retrieved from http://www.ifpri.org/publication/computational-tools-poverty-measurement-and-analysis

10 Kohli, Harpaul Alberto, Szyf, Y. Aaron, & Arnold, Drew. (2012). Construction and Analysis of a Global GDP Growth Model for 185 Countries through 2050. Global Journal of Emerging Market Economies, 4(2), 91–153.

FIGURE A1.2: POPULATION DISTRIBUTION BY INCOME (BLUE) AND EGG CONSUMPTION: INDONESIA 2010



Source: Centennial Model

FOOD CONSUMPTION MODEL

For each food commodity, future consumption is estimated as follows: a table is formed showing, for a set of 9 to 11 consumption income group cohorts, how much of that commodity the average member of each cohort eats. (This pattern already takes into account urban-rural differences.) For each year, the macro model computes what fraction of the population is in each cohort. The final per capita food consumption number equals the weighed average of how much each cohort consumes, weighed by each cohort's share of the total population. As the country grows richer, the number of people in each cohort changes, and so the country's average consumption changes, as illustrated in the following two charts for egg consumption in Indonesia.

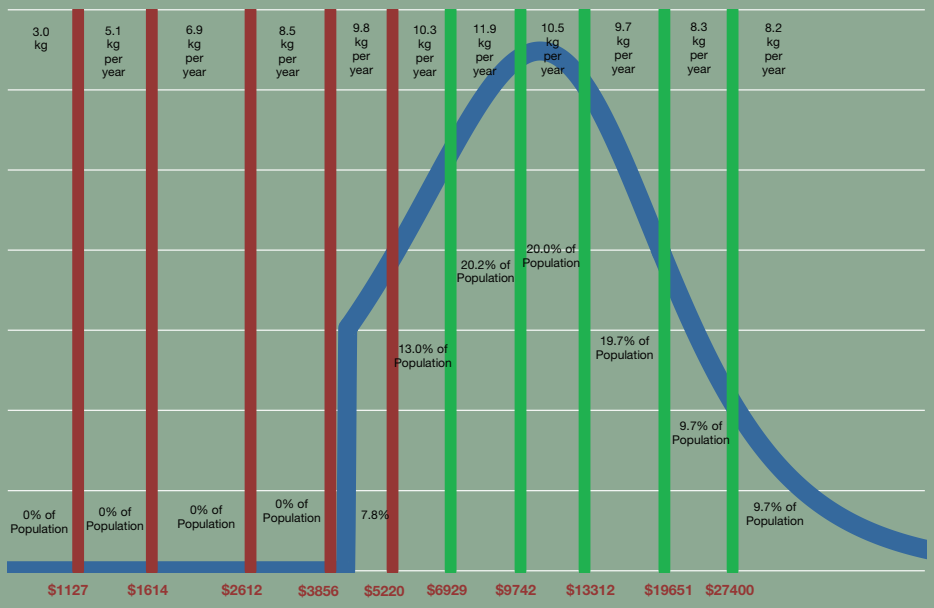
In each chart, the horizontal axis represents a person's consumption income per year, in 2010 PPP dollars (as we will see below, we use PPP because we will be extrapolating between different countries' experiences of how much food each eats, for which PPP is a better measure). The blue line represents a population density function: what the probability is that a random person in the country will have that level of consumption. (The vertical axis values are arbitrary and are not shown.) The higher the value of the blue line, the more people in the country have the consumption level indicated by the corresponding value of on the x axis.

The red and green lines demarcate the different cohorts we use, each cohort defined as a range of possible consumption levels. For example, the second cohort contains everyone with a consumption level between $1,127 and $1,614 a year. As will be explained below, the red lines indicate cohorts derived from the actual 2010 or 2006 historical household consumption data and green ones are constructed based on estimates of possible 2040 (optimistic scenario) outcomes.

For each cohort, at the top of the chart appears how many kilograms of eggs the average person in that cohort eats a week. For example, for the $1,127 to $1,614 cohort the value is 0.426 kg.

Finally, towards the bottom of the graph appears the percentage of the population in that cohort. This simply equals the area on the graph that is under the blue curve and between the upper and lower vertical lines demarcating the cohort (more precisely, this equals the integral of the blue curve between the two demarcating vertical lines). There-

Figure A1.3: Population distribution by income (blue) and egg consumption: Indonesia 2040 (opt.)



Source: Centennial Model

Table A1.4: Indonesian eggs

income range	< $1127	$1127–$1614	$1614–$2612	$2612–$3856	$3856–$5220	$5220 +
KG eggs/year	3.0	5.1	6.9	8.5	9.8	10.6
2010 population share	13.9%	23.4%	30.1%	17.2%	7.4%	8.0%
2040 (opt.) pop. share	0%	0%	0%	0%	7.8%	92.2%

Source: Centennial Model

Table A1.5: Singapore's eating habits

	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
	< $6353	$6353–$10417	$10417–$15470	$15470–$24271	$24271 +
KG eggs/year	4.9	5.6	5.0	4.6	3.9

Source: Singapore Household Expenditure Survey and Centennial Model (for quintiles)

fore, the $1,127 to $1,614 cohort contains 23.4 percent of Indonesia's 2010 population.

In the first chart, when we take a weighed average of each cohort's egg consumption, weighed by each cohort's share

Table A1.6: Inter-cohort ratios

cohort #	1	2	3	4	5	6	7	8	9	10 (& 11)
orig IDN cohort	<$1127	$1127–$1614	$1614–$2612	$2612–$3856	$3856–$5220	$5220+				
KG eggs/year	3.0	5.1	6.9	8.5	9.8	10.6				
SGP cohort						<$6353	$6353–$10417	$10417–$15470	$15470–$24271	$24271+
SGP eggs/yr						4.9	5.6	5.0	4.6	3.9
ratio of SGP quintile's KG eggs to previous quintile's							1.1= 5.6/4.9	0.9= 5.0/5.6	0.9= 4.6/5.0	0.8= 3.9/4.6
new IDN cohort	<$1127	$1127–$1614	$1614–$2612	$2612–$3856	$3856–$5220	$5220–$6929	$6929–$9742	$9742–$13312	$13312–$19651	$19651+
share of 2010 IDN population	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	3.7%	2.3%	1.0%	0.6%	0.4%
new KG eggs/yr value	3.0	5.1	6.9	8.5	9.8	10.3	11.9	10.5	9.7	8.3
new KG eggs/yr formula	3.0	5.1	6.9	8.5	9.8	x	x*1.1	x*1.1*.09	x*1.1*.09*0.9	x*1.1*.09*0.9*0.8

Source: SUSENAS (Indonesia), Singapore Household Expenditure Survey, and Centennial Model

of the population (the area under the curve), we reach an average of 6.7 kg per year.

But in the following graph, representing 2040's optimistic scenario, the average is 10.1 kg per year. The only difference between the two graphs is the income distribution. The cohort definitions (and corresponding vertical lines) and cohort quantities eaten are exactly the same. But as the blue curve moves right over time (indicating more prosperity), more of the population falls into the higher cohorts and less into the lower.

This model is therefore an application of the macro model to an estimate of the country's food eating patterns by consumption cohort. These patterns are determined as follows:

We begin with the historical household consumption surveys (broken down by consumption income cohort) collected for each country. (For fish in Indonesia and fish, meat, eggs, roots, vegetables, fruit, and corn in the Philippines, we make adjustments based on other country sources.) For Vietnam and the Philippines, the cohorts are given as quintiles. For Indonesia, a different percentile distribution is provided. For Indonesia we use the 2010 SUSENAS, for Vietnam the 2010 GSO household survey, and for the Philippines the 2006 household survey.

As our consumption model depends on having absolute dollar cutoffs for cohorts, not percentiles, we use the macro model to translate quintiles or other percentiles into dollar amounts. In our example of Indonesian eggs, that gives us the following pattern, with these cohort cutoffs drawn in dark red in the two graphs above. (As said, the green cutoffs above are not based on the historical data.)

But although this division into cohorts gives an acceptable level of detail to analyze 2010 eating habits, it does not provide a useful level of resolution for the 2040 optimistic scenario: there, 92% of people fall into the top red cohort. In other words, if we were to remove all the green lines from the graph above (all cohorts defined in the actual SUSENAS are drawn in red), our methodology would not be very useful. If we are to understand the national eating habits as the result of the population being distributed into a changing mix of the fixed cohorts (which also already reflect urban

and rural differences), not much change or information can be gleaned for 2040 if the top cutoff is $5,220.

However, our actual historical data for Indonesia does not report any cohort cutoffs above this. That is why the right half of the charts has only green lines, not red ones. If we are to have enough detail through our cohort demarcations to estimate future consumption, we will have to derive richer cohorts' eating habits from elsewhere, thus letting us decompose the richest SUSENAS cohort ($5,220+) into smaller cohorts.

We use comparator countries for this purpose. But because culture is different in other countries, we do not directly use our comparators' eating patterns. Instead, we use the following extrapolation procedure, again illustrated using Indonesia and eggs, for which we use a single comparator: Singapore.

Singapore's egg-eating habits for 2008 are:

As with the Philippines and Vietnam, the Singapore cohort data comes in the form of quintiles and not dollar ranges. We derive the dollar cutoffs via our macro model and its income distributions.

To use Singapore's data in order to estimate the behavior of Indonesia's richer cohorts for which we do not have Indonesian data, we create new richer Indonesian cohort demarcations by taking quintiles and deciles of the 2040 optimistic scenario and then construct the table below. (Note that to simplify the following explanation, we aggregate our 10th and 11th Indonesian cohorts into one)

In the below table, we very roughly line up the Singapore cohort cutoffs with our new Indonesian cohorts (the green lines in the charts above). If we were to directly apply the Singaporean eating habits to Indonesia—which we do not do, because of cultural differences—then we would take the Singaporean 5.6 value for our cohort 7. But as seen, we use a value of 11.9 instead.

To derive that, we take the ratio of many kilograms of eggs our approximate cohort 7 consumes in Singapore to how many our approximate cohort 6 consumes there, and then we multiply that by the actual kilograms of eggs consumed by Indonesia's cohort 6.

Likewise, to estimate Indonesia's cohort 9 egg consumption, we take Singapore's egg consumption ratio between cohorts 8 and 9 and then multiple Indonesia's cohort 8 egg consumption by that ratio.

Data permitting, for all countries and commodities, we employ this technique of applying the richer countries' inter-cohort ratios to our countries. As our comparators, we use Singapore and Japan, sometimes choosing one and sometimes taking their average.

One step is missing. We have established the relative values between cohorts 6, 7, 8, 9, and 10/11 based on this ratio-extrapolation method, but this does not give us the absolute values.

This is because we want our new eating pattern to be fully consistent with the real household survey table for 2010. What we have just done is decompose the richest cohort from the SUSENAS into subcohorts. We want the weighted average of our new sub-cohorts to equal the 10.6 SUSENAS value for the richest cohort.

For this we use the last line of the table. In it, the kg of eggs per year is expressed in terms of an unknown number x and the ratios derived from Singapore. We therefore search for the x that makes the weighed average of cohorts 6, 7, 8, 9, and 10/11 (weighed by the third-to-last row, which is the population shares) equal to the original 10.6 value of the original highest cohort, before we decomposed it into subcohorts. Once we have identified this x, our food eating pattern for Indonesian eggs is completed, with the relative values of the new subcohorts determined by the ratios between the Singaporean cohorts and with the absolute values chosen to be consistent with the original 2010 SUSENAS. Data permitting, we employ the same procedure for all countries and commodities.

Aggregate Agricultural Production Model

To estimate future aggregate agricultural production, we use the following function, based on Fuglie (2010b):[11]

$$AgProd = TFP \times Labor^{\alpha} \times QualAdjLand^{\beta} \times LivestK^{\gamma} \times MachK^{\delta} \times Fert^{\varepsilon}$$

where AgProd represents the total agricultural production, Labor the agricultural labor force, QuaAdjLand a measure of land area adjusted for quality, LivestK the livestock capital, MachK the machine capital, and Fert the fertilizer and chemicals. (Factor definitions are given in Fuglie (2010b).[12] The exponents α, β, γ, δ, and ε are the factor shares and together always sum to 1.

For our historical values of agricultural production, we multiply the country's GDP by the World Bank figure for agriculture's value added as a share of GDP.

Land

The quality-adjusted land measure we use is based on dividing land into 3 categories: Rain-fed land gets a weight of 1, irrigated land a weight of 2.993, and pasture land a weight of 0.094 (Fuglie, 2010b).[13] For our purposes, we ignore pasture land because its weight is so low. Land for tree crops is treated the same as rain-fed land (Fuglie, 2012).[14]

For Indonesia, we have one scenario for quality-adjusted land area change over time: a 0.50% average increase per year. For Vietnam we also have one scenario: a 0.27% decrease per year. For the Philippines, we have two scenarios: In the first, there is an increase of 0.47% per year; in the second, the increase is 0.65% per year. These rates are based on taking quality-adjusted sums of the initial and final land areas used in the country studies.

Livestock, Machine Capital, and Fertilizer

For all countries and scenarios, estimates for future growth rates for livestock capital, machine capital, and fertilizer are set equal to the average annual growth rates experienced from 1990 to 2006 derived from the data in Fuglie (2010a).[15]

Population

To estimate the future agricultural labor force, we use the following relation:

Labor=Population×Share of Population that is Rural×Ratio of Ag Workers to Rural Pop

For population we use our macro model's estimates; for the second term we use the UN urbanization estimates; and for the third term we use, for future years, the value of the agricultural-workers-to-rural-population ratio for the most recent year with actual data available. Therefore, the third term remains constant, the second term decreases over time, and the first term increases over time. The result is little net change in the agricultural labor force.

Factor Shares

The next component of the production equation is the factor shares. For years through 2013, we use the factor shares for Southeast Asia given in Fuglie (2010b).[16] As a country becomes more prosperous, though, the structure of its economy changes, and so the factor shares change. For example, in Fuglie (2010a),[17] the factor share for machine capital was usually about 0.01, and sometimes was even listed as 0. But in more developed countries, mechanization strongly boosts output. Therefore, as a country's income level rises, we set its factor shares' values to linearly change, converging to China's 1997 share values as its

11 Fuglie, Keith O. (2010b). Total Factor Productivity in the Global Agricultural Economy: Evidence from FAO data. In J. M. Alston, B. Babcock & P. G. Pardey (Eds.), The Shifting Patterns of Agricultural Production and Productivity Worldwide (pp. 63–95). Ames, Iowa: Midwest Agribusiness Trade and Research Information Center.
12 Ibid.
13 Ibid.
14 Fuglie, Keith O. (2012, August 13, 2012). [Conversation with Centennial Group].
15 Fuglie, Keith O. (2010a). Sources of Growth in Indonesian Agriculture. Journal of Productivity Analysis, 33, 225–240.
16 Fuglie, Keith O. (2010b). Total Factor Productivity in the Global Agricultural Economy: Evidence from FAO data. In J. M. Alston, B. Babcock & P. G. Pardey (Eds.), The Shifting Patterns of Agricultural Production and Productivity Worldwide (pp. 63–95). Ames, Iowa: Midwest Agribusiness Trade and Research Information Center.
17 Fuglie, Keith O. (2010a). Sources of Growth in Indonesian Agriculture. Journal of Productivity Analysis, 33, 225–240.

income approaches that of 1997 China, and, beyond that income level, converging towards the 2002 US values as its income approaches that of the 2002 United States.

TFP

The last component of the production model is the agricultural TFP growth rate. For each country macro scenario (GDP growth and population), we generate two agricultural TFP scenarios:

Vietnam and the Philippines: In the pessimistic agriculture scenarios, agricultural TFP growth is 2% per year. In the optimistic scenarios, it rises linearly to 3.22% in 2020, stays at that value for ten years, and then decreases linearly to 2.61% in 2040. (The 3.22% is that given in Fuglie and Evenson (2010) for China's most recent period.)

For Indonesia, yearly TFP growth is 3% in the pessimistic scenarios. In the optimistic scenarios, it rises linearly to 3.5% in 2020, stays at that value for ten years, and then decreases linearly to 3.25% in 2040.

Scenario Specifications

Table A1.7 shows how many variants each country has for each alterable component and in which section of this appendix those variants are defined:

Table A1.8 defines each scenario. See the previous table to locate where in this appendix the definition of each component appears.

Table A1.7: Scenario specifications

# alternatives for each component	GDP growth (§1.3)	population (§1.3)	agr. TFP (§1.7)	agr. land area (§1.7)	total # of scenarios for macro & consumption	total # of scenarios for production
Indonesia	2	2	2	1	4	8
Philippines	2	1	2	2	2	8
Vietnam	2	1	2	1	2	4

Source: This table is a re-statement and summary of the scenario specifications in this annex. Therefore, the source is the previous content in this annex.

Table A1.8: Scenario definitions

	Indonesia	Philippines	Vietnam
Scenario 1	High GDP Growth	High GDP Growth	High GDP Growth
	Low Population Growth	High Ag. TFP Growth	High Ag. TFP Growth
	High Ag. TFP Growth	Low Land Growth	
Scenario 2	Low GDP Growth	Low GDP Growth	Low GDP Growth
	Low Population Growth	High Ag. TFP Growth	High Ag. TFP Growth
	High Ag. TFP Growth	Low Land Growth	
Scenario 3	High GDP Growth	High GDP Growth	High GDP Growth
	Low Population Growth	Low Ag. TFP Growth	Low Ag. TFP Growth
	Low Ag. TFP Growth	Low Land Growth	
Scenario 4	Low GDP Growth	Low GDP Growth	Low GDP Growth
	Low Population Growth	Low Ag. TFP Growth	Low Ag. TFP Growth
	High Ag. TFP Growth	Low Land Growth	
Scenario 5	High GDP Growth	High GDP Growth	
	High Population Growth	High Ag. TFP Growth	
	High Ag. TFP Growth	High Land Growth	
Scenario 6	Low GDP Growth	Low GDP Growth	
	High Population Growth	High Ag. TFP Growth	
	High Ag. TFP Growth	High Land Growth	
Scenario 7	High GDP Growth	High GDP Growth	
	High Population Growth	Low Ag. TFP Growth	
	Low Ag. TFP Growth	High Land Growth	
Scenario 8	Low GDP Growth	Low GDP Growth	
	High Population Growth	Low Ag. TFP Growth	
	High Ag. TFP Growth	High Land Growth	

Source: This table is a re-statement and summary of the scenario specifications in this annex. Therefore, the source is the previous content in this annex.

Annex 2—Fisheries Outlook 2010-2040

Table A2.1: Fish production in Indonesia 2000–2011

	2002 ('000 tons)	2009[2] ('000 tons)	% annual growth 2002–2009
Marine Capture	4,073	4,789	2.1%
Inland Capture	305	310	0.1%
Total Fish Capture	4,378	5,099	2.2%
Inland Culture	903	1,721	9.6%
Marine Culture	n.a.	13	-
Total Fish Culture	903	1,733	9.6%
Seaweed	n.a.	2,963	-

Source: 2002: Statistics Indonesia; 2009: FAO Fisheries Statistics Yearbook

Executive Summary

After rice, fish is an essential source of protein in the Indonesian diet; the fish production an important economic activity. Exploitation of 5.8 million square kilometers of Indonesia's territorial waters, 5.4 million ha of inland waters and 1.1 million ha of ponds contributed about 3.34% to Gross National Product (GNP—without oil and gas) in 2011[1] or almost 20% of agricultural GNP. In constant prices, the fisheries sector growth since 2004 has been consistently 2% higher than that of the agricultural sector.

Past pro-growth sector policies particularly benefited from the (declining) availability of under-exploited marine resources inside and outside the EEZ, from the mostly free access to these resources, from newly developed or improved technologies (seaweed, marine cage culture, shrimp, tilapia), abundant areas for fish culture expansion and the availability of cheap labor and land/water. Investment in the sector—notably for supporting infrastructure—has been mostly public and well below what would be expected to maintain growth.

Coastal, traditional fisheries have historically been an 'unemployment sink'; many of the 6.21 million full- and part-time fisherman and fish culturists originate from agriculture.

The volume and value of Indonesia's fish exports show substantial differences between local and international statistics. Local statistics[2] suggest exports, excluding seaweed, totalled about 1 million tons in 2009, and did not change much since 2004 (0.9 million tons) while seaweed exports (reported separately) reflected the explosive production growth. Total export value increased by 8% annually to US$ 3.2 billion in 2009. Exports (mostly tuna, shrimp and crab) increasingly targeted new markets (China, the Middle East) in addition to traditional ones: Japan, EU and the USA.

Between 2004 and 2009 fish imports (notably fishmeal and frozen fish) expanded 21% annually in terms of volume

1 Sources: Indonesian Fisheries Yearbook 2011; Ministry of Marine Affairs and Fisheries, and Japan International Cooperation Agency, Jakarta 2011. MMAF; Capaian Dan Target Indikator Kinerja KKP Tahun 2010–2012. Ministry of Marine Affairs and Fisheries, Jakarta 2012.

2 Indonesian Fisheries Yearbook 2011; Ministry of Marine Affairs and Fisheries, and Japan International Cooperation Agency, Jakarta, 2011. By comparison, FAO (Fisheries and Aquculture Statistics, FAO, Rome 2009) reports Indonesia exporting fish and fish products worth US$ 2.247 billion and importing US$ 229 million in 2009.

(0.33 million tons in 2009) and 18% in value to US$ 300 million in 2009.

Future domestic demand for fish may almost double by 2040. As marine fish production has mostly reached sustainability limits, local aquaculture production growth of food-fish will be the key source of future incremental supply to satisfy demand. The national average protein consumption from fish well exceeded the combined protein consumption from beef, chicken and eggs in 2011[3].

National Socio-economic Survey (Susenas) estimates that consumers in Indonesia in 2011 annually individually consumed an average of 21.5 kg of fish. Since 2002 (16.3 kg) fish consumption increased by 3%/year.

The single heading 'fish' does no justice to the variety and complexity of fish consumption of dozens of fish products; consumers currently annually eat an average of 4 kg in rural areas around Yogyakarta and 53kg in the Riau Archipelago. Consumption levels in Java, with over 60% of all consumers, are a third below average, notably in the cities. Since 1999 the percentage of monthly average per capita expenditure for fish declined from 5.6% to 4.3% in 2009; the poor (those earning less than $1.25/day) spend about 7.5%[4]. Producer prices for fish (2011 = 140, 2007 = 100) increased slightly faster than the general Consumer Price Index (2011 = 130, 2007 = 100). Fish consumption still does increase substantially with wealth.

As future population growth will be largely concentrated in urban areas, and average income growth in real terms will remain moderate, two conclusions can be drawn. Fish consumption growth over time will decline in relative terms—urban consumers eat less fish, have access to more alternative foods, while demand for higher value fish will relatively increase. In terms of future national food security policies, production location, growth and distribution may be seen as critical, linked, parameters. Public policies should not only focus on growth but also on fish distribution, notably on availability of low priced fish. Policies defining the future location of incremental fish production and fish imports and related logistics requirements should in part be driven by national and regional nutrition policies.

In terms of future consumption projections this report assumes total demand in volume terms will plateau, but not before 2040. Indonesia will still have quite a few poor people by 2040, and while the middle and upper income consumers may well limit the growth of the physical consumption of fish, the less affluent may still wish to consume more; particularly in rural areas with lower income growth, demand for fish is likely to remain strong.[5]

Compared to current production levels of food fish less net trade (6.3 million tons in 2010), domestic demand may double by 2040, assuming low or higher population growth (.6% or 1.2% annually).

Aquaculture food fish production, currently about 1.7 million tons, would need to almost triple by 2040 to satisfy projected domestic demand in the pessimistic scenario assuming the more modest population growth assumption and no changes in external trade, prices and consumption preferences. Higher aquaculture growth would be needed under more optimistic circumstances and higher population growth.

Fish trade will assist mitigating short-term demand and supply imbalances of food fish; its long-term structural role will depend on the competitiveness of the Indonesian industry and international fish prices. The volume and value of Indonesia's fish exports are modest compared to local production. Indonesia's current trade tariffs are relatively benign, reflecting ASEAN efforts to reduce regional trade impediments. The country may consider (temporary) reduc-

3 Buro Pusat Statistik (Central Bureau of Statistics, BPS): Konsumsi Kalori dan Protein Penduduk Indonesia dan Provinsi, book 2, 2011; table 3.2.

4 David A. Raizer et al; Prioritzing the agricultural research agenda for South-East Asia; refocusing the research agenda to benefit the poor; Global Conference on Agricultural Research and Development (APAARI, AsDB, GFAR); 2010.

5 In China in the period 1973–97 consumption/capita of low-value fish increased very rapidly until it reached about 15 kg, after which growth slowed considerably. In SE Asia the 15kg level of consumption was already reached a decade earlier, and per capita consumption growth has been quite modest since then, despite relatively high-income growth levels. For high-value fish China showed consumption/capita growth of about 9% annually during an era that constraints on fish supplies were limited.

Table A2.2: Annual fish consumption (2010)

	Consumption of fish: (Kg/head/year) (a)	National annual consumption (Million tons) (a) * 240 million (b)	Total national fish production less seaweed and net trade (Million tons) (c)	Total loss between production and consumption (c) – (b)/(c)*100 (d)
Susenas 2010 Survey	21.5	5.2	6.3	17%

Source: Susenas and author estimates.

Table A2.3: Annual fish consumption of urban and rural consumers by monthly income group ('000Rp) in kg/head/year (2011)

Income	>100	100–149	150–199	200–299	300–499	500–749	750–999	>1000	Average
Urban	-	6.7	9.8	13.2	18.3	22	26.1	27.3	20.6
Rural	7.1	12.1	13.5	17.5	22.9	28.3	33.6	37.3	22.5
Average	7.1	11.1	12.5	16	20.7	25.1	28.7	29.3	21.5

Source: BPS, Konsumsi Kalori dan Protein Penduduk Indonesia dan Provinsi, book 2, 2011.

Table A2.4: Projected demand for fish products in Indonesia (2010–2040)*

	Consumption per capita 2010 (Kg/year)	Consumption per capita growth (2010–2040) (%)	Projected consumption per capita in 2040 (Kg/year)	Assumed losses between production and consumption (%)	Projected production required to satisfy 2040 demand (290 M population) (million tons)	Projected production required to satisfy 2040 demand (318 M population) (million tons)
Low value food fish	12.5	24	15.6	12	5.1	5.6
High value finfish	7.3	195	14.2	8	4.4	4.9
Mollusks	0.1	210	0.2	15	0.1	0.1
Crustaceans	1.6	170	2.7	40	1	1.2
Total	21.5		32.7		10.6	11.8

Source: Centennial model estimates
There is a discrepancy between the total 2040 fish consumption given here and in the main report. These projections use two slightly different methodologies, thus causing a discrepancy.

ing existing constraints on 'low value' imports as part of its food safety policy, while in the short- to medium term it may issue temporary volume limits on exports of fish products that appeal to low- and middle-income consumers in situations where China and other countries in the region suffer major declines in production. Given its exposure to developments in the region, an active fish products trade

policy—within the limits of ASEAN and WTO agreements—will remain necessary as part of food security strategies.

The complex domestic logistic network of traders, processors and retailers mostly comprise small- or medium-sized enterprises; employment in processing, trade and sector services is substantial (0.85 million in 2009). A few companies are large, such as vertically integrated shrimp farms. In fish production, culture, processing and marketing, size matters, notably when firms operate in highly competitive foreign markets (shrimp, tuna), when activities require cutting edge research (shrimp) or involve substantial operational risks, or when solutions are needed for ingrained logistical issues.

Small-scale, traditional, extensive fish culture does flourish near consumption centers, but farmers have often difficulty satisfying stringent sanitary and quality standards. Efforts are being made to link active interested buyers with small-holders; the DG of Fisheries Product Processing and Marketing (FPPM) has linked buyers to centers of small-scale production for a range of higher value products under its Fisheries One Village One Product Project, applying a cluster-based approach. A healthy mix of larger and small scale enterprises involved in fish catching, aquaculture and trade will be critical for sustainable production growth.

Indonesia's ability to satisfy demand for fish will above all depend on its ability to transform the current administrative sector control into active resources and sector management, in which the public and private sectors cooperate more closely. Indonesia's sector policies have historically focused on development, less on management. During the 1970s and 1980s strong centralist and statist development policies maintained the principle of open access to the marine resources. Starting in 1998, policy switched from a top-down to a bottom-up approach, as part of a broader process of devolution, giving much wider powers to local administrations and created administrative competition and overlap. The current multi-layered structure is unable to match financial and human resources with obligations that have been devolved. Most important, the culture of sector administration didn't transform into a focus on effective sector management.

Following the Presidential Degree no 5 and as part of the long-term Masterplan Percepatan dan Perluasan Pembangunan Ekonomi Indonesia 2011-2025: MP3EI, adopted in May 2011[6], Indonesia adopted a National Medium Term Development Plan. Its four pillar development strategy—pro growth, pro-job, pro-poor and pro-environment—focuses on infrastructure spending to increase economic growth, fiscal incentives to encourage export industries, social programs—which includes specific improvement of fishermen's livelihoods—and on enhancing mitigation against climate change. The relative importance of public investment in the sector reflects the precedent of multiple five-year plans. Compared to current and future requirements, public—and private—investment levels have been modest in the past compared to future, long-term requirements to develop a sustainable and competitive industry. In the future, the level and focus of public and private investments—at all levels, including logistics, infrastructure and supporting services—will need balance towards the private sector, and increase substantially compared to historic levels.

The prevailing developmental role of the public sector compared to the relatively limited private sector investment levels is partly the result of the nature of the fish resources, the small-scale character of most fisheries related activities, and partly of the private sector perception of the poor investment climate for the sector. High bank loan interest rates (between 12 and 13.5%, almost double those in neighboring countries) counterproductive employment policies, uncertain multiple layer public licensing practices, and the impact of devolution—creating additional layers of regulation, bureaucracy, multiple levels of taxes and fees, and corruption—are listed by the industry as key factors that constrain operations and limit private sector interest in expanding investment. Uncertain land legislation and title registration affects investment in aquaculture. Administrative deregulation and improvement of the business climate will be critical conditions for further sustainable development of the fisheries sector.

6 MP3EI particularly targets fisheries development in two of the six ' economic corridors': Sulawesi and Maluku/Papua. It also suggests regional coordination in such areas as research, processing and logistics, which may particularly affect cooperation with Philippines in aquaculture research, tuna processing and fish logistics.

Maintaining marine fish production at current levels will critically depend on more effective resources management. The de-facto free-access principle of past resources management strategies particularly affected the large army of small-scale, traditional fishermen, ever more dependent on declining catches[7] for income and food, while their share of total production has declined over time. Research suggests that on average marine resources are exploited close to their Maximum Sustainable Yield (MSY), estimated at about 6 million ton. However, current catch statistics and survey methods may not capture the true state of stocks, or the requirements of future management. Modest potential may exist to increase production from a few resources, but the size of (assumed) under-exploited small-pelagic resources in Eastern Indonesia is subject to debate. Tuna resources in the Indian and Pacific Oceans are mostly moderately exploited, but ongoing efforts to control exploitation by Regional Fisheries Management Organizations (RFMOs) responsible for these oceans and major competition for access to the resources from other countries are likely to limit unrestricted future access[8]. Over the next three decades, no substantial expansion of total marine fish production can be reasonably expected; production in selected over-exploited areas may well decline. Sustainable exploitation of all marine resources in Indonesia will require adjustment of fishing effort towards balanced harvesting—distributing moderate fishing efforts more evenly across species—and to increase catches per unit effort to enhance the financial viability of fishing operations.

Decentralization currently severely constrains critical research and private sector inputs being effectively integrated into sensible resource management decisions. A number of pilot projects demonstrated that community-based approaches can be established in coastal resource management, but the record is far from conclusive. The chances of community management succeeding may be highest if they are part of a broader program covering contiguous areas, focus on resource rich areas that are not severely over-exploited and satisfy critical requirements of political support, leadership, funding, technical support and services, adequate infrastructure and potential for alternative livelihoods. Unfortunately, few areas in Indonesia currently satisfy all those criteria. The record of Japan and of Philippines suggests optimism about the feasibility of rapid introduction of such systems nationwide is misplaced.

Under the current regulatory structure District/Municipal, Province and central government resources management responsibilities are linked to vessel size and area, but have no relationship to migrating fish resources and related complex multiple fisheries. An alternative strategy would give priority to effectively controlling industrial and commercial fisheries, which currently catch about 50–60% of the marine fish production. Under this strategy currently planned efforts to expand fish culture and other alternative income generating activities at the district and municipal level should remain priority activities. Since adjustment of the current devolution principles appears politically unlikely, an institutional solution is required within the current legal framework to adjust the resources management paradigm. Rather than maintaining the separation of the responsibilities of Ministry of Marine Affairs and Fisheries (MMAF), the provinces and municipalities/districts, the future management framework could aim to combine their prerogatives into a single process in each of the eleven marine zones already defined for research purposes. Such regional approach would:

1. give priority to better controlling—and selectively reducing—industrial and commercial fishing, while
2. expanding research and monitoring, control and surveillance coverage and effectiveness,
3. restructuring the institutional framework for fisheries management, and

7 About 2.6 million fishermen engage in marine fisheries of which 40% operate full time, located in over six thousand coastal villages located along a 95 000 km long coast line bordering about 500 districts.
8 Long-term access to these tuna resources will require political coordination between the public and private sectors, whereby Indonesia may obtain additional resource access in exchange for supporting local Pacific or Indian Ocean Island fisheries and improved local and regional participation of these Island countries in the value chain. Indonesia may also benefit from closer regional coordination with Philippines in international tuna matters.

4. addressing the issue of managing traditional fishing and coastal fish resources initially mainly through indirect means.

While such strategy would not be without risks—effective implementation would require substantial political commitment—it would create the institutional framework and build capacity to manage and control all fisheries before it tackles the most difficult part—actively managing coastal small-scale fisheries.

Maintaining sustained high growth of food-fish aquaculture production—projected by the Government to be concentrated in Eastern Indonesia—will require a multitude of 'internal' structural adjustments, focusing on research, extension, logistics, quality control, fish-health and investment. MMAF estimated in 2005 that the country has substantial marine areas where fish culture and seaweed potentially can be expanded. The brackish water culture area could also be increased (by 80%) but such expansion could raise environmental risks (mangrove destruction, coastal erosion, and further loss of coastal environment for fish spawning). A 1997 assessment suggested the area of freshwater ponds could potentially be doubled, while the area of open inland waters and rice fields that could be used for fish-culture could increase manifold. However, no detailed recent assessments have been made of the technical feasibility, required public and private investment levels and potential risks—climate change, disease, markets, logistics and competitiveness—of developing these areas, or the ability and willingness of the private sector to invest in such expansion.

From a nutrition point of view future low-value fish production may lag. The projected production growth to satisfy long-term demand infers that aquaculture will be able to produce low value products that would augment marine fish supplies in local markets, notably in the main market: Java. Past aquaculture growth was particularly driven by the expansion of seaweed culture and high-value fish, enjoying strong local and foreign demand; current farmer incentives still encourage investment in high priced products. Demand from developed markets and possibly China will cause global prices to continue to increase compared to other sources of protein and Indonesia may benefit from such demand if it can improve local competitiveness. This focus on high priced products may however limit investment in the production of cheaper products for the local market, mainly Java, and may impair another public objective: long-term future domestic demand for fish being satisfied mainly from domestic resources. This in turn will increase domestic fish prices for cheaper fish and encourage imports of cheaper fish. Indonesia does have the potential to substantially increase future production of cultured fish and seaweed, but if current investment incentives prevail it may not be able to satisfy domestic demand for low value products in the more distant future.

To ensue future productivity growth many aspects of the aquaculture value chains need to be strengthened. Aquaculture requires drivers to ensure effective research, technology transfer and capacity building. It also requires a complex combination of human and institutional resource capacity building to satisfy specific technical disciplines and services. It requires a coherent set of policies and regulations, an efficient transport network, a functioning land market, improved water management and effective downstream distribution and marketing. It also requires effective spatial planning, and allocation process to locate viable areas for expansion or define where restructuring of production is necessary. Integration of these multiple requirements into a coherent development strategy is the most critical requirement facing the sector, and failure to satisfy these requirements may impair sustained production growth.

To maintain high aquaculture production growth research budgets and the research agenda will require substantial expansion. For critical research subjects listed below truly international rather than predominantly national networks should be organized and maintained. Exceptional and wide-ranging research will be critical to maintain future aquaculture production growth.

- Brood stock quality. Maintaining high quality brood stock and ensuring effective hatchery operations will require sustained back-up research, training, experimentation and investment, both public and private. Maintaining high quality hatchery products

and the genetic integrity of wild stocks from the impact of artificial propagation and genetic manipulation will be essential. National strategies to deal with these risks remain to be fully implemented.

- Disease control remains only partly effective and satisfactory solutions—in the region and globally—for existing and newly emerging diseases need to be vigorously pursued. Several universities and institutes have programs dealing with fish diseases; better coordination of these programs within a national and international research strategy will be necessary.

- Many cultured species require specialized high-protein feeds; currently available feeds are critically dependent on (mostly imported) fishmeal and oil. Global demand for fishmeal has substantially increased over the past 15 years while fish resources supplying meal[9] are limited and mostly fully exploited. Substitutes exist, but the cost of production and extraction remain high. Development of alternatives to fishmeal and oil and production of herbivores or filter feeders to reduce future demand for high protein feeds will be critical, and may be best pursued through regionally and internationally coordinated research.

Multiple extension efforts will be required. Extension has been a factor in transforming aquaculture from a subsistence food system to an important sub-sector. Improved hatchery technology, genetic manipulation, feed improvements and disease control also played a positive role, but their impact could have been higher. Indonesia requires markets, education systems and extension services particularly tailored to highly disperse small-holder activities. Large operators have access to international research and technology developments—small operators don't. Devolution has reduced the effectiveness of traditional aquaculture extension activities. Alternative systems have been successfully tested (UPT's, nucleus estate, activities by Universities) but these separate activities may not satisfy all local conditions and requirements. Alternative approached tried in the SE Asia region (pooling of resources, public private partnerships, private extension services linked to feed providers, One-stop service centers, and producer associations) all have strengths and weaknesses. Indonesia needs an effective aquaculture extension function; testing various approaches and selecting the most effective (combination) will be essential for future production growth and farmer income.

Success in satisfying long-term local demand for fish will depend in part on 'external' parameters. China's ability to maintain high fish production growth. Global fish production growth during the past 20 years has been largely generated by China; it produces almost 70% of global aquaculture production and an increasing share of the marine catch. The impact on world market prices and fish trade would be major if China's production growth were to substantially decline or increase compared to currently projected levels. Fundamentally, the fish consumption fate of the countries in the region is directly linked to their joint ability to develop and maintain an efficient and highly productive aquaculture sector, and jointly and individually solve critical technological, disease, feed, environmental, institutional, regulatory and logistical issues. While China may be able to continue to import fish from across the globe to satisfy gaps in local demand, Indonesia may have greater difficulty pursuing the same strategy facing a combination of limited local appeal of imported fish and having few industrial groups operating globally catching fish, while current import restrictions also limit the appeal of imports. The ability to pay higher prices for fish will increasingly determine global trade flows and global demand. For lower-income countries like Indonesia this implies limits on their long-term access to external supplies of cheap fish.

Regional diversification of aquaculture production towards species less prone to disease. Intensive aquaculture already had its share of national or global pandemics—shrimp, salmon, carp—and the risk of a new disease seriously affecting a globally important fish is not negligible. That may affect global fish supplies and prices, but may also affect

9 About 22–26 million tons globally + 5–7 million tons of fish processing waste), producing about 6–7 million tons of fishmeal and 1 million tons of fish oil.

Indonesian production. While it may be impossible to eliminate this risk, the country can reduce it by diversification, having a strict regulatory framework and quality controls, top-level researchers, and effective extension services.

Effective management of global resources of small-pelagic species. Like the rest of the world, Indonesia will need to depend on global markets to satisfy large gaps between demand and local supply of fish, or absorb price hikes for (imported) fish and alternative products. Markets for high-value species are well developed globally and fish imports in Indonesia may only be constrained on account of prices and consumer preferences. Dependence on imports of cheap fish in the future will be riskier. At present sufficient supplies of 'small-pelagic' fishes are available in global markets. However, future demand for these fish may increase substantially, notably in Africa and Asia, while sustainable production is not unlimited. Supplies of cheaper fish species may cost much more in the longer-term future; this may limit the effectiveness of fish imports as a tool to control domestic fish prices for poorer segments of the population or to substitute imports for slower than expected aquaculture production growth.

The likely impact of the projected effects of climate change will probably be manageable. Climate change may create four threats: a temperature and precipitation increase, a sea level rise, and an increase in frequency of extreme events. The impact of these threats on fisheries activities by 2040 is likely to be moderate to modest. Temperature increases may affect spawning and migration of wild stocks, but the impact on Indonesian resources remains to be clarified; severely over-exploited fish resources may run the highest risks of being affected by 2040. Aquaculture has several means to easily mitigate high temperatures—deepening of ponds, higher water exchange rates etc. Similarly higher levels of precipitation may affect spawning and migration of wild stocks—again the impact is likely to be modest, and marine systems under stress may run the highest risks. Low intensity aquaculture may also be affected, as infrastructure may be unable to cope, but is unlikely to affect other production except through flooding. Careful site selection of aquaculture operations can minimize such risks. Sea level rises may still be moderate by 2040 and would mostly affect brackish water ponds in coastal areas. In selected areas the impact may well be mitigated by restoration of mangrove forests, which can trap silt and 'grow with the rise'. If such option is not available, man-made structures may protect low-lying ponds. In selected areas mitigation costs may become too high, and ponds may be abandoned.

The threat of extreme climatic events is probably the most pressing, as it could affect large coastal areas used for marine culture of fish and sea-weeds. While submerged line cultures for seaweed and mussels may be less prone to storm damage, floating cages are. In sea areas with limited natural protection from waves and currents these may particularly be prone to losses, leading to the escape of the crop. While technical solutions exist to limit storm damage—submerged cages, heavier anchors etc—the costs are high, and may not yet be feasible for most current culture practices and intensities. Site selection will be the critical variable determining future losses of cage culture due to extreme climatic events.

TABLE A2.5

	2008	2009	Total p/a growth 2000–09
Marine Capture		4,789	
Inland Capture		310	
Total Capture	5,002	5,099	2.5%
Inland Culture		1,721	
Marine Culture		13	
Total Culture	1,690	1,733	9.1%

DEVELOPMENT OF INDONESIA'S FISHERIES SECTOR; PAST AND PRESENT

OVERVIEW

Fisheries: an Important Sector. After rice, fish has historically been, and remains, the second key source of protein in the Indonesian diet. The national average protein consumption from fish well exceeded the combined protein consumption

from beef, chicken and eggs in 2011[10]. The poor (those earning less than $1.25/day) spend about 7.5% of their income on fish, compared to 5.6% by the rest of the population[11]. Exploitation of 5.8 million square kilometers of Indonesia's territorial waters, 5.4 million ha of inland waters and 1.1 million ha of ponds contributed about 3.34% to Gross National Product (without oil and gas) in 2011[12] or almost 20% of agricultural GDP. In constant prices, fisheries sector GDP growth since 2004 has been consistently 2% higher than agricultural GDP. Nominal growth was particularly rapid after 2007.

The fishing sector is also an important source of employment and income. The overwhelming majority of the country's 6.21 million full- and part-time fisherman and fish culturists operate traditional small-scale boats and gear, or small ponds. Coastal, traditional fisheries has historically been an 'unemployment sink', absorbing surplus labor from agriculture. Most fishing techniques are labor intensive and catches per unit of effort (productivity) of most fisheries have been declining for decades, as the number of fishermen, boats and gear steadily increased. The de-facto free-access principle of past management strategies particularly affected this large army of small-scale, traditional fishermen, ever more dependent on declining catches[13] for income and food. While their share of total production has declined over time—as coastal resources dwindled and commercial fisheries expanded—their weak social and financial status also constrained their socio-economic advancement. However, they still play a critical role in supplying local communities, processors and traders with fresh, often cheap fish.

Industrial fishing and fish culture activities have targeted tuna and shrimp, and more recently, seaweed, mainly for export. Although production levels and employment are modest compared to coastal fisheries, the industrial sector generates about a third of fish export value. Industrial and smallholder investment sometimes operate side by side; industrial investment has supported the nucleus-estate model for shrimp farming. Not all export industries depend on industrial investment: smallholder investment dominates the rapidly growing seaweed production.

Aquaculture has historically been important; its rapid growth during the past ten years has been mainly driven by the successful introduction of technological advances, affecting shrimp, tilapia and seaweed farming, supported by public and private investment. As marine fisheries production has reached beyond its natural limits, future growth of domestic demand for fish will need to be mainly satisfied from aquaculture production growth.

Historic Fish Production and Trade Trends; Resources Potential

Marine and freshwater fish catches

Marine fish production—which includes modest catches of tuna made outside the country's 200 mile Exclusive Economic Zone (EEZ) totaled 5.11 million tons in 2011[14]; capture fisheries from fresh water bodies added about 0.3 million tons[15]. Since 2002 marine capture production increased an average of about 2%/year, inland capture from open inland water bodies declined by 2%; trends vary widely between provinces, with no discernible pattern.[16] [17]

10 Buro Pusat Statistik (Central Bureau of Statistics, BPS): Konsumsi Kalori dan Protein Penduduk Indonesia dan Provinsi, book 2, 2011; table 3.2.
11 David A. Raizer et al; Prioritzing the agricultural research agenda for South-East Asia; refocusing the research agenda to benefit the poor; Global Conference on Agricultural Research and Development (APAARI, AsDB, GFAR); 2010.
12 Sources: Indonesian Fisheries Yearbook 2011; Ministry of Marine Affairs and Fisheries, and Japan International Cooperation Agency, Jakarta 2011. MMAF; Capaian Dan Target Indikator Kinerja KKP Tahun 2010–2012. Ministry of Marine Affairs and Fisheries, Jakarta 2012.
13 About 2.6 million fishermen engage in marine fisheries of which 40% operate full time, located in over six thousand coastal villages located along a 95 000 km long coast line bordering about 500 districts.

14 Capaian Dan Target Indikator Kinerja KKP Tahun 2010–2012. Ministry of Marine Affairs and Fisheries, Jakarta 2012
15 FAO reported the following fish production data for Indonesia (excluding seaweed): ('000 tons)
16 Indonesian Fisheries Yearbook 2011; Ministry of Marine Affairs and Fisheries, and Japan International Cooperation Agency, Jakarta, 2011.
17 BPS/MMAF's official fresh water catch statistics show a 60% increase of 2008 and 2009 national production compared to 2007 mainly on account of an 1800% increase in North Sumatra. (BPS: Indeks Produksi Perikanan Menurur Provinsi, 2005–2009). More recent publications (Indonesian Fisheries Yearbook 2011; Ministry of Marine Affairs and Fisheries, and Japan International Cooperation Agency, Jakarta, 2011) ignore the jump.

Indonesian statistics cover about 35 commercial fish species, of which only three exceed 10% of the total catch.

Within Indonesia research monitors four groups of fish resources in eleven resource management zones covering the entire sea area including the EEZ. Each of these zones reasonably represents a coherent group of fish resources and fishing activities. Coastal fisheries employing a multitude of methods in shallow waters targeting bottom dwelling and small 'above bottom' schooling species dominate the Java Sea and Malacca Strait. Tuna and other ocean dwelling species are caught by larger traditional and industrial vessels south of Sumatra and Java, and in oceanic areas in eastern Indonesia. Coral reef and shrimp fisheries dominate eastern Indonesia.

Status of marine fish resources

Research suggests that on average marine resources are exploited close to their Maximum Sustainable Yield (MSY), estimated at about 6 million ton. However, current catch statistics and survey methods may not capture the true state of stocks, or the requirements of future management[18]. Scientific consensus does exist that bottom dwelling fish resources—a critical food fish resource—are universally overexploited[19] in the western part of Indonesia; their status in the rest of Indonesia is uncertain. Resources of small pelagic (above bottom) species—another key resource for cheap, traditionally processed fish—are fully or overexploited in West Indonesia, and moderately exploited elsewhere. Expanded fishing efforts on the small-pelagic resources in Eastern Indonesia may be biologically feasible, although their location suggests the need for industrial exploitation, of which the financial and technical feasibility remains to be proven, as demand for these species would be concentrated in Java. The status of oceanic resources (tuna-like species) within the country's Extended Economic Zone (EEZ) is less clear. In some areas they are recorded as overexploited, in others the status is uncertain or resources are moderately exploited (Maluku area)[20].

The oceanic areas outside Indonesia's EEZ do offer opportunities for expanded exploitation. Tuna resources in the Indian and Pacific Oceans are mostly moderately exploited[21], but ongoing efforts to control exploitation by Regional Fisheries Management Organizations (RFMOs) responsible for these oceans and major competition for access to the resources from other countries are likely to limit unrestricted future access. Some tuna spawn in Indonesian waters, or enable juveniles to move from spawning to ocean areas (bluefin tuna, skipjack). Tuna fisheries in Indonesia catch relatively large numbers of juveniles. The critical role of Indonesia in regional tuna movements gives her a key argument in future negotiations about access to oceanic tunas: more careful management of local tuna fisheries should lead to improved access to oceanic tuna resources. The importance of tuna fisheries for local consumption should not be over-estimated; tuna and related species comprise less than 20% of total marine catches, and about 11% of all locally available food fish; about a third of the catch is exported.

Over the next three decades, no substantial expansion of total marine fish production can be reasonably expected. Without major improvement of the effectiveness of fisheries resources management, production in selected over-exploited areas may well decline. While some expansion in East Indonesia and outside the EEZ appears biologically possible, sustainable exploitation of all marine resources in Indonesia will require adjustment of fishing effort towards balanced harvesting—exploiting resources while distributing moderate mortality evenly across species[22]. This would limit future growth potential, notably during the process of production restructuring.

18 For a recent assessment of the key requirement for effective fisheries management, balanced harvesting, see: Garcia et al; Reconsidering the Consequences of Selective Fisheries; Nature, Policy Forum; www.sciencemag.org; March 2, 2012.
19 Over-exploitation generally implies fish catches and natural mortality substantially exceed natural biomass growth, reducing the robustness of fish stocks to accommodate natural shocks.
20 The catch data collection system from small-scale fisheries and in remote areas in Eastern Indonesia is weak, and national statistics and resource stock assessments should be treated as estimates rather than absolutes.
21 Exceptions are bigeye and bluefin stocks, while yellowfin and particularly skipjack tuna stocks are generally still in good shape.
22 S. M. Garcia et al; Reconsidering the Consequences of Selective Fisheries, Nature, Policy Forum; www.sciencemag.org; March 2, 2012.

TABLE A2.6: REGULATORY RESPONSIBILITY FOR MARINE FISHERIES MANAGEMENT

Fisheries Responsibility[3]	Vessel size	Area
District Government (commercial vessels)	5–10 tons	1/3 of 12 miles from coast
Provincial Government (commercial vessels)	10–30 tons	Up to 12 miles from coast
Central Government (industrial vessels)	Over 30 tons	Up to 200 miles from coast

FISH CULTURE

Fresh water culture has historically been practiced in Java. Brackish water culture already existed centuries ago in Java, and gradually developed in Sumatra and South and South-East Sulawesi. Seaweed culture particularly developed in the eastern provinces, less than a decade ago. Brackish and freshwater fish culture production steadily expanded since 2002. Marine culture—notably seaweed[23]—demonstrated rapid gains, particularly since 2008[24]. Overall production of cultured products increased almost 700% since 2002 to 6.97 million tons in 2011, or an average of 24%/year. Excluding seaweed the average annual growth of food fish production was still a respectable 10%. Area expansion in marine areas has particularly driven past growth of non-pond-based production; in-pond productivity increases have been modest. Fish culture is a knowledge intense activity; experience and regularly updated knowledge count. Disease (white spot in shrimp, koi herpes virus in carp) substantially affected production of traditionally cultured species, necessitating switches to alternatives. The rapidly rising costs of protein-rich fish feed[25] and lack of technical competence of culturists have restrained productivity growth for some other species. Productivity growth of fish culture in cages and of seaweed culture has been high, but from a low base.

FISH CULTURE POTENTIAL

Fish is being reared in pens in protected coastal sea areas, in cages in inland waters, and in ponds near the coast (brackish water) or inland (fresh water). In addition, fish is reared in rice fields and in open inland waters. Seaweed is mainly grown in coastal sea areas, using multiple methods. MMAF estimated in 2005 that the country has substantial marine areas where fish culture and seaweed potentially can be expanded (an estimated 2.9 million ha for seaweed alone), while the potential area for shellfish (mollusks) totals 4.7 million ha. The brackish water culture area could potentially also be increased by 80% from the current 0.7 million ha, but such expansion could raise environmental risks (mangrove destruction, coastal erosion, and further loss of coastal environment for fish spawning). A 1997 assessment suggested the area of freshwater ponds could also potentially be doubled, while the area of open inland waters and

23 Mostly used to produce hydrocolloids known as carrageenan and agar-agar.

24 Indonesian Fisheries Yearbook 2011; Ministry of Marine Affairs and Fisheries, and Japan International Cooperation Agency, Jakarta, 2011.

25 The costs of fishmeal has increased >50% since 2008. Historically, the ratio of fishmeal and soybean meal prices has fluctuated between 2 and 3, but in 2009 the ratio jumped to 5.5 and has since then declined to 4.0 (US$ 1,330/metric ton). The rapid price increase and decline are the result of management decisions that control the level of exploitation of the main fish stocks from which fishmeal and oil is being processed. The large share of fishmeal now consumed by the aquaculture industry—in 2006 this sector absorbed 56 and 87% respectively of world fishmeal and oil supplies—is still increasing, reflecting the rapid growth of global aquaculture fish production, with strong demand particularly in China. Unless new catching and processing technologies are being developed, global supplies of fishmeal are unlikely to increase beyond 7 million tons on a sustainable basis. Fishmeal prices will also be conditioned by future demand from the livestock sector and other users, but their role has substantially diminished.

rice fields that could be used for fish-culture could increase manifold. To ensure future productivity growth aquaculture research covering all aspects of the aquaculture value chains needs to be strengthened[26]. No detailed assessment has been made of the technical feasibility, public and private investment levels and potential risks—climate change, extreme weather events and temperature changes and more traditional risks related to disease, markets and competitiveness—of developing these areas, or the ability and willingness of the private sector to invest in such expansion. Indonesia does have the potential to substantially increase future production of cultured fish and seaweed, provided critical constraints are being addressed.

External and internal fish trade

The volume and value of Indonesia's fish exports show substantial differences between local and international statistics. Local statistics [27] suggest exports, excluding seaweed, totaled about 1 million tons in 2009, (mostly tuna, shrimp and crab; the main markets are Japan, USA, Europe Union) and did not change much since 2004 (0.9 million tons) while seaweed exports (reported separately) reflected the explosive production growth. Total export value increased by 8% annually to US$ 3.2 billion in 2009. Exports increasingly targeted new markets (China[28], Korea, the Middle East) in addition to traditional markets (Japan, EU, USA)

Between 2004 and 2009 fish imports (notably fishmeal and frozen fish) expanded 21% annually in terms of volume (0.33 million tons in 2009) and 18% in value to US$ 300 million in 2009. By comparison FAO statistics[29] show Indonesia exporting fish and fish products worth US$ 2.247 billion and importing US$ 229 million in 2009. The difference between national and international trade statistics for seafood is probably caused by each system using different trade categories, and reporting time differentials.

Indonesia has modest trade tariff levels and restrictions on international trade. Tariffs on exports of fish products are less than 5%; imports.

Demand fromdeveloped markets and possibly China will cause global prices to continue to increase compared to other sources of protein and Indonesia may benefit from such demand if it can improve local competitiveness. This focus on high priced products may however limit investment in the production of cheaper products for the local market, mainly Java, and may impair another public objective: long-term future domestic demand for fish being satisfied mainly from domestic resources. This in turn will increase domestic fish prices for cheaper fish and encourage imports of cheaper fish.

Fish is transported and traded after being landed or cultured. Few statistics illuminate the complex domestic logistic network of traders, processors and retailers, and the credit relationships they employ. Although most traders and processors operate small- or medium-sized enterprises, a few are large, such as vertically integrated shrimp farms. In fish production, culture, processing and marketing, size matters, notably when firms operate in highly competitive foreign markets (shrimp, tuna), when activities require cutting edge research (shrimp), involve substantial operational and financial risks, or when solutions are needed for ingrained logistical issues.

Small-scale, traditional, extensive fish culture does flourish near consumption centers, but farmers have often difficulty satisfying stringent sanitary and quality standards. Efforts are being made to scale development of good market opportunities, linking active interested buyers with small-holders to exploit opportunities well suited to small scale production with good industry models involving small scale producers elsewhere in Indonesia. The DG of Fisheries Product Processing and Marketing (FPPM) has linked buyers to centers of small-scale production for a range of higher value products under its Fisheries One Village One

26 David A. Raizer et al; Prioritizing the agricultural research agenda for South-East Asia; refocusing the research agenda to benefit the poor; Global Conference on Agricultural Research and Development (APAARI, AsDB, GFAR); 2010. In 2003 only 3.5% of all agricultural researchers focused on fisheries and aquaculture.
27 Indonesian Fisheries Yearbook 2011; Ministry of Marine Affairs and Fisheries, and Japan International Cooperation Agency, Jakarta, 2011.
28 China Competent Authority removed an embargo on Indonesian fish products following signature of the Cooperation Agreement on Safety Insurance for the Import and Export of Aquatic Products in 2009. Quality problems with shipments to the EU are declining.
29 Fisheries and Aquaculture Statistics, FAO, Rome 2009.

Product Project, applying a cluster-based approach. Similar approaches are now being planned under a project that may be funded by IFAD. Employment in processing, trade and sector services is substantial (0.85 million in 2009).

A critical lack of information—not data

Like other countries in the region, Indonesia has historically focused on catch and fishing effort (boats, number of fishermen) information, using a sampling system designed by the famous Japanese statistician Tadashi Yamamoto in the early 1970s. Over time, three flaws have reduced the usefulness of the fisheries statistics being collected:

Data are collected at the district, municipality and even village level by large numbers of enumerators. While some quality control measures are in place, the system is open to 'political' and bureaucratic abuse, leading to fish production creep but also to questions about the quality of derived statistics (GDP) and nutrition trends. Some anomalies appear quite blatant[30].

The status of many fish resources is being explored every 5 years, using approaches developed during the 1970s. A country the size and with the resource diversity and complexity like Indonesia, where marine resources are under heavy pressure, requires more frequent and more in-depth—no pun intended—assessments of its main integrated marine environments, as the demands of effective fisheries management have evolved[31]. For decision makers, assessing the status of individual resources and the need to introduce measures to reduce the chances of rapid resource decline or even collapse is frequently impossible.

To guide the structural changes in the sector— the rapid growth of aquaculture, the move towards production in Eastern Indonesia—a better understanding is needed about the technical and particularly the financial feasibility of new developments, and of their impact on employment, income, nutrition and the environment. Information is required to assess the demand for public and private services, logistics, training, extension, research etc. The data to support such analysis are only partly being collected, and are often incomplete or unreliable.[32]

Public and Private Involvement in the Fishing Sector

History. The role of the Government in fisheries sector management—including resources management and domestic food supply—has changed fundamentally over time. Until the late 1960 local government interventions focused on incidental development—resource management interventions were limited, allowing traditional practices to be maintained at a time that exploitation levels of marine fish resources were modest. During the 1970s and 1980s strong centralist development policies focusing on rapid production growth[33], undermining traditional management systems and the (modest) role of local government. The principle of open access to the marine resources—considered truly common property—guided resources management policies, although during this era the famous trawling ban was instituted for the Java Sea. As marine fish catches increased and fishing fleets expanded, the combination of the open access strategy and 'light' central management control proved increasingly risky. Over time, new administrative mechanisms to indirectly control fishing effort (registration and licensing of the number of boats, nets) proved ineffective for all but the largest vessels and proved open to abuse. This led to overexploitation in critical fishing areas and the use of destructive fishing practices. Environmental degradation and habitat destruction resulted, causing a reduction in fishery resource potential and of the robustness of the marine environment to weather and adjust to external shocks.

30 The explosion of the area under marine aquaculture in 2005 and of fresh water pond culture in 2008 appear unlikely; the twentyfold expansion of freshwater fish production in North Sumatra in 2008, which allowed total fish catches in Indonesia between 2005 and 2008 to show a nice annual increase appear equally questionable.
31 Garcia et al; Reconsidering the Consequences of Selective Fisheries; Nature, Policy Forum; www.sciencemag.org; March 2, 2012.

32 One senior manager in MMAF, when asked what Indonesia lacked more than anything else, answered without hesitation, 'reliable, useful information'.
33 The Basic Provisions of Local Government Law No. 5/1974 asserted Provinces and Districts did not have jurisdiction over marine and fisheries resources. Fisheries Law No. 9/1985, did not clearly mandate fisheries management to either the local government or the local people.

The impact of devolution. The government significantly modified its governance approach[34] during the Reform Era. Starting in 1998, it switched from a top-down to a bottom-up approach, as part of a broader process of devolution, giving much wider powers to local government[35]. The paradigm shift particularly modified coastal resources management, reflecting a growing interest in incorporating principles of traditional resources management[36]. A number of pilot projects demonstrated that community-based approaches can be established in coastal resource management, but the record is far from conclusive. The chances of community management succeeding may be highest if they are part of a broader program covering contiguous areas, focus on resource rich areas that are not severely over-exploited and satisfy critical requirements of political support, leadership, funding, technical support and services, adequate infrastructure and potential for alternative livelihoods. Unfortunately, few areas in Indonesia currently satisfy all those criteria. The record of Japan and of Philippines suggests optimism about the feasibility of rapid introduction of such systems nationwide is misplaced.

An ineffective management structure. Devolution had major, and some unexpected, implications. It constrained the ability of central Government to direct and implement sector policies, as local administrations started to develop their own sector ideas, creating administrative competition[37]. Decentralization also affected research activities, facing new (Provincial and District/Municipal) client demands, for which they were—and still are—not well equipped. The effectiveness of extension—notably for aquaculture—suffered from a combination of changes in institutional responsibilities, lack of funding and often experienced staff, broken or extended links to research, and lack of training. Multiple 'extension' activities developed, as Universities, research institutes and their local affiliates and some private sector players—operators and suppliers—created their own activities, sometimes without coordination and integration.

Devolution most directly affected the nascent efforts to improve fish resources management. Under the new regulatory structure District/Municipal, Province and central government resources management responsibilities are linked to vessel size and area, but have no relationship with migrating fish resources and related multiple fisheries. The large majority of the fleet, traditional mechanized and non-mechanized fishing prahus, are often not registered and licensed at all.

The present management approach is 'administrative', and mainly focuses on revenue from registration of commercial and industrial vessels and gear. Effective management of resources is—with a few exceptions—not happening. Similarly surveillance—mostly against foreign vessels fishing illicitly—remains spotty; industry sources call illicit fishing in some areas—North Sulawesi, Papua, Riau—rampant. Decentralization currently severely constrains critical research and private sector inputs being effectively integrated into sensible resource management decisions, financial resources to restructure local fisheries—when available—are not linked to the level of over-exploitation and the size of the resources and fishing fleet. Contrary to expectations the current approach doesn't effectively delineate the often-competing interests of traditional and commercial fishermen.

Ministry of Marine Affairs and Fisheries (MMAF) strategic plan 2010–2014[38]

Following the Presidential Degree no 5 and as part of the long-term Masterplan Percepatan dan Perluasan Pemban-

34 Autonomy Law No. 22/1999—revised by Autonomy Law No. 32/2004.

35 The decentralization principle affects many social and economic activities beyond coastal management. The districts are responsible for: (i) development planning and control and supervision of zoning and spatial planning, (ii) public security, (iii) public infrastructure, (iv) health services, (v) education, (vi) manpower administration, (vii) social programs, (viii) development of cooperatives, small and medium businesses, (ix) environmental management, (x) agricultural services, (xi) citizenship and civil registration, (xii) finance and administrative affairs, and (xiii) other affairs as instructed by the law.

36 Panglima Laut in Aceh, Sasi In Maluku, Awig Awig in Bali. The Law 22/1999 recognizes local community-based resource management systems in coastal zone and fisheries and the recognition by local authorities of the concepts of customary law and local territorial rights.

37 Local governments claiming rights already established local acts which focus on revenue raising rather than sustainable resources management.

38 Strategic plan, Ministry of Marine Affairs and Fisheries, 2010–2014; MMAF and JICA, 2010.

Table A2.7: Fisheries sector Gross Domestic Product (GDP), in real terms (in 2000 trillion Rupiah) and as percentage of Agriculture GDP (2004–2009)

	2004	2005	2006	2007	2008	2009
Fisheries GDP (Trillion Rupiah)	36.6	38.7	41.4	43.7	45.9	48.3
Percentage of Agricultural GDP (%)	14.8	15.2	15.8	16.1	16.1	16.3

Source: Badan Pusat Statistik.

Table A2.8: Comparison of annual fish consumption sources (2010)

Source	Consumption of fish: (Kg/head/year) (a)	National annual consumption (Million tons) (a) * 240 million (b)	Total national fish production less seaweed and net trade (Million tons) (c)	Total loss between production and consumption (%) (c) – (b)/(c)*100 (d)
Susenas 2010 Survey	21.5	5.2	6.3	17
Susenas 2010 Weekly Consumption	16.4	3.9	6.3	38
MMAF fish availability data	30.5	7.3	6.3	(16)

Source: Susenas and author estimates.

gunan Ekonomi Indonesia 2011–2025: MP3EI, adopted in May 2011[39], Indonesia adopted a National Medium Term Development Plan for 2014 which aims "to position itself as one of the world's main food suppliers and as a processing centre for agricultural, fishery, and natural resources". Its four pillar development strategy—pro growth, pro-job, pro-poor and pro-environment—focuses on infrastructure spending to increase economic growth, fiscal incentives to encourage export industries, social programs—like the 'cluster 4' poverty programs, which includes specific improvement of fishermen's livelihoods—and on enhancing mitigation against climate change. It targets infrastructure investment, future production growth, exports and social welfare (pro-poor and pro-employment) objectives. Its vision—to become the largest fish producer in the world—gives limited weight to critical resource constraints, discussed in the next sections, and likely future foreign developments. The strategy plan goals—focusing on institutional strengthening, sustainable management of fish resources, strengthening the knowledge base and expanding access to international markets—do reflect key current constraints faced by the sector, but ignore others.

The strategic plan puts in practice a major MMAF sector strategy decision made in 2008 to generate future fish production growth predominantly from aquaculture. The strategy is based on three assumptions that are uncertain or unproven:

1. It targets aquaculture development predominantly in Eastern Indonesia and around small islands, in part because it assumes the area offers the best potential for development and satisfies socio-political objectives. It supports special regions where fisheries would become the driving force of development. These 'minapolitan' centers would strengthen the economy of small-scale fisheries and coastal communities, linking them to large-scale fisheries businesses. This approach may

39 MP3EI particularly focuses on support for the poorer sections of the population, encouraging research, education and private sector involvement to reduce poverty. It targets fisheries development in two of the six ' economic corridors' : Sulawesi and Maluku/Papua. It also suggests regional coordination in such areas as research, processing and logistics, which may particularly affect cooperation with Philippines in such areas as aquaculture research, tuna processing and fish logistics.

work for high-value export products; its feasibility for low value products (small-pelagic species) for poorer consumers, located particularly in Java, has not been established.

2. It aims to reduce poverty in coastal communities throughout the country by supporting local 'empowerment' (local resources management leading to recovering resources and higher catches) and investment in non-fishery activities. As the boom in seaweed culture and the ' one village—one product' approach has proven, investment in alternative income generating activities in local communities can be highly successful. Past pilot activities—and the recent experience in Philippines—have demonstrated the many weaknesses of a system of locally managed sustainable coastal fisheries[40].

3. It assumes that aquaculture—notably community organized fish culture activities—will be able to produce products that would replace marine fish products in local markets, notably in Java, while the incentives for farmers could be to invest in high priced products for export. Past aquaculture growth was particularly driven by the expansion of seaweed culture and other high-value export products, enjoying strong external demand—less by lower value fish products for local markets, particularly Java.

MMAF performance. Decentralization was not accompanied by a restructuring and streamlining of responsibilities of MMAF and the various research and other linked institutions involved, particularly at the national level. The multi layered new structure is unable to match financial and human resources with obligations that have been devolved. Measures are needed which improve governance and accountability of the political and administrative establishments at the local and national level. Responsibilities at the local level need further analysis, whereby complex temporary tasks may be contracted to external parties, including teams of MMAF. Presently activities are being undertaken by the national and local government agencies which should be the responsibility of the private sector, or at best something which needs to be delivered in partnership with the private sector. Public-private partnership (PPP) has been heralded by the government as an important generator of economic development, but the principle has only sparingly been pursued effectively in support of the fisheries/aquaculture sector.

Levels of public and private sector investment. Industrial private investment in the fishing sector (about US$180 million by foreign and local investors, <1% of national investment during 2004–09) is modest compared to the sector's contribution to GDP and importance in terms of food security and employment[41]. Private investment has been particularly important in shrimp production, tuna catching and processing, and in trade. Investment levels by small-scale operators are unknown, but have driven the expansion of seaweed and marine fish culture.

Public sector outlays by the Central Government for development of the fishing sector totaled US$ 0.5 billion for 2011.[42] The relative importance of public investment in the sector reflects the precedent of multiple five-year plans. Investments in port and market infrastructure, Monitoring Control and Surveillance (MCS), aquaculture services (hatcheries—500 currently operated by provincial and district authorities), water management, environmental protection (12 million ha of sea area by the Forestry department and regional governments), research (11 research

40 Recent local evaluations of the situation in Philippines - and the opinions of research and fisheries staff in the field - suggest that the present decentralized fisheries sector management system suffers from multiple ills: an over-exploited, changing and less predictable resource base, a lack of knowledgeable people in the field and lack of research, a pervasive shortage of funding, despite rapidly increasing budget outlays, a lack of local control, and major interference of the political classes—including changing priorities after each election. As one USAID pilot program clearly demonstrated, the costs of setting-up a functional national system are very high and far exceed local budget limits. In Japan, a highly disciplined society, it took decades to establish a well functioning fisheries management system—mostly in temperate waters—operating at three levels (local, provincial and national) for different species. In the political and cultural context of the Philippines, management of freely moving resources based on 'control' over a 15 by 15 km piece of the coastal waters may need to start with consolidation of commercial and industrial fisheries at the national level and over time employ indirect means to restructure coastal fisheries.

41 Investment Coordinating Board, (BKPM), 2008.

42 Strategic plan, Ministry of Marine Affairs and Fisheries, 2010–2014; MMAF and JICA, 2010.

centers), product quality control, and education have traditionally been made by the public sector. Since the start of devolution budget requirements from lower level authorities (provinces, districts and municipalities) have soared, but actual allocations—with some notable exceptions, like aquaculture—have been modest during the past 5 years[43] and the role of MMAF as financial supporter of local activities remains important. Compared to current and future requirements, public—and private—investment levels have been limited compared to actual requirements to develop a sustainable and competitive industry. In the future, the level and focus of public and private investments—at all levels, including logistics, infrastructure and supporting services—will require considerable adjustment if future local demand for fish is to be satisfied from local sources.

A poor investment climate The prevailing developmental role of the public sector compared to the relatively limited private sector investment levels is partly the result of the nature of the fish resources, the small-scale character of most fisheries related activities, and partly of the private sector perception of the poor investment climate for the sector. High bank loan interest rates (between 12 and 13.5%, almost double those in neighboring countries[44] while inflation in the region is about 4–5%[45]), counterproductive employment policies, uncertain multiple layer public licensing practices, and the impact of devolution—creating additional layers of regulation, bureaucracy, multiple levels of taxes and fees, and corruption[46]—are listed by the industry as key factors[47] that constrain operations and limit private sector interest in expanding investment. Uncertain land legislation and title registration affects investment in aquaculture. Low fish quality standards and poor logistics and fisheries related infrastructure particularly affect the industry's international competitiveness. Poor operating conditions is being quoted as one reason the industry actively seeks to develop non-traditional markets—with less stringent quality requirements and tariffs—in the Middle East and China. The limited growth of non-seaweed fish exports during the past decade indirectly confirms the relative weak international competitiveness of Indonesian fish production. For seaweed it is striking that Indonesia does not process most product, while neighboring Philippines—another major producer—does.

Economic and Welfare Implications of Past and Current Sector Policies

A surprising sector performance

Past pro-growth sector policies particularly benefited from the continuing availability of under-exploited marine resources inside and outside the EEZ, mostly free access to these resources, newly developed or improved technologies (seaweed, marine cage culture, shrimp, tilapia), abundant areas for fish culture expansion and availability of cheap labor and land/water. Funding requirements from the private sector for many small-scale productive activities remained limited, and investment in the sector—notably for supporting infrastructure—has been mostly public and well below what would be expected to maintain rapid growth. As demand for fish grew strongly—and despite poor logistics support and the confusion created by devolution—value chains performed their traditional role. Indonesia's international competitiveness and exports did suffer from limited investment in infrastructure, quality control and resources management. The modest percentage growth over the past ten years of the sector's contribution to GDP—and substantial contribution to agricultural GDP—highlights one (successful) side of the domestic economic impact of past policies—even though some of the past growth may be the result of poor statistics rather than physical production.

Sector employment has not declined. Sector value added has particularly benefited the marketing and distribution activities of the value chain; over the past five years fishermen and culturists average incomes continued to lag (find source). Since 2000 full-time employment in marine and inland fisheries has been slightly declining to 2.8 million fishermen in 2009, while part-time fishing increased. The

43 Ibid.
44 The fishing sector outstanding bank debt was 0.1% of total outstanding bank credit (2000 trillion Rp).
45 Bank Indonesia, 2011.
46 GAPPINDO, personal communication.
47 IFC survey 'Doing business in 2012 in a more transparent world' rates Indonesia at 129, well after Vietnam (98), Malaysia (18), Thailand (17) and Singapore (1), but before Philippines (136) and East Timor (168).

highly dynamic aquaculture sector actually created employment (3% annually since 2000) to 2.8 million farmers. Employment increased fastest in trade, processing and marketing (>10%).

Fish Consumption 1973–2010; Protein Food Security

Fish Consumption

One of the earliest attempts to calculate the theoretical local availability of fish—which substantially exceeds actual food intake—was made in 1975 by the Directorate General of Fisheries in Sumatra[48]. Fish availability per head per year ranged from 6 kg in West Sumatra to 18 kg in North Sumatra. In rural inland areas it was as low as 1.7 kg, in the big cities it ranged from 22kg to 31 kg. About 55% of fish was consumed fresh. Complex transport and trade networks were critical to distribute fish between production areas and rural and urban consumers in the Provinces and in Java. Most producers and traders operated small business, although some large traders did operate trade networks targeting Java.

The National Socio-economic Survey (Susenas) estimates that consumers in Indonesia in 2011 annually individually consumed an average of 21.5 kg of fish, based on daily protein intake.[49] Since 2002 (16.3 kg) fish consumption increased by 3.0%/year. Data from Susenas assessment of weekly fish consumption[50], suggest 2011 consumption of 16.4 kg/head/year, but these data may omit certain fish categories. MMAF reports average fish availability levels of 31.6 kg/head/year[51] for 2011.

When projecting future consumption, the range between fish availability and actual consumption becomes important. Comparison of the 2010 figures of the Susenas data with those of the weekly BPS survey and the fish availability data from MMAF gives the following picture.

Susenas 2010 daily consumption survey data appear the most realistic, as they have been collected independently of the regular statistics system. Assuming official production statistics show an inflated picture of production, the loss between production and consumption would be well within international loss estimates, which range from 15–25%. Losses between catch and consumers of 38%, as the weekly consumption data imply, appear much less likely. This report will use 21.5 kg/head as the average annual fish consumption in Indonesia in 2010 for future fish consumption projections, and assumes a 15% loss between catch and consumption.

Consumption by area and income group52

The single heading 'fish' does no justice to the variety and complexity of fish consumption of dozens of fish products. The Susenas daily survey uses 32 categories of fish products. As in 1974, consumption levels of fish still vary widely between Provinces and income groups. Consumers currently annually eat an average of 4 kg in rural areas around Yogyakarta and 53kg in the Riau Archipelago. Consumption levels in Java, with over 60% of all consumers, are a third below average, notably in the cities and Central Java. Consumers in Sulawesi, Kalimantan and Sumatra consume much more fish than average. Along the coast, people prefer fresh fish; in inland areas, notably in those with difficult access to the coast, fresh water fish and processed marine fish (dried, salted, smoked) still dominates.

By comparison, a 2003 estimate of per capita fish consumption for the South-East Asia region[53] showed a modest annual growth of 1.3% from 17.6 kg/year in 1973 to 23.0

48 Magnusson, Magnus KR., and Gert van Santen; Marketing of Fresh and Frozen Fish In Sumatra; FAO Fisheries Development and Management Project, Jakarta, March 1975.
49 BPS: National Socio-economic Survey, Module Consumption, based on 68,800 households (2002–2009) and Konsumsi Kalori dan Protein Penduduk Indonesia dan Provinsi, book 2, 2011.
50 Konsumsi Kalori dan Protein Penduduk Indonesia dan Provinsi, National Socio-economic Survey, book 1, 2011.
51 Personal communication; Preliminary data .

52 This analysis is based on data from: Konsumsi Kalori dan Protein Penduduk Indonesia dan Provinsi, National Socio-economic Survey, book 2, 2011.
53 Delgado, Christopher L., Nicholas Wada, Mark W. Rosegrant, Siet Meijer, and Mahfuzuddin Ahmed; Outlook for Fish to 2020, Meeting Global Demand; International Food Policy Research Institute, Washington DC and World Fish Center, Penang; October 2003.

kg/year in 1997, while China saw consumption increase by 10.4% annually from a low of 5.5kg/year in 1973[54].

Price and consumption of fish and other sources of protein

Consumer diets and food preferences are changing, but slowly. Since 1999 consumption of rice—a major source of protein (84g/kg) for the Indonesian consumer—slowly declined by 14%[55] to 89 kg/head/year in 2011. Over the same period annual consumption of beef stayed almost constant at 0.5kg/head, while chicken and egg consumption increased by 250 % and 324 % to 4.3 kg/capita and 10.5 kg/capita respectively[56], compared to the 21,5 kg/capita/year consumption of fish in 2011.

Since 1999 the percentage of monthly average per capita expenditure for fish declined from 5.6% to 4.3% in 2009, as it did for meat (2.3% to 1.9%). Expenditure for eggs and milk increased from 2.9% to 3.3%[57]. Producer prices for fish (2011 = 140, 2007 = 100) increased faster than the general Consumer Price Index (2011 = 130, 2007 = 100), although large regional differences and differences between aquaculture and marine fish limit conclusions about what effect this may have had on changing consumption patterns. Consumers clearly prefer eggs, chicken and milk; it is unclear from the available data whether over time these products became more easily available—or relatively cheaper—than fish. Regardless of the levels of chicken and egg consumption, fish consumption still does increase substantially with wealth. Rural consumers eat more fish than their urban counterparts having the same income level, particularly when they are poor.

54 For the period 1973–97 China's consumption/capita of low-value fish increased very rapidly until it hit about 15 kg, after which growth slowed considerably. In SE Asia the 15kg level of consumption was already reached a decade earlier, and per capita consumption growth has been quite modest since then, despite relatively high-income growth levels. For high-value fish China showed consumption/capita growth of about 9% annually during this period.
55 BPS: Weekly average per capita consumption of several food items in Indonesia: 1999–2011.
56 Ibid.
57 Source: National Socio-Economic Survey, Module Consumption 1999, 2002-09, BPS, 2011.

Current food security policies

As long as official fish production statistics and national fish consumption data showed positive growth, fish food security received modest attention in the past; rice dominated food security policies. Fish has recently been added to the list of foods that officially are subject to national food-security policies. Fish is a critical source of protein in local diets, and from a nutritional point of view, major differences in consumption levels between regions and income groups persist. Although the national average level of fish consumption has been the main parameter being monitored, mitigating the large differences in consumption between regions and income groups should be the main interest of future food security policies and interventions[58]. Improved nutrition was not one of MMAF's key strategic goals yet. The 2010–14 strategy aims to expand export and achieve self-sufficiency (not defined), while improving the competitiveness of domestic production. In the future production growth and distribution may be seen as critical, linked, parameters[59].

The impact of future demographics

If one assumes that future population growth will be largely concentrated in urban areas, two conclusions can be drawn. Fish consumption will decline in relative terms—urban consumers eat less fish, have access to more alternative foods—and demand growth for cheap fish in rural areas may decline. The implications are that future incremental fish production—virtually all from aquaculture—will require substantially more effective logistics to move fish to the urban centers, and that to maintain supplies of cheap fish to rural areas, management of the marine resource base will remain critical. To supply cheap fish to poor urban consumers, supplies need to be more concentrated around—but not too far from—major urban conglomerates. MMAF's,

58 Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Food security by this definition relates to security at the individual level. World Food Summit, 1996.
59 One factor is price/wealth effect. It is demand from the 'luxury consumption' of the richer consumers that drives up fish prices. The net result is two-fold. The general consumption shifts to less expensive species of 'second preference' and the poor consume less.

provincial and district policies should not only focus on growth but also focus on fish distribution, notably on availability of low priced fish, particularly in areas with low consumption. The future location of incremental fish production and fish imports and related logistics requirements should in part be driven by national and regional nutrition policies.

The Political Economy of Fisheries: Sector Governance and Resources Management

Short-term financial and social gains versus long-term nutritional losses.

Indonesia faces three fundamental political economy choices for fisheries in the long-term. All impact on future nutrition levels. The 2010–14 strategic plan goal to focus future growth of the aquaculture sector on high value products, for which ready export markets are assumed in the region, may limit investment in the production of cheaper products for the local market. Current plans suggest they should be met through an expansion of 'community organized production'. For high priced fish products demand from developed markets and possibly China will cause global prices to continue to increase compared to other sources of protein[60] and Indonesia may benefit from such demand if it can improve local competitiveness. But a focus on export performance may reduce investment in lower priced fish production and may impair long-term future domestic demand for fish being satisfied mainly from domestic resources[61]. This in turn will increase domestic fish prices for cheaper fish and further increase incentives to maintain or expand fishing pressure on already stressed coastal fish resources. It will also encourage imports of cheaper fish. While global supplies of cheap frozen fish are still available today, demand from Africa and potentially from South and East Asia for these products will likely grow over the next decades, while global supplies are limited. Either way, domestic prices of most fish are likely to increase relative to other protein sources, particularly affecting the poorest consumers, who may be forced to further reduce protein consumption or switch to alternative products. Future production of lower value fish, and its availability in low consumption areas, should receive more (food-security) priority[62] in public policies.

Management of industrial versus small-scale fisheries

The current strategy to give priority to strengthening the ability of local communities to manage coastal resources—only successfully implemented in Japan following four centuries of testing and modification[63]—is unlikely to provide rapid results, as supporting institutional capabilities and appropriate management structures are currently lacking, and once created, may be difficult to sustain—as the recent experience in Philippines has demonstrated. The risks that continuation of the current strategy will lead to substantially declining marine fish production from coastal fisheries are therefore—under the current strategy—not negligible. The costs and human resources to establish an effective local resources management capability at the district/municipal level nationwide[64] will be very high. An alternative strategy could be more effective in gradually controlling fishing effort, at lower costs. It would give priority to effectively controlling industrial and commercial fisheries. They currently catch about 50–60% of the marine fish production.

60 Delgado et al; Outlook for Fish to 2020, Meeting Global Demand; International Food Policy Research Institute, Washington DC and World Fish Center, Penang; October 2003. Only if China produces more than currently projected would fish prices globally decline—including demand for Indonesian aquaculture export products.

61 This scenario has already happened in Philippines, where the poorest sections of the population have reduced fish consumption and switched to fortified noodles.

62 "In the realm of exports of fishery products it may also be desirable for national governments to place some degree of social control over the quantum and species of fishery products exported. When there is clear evidence that certain species are essential for the food security of local populations, certain developmental and social 'safeguards' may have to be instituted to ensure that the larger social good is optimized… The prospect for moving from free trade to 'negotiated' international trade, particularly in contexts where issues of food security may be at stake, needs to be strongly supported." (Delgado et al.)

63 Shingo Ota; The History of the Japanese Community-based Fisheries and the Reasons for the Current Success; Office of Overseas Fisheries Cooperation, Fisheries Agency, Tokyo.

64 The recent experience in Philippines—which proceeded far ahead of Indonesia with the same devolution strategy—is not encouraging. The local fisheries management approach does not work and has led to 'fishing down the food chain ' effects, reducing the robustness of the marine environment to absorb external shocks. Many areas face serious over-exploitation of marine resources, and substantial declines in small-scale fishermen incomes. See: Stuart Green et al: The Fisheries of Central Visayas, Philippines: Status and Trends, Cebu City, 2004. The national costs of this disaster have been estimated at $3.5 billion. Melody M. Aquiba, Manila Bulletin Publishing Corporation, 2008.

Globally available technology to monitor vessel movements electronically and control fish landings enables close control of the industrial and commercial fleets, and is already being used in Indonesia for larger vessels. Recent technological advances and improved regional cooperation have the potential to make surveillance of national waters much more effective, even in a country with the size and complex sea areas as Indonesia. Extending and improving the MCS capability at sea and at designated fishing ports could substantially reduce illicit fishing. At the district and municipal level, currently planned efforts to expand fish culture and other alternative income generating activities should remain priority activities; these require less institutional capacity and can more easily target potentially suitable areas, as the expansion of seaweed production has shown. In summary: reducing fishing pressure in coastal areas should be based on direct measures (reducing industrial and commercial fishing pressure in over-exploited areas and species) and indirect measures (tempting fishermen and their off-spring to engage in alternative employment). The country should consider to: (i) give priority to better controlling—and selectively reducing—industrial and commercial fishing, while (ii) expanding research and MCS coverage and effectiveness, (iii) restructuring the institutional framework for fisheries management (next bullet), and (iv) addressing the far more complicated issue of managing traditional fishing and coastal fish resources initially mainly through indirect means (support for alternative income activities). The strategy is not without risks; effective implementation would require substantial political commitment. But this approach would enable Indonesia to create the institutional framework and build capacity to manage and control all fisheries before it tackles the most difficult part—managingcoastal small-scale fisheries.

Decentralization Revisited

Giving priority to improvement of management of industrial and commercial fisheries would make it politically easier to create a more effective alternative institutional structure responsible for fisheries resources management. The current structure lacks coherence and has difficulty translating and implementing scientific findings into effective management decisions. The area- and vessel size-based distinction of responsibilities between district, province and MMAF in management of fish resources is artificial and has no scientific or practical basis. Since adjustment of the current devolution principles appears politically unlikely, an institutional solution is required within the current legal framework. Rather than separating the responsibilities of MMAF, the provinces and municipalities/districts, the future management framework could aim to combine their prerogatives into a single process. Specifically, the alternative system may include: (i) acceptance of the (about) eleven fishing zones already defined as the basic unit of resources management and research, (ii) the creation of single fisheries management authorities for each zone (in which MMAF, provincial and municipal/district institutions would be fully represented and cooperate), that would be responsible for management of exploitation of all marine fish resources and all fisheries in these areas, (iii) research, data collection and information exchange organized by zone, (iv) zone based effective electronic and at sea/port monitoring, control and surveillance of all commercial and industrial fisheries, and (v) adjustment of the current legal and regulatory framework and a clear political long-term commitment at the national and local level to implement this structure. To succeed the country needs a resource management structure that no longer reflects an administrative culture but a management culture. Creating new Fisheries Management Authorities with appropriately trained staff, linked to effective research and MCS systems may have a better chance for such culture change to take place.

Aquaculture: Systems and Sustainability

A critical knowledge based resource

Aquaculture will carry most of the future production growth burden necessary to satisfy future demand for food fish. Above all aquaculture requires drivers to ensure effective research, technology transfer and capacity building. It also requires a complex combination of human and institutional resource capacity building to satisfy specific technical disciplines and services. It requires a coherent set of policies and regulations, an efficient transport network, a functioning

land market, improved water management and effective downstream distribution and marketing. It also requires effective special planning to locate viable areas for expansion or define where restructuring of production is necessary. Integration of these multiple requirements into a coherent development strategy is the most critical requirement facing the sector.

Past efforts to improve the efficiency of existing fish culture operations have been quite successful, driven by local and internationally supported research and local extension—by research institutes, Universities and local UPTs (MMAF's technical implementation units)—of newly developed knowledge and experience. Continued rapid aquaculture growth will require research to continue improvement of suitable culture techniques, for high value export products and for low cost production methods and species. Research in Indonesia is currently organized in clusters; research activities are spread over multiple institutions, specialized public research institutions, private institutions and faculties of Universities, of which selective mandates are overlapping. While much research is part of a broad research agenda, individual research often reflects personal priorities. To maintain high future aquaculture production growth—and become a major global producer of cultured fish—aquaculture research budgets and the research agenda will require substantial expansion. For critical research subjects listed below truly international rather than predominantly national networks should be organized and maintained. Exceptional and wide-ranging research will be critical to maintain future aquaculture production growth.

Outstanding research issues, a selection:

While local brood stock quality is presently reported as satisfactory and hatchery operations reasonably effective, maintaining high quality brood stock and ensure effective hatchery operations for the long term will require sustained back-up research, training, experimentation and investment, both public and private. Genetically improved cultured species can significantly increase aquaculture productivity, reduce diseases and the requirements of feed, land and water. In Indonesia today only tilapia has benefited from a successful international genetic modification program (the GIFT program). Timely and adequate supply of quality seed is a pre-condition for effective aquaculture. Networks of public and private producers and traders dominate the supply of seed to farmers although poor quality seed, caused by poor genetic management of breeders and accidental hybridization, is not uncommon. Inbred fish have a much lower productivity and pose a risk to their wild counterparts. The risks to the genetic integrity of wild stocks from artificial propagation and genetic manipulation are considerable. National strategies to deal with these risks have been defined, but parts remain to be fully implemented.

Disease control remains only partly effective and satisfactory solutions—in the region and globally—for existing and newly emerging diseases (white spot, koi herpes virus) need to be vigorously pursued. Several universities have programs dealing with fish diseases. It makes sense to coordinate these programs within a national and international research strategy.

Many cultured species (including shrimp, milkfish, pangasius, and other catfish) require specialized high protein feeds; currently available feeds are critically dependent on (mostly imported) fishmeal and oil. High value species have benefited most from advances in fish nutrition, improved feed composition, pelleting technology, development of larval feeds and substitutes for high cost ingredients, often linked to fish breeding programs. Global demand for fishmeal has substantially increased over the past 15 years while fish resources supplying meal (about 22–26 million tons globally, producing about 6 million tons of fishmeal and 1 million tons of fish oil) are limited and mostly fully exploited[65]. Substitutes exist, but the cost of production and extraction remain high, while resistance against GMO foods persists. Fishmeal and oil prices are expected show some of the highest price increases globally over the next ten years and beyond, notably if global aquaculture production exceeds

65 The global share of fishmeal and oil being used for fish feed (52% of meal, 82% of oil in 2004, currently higher) has been steadily increasing, with fish oil being the critical limiting factor.

current baseline estimates[66]. Unless alternative protein rich feeds are developed—or fishmeal and oil are more efficiently used—fish feed costs will continue to rise. Development of alternative feeds—or alternatives to fishmeal and oil—and production of herbivores or filter feeders to reduce future demand for high protein feeds will be critical, and may be best pursued through regionally and internationally coordinated research.

Defining an appropriate structure for the sector

Efficient fish culture requires the right environmental conditions, access to land and water, and location to markets. Effective spatial planning to properly locate new and existing production capacity will be essential to enhance future productivity and locate production where effective logistics are available. Some spatial planning has been performed in the past, but translating such planning into real investment programs in which the requirements for aquaculture have been fully taken into account has proven difficult; human and institutional capabilities and financial resources at the district and provincial level are usually inadequate. Notably in areas exposed to tidal waves the resulting restructuring is expensive, and requires a combination of traditional—mangrove—and alternative infrastructure. Expansion of marine cage culture requires a proper regulatory framework covering leasing, operations, environmental safeguards to limit marine pollution and a regulatory framework to limit exposure to future climate change conditions. For land-based fish culture, and culture in lakes and rivers, a combination of area expansion and productivity increases will be necessary but will face natural and environmental boundaries if not properly planned. Strengthening implementation capacity at the provincial level to translate the conclusions of spatial planning into private and public investments will be necessary to maintain aquaculture production growth.

66 Delgado, Christopher L., Nicholas Wada, Mark W. Rosegrant, Siet Meijer, and Mahfuzuddin Ahmed; Outlook for Fish to 2020, Meeting Global Demand; International Food Policy Research Institute, Washington DC and World Fish Center, Penang; October 2003. World Bank; Changing the Face of the Waters, Washington DC; 2007.

Creating domestic value added

On-farm activities are only one link in the total value chain, and create only one half of total value added. Outside Indonesia growing coordination between private and public sector inputs and output chains and between smallholders and large processing companies are increasingly common, leading to greater efficiency, improved quality assurance, and improved marketing. Export certification has also streamlined production. Supermarket chains increasingly mold urban consumption behavior. In Indonesia these trends have started, but mainly affect high value products. Most cheaper food fish production is still small-scale and relies on traditional distribution and marketing chains. The benefits of a more integrated industry, in terms of efficiency and export competitiveness, will be enhanced by having more, and larger, vertically integrated operations functioning in parallel to the traditional networks. This requires improvement of the investment climate in general, but also a regulatory framework supporting vertical integration and ensuring value added created by vertically integrated companies benefits the country. The booming production of seaweed—mainly produced by smallholders—is a case in point; its products are mostly processed abroad. While a competitive export industry may reduce incentives to produce for the local market, it may also guide—and support—transformation of the culture of food fish for the local market.

Technology transfer through extension

Multiple extension efforts have played a role in transforming aquaculture from a subsistence food system to an important sub-sector. Improved hatchery technology, genetic manipulation, feed improvements and disease control did all play a positive role, but their impact could have been higher. Indonesia requires markets, education systems and extension services particularly tailored to highly disperse small-holder activities. Large operators have access to international research and technology developments—small operators don't. For example, Indonesia has highly successful examples of integrated livestock-fish farming systems linked to

TABLE A2.9: PROJECTED ANNUAL PERCENTAGE GROWTH OF CONSUMPTION PER CAPITA OF FISH PRODUCTS FOR SE ASIA (1997–2020) AND GROWTH PROJECTED FOR INDONESIA (2010–2040)

	1997 per capita fish consumption SE Asia (kg/year)	Projected annual growth per capita fish consumption SE Asia 1997–2020 (%)	Estimated 2010 per capita fish consumption in Indonesia (kg/year)	Projected annual growth of per capita fish consumption in Indonesia 2010–2040 (%)
Low value food fish	15.9	0.2	12.5	0.6
High value food fish	3.8	1.0	7.3	1.9
Mollusks	1.4	1.3	0.1	2.2
Crustaceans	1.9	1.2	1.6	1.8
Total	23.0	Weighted average: 0.48	21.5	Weighted average: 1.24

Source: Delgado et al.and author estimates.

rice[67], but has had difficulty scaling these examples to the provincial and national level.

Devolution has reduced the effectiveness of traditional aquaculture extension activities, while UPTs have assumed part of their responsibilities. Alternative systems have been successfully tested (nucleus estate, activities by Universities) but these separate activities may not satisfy all local conditions and requirements. Alternative approached tried in the SE Asia region (pooling of resources, public private partnerships, private extension services linked to feed providers, One-stop service centers, and producer associations) all have strengths and weaknesses. Indonesia needs an effective aquaculture extension function; testing various approaches and selecting the most effective (combination) will be essential for future production growth and farmer income.

EXPANSION OF INDUSTRIAL FISHING OUTSIDE THE 200-MILE EEZ

TUNA

Expansion of exploitation of tuna resources in the Indian and Pacific Oceans and Indonesian waters is currently still possible. While Indonesia has the technology and knowhow to exploit these resources, future access and development of a regionally competitive industry will likely require a combination of public sector and private industry strategies.

1. Indonesia needs to participate effectively in existing RFMOs for the Indian Ocean and Western Central Pacific. In the Pacific access to (major) tuna resources is already subject to a fairly strict management regime; in the Indian Ocean management is still less effective. Long-term commitment to sustainable and controlled exploitation of the tuna resources inside Indonesia is likely to be part of the price for future Indonesian access to regional tuna resources.

2. Future access will not only require active RFMO membership. Pacific and Indian Ocean Island countries increasingly link future access to tuna in their EEZ not only to participation in RFMO management programs but also to bilateral agreements, which may delineate how future catches can be used. Long-term access to these tuna resources will require political coordination between the public and private sectors, whereby Indonesia may obtain additional resource access in exchange for supporting local Pacific or Indian Ocean Island fisheries

67 For example, the Batu Kumbung village in Lombok, where traditional rice-fresh water fish farming was expanded to add poultry and other fish species; it not only substantially increased income, but also local nutrition.

Table A2.10: Projected demand for fish products in Indonesia (2010–2040)

	Consumption per capita 2010 (Kg/year)	Consumption per capita growth (2010–2040) (%)	Projected consumption per capita in 2040 (Pessimistic scenario) (Kg/year)	Assumed losses between production and consumption (%)	Projected production required to satisfy 2040 demand (290 M population) (Million tons)	Projected production required to satisfy 2040 demand (318 M population) (Million tons)
Low value food fish	12.5	24	15.6	12	5.1	5.6
High value finfish	7.3	195	14.2	8	4.4	4.9
Mollusks	0.1	210	0.2	15	0.1	0.1
Crustaceans	1.6	170	2.7	40	1.0	1.2
Total	21.5		32.7		10.6	11.8

Source: Delgado et al. and author estimates.

and improved local and regional participation of these Island countries in the value chain.[68]

3. Indonesia may also benefit from closer regional coordination with Philippines in international tuna matters. Both countries have tuna industries that have difficulty competing with the 'big three' global concerns currently dominating the canned tuna industry and the few trading houses dominating the fresh and frozen sashimi quality tuna trade and distribution in the region. Development of a joint strategy to secure future access to oceanic tuna resources, a stronger say in the RFMOs and World Trade Organization (WTO) tuna and other fish trade negotiations and joint strategies to create a truly competitive regional tuna industry would be in the interest of both countries.

4. While most of the tuna caught by Indonesia is being canned, the markets in the developed world will increasing seek fresh and deep frozen tuna for direct consumption. Continuation of this global trend may have two implications: (i) larger tuna will increase in value, and will require highly efficient international (air and container) transport; and (ii) the large quantity of small tuna (juvenile tunas, lesser tunas) currently caught in Indonesia may increasingly be used for the local market, in canned, frozen or other processed form.

Fish requires complex, effective—and cheap—logistics

The current transport network to move perishable fish products from multiple production locations to consumers is old, costly, sometimes ineffective and often reduces fish quality—it is cheaper to import fish from Pakistan than move it from Ambon to Java. Poor logistics will impair the potential effectiveness of MMFAs strategy encouraging future expansion of fish production (marine, brackish and fresh water culture) for export and for local consumption. Although inter-island transport and export logistics fall outside the scope of this report, it is a critical issue that will have a major impact on the success of future production growth. Substantial investments will need to be made in infrastructure, services, and equipment, and in fish preservation and handling methods to satisfy future logistics requirements in terms of

68 This is already happening in PNG, where Philippines is seeking priority access in exchange for agricultural or other commodities and support for other development activities.

frequency, price and quality. Current regulatory constraints on fish transport also need review and adjustment[69].

Synthesis

Indonesia has had a long history of sustained fish production growth. Marine production has reached fish resource limits; more effective management of the resource will reduce the risks of major long-term production declines. Aquaculture production has demonstrated very high growth, particularly of (non-food) seaweed for export. Fish is a fundamental component of the Indonesian diet; consumption already exceeds average global and regional levels, and—as argued in the next chapter—demand for fish is likely to double by 2040. While marine production levels have hit a plateau in most areas, aquaculture production and fish imports are the only two sources of supply able to satisfy future demand. As major variations exist in fish consumption levels between regions and income levels, mitigating these major differences should become one of the critical objectives of future sector development and food-security policies. Sustaining high aquaculture production growth by itself will not be enough; high value fish (and seaweed) will have the best chance finding domestic and export markets. Producing sufficient lower value fish for the poorer sections of the population—as marine production of cheap fish products will likely decline—will be aquaculture's major long-term challenge.

Demand and Supply Scenarios 2012–40

Demand for Fish Products

Projection principles. Long-term forecasting is an inexact science and every scenario requires multiple, uncertain, assumptions. Two approaches have been mostly used in the literature to project demand. The first links future demand directly to projected population growth, income growth in real terms and applies price and income elasticities. The second is a simplification of the first; it has been used most recently by Delgado et al. (2003) to estimate global demand and supply for fish. It uses population growth projections but assumes annual growth of per capita consumption of four categories of fish (low value, high value, mollusks and crustaceans) by a fixed percentage, which are derived from a multitude of other variables, like prevailing consumption levels, likely developments of global fish prices, including fishmeal, and international trade patterns. They ignore uncertain real income growth projections and elasticities of individual fish products. Although Delgado's projections covered the period 2000–2020 and only provide consumption estimates for South-East Asia, not individual countries, they have reasonably predicted past production growth. Indonesians consumed in 2010 21.5 kg of fish each, almost the same consumption level as the 'average' South-East Asian consumer in 1997, the base year of Delgado's projections. The simplified method has two advantages: it does note require uncertain estimates of per capita income growth and of highly uncertain price—and income elasticities. The result may be a scientifically less robust estimate, but the more elaborate estimation method, with more assumptions, may not necessarily provide a higher degree of confidence. Since this study focuses particularly on the policies and actions required to achieve future production growth, the estimate of the absolute level of 2040 consumption—of an uncertain mix of fish products—appears defensible.

Basic assumptions

Indonesian population growth projections vary quite widely. The Centennial model predicts a population growth of 21% by 2040 compared to 2010; a recent seminar of Universitas Pertanian Bogor suggested growth of 42% or about 1.2% annually[70]. For this report both estimates have been used to calculate future demand. Modest changes have been made in Delgado's per capita consumption growth assumptions to better reflect the specific Indonesian situation. Given the large percentage of the population with well below average

69 Regulatory requirements force tuna exporters from Menado to export through Surabaya or Jakarta; local fish transport between districts requires payment of transport fees at district boundaries.

70 Official estimates of future population growth, based on the 2010 census have not been published yet. This report uses Centennial estimate of the 2010 population of 219 million and projected 240 population of 290 million. An agricultural symposium in Bogor suggested and alternative projection for the 2040 population (318 million).

fish consumption and low incomes, the estimate for future growth of per capita low value food fish consumption has been increased by 20%. Assuming steady income growth of all income segments of the population, the estimate could even have been higher, but for the likely shift of incremental population growth towards the cities, where fish consumption is relatively lower, and for the likely increase in fish prices expected for the longer term. Fish prices are likely to increase in Indonesia relative to other protein alternatives over the next three decades, as they have been over the past decade and will continue to do globally. This will dampen future domestic demand for fish somewhat compared to other protein sources.

The estimate for the annual growth of consumption of high value finfish has been increased by 10% to 1.1%, reflecting: (i) growing demand from the rapidly rising urban markets in Indonesia and (ii) the likely progression of poor people entering lower middle class status.

Globally, prices for high value cultured species do decline once more productive systems are adopted. Genetically modified strains, higher feed efficiency and improved disease control have been instrumental in accelerating production growth, both in developed and developing countries for salmon, pangasius and tilapia. It is expected that in Indonesia the relative price decline resulting from productivity improvement will be cancelled out by strong demand from particularly urban affluent consumers, relatively high logistics costs and demand from export markets.

Indonesian consumers like shrimp; external demand and high feed costs are likely to dampen domestic consumption growth of crustaceans (shrimp) somewhat. Compared to Thailand and Vietnam, Indonesian production and demand for mollusks is limited.

The major difference between Delgado's 1997 estimates and the present one for Indonesia is the much higher percentage of high value finfish—mostly aquaculture produced—in the base year local diet compared to the SE Asia 1997 estimate. Aquaculture plays a more dominant role in Indonesian fish production, while high value fish export levels are presently modest.

One critical assumption in the projection concerns their linear nature: should fish consumption plateau just like other foodstuffs such as rice once a certain income or consumption thresh hold is being reached. Indonesians by 2040 are likely to be in a different situation compared to Japanese consumers now, who consume some 58 kg[71], and have the long cultural tradition and income to satisfy their desire for high quality and highly priced sea food. This report assumes demand in volume terms will plateau, but not before 2040.

Indonesia will still have quite a few poor people by 2040, and while the middle and upper income consumers may well limit their—well above the global average of about 13–16 kg net—consumption of fish, the less affluent may still wish to consume more72. While expenditure for fish in nominal terms may continue upward as more affluent consumers increasingly pay for higher priced fish, their absolute consumption levels may be maintained or even decline as other foods grow in importance in the diet. Particularly in rural areas with lower income growth, demand for lower priced fish is likely to remain strong.

Demand Projections

Compared to current production levels of food fish (6.3 million tons in 2010), domestic demand in 2040 would depend population growth and assumptions on sound policies and effective sector and resources management. The Centennial model pessimistic scenario—assuming high population growth—would require fish production—less trade—to almost double by 2040. Better policies and management would further increase the projected level of future production.

71 FAO fisheries Statistics: Food Balance Sheets, Rome, 2009
72 In China in the period 1973–97 consumption/capita of low-value fish increased very rapidly until it reached about 15 kg, after which growth slowed considerably. In SE Asia the 15kg level of consumption was already reached a decade earlier, and per capita consumption growth has been quite modest since then, despite relatively high-income growth levels. For high-value fish China showed consumption/capita growth of about 9% annually; assuming real per capita income grew at about 5% annually that implies an income elasticity of close to 2, very high! These elasticities applied for an era that constraints on fish supplies were limited.

Prices

Projected global fish prices for 2020 73suggest real price increases of 6–15% for food fish, and 18% for fishmeal and fish oil relative to modest declines of prices for all protein alternatives, including meat, chicken and eggs74. Whether these relative price movements will be followed by Indonesia in the longer term will depend on future domestic—and regional, mostly China's—aquaculture production growth. China's aquaculture growth performance will be a most critical variable in all projections (section 5aii). Fundamentally, the fish consumption fate of the countries in the region, including China, is directly linked to their joint ability to develop and maintain an efficient and highly productive aquaculture sector, and jointly and individually solve critical technological, disease, feed, environmental, institutional, regulatory and logistical issues. While China may be able to continue to import fish from across the globe to satisfy gaps in local demand, Indonesia may have greater difficulty pursuing the same strategy facing a combination of limited local appeal of imported fish and having few industrial groups operating globally catching fish, while current import restrictions also limit the appeal of imports75. The ability to pay higher prices for fish will increasingly determine global trade flows and global demand. The lower-income countries like Indonesia will pay the price.

Inside Indonesia lower growth than required to satisfy future demand will likely translate in relatively large increases in fish prices, and possibly more rapid changes in consumption patterns towards alternative protein sources, as has been demonstrated in the past. Tuna production may also play a larger domestic role as regional demand turns towards high priced fresh and frozen products, and the Indonesian catch contains relatively many smaller tunas. As Indonesians never developed a taste for imported fish, the role of imports may be less important in satisfying local demand than changes in consumption patterns towards chicken and eggs.

Domestic supply of fish

Area Expansion and Intensification

Aquaculture will need to carry most of the burden of satisfying local demand projected above, as total catches from marine and inland waters are unlikely to grow much above current levels. Not only are most marine fish resources in Western and Central Indonesia fully or over-exploited, the ability of the private sector to expand production of small-pelagic species—which comprise most of the under-exploited marine resources in Eastern Indonesia—remains at best uncertain. Many alternative—and more remunerative—investment options are available in the region, reducing the likelihood of major private investment in low—margin, mostly industrial small-pelagics production and distribution. Aquaculture food fish production, currently about 1.7 million tons, would need to almost triple by 2040 to satisfy projected domestic demand (grow 4% annually)—assuming low (.6% annually) population growth and no changes in external trade, prices and consumption preferences. To satisfy the low case demand, the share of aquaculture in total food-fish production by 2040 may need to increase from 22% at present to about half. Alternative assumptions would all increase future demand—and higher aquaculture production growth. Higher population and income growth, a more rapid decline of the percentage

73 Faster expansion may lead to considerable price declines, notably for low value fish and higher levels of exports. An ecological disaster, a major decline of food fish catches on account of poor resources management or climate change would increase prices more substantially, and probably lead to demand for larger imports and alternative products like chicken and eggs: Delgado et al.; Outlook for Fish to 2020, Meeting Global Demand; International Food Policy Research Institute, Washington DC and World Fish Center, Penang; October 2003. Fish prices in Indonesia have been going up relative to other proteins, and if Japan is any guide (for 2002) an overall income / expenditure elasticity (for fresh fish only—for processed fish the values will be substantially lower) of .84 was calculated, and a price elasticity of minus 0.703. Expenditure elasticities declined quite rapidly from low to higher income consumers in Japan (.95 to .71): Wen S. Chern, Kimiko Ishibashi, Kiyoshi Taniguchi and Yuki Tokoyama: Analysis of food consumption behavior by Japanese households; Ohio State University, Columbus, (April 2002).

74 Ibid.

75 Growing demand for cheap fish from emerging economies - across the globe—will in the near future exceed the clearly limited global supplies of marine fish. West Africa is already a major importer, and its demand will further increase over time. India may start importing in the future. Global resources of these species are already exploited close to environmental limits. For 2020 Japan and China are expected to remain net importers; no projections are available beyond that date. The main markets in the EU and USA will remain major importers—although the product range will differ over time.

of poor people in society and larger net—trade balance of food-fish, would all require local fish culture production to grow even faster.

Maintaining such sustained growth for three decades will necessitate a fundamental transformation of the aquaculture production system. While in the future abundant low cost labor and land may still be available, the costs of capital and logistics may well increase. To maintain sustained long-term growth, Total Factor Productivity will need to increase, based on technological advances and improvements in operational productivity and improved control over logistics and capital costs. In addition to area expansion, intensification will need to become an increasing part of the industry growth strategy.

External risks

From the multiple external risks that the Indonesian fishery sector may face until 2040, four could affect the sector particularly:

1. China's aquaculture production. Global fish production growth during the past 20 years has been largely generated by China; it produces almost 70% of global aquaculture production and an increasing share of marine production[76]. The impact on world market prices and fish trade would be major if China's production growth was to substantially decline or increase compared to currently projected levels. Faster growth would lead to substantially lower fish prices but much higher fishmeal and oil prices[77] on global markets, and would probably increase China's fish exports, competing with regional producers. Alternatively, slower expansion, or even an absolute decline would lead to rapidly increasing global fish prices and declining fishmeal and oil prices, and probably lead to stronger demand for regionally produced fish. Hence, the success of Indonesia's aquaculture development strategy will in part depend on China's future aquaculture growth performance.

2. Availability of reasonably priced fish in global markets. Although fish can be stored in dried, salted, frozen and canned form, no country has created national stockpiles to satisfy demand for fish in cases of emergency, or to regulate local market prices. Like the rest of the world, Indonesia will need to depend on global markets to satisfy large gaps between demand and local supply of fish, or absorb price hikes for fish and alternative products. Markets for high-value species are well developed globally and fish imports in Indonesia may only be constrained on account of prices and consumer preferences. Dependence on imports of cheap fish in the future will be riskier. At present ample supplies of frozen blocks of certain types of 'small-pelagic'[78] fishes are available in global markets. However, future demand for these fish may increase substantially. Global supplies of cheaper fish species may cost much more in the longer-term future; this may limit the effectiveness of fish imports as a tool to control domestic fish prices for poorer segments of the population or to substitute imports for slower than expected aquaculture production growth.

3. Shortages of fishmeal and fish oil for aquaculture feeds. Fishmeal and oil are critical ingredients for fish feeds, while chicken, egg, and pork production also benefit from—declining—meal and oil rations in feeds. Global fishmeal and oil production are finite, and unless suitable replacements or efficiency improvements are found—demand will increase, leading to higher prices. Price increases of well over 100% can be expected if anchovy production off the coast of Chile and Peru—the main fishmeal producers—fails through an extreme el Niño event.

76 The actual level of China's marine and aquaculture production remains the subject of substantial international debate—few doubts exist about the country's astonishing growth of aquaculture production over the past 20 years.

77 Delgado, Christopher L., Nicholas Wada, Mark W. Rosegrant, Siet Meijer, and Mahfuzuddin Ahmed; Outlook for Fish to 2020, Meeting Global Demand; International Food Policy Research Institute, Washington DC and World Fish Center, Penang; October 2003.

78 Species like mackerel, sardines, herrings etc.

These events are likely to happen more frequently in the future. New fish processing technologies may also increase the suitability of fish species currently processed into fishmeal for direct human consumption. The historic ratio of fishmeal and soya meal prices has been around 2 to 3. In 2009 it peaked at 5.5, and currently is about 4. Historically high fishmeal and oil prices will occur more frequently than in the past.

4. Pandemics. Intensive aquaculture already had its share of national or global pandemics—shrimp, salmon, carp—and the risk of a new disease seriously affecting a globally important fish is not negligible. That may affect global fish supplies and prices, but may also affect Indonesian production. While it may be impossible to eliminate this risk, the country can reduce it having a strict regulatory framework and quality controls, top-level researchers, and effective extension services.

Future fish trade policy, a defensive role

Indonesia's current trade tariffs are relatively benign, reflecting ASEAN efforts to reduce regional trade impediments. Two items stand out: (i) imports of 'cheap' frozen fish can only be used for further processing inside Indonesia, not for direct consumption, and exports of fish face a modest export tariff (and increasing quality requirements from importing countries). Indonesia may have limited flexibility in setting its future trade policy and tariffs within the context of future ASEAN, WTO and other fora. It may consider (temporary) reducing existing constraints on 'low value' imports as part of its food safety policy, while in the short- to medium term it may issue temporary volume limits on exports of fish products that appeal to low- and middle-income consumers in situations where China and other countries in the region suffer major declines in production. Given its exposure to developments in the region, an active fish products trade policy—within the limits of ASEAN and WTO agreements, will remain necessary as part of food security strategies.

The risks of medium-term climate change

Climate change may create four threats: a temperature and precipitation increase, a sea level rise, and an increase in frequency of extreme events[79]. The impact of these threats on fisheries activities by 2040 is likely to be moderate to modest. Temperature increases may affect spawning and migration of wild stocks, but the impact on Indonesian resources remains to be clarified, and is unlikely to be substantial by 2040. Aquaculture has several means to easily mitigate high temperatures—deepening of ponds, higher water exchange rates etc. Similarly higher levels of precipitation may affect spawning and migration of wild stocks—again the impact is likely to be modest. Low intensity aquaculture may also be affected, as infrastructure may be unable to cope, but is unlikely to affect other production except through flooding. Careful site selection of aquaculture operations can minimize such risks.

Sea level rises may still be moderate by 2040 and would mostly affect brackish water ponds in coastal areas. In selected areas the impact may well be mitigated by restoration of mangrove forests, which can trap silt and 'grow with the rise'. If such option is not available, man-made structures may protect low-lying ponds. These can be simple embankments, built from pond material—or higher embankments, using more elaborate construction materials. Low-lying pond areas may actually benefit from higher sea-levels, enabling easier water exchanges. In some areas the costs of embankments may become too high, and ponds may be abandoned.

The threat of extreme events is probably the most pressing, as it could affect large coastal areas used for marine culture of fish and sea-weeds. While submerged line cultures for seaweed and mussels may be less prone to storm dam-

79 Anand Seth: For 2050, Global Mean Temperature (GMT) is projected to rise by 1C. A temperature rise of 0.1–0.3 C per decade has been observed in SE Asia. Global Mean Precipitation (GMP) is projected to increase in high latitudes and tropics. Global Sea Level Rise (GSL) is projected to be from 0.18M to 0.6M by 2100 and increased ocean acidification is projected to increase with a Ph change from 8.1 to 7.7 to 8. Sea level has risen by 1–3 mm/yr over last 50 years in SE Asia. Global Sea Surface Temperature (GSST) is projected to rise by 1.5C to 2.6 C by 2100, with regional differences. SE Asia has seen a significant increase in the number of tropical depressions.

age, floating cages are. In sea areas with limited natural protection from waves and currents these may particularly be prone to losses, leading to the escape of the crop. While technical solutions exist to limit storm damage—submerged cages, heavier anchors etc.—the costs are high, and may not yet be feasible for most current culture practices and intensities. Site selection will be the critical variable determining future losses of cage culture due to extreme climatic events.

Satisfying Demand—How to Sustainably Increase Supply?

The Ideal Scenario

Preamble

Ideal scenarios almost never happen and describing one is particularly audacious when the outcome depends on a multitude of difficult, complex and possibly impossible to manage institutional and regulatory processes, actions and some politically sensitive decisions, some of which outside the realm of the fishing sector. A description of what may happen—even if the 'ideal' may not fully materialize—does make some sense for the fishing sector; over the next 28 years it will need to adjust the nature of its sector governance and the structure of its activities to remain internationally competitive and satisfy growing demand for fish and other protein foods for its citizens. The 'ideal' provides direction to the change process.

Marine fisheries

The ideal scenario for sustainable production from marine fishing sector may create the following situation:

1. An improved coastal marine environment, resulting from more widespread introduction of Marine Protected Areas, enhanced marine fish culture and lower fishing pressure;
2. Coastal fisheries, limited to fewer—registered—traditional boats, generating higher local incomes;
3. A registered and licensed fleet of efficient commercial and industrial vessels, exploiting clearly defined and monitored resources outside areas reserved for traditional fisheries, under a zone wide fisheries management plan drafted and executed by a 'Fisheries Zone Management Authority' supported by a zone coordinated MSC system;
4. Total marine fish production below MSY levels, reflecting application of the cautionary principle (and requirements of selected international markets);
5. A modern tuna fleet exploiting the EEZ and the Pacific and Indian Oceans under bilateral and RFMO protocols; tuna processing concentrated in large, efficient plants owned by one or more regionally operating tuna processors;
6. Most fish would be landed at well-equipped and located landing facilities with proper logistics connections to markets; well organized collection of fish from small landing places;
7. Education of fishermen and their children and widespread support for the creation of alternative employment prepares them for jobs outside the sector;
8. Universal quality control being applied along the entire value chain; and
9. Multiple traders operating the local distribution of fish; large industrial groups—some regional—dominate fish processing and exports of higher value species and seaweed.

Aquaculture

The evolution of aquaculture may lead to:

1. A wide spectrum of fish species being cultured, of which many are less dependent on feeds containing fishmeal and oil;

2. Most fish and seaweed production concentrated at locations that satisfy major requirements of efficiency, technical and financial feasibility, domestic and international demand, controlled environmental impact, and defined risk of the potential impact of climate change, reflecting nationwide implementation of spatial planning findings; full integration of the sector's water and land requirements in local coastal zone management plans;

3. An industry structure for locally consumed fish mostly based on individually owned small-holder and community owned production—many integrated into larger distribution networks—in parallel to several large and medium-sized domestic and foreign producers;

4. Production and export of high-value cultured fish products dominated by larger industrial groups, partly through smallholder-estate structures;

5. Public and private hatchery activities subject to rigorous quality control;

6. Government, industry, academia and NGOs provide a network of universal extension services supported by sufficient public and private funding; practical and academic education and recurrent training for fish culturists and related services being provided at multiple locations and levels; and

7. Fundamental research concentrated in a few domestic centers of excellence that are part of global research efforts; applied research managed by zone, technology and subject; substantial public and private funding of research budgets, partly targeted at improving production of lower value species.

Sector governance and trade

1. Sector governance, directed by MMAF, involves frequent consultation with the private sector and lower level government; sector policies are coherent with a stable long-term vision of development and management, and implementation relies on high quality information—MMAF has a strong, permanent, sector management team;

2. Provincial and district/municipal institutional capacity is permanently being strengthened for clearly defined tasks; part-time support for more complex tasks is being provided—on demand—by MMAF and private sector specialists; MMAF maintains a major, highly experienced, labor-force available for such support;

3. Responsibility for marine fish resources management remains at present levels, but will be centered into Fisheries Zone Management Authorities, where representatives of MMAF, the provinces and districts will direct marine resources research, create resources management plans, monitor their implementation and coordinate zonal MCS activities;

4. Trade policies constrain the export of low value fish, and—for products that require processing—unprocessed commodities; minimal tariffs and use restrictions are applied to imported fish and fish products;

5. Fisheries research, extension, education and investment in critical infrastructure receive sufficient budget support; and

6. MMAF maintains a permanent review of the legal, fiscal and regulatory framework at the international, national and local level, and actively seeks adjustment and simplification.

The private sector

1. Export oriented industrial activities are handled by companies able to function effectively in key markets; Indonesia actively encourages industry cooperation at the national and regional level, notably for tuna and seaweed related activities;

2. A pro-investor business climate enables continuing industry expansion and replacement investment, and development of new products;

3. The regulatory and fiscal environment encourages high quality production rather than volume growth, is coherent and simple, and its application is dependable;

4. Financing of large and small-scale fisheries activities is available at reasonable costs.

5. Transport to and from Java and the Outer Islands has become frequent, reliable and cost-effective;

6. Infrastructure to land fish, and collect fish from remote locations is available, and operators apply consistent, high quality and hygienic standards; and

7. The Government maintains an intensive, permanent dialogue with the representatives of the private sector.

Key Sources of Growth—and Reducing Risks—for a High Performance Scenario

Getting to high sector performance

The Challenge

Demand for fish will almost double by 2040 to over ten million tons. This fish may be caught by marine fishermen, grown by domestic aqua culturists, or be imported. Demand would decline if fish prices increase faster than general inflation levels, and when alternative protein foods decline in price. Demand will also increase if poverty substantially declines and the percentage of people becoming 'middle class' grows rapidly.

External factors will indirectly influence future demand. China's future performance—and of other major fish producers in the region—will impact global fish (and fishmeal and oil) prices and demand and supply in Indonesia. A relative decline of its growth rate will increase fish prices, and encourage Indonesian exports; higher Chinese growth would increase the price of fishmeal and oil, but reduce fish prices.

Indonesia could import fish to satisfy local demand, but will face a global market where prices—notably for marine fish—will increase relative to other protein foods, and a local market not used to imported fish species and products.

If Indonesia is unable to satisfy local demand fish prices will increase even faster relative to other protein foods, demand will decline, and the poorer sections of the population will be unable to maintain their current—modest—intake of a critical food.

How to get there

Rapid aquaculture production of food fish will be the key to satisfy future demand. High production growth will require a combination of 'horizontal' expansion, using cheap land, water and labor, and productivity growth: more capital and knowledge intensive production methods. Both will require substantial public and private investment in research, extension, local infrastructure and production capacity.

1. Innovation—research: All forms of aquaculture will increasingly depend on technological progress. As a global industry, aquaculture requires cutting edge international and private research and adaptive research. Indonesia should actively participate in the former, and dominate the latter.

2. Extension: Productive and efficient aquaculture requires well-educated and trained fish-farmers. In the short-term support strengthening the current mix of public, private, academic and NGO executed 'extension' channels will be needed; in the long-term the knowledge transfer mix should increasingly be based on the relative efficiency of each method. Farmer preferences may be built into the system, using vouchers.

3. The private sector-business environment: Future investment by the private sector in food fish production requires a clear, supportive and dependable business environment; specifically, regionally competitive bank lending interest rates, a better performing land market and a streamlined regulatory and fiscal environment. The proliferation of lower level authority regulations needs control and the regulatory and fiscal framework should be part of a national, coherent, system. Without improvement in the business climate, investment levels by large and medium-sized domestic investors will likely remain modest.

4. Industry structure: Aquaculture production requires a healthy mix of many small- and medium-sized producers and a limited number of large-scale operators. The actual mix may well vary over time and by production system. To ensure high production growth of lower value food fish, future involvement of large operators, to play a 'lead' role, will be essential. Public policy should also encourage public-private consultation and actual partnerships—notably between small-scale producers and distribution systems.

5. Logistics: Aquaculture production requires effective and cheap logistics. Improvement of the current, cumbersome transport and distribution of fish from the Outer Islands

Annex 3—Livestock

Table A3.1: Average consumer prices (USD/KG) for Beef and Poultry meat and ratio

	2005	2006	2007	2008	2009	2010	2011	2012[4]
Beef	4.85	5.42	5.47	5.79	5.89	6.92	7.58	7.53
Poultry	1.38	1.59	2.51	2.75	2.94	3.06	3.3	3.28
Ratio B/P	3.51	3.41	2.17	2.1	2	2.26	2.3	2.3

Introduction

Historically livestock played a minor role in the agricultural production systems of Indonesia, where plantation crops and rice were the mainstay. Water buffalo and cattle were and still are used for animal traction. Traditionally all species play important roles in religious and socio-cultural events, such as Madura cow races, pigs in social exchanges in Papua and chicken in ceremonies.

The green revolution of the seventies had a major impact on rice, wheat and maize production but bypassed the livestock sector. The current much heralded livestock revolution, largely driven from the demand side with population growth, urbanization and increasing affluence as the major drivers, caused a strong demand for and price increase of most products of animal origin. Table 1 gives an overview of the price developments for beef and poultry. The effect of the increase in grain prices can be seen in the narrowing price ratio between beef, largely fed on roughage, and poultry, fed on grain. The producer price increases formed a strong incentive to increase livestock production by those who had the means to do so. It is however questionable whether in a traditional livestock production system as found in Indonesia, in which livestock played many roles not directly of a commercial nature and with the availability of land as a limiting factor, smallholders were/ are and will be capable and able to take advantage of this market driven opportunity to expand their livestock business without outside support. It seems that corporate agriculture did make good use of this opportunity, explaining the exponential growth of the highly industrialized poultry sector with vast investments in feed milling, breeding farms, hatcheries and grower and layer facilities. Also the beef feed-lotting industry largely based on imported weaners is an example of a production system originating from corporate investments, not from expanding smallholders. Besides the dairy small-holder farms linked to a milk processing company there have been several recent developments of large-scale dairy farms, where thousands of cows produce a quality controlled and guaranteed range of dairy products for export and the high-end supermarket trade.

The above-mentioned developments have led to the existence of three distinct modes of livestock production in all species in the country:

1. The corporate vertically integrated production system: by making use of own production facilities or contracting and controlling third party production facilities, these units produce, process and market the produce, often through modern retail outlets such as supermarkets and through the fast food and restaurant industry

2. the commercial production systems: largely making use of similar genetic resources, feed and methods as the first group, some working as outgrowers for the first group, others remaining independent in

their marketing, usually preferring to work through middlemen and wet markets

3. The family farming/traditional production systems: within a family household livestock production is in symbiosis with the family's crop production and serves in the first place the family needs followed by sale of surplus on local markets or to middlemen.

Over the last 20 years the contribution of corporate farming towards aggregate production has steadily increased to the point where currently some 70% of urban poultry consumption is now derived from corporate farming. Feed lotting in the beef sector has not reached a similar level throughout the country except for the main population centers due to the fact that it is difficult to link the traditional cattle keeping areas with the end markets, which can be readily served from the feed lots or imported beef. If small-holders can participate in this development it will assist them to escape the poverty trap, but this would require a radical change in their livestock production system from subsistence to commercial, for which they would have to gain access to more land and finance and to be incorporated in a value chain system that would guarantee the right veterinary and extension services, quality assured inputs and a fair marketing of their produce. Value-chain financing is a powerful credit tool to link producers to suppliers of inputs and the processing industry. In many countries with commercial broiler production, financing of day old chicks and feed is done through the integrator, who takes responsibility for slaughter, processing and marketing and in this way is guaranteed repayment of the value chain credit, usually in kind. Such schemes could be powerful instruments to modernize the kampong (village) poultry production systems, both for eggs and broiler production. In the following sections a picture of current status and expected developments for poultry, piggery, dairy and beef cattle farming will be given.

Consumption pattern

The overall meat consumption in Indonesia is still extremely low in comparison with neighboring countries. The following table gives an overview of the consumption of products of animal origin in 2009.

From this table it can be seen that poultry meat and eggs are and will remain the most important source of animal protein for Indonesian consumers. Dairy consumption has grown and local production can cover only a fraction of the overall consumption so that import is necessary. While with poultry it is possible to increase the local production through the import of feed, this is far more difficult in the case of cattle as this would require more land. Milk production is best done near the areas of consumption, especially when the market exists for fresh dairy products.

Feed milling

Feed mills are the engines for large-scale livestock production increase. Their economies of scale and state of the art technology give the highest returns per kilogram feed. Maize is the basis of all stock feeds. Since 1980 technology changes in maize cultivation (use of hybrids and fertilizers, mechanization) have increased the productivity of maize by a factor 2. The adoption of GMO's is likely to boost productivity by at least 50%. Of all maize used in the feed milling industry in Indonesia, 30% is imported (3 million tons). Another important feed ingredient is soya. Because of climatic factors Indonesia is not well suited to soya production

Table A3.2: Per Capita Livestock Products Consumption (Kilograms)

	2009
Beef	1.18
Buffalo	0.09
Goat	0.15
Mutton	0.12
Pork	0.55
Chicken	2.97
Other poultry	0.08
Other meat	1.33
Eggs	5.61
Local dairy products	2.50
Imported dairy products	7.03
Total dairy products	9.53

Source: Directorate General of Livestock Services

and must largely dependent for its soya requirements on imports, mainly from India, Brazil and USA. The government through research and extension is trying to make feed millers reformulate the feed composition to replace part of the soya with palm kernel cake, which currently is exported. Developments to further process estate crops before exporting will create more byproducts that can be used in the animal feed industry, but will require research and development to bypass technological, anti-nutritional and other obstacles.

The animal feed industry is fragmented and many factories belong to a particular commercial poultry farming enterprise. In 2000 the total reported feed production was 4.482 million ton, in 2012 it is expected that the industry will produce up to 12 million ton compounded feed. The following figure gives an overview of the total feed production over the last 27 years. The average growth of the feed production since 2006 has been 7% and the industry expects this growth rate for the coming years to continue.

Indonesia's largest feed milling company, Charoen Pokphand from Thailand, which is also involved in layers, broilers and fish, commands more than a 50% share of the total market, with JAPFA Comfeed taking up another 20%. Of the 12 million ton compounded feed, 4.5 million ton is for layers and 4.5 million ton for broilers. A good indicator for the amount of animal feed produced is the statistics of the premix industry. With a known ratio of premix to the total feed it is easy to calculate how much feed is produced. A major premix manufacturer gave the following distribution of the total amount of feed produced over the different types of farmers and animal species.

It shows that the integrated production systems are mainly in broilers, shrimp and fish.

Most livestock is being kept on Java; this is also apparent from the amount of animal feed (mainly for broilers and layers) formulated on the various islands.

With the impact of climate change, the risk of crop failure in maize cultivation becomes bigger. Alternatives for maize in the feed rations have to be found. This could be sweet or bitter (after dehusking) sorghum and cassava/tapioca.

As cassava is processed before use in a feedmill it carries a 10% sales tax, whereas when feed mills buy wheat or maize and mill it, there is no sales tax.

The sector has a professional association GPMT (Gabungan Perusahaan Makanan Ternak- Indonesian Feedmill Association) with 48 members. This association is probably the best way of guaranteeing minimum standards of operation and the application of GMP principles in the industry. It could involve itself in independent feed quality analysis, adaptive research and training of farmers in the right application of animal feed. This training can greatly assist in reducing GHG emissions per ton of product through increased efficiency in the animal production industry. An important aspect of food safety assurance should be the gradual reduction of antibiotics in the feed and replacing them with more hygiene in the husbandry system and use of probiotics.

Poultry

Introduction

The Indonesian poultry sector can be divided in 4 sectors:

- the corporate poultry sector: approximately 23 large corporations
- the large-scale commercial poultry sector: 3,000–3,500 layer farmers and 2,600 large-scale broiler farmers (including breeder farms)

Table A3.3: 2011 total animal feed production per area

Island	Zone	MT/year
Sumatra	Medan	720,000
	Padang	210,000
	Lampung	600,000
Java	W. Java	3.000,000
	C. Java	240,000
	E. Java	3,500,000
Sulawesi		360,000
Total		8,720,000

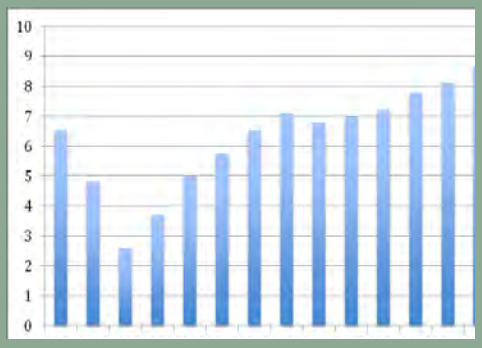
Source: Trouw and Centennial team's estimates

- the small-scale commercial poultry sector: an estimated 2.5 million farmers
- the village/kampong poultry sector: estimated 25–30 million farmers

Poultry is after fish the most important animal protein for the Indonesian consumers. The official statistics state that 20% of all eggs and meat in the urban areas come from the village/kampong poultry production system and 80% from the commercial sector, whereas in the rural areas 20% comes from commercial poultry and 80% from village/kampong chickens. In the Indonesian poultry sector both chicken meat and eggs are sold per kg, whereas in most neighboring countries sale is per unit.

With the increase in the size of poultry farms farmers need to employ more labor but existing labor protection laws are restrictive: fired workers are entitled to 2 months' salary per year employed; when workers resign for any reason they are entitled to a payment of 1 month's salary per year worked. This means that workers who want to resign are better off to misbehave and get fired. In 2011 the minimum wage was increased by 15% and during the first half of 2012 it was increased by a further 18%. This means that the commercial poultry sector invests as much as possible in automated systems to keep the number of workers as low as possible. Although the Indonesian government wants to promote commercial agriculture it seems that in many instances the lower level administrations costly operational barriers for commercial operators. Importers of animals and feed in a number of cases mentioned that there are non-documented additional costs to procure the necessary licenses for imports.

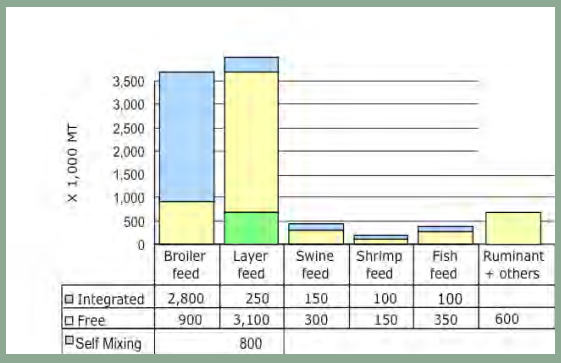
Figure A3.1: Total animal feed production (million tons)



Source: Trouw Nutrition

Poultry contributes around 60% to livestock GDP and around 1% to national GDP. The poultry industry is estimated to employ around 2.5 million workers, meaning that around 10 million people are dependent on it (assuming 4 people per family). The sector has various organizations catering to the interests of the different segments. The sector is dominated by eight large integrators, of which CP Indonesia is part of the Charoen Pokphand Group, the largest business conglomerate in Thailand. CP is responsible for more than 50% of the industrial broiler and poultry feed market. It also operates in Cambodia, China, India, Malaysia, Myanmar, Singapore, Turkey, Taiwan, Vietnam; it recently entered the Russian market and also has interests in American and Indian commodity trading companies. CP's Indonesian subsidiary had revenues of IRp 17.958,00 billion in 2011,

Figure A3.2: Distribution of 2011 feed production over species and types of farms



Source: Trouw Nutrition presentation

a 19.1% increase over 2010. This was achieved through the sales of three core products: poultry feed (80%), DOCs (13%) and processed foods (7%)[1]. PT Japfa Comfeed, the second largest integrator, has annual earnings of around US$ 1 billion. It is obvious that companies of this size have

1 PT Chaoen Pokphand Indonesia Tbk 2011 Annual Report

influence on the way the industry develops and also on the way the government will regulate the sector.

There are large numbers of organizations and associations operating within the poultry sector. It is obvious that influencing decision-making is the most important reason for stakeholders to form organizations and associations. The largest umbrella organization is the FMPI (Forum Masyarakat Perunggassan Indonesia, Indonesian Poultry Forum), which includes representatives from most other organizations and is meant to promote discussion and understanding among the various stakeholders. GAPPI (Gabungan Perusahaan Perunggassan Indonesia- Indonesian Poultry Association) represents the 8 largest integrated companies. GOPAN (Gabungan Organisasi Peternak Ayam Nasional) is the national confederation of broiler breeders, comprising of 15 associations with thousands of members, most of them outgrowers. PINSAR (Pusat Informasi Pasar) is a market information centre, which on a daily basis publishes price information of DOCs, feed, eggs and poultry meat of the different types. This information is disseminated through the Internet[2], SMS and e-mails. These are just a few examples of the many organizations operating in the poultry sector.

The arrival of HPAI in 2003 caused many changes in the poultry sector and should have caused more changes to effectively control and eradicate HPAI in Indonesia, like e.g. Thailand managed to do. It is very likely that the above potential of poultry organizations to influence decision-making might have contributed to the fact that in Indonesia HPAI was not eradicated, but became endemic. The slaughtering outside slaughterhouses is continuing, live birds are still brought into town although it was banned in 2004, people still readily mix different types of birds and of different ages. The USAID/AUSAID funded FAO executed Participatory Disease Surveillance and Response (PDSR) project during the last 8 years has built up a wealth of knowledge on the transmission of HPAI and is increasingly convinced that a major problem for the persistence of HPAI is not the smallholder family poultry farmers, but the commercial poultry sector, long overlooked by this type of research, because people assumed that through superior technology and management HPAI would not strike there. It did and the sale of (sub) clinically diseased birds keeps on bringing the virus back into the environment where it flares up in the non vaccinated village chickens. Sector actors and government are currently discussing how to change the Country-Based HPAI control system into a Zone-Based system, which would create more flexibility and opportunities for the industry in non-infected areas to continue its operations when there is an outbreak elsewhere. Such a ZB system is however much more difficult to manage than blanket decisions for a CB system.

Customer preference and development of consumption

The current consumption of poultry products in Indonesia is around 4 kg poultry meat and 87 eggs/capita per year[3]. Consumers prefer local kampong hens, fresh meat and usually whole carcasses of 1–1.2 kg. This puts a major challenge on the industry to develop cold chains to bring chilled product to the consumers. The market for ready to eat and cook products is still small and under- developed. The largest purchasers of such products are the supermarkets and fast food chains. Although Indonesia has since 2004 a law forbidding live birds in towns, every night between 750.000 and 1.000.000 live broilers are passing through the various collector markets in Jakarta: the power of these poultry collectors and distributors is big and probably could only be broken by changed consumers' attitude and preferences. Consumers however so far do not seem to have any problem with birds slaughtered outdoors behind houses during the night under unsanitary conditions and without veterinary supervision. The big poultry integrated operators have slaughterhouses and processing plants, of which none runs at capacity for the simple reason that there is not yet sufficient market demand for chilled, portioned and processed poultry meat in restaurants and supermarkets.

Between 2000 and 2010 the poultry meat consumption has grown by 5.5 per cent per annum, increasing from 2.3 to 4 kg per capita per year. Poultry meat consumption will continue to grow at this rate, with the broiler population also

2 http://www.pinsar.com/

3 Pers. Comm DG Livestock Mr. Syuku Iwantoro

growing at a similar or slightly higher rate. This would mean a consumption of 6.5–7 kg/capita in 2040, which is still low in comparison to European (20kg/capita) and by Muslim Malaysian (32 kg/capita). With the population growth foreseen it would mean a doubling of the amount consumed in Indonesia.

Poultry meat

Poultry meat comes in three categories: meat from commercial broilers, village chickens and spent layers. Indonesia is one of the major broiler markets in South East Asia and has as said above a tremendous growth potential. In 2010 around 1,226 million day-old-chicks were produced, meaning that more than a billion broilers are slaughtered per year. This growth is expected to continue till 2020 and will then slow down.

The following figures give an overview of the absolute and relative share of the various segments of the poultry meat and egg production in the overall production in Indonesia.

From the above figures it can be seen that the major growth in poultry meat production has come from the broiler section with an average annual growth rate of slightly under 14%. The layer meat production increases with the increase in layer egg production with an average growth of 12.5% per year; the village poultry meat production, which is extremely difficult to reliably estimate, grew during the last 20 years with an average of 1.6%. The following figures give an overview of the total chicken poultry meat production and the relative shares of the three segments in this overall production.

Indonesia has a number of organizations promoting the use of traditional chickens and these organizations have now set up parent stock farms. Although laying percentage of the parent stock is only 35%, the high price for a 1kg of live/600–700 gram slaughtered chicken more than compensates for the lower laying percentage and growth rate; by comparison, 1 kg kampong chicken is sold live for up to Rp50, 000, whereas a broiler is sold retail for Rp26,000 per kg live.

Most broilers are produced in outgrower schemes, in which the integrator provides the farmers with DOCs, feed, vaccines, drugs and advice. The money is recouped from the birds sold back. Possible losses will be recovered from future batches.

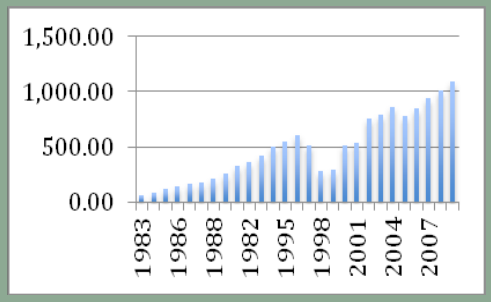
The outgrowers' scheme suffers from two issues:

- The integrity of many outgrowers: it happens that outgrowers add 10–20% chicks from other sources, which will eat from the integrator's feed and can eventually be sold privately. This suppresses the technical results and the profitability for the integrator
- Breaches in biosecurity on the outgrowers' farms, especially involving his private birds, leading to problems for the integrators in their plans of production and processing in case batches are being culled for e.g. HPAI or are not ready for slaughter at the planned day due to disease.

Although the Indonesian government is a strong proponent of the outgrower model ("inti plasma"), developments in Thailand, where before the arrival of HPAI the outgrower system was the norm, were for the integrators to take control over the rearing of the broiler chicks themselves after constructing with relatively low investment costs the required broilers sheds. It is only a matter of time for the Indonesian broiler integrators to shift to managing their own broiler farms if government gives the permission and makes the land for the construction available.

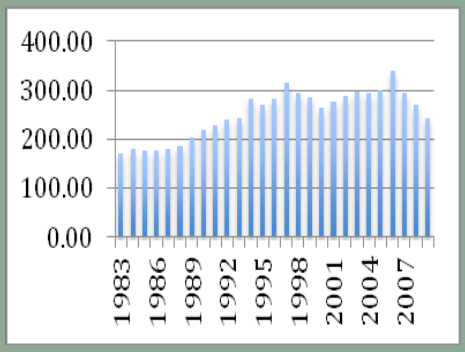
The price for poultry meat and eggs is determined by a group of traders, who bring the information to the PINSAR organization, which issues a price table for broilers in different weight classes and for different types of eggs. This information helps determine the price for poultry meat and eggs in the different markets. There is a relationship between the price for meat and eggs and the price for DOCs and most actors in the poultry sector see this system as fairly impartial and reliable.

Figure A3.3: Broiler Meat Production



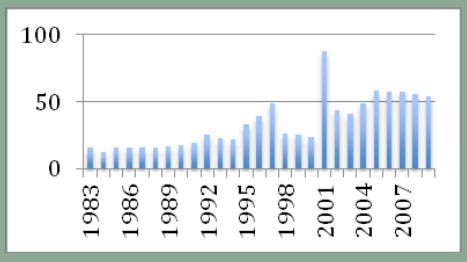
Source: Ministry of Agriculture

Figure A3.4: Broiler Meat Production



Source: Ministry of Agriculture

Figure A3.5: Layer Meat Production (1000 ton)



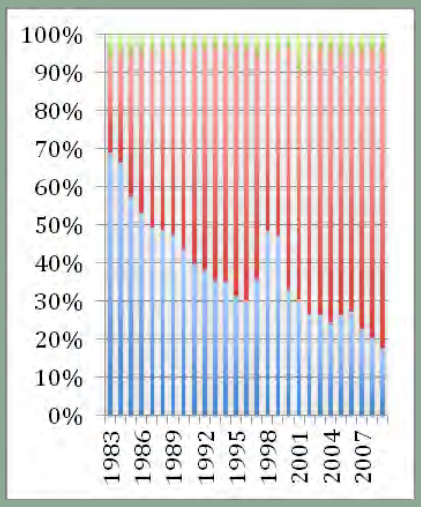
Source: Ministry of Agriculture

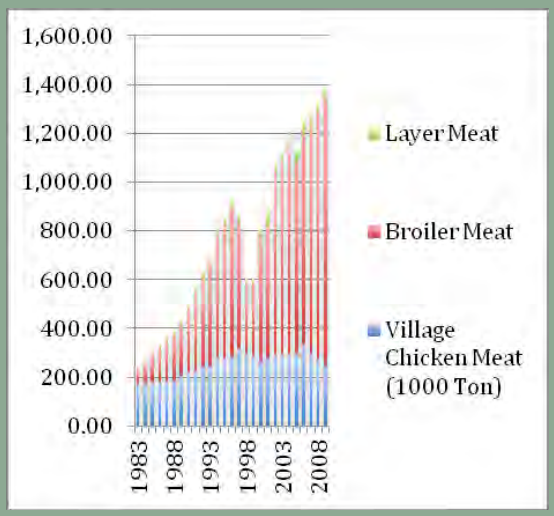
In May 2012 broiler meat retailed for 26,500 IRp/kg in the supermarket, a cockerel or spent hen in the same supermarket retailed for 46,900 IRp/kg. A true certified village chicken retailed at 50,000 IRp/kg live, which is equal to 71,500 IRp/kg slaughtered, or 270% above the price of a kg industrial broiler meat. Even with an increased supply of genuine village chickens on the market, and less effect of scarcity on the price of such a chicken, it will still be double the price per kg of a broiler.

Egg production

In Indonesia there are two types of eggs: the local kampong and the industrial/commercial eggs. All industrial/commercial eggs are brown, whereas the kampong eggs have a varying color, but are usually smaller and lighter colored. The price of kampong eggs is 50% higher per egg and the weight is 75% of industrial eggs, which shows the price

Figure A3.6: Overall Chicken Meat Production and Relative Shares over time of each sector





Source: Ministry of Agriculture

advantage of local eggs over industrial egg, considering the lower production cost.

The following figures give an overview of the development of chicken egg production in Indonesia.

From the above figures it can be concluded that in absolute terms the village poultry meat and egg production do still grow, but that they loose their share in the overall production due to the much faster production increase in the commercial layer and broiler production sectors.

The rule of thump in the layer industry is that the egg price should be at least three times the feed price for the sector to make a profit. With a feed price of 3,700 IRp per kg and eggs selling for 12,000–12,500 IRp, there is a narrow profit margin in the egg sector.

There are 2 companies with Grand Parent Stock (GPS) (ISA and Hyline/Lohman), producing Parent Stock (PS) for 15 parent stock farms, which produce the pullet chicks for the 3,000–3,500 commercial layer farms. With 130 million layers Indonesia is 100% self sufficient for eggs (with some 'grey' import into Sumatra from Malaysia)

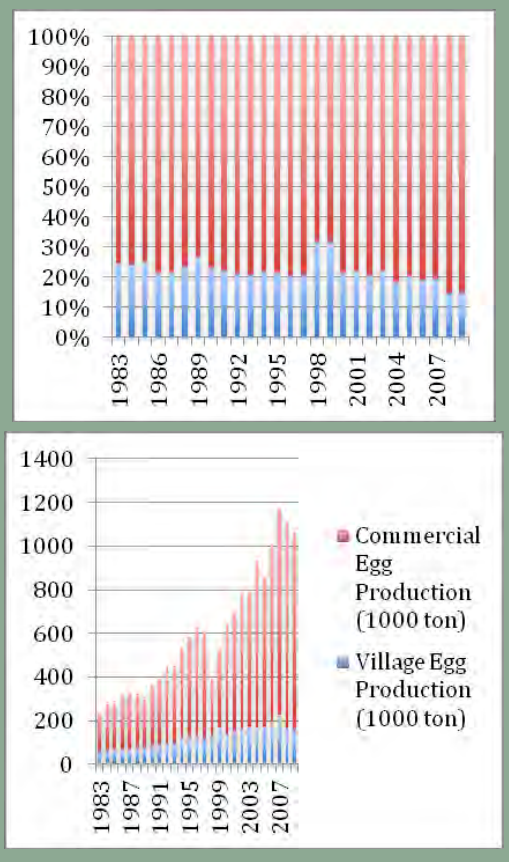
With consumers preferring local hens for their taste, flavor and the texture of the meat, there is also a good market for spent layers and layer cockerels of 3–4 months old and 1kg slaughtered weight. This means that the layer industry in Indonesia has a good market for DOC cockerels and spent layers. This demand for spent layers and cockerels in the market gives Indonesia a good competitive advantage over egg producers in neighboring countries if feed and other costs are about the same as in other countries the DOC cockerels are exterminated and spent layers sold for a token price.

Future developments

It is expected that especially in the feed milling industry there will be a reduction in the number of feed mills and an increase in the production per mill. The number of commercial broiler breeder and production farms will decrease with the need to reduce operating costs to remain competitive. The level of integration in the poultry sector will for the same reason increase further. With increasing supermarketization over time the consumer acceptance and use of processed poultry products will increase. Consumption of poultry meat will continue to increase at the current rate of 5–6% per year.

The village poultry sector will have to specialize in the type of product for which consumers are prepared to pay a premium price. There will have to be changes in the husbandry system to increase the biosecurity and the acceptance by government of keeping livestock close to people. It is however increasingly clear that the village sector is not the main reason that HPAI has become endemic. The increase in scale of production will take out many of the smaller commercial poultry farmers, who failed to meet and comply with the required biosecurity measures.

Figure A3.7: Overall Egg Production and Relative Share of Commerical and Informal Sectors



Source: Ministry of Agriculture

Pig production

Introduction

An unexpected species in the livestock production system of Indonesia is the pig. Although a large majority of the population is Muslim, about 16% of the population belongs to other denominations that consume pork. This means that in a population of 242 million there are about 38 million people ready to eat pork. According to consumption figures from FAOSTAT, pork consumption totaled 654,200 tons in 2010; this translates into about 17 Kg/capita among the non-Muslim population.

The following figures give the pork production as reported by MinAg. The long-term average production growth has been 2.4%.

With a growing agro-processing industry there will be increasing amounts of by-products available, which pigs can convert to valuable animal protein. When this sector is allowed to develop into a diversified system with breeders, multipliers and perhaps contract fatteners it can contribute to increased income from agriculture in the non-Muslim areas away from the urban centers. When compliant with international standards it could easily form a potential export industry, perhaps with Singapore, which banned the production of pigs in 2004 with the H1N1 pandemic scare, as an important market. Also in Hongkong and China it is to be expected that with increasing population and consumption the local pig industry will not be able to keep up with the increased demand. The major number of pigs is kept on Java in about 350,000 households in relatively small numbers. The government is trying to promote large-scale commercial pig production away from urban centers. The 20,000 sow integrated farm on Bulan Island, supplying 1,200 live slaughter pigs to Singapore on a daily basis, is an example of such a fully integrated farm.

Consumption and consumer preferences

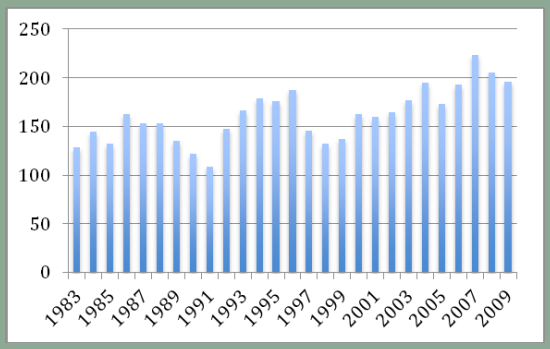
Consumers demand increasingly lean pork and guarantees that the meat is without residues of antibiotics or other drugs (beta agonist especially). It is hard to build up such a guarantee system with the estimated 350,000 smallholders with pigs on Java. Aside from the presence of many people opposed to pig production, another reason for the consolidation of the pig production sector in larger units is to move production away from population centers, where it will be easier to control the food safety aspects of the pig production.

Future developments

For the pig sector to modernize and become more efficient it will be necessary for farmers to specialize into breeders, multipliers and fatteners. It will also facilitate the maintenance of quarantine and possibly all in-all out systems on the fattening farms. This means further value chain development is required to link all these in one step of the value chain's specialized producers. Such a role is usually best played by an integrator, who manages the genetic stock material and animal feed. In case of a monopoly position of such an integrator it is well possible that farmers will not receive the price they deserve. Cooperatives have proven to be successful pig integrators, especially when also the slaughter and processing is in the hands of the cooperative. Pig breeding nucleus farms, where the best genetics from the world will be multiplied and infused into the national pig sector, could also be run by a pig producers' cooperative. However it is most likely that when permission is granted one of the existing corporations with experience as a pig integrator in other countries will step in.

The regional requirement for pork will continue to grow. It is questionable whether densely populated countries in need of more pork can continue to increase the domestic production due to environmental and social issues. With so many metropoles without the facilities to keep sufficient pigs (e.g. Singapore and Hong Kong), Indonesia seems to have the right geographical position and niches to develop an intensive pork production system that includes slaughterhouses and processing plants based on international standards. The current consumption of 17kg per "eligible" consumer is expected to go up to around 30kg, a level similar to that in various countries (e.g. Vietnam, many EU states).

FIGURE A3.8: PORK PRODUCTION (1000 TON)



Source: Ministry of Agriculture

RUMINANTS

GENERAL

Indonesia has 14.8 million beef cattle, 1.3 million buffaloes, 600.000 dairy cattle, and 16.8 million goats and sheep according to the 2011 livestock census. Before the 2011 census the general belief was that there were 12 million head of cattle, but the census uncovered 2.8 million extra animals. It is now expected that the country will be self sufficient in beef in 2014. Of the total cattle population, 95% of the total is estimated to be of local breeds comprising: 4.7 million of the Bali breed, 4.3 million of Ongole, 1.3 Madura and 4.5 million other breeds. The government's policy has been to promote smallholder cattle keeping and improve it through artificial insemination with Zebu type animals and French beef breeds. Farmers' experience with especially the 2nd and 3rd cross bred are not positive: animals loose their resilience to the prevailing conditions, require more and better feed, have lower calving rates and suffer from diseases and high mortality. One of the key bottlenecks in cattle is a low calving rate of 64% and a high mortality rate of 20% during the first year.

Especially on the densely populated islands Indonesia has very little or no exclusive grazing areas for cattle. The government tries to promote the integration of palm oil plantations with livestock grazing. With the approximately 9 million ha of oil palm plantation and an estimated carrying capacity of 1 brood cow with calf per ha this would amount to an enormous increase in the capacity to keep brood cows. In Malaysia, where already 15 years ago the government started to promote such a system only about 3% of the oil palm area is associated with cattle grazing under them. Although theoretically one could feed animals on chopped palm fronds as suggested by research, it would be very costly to harvest and chop palm fronds to feed brood cows. Currently 17% of all beef is imported, and the government's plan to achieve self-sufficiency by 2014 appears overly ambitious.

DAIRY

Milk consumption in Indonesia is a mere 2 liter /capita per year, with 75% of all milk requirements being imported from New Zealand, Australia, Canada and the USA. Milk production is promoted in a system of smallholders linked to a dairy plant. The average number of cows is 3–4 cows/farmer. Farmers are organized in Desa Cooperative Units (KUD—Kooperasi Unit Desa). There is a National Dairy Board (Dewan Susu), which talks on behalf of the sector with the government. The KUD collects the milk and sells to a dairy plant. Most milk is produced in East Java, where Nestle has over the years given farmers and KUDs support in setting up milk collection centers and to expand the production.

Figure 9 gives the total milk production in Indonesia in the period 1980 to 2009. The average production growth in this production has been 7%; the average growth in 2008–2009 was more than 25%.

The government encourages dairy processors to collaborate with small-scale dairy producers. To achieve this it developed a guideline stipulating from the number of cows from which milk should be collected for a certain amount of imported milk powder, this to avoid that dairy products would be 100% made from milk powder. Most dairies develop support programmes for farmers, train them in better cow management and milk quality. The best dairies with lucrative markets for fresh milk products pay farmers up to 5,500 IRp per liter, whereas the average farm gate price is around 3,500. This shows that through value chain and end

Table A3.4: Live and boxed meat imports 2005–2010

	2005	2006	2007	2008	2009	2010
Live import (heads)[5]	347,967	386,566	516,992	644,849	772,868	520,987
Beef (Ton)[6]	8,762	12,153	26.768	33,017	51,815	48,436

Source: Meat and Livestock of Australia for live imports and Australian Department of Agriculture and Fish for meat export figures.

market development, higher margins can be made by all in the chain.

Beef

Indonesia derives its beef from domestic production, import of boxed beef and import of live feeder cattle. The following table gives an overview of the imports of the last 6 years.

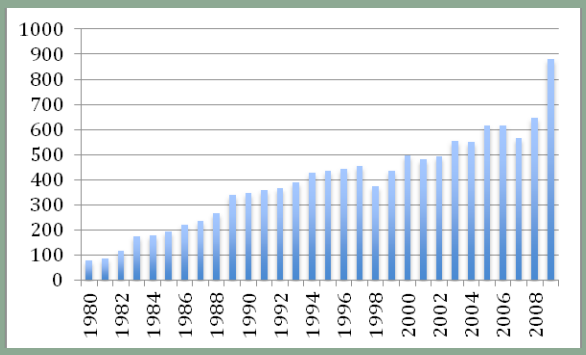
In 2011 there was a drop in live import due to an Australian export ban for live cattle and the Indonesian reaction on this, striving for self-sufficiency in beef. From the statistics it is not clear what part of the local production is derived from imported feedlot cattle and how much from locally produced feedlot cattle.

Figure A3.10 above gives an overview of beef and carabeef production for the last 30 years.

Beef is still very much seen as meat for festivities. The current consumption of beef is 2kg/capita per year, but more than 50% of the population of Indonesia never eats beef. The average beef consumption in the greater Jakarta area is around 10kg/capita per year (12 million people). Java has the largest share of cattle in Indonesia (45%), followed by Sumatra with 22% and Nusatengarra and Sulawesi both having around 13%. The government tried to promote the link-in of the traditional cattle keepers in those parts of the country with the industrial feedlots on Java. The poor local infrastructure is a serious stumbling block for this development to take place. The decentralization of 2000 has led to all sorts of local governments' regulations and taxes, which increase the price of local cattle being taken to another zone. These are two of the reasons why it is cheaper (on a per kg live weight basis) to import weaner from Australia than to use locally produced ones. Indonesia is officially free from FMD and BSE. To maintain that status it is selective in the countries from where it allows import of animals and meat. Indonesia's disease control programs are Country-Based (CB) and not Zone-Based (ZB), which means that it is inclined to import only from countries that have a CB animal health control. One of the risks of prices going up is that, although it might give producers temporary windfall profits, it also increases the profitability of importing beef in non-registered ways (smuggling): this could introduce FMD from countries towards the north. The CB system favors Australia, but some observers accuse Australian exporters of abusing this virtual monopoly. Also, in a ZB system countries not declared free from FMD by OIE, but with disease free zones such as Brazil, India and Argentina, could export beef to Indonesia. Australia and New Zealand through the Asean trade agreement with these countries can export both livestock and meat at a 0% tariff.

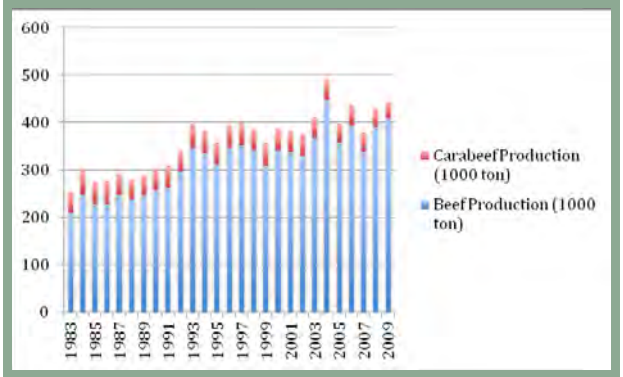
In 2011 a total of 120,000 tons of deboned boxed beef and 500,000 head of cattle were imported. It was also the year

Figure A3.9: Milk Production in Indonesia (1000 ton)



Source: Ministry of Agriculture

FIGURE A3.10: TOTAL MEAT PRODUCTION FROM CATTLE AND BUFFALO/CARABAO (1000 TON)



Source: Ministry of Agriculture

that animal rights activists from Australia filmed excesses in Indonesian slaughterhouses, which led first to an export ban by Australia, followed by an import ban by Indonesia, which was later relaxed, but with a severely reduced quota for both live animals and boxed beef. The live weight price before the import control was 18,000 IRp, which discouraged local farmers from expanding production. After the import restrictions the price went up to 23,500 IRp/kg live weight and retail prices from 67,000 to 70,000 IRp per kg. The prices for Brahman crosses are at 26,000 IRp per kg, or slightly higher than local cattle. Supply and demand calculations indicate the country needs 3 million animals to be slaughtered. The major bottleneck is to transport such animals from the many smallholders through feedlots to the urban centers. The inadequate inter-island transport grid adds a high overhead cost for this transfer.

Calculations made in the Ministry of Agriculture show that the local production stands at 399,000 tons; with a consumption of 2kg/capita and 242 million people, the country needs 484,000 tons, which means that the import quota for 2012 was put at 85,000 tons, consisting of 60% live cattle and 40% boxed beef (283,000 cows and weaners and 34,000 ton frozen beef). It is assumed that in feedlots the animals dress at 52% with an average carcass weight of 250kg and carcass to meat efficiency of 72%.

This way of calculation does not leave room for the increase in consumption, the different consumption behavior by the many tourists who come into the country and expats who live in the country. Feedlots use 30% local cattle and 70% imported. The country has 22 feedlot companies and 20 major slaughter and processing companies. Meat sold on the wet markets is mainly from local cattle, hotels and supermarkets are more inclined to use meat from exotic animals in the feedlots or imported boxed beef.

Indonesia has a considerable meat processing industry that makes sausages and meatballs, which form the principle form of beef many poorer people eat. The industry uses on average 40% of imported low quality and low priced meat, mainly organ meat (liver and hearts), for the manufacture of these traditional meat products. With the reduced levels of import of raw material for the meat industry, companies have had to reduce the manufacture of the cheaper products, which caused price increases and an increasing absence on the market of these products.

Yet another side-effect of the increased prices for livestock is that farmers are inclined to send female animals, which could still be used for reproduction, for slaughter. It is estimated that this year 150,000 productive female cattle are slaughtered, even though there is a government program to avoid the slaughter of such animals.

In the last 10 years the average live weight of slaughter bulls from local breeds according to a spokesperson of the beef industry has gone down from 400–500kg to 200–330kg. Although it is attributed to inbreeding it is more likely that this is a combined effect with reduced availability of grazing and feed and thus stunted growth.

BUFFALOES

There were about 2 million buffaloes in Indonesia in 2010 (FAOSTAT). These animals are traditionally used for land cultivation and transport. This role is increasingly being taken over by 2 and 4 wheel tractors. Carabao/buffalo meat is cheaper than beef as it is associated with old animals being slaughtered. If buffaloes are no longer used for traction but will be fully employed for meat production there would be need for a re-branding of the product to increase consumers' appreciation for it. With its superior capacity to handle

roughage and resistance to hot and humid climates there is a place for caribou/buffalo in the farming system. Ongoing work in the Philippines to change the swamp buffalo type with little milk production into a water buffalo type with more milk production through repeated crossing with Murrah could be a developmental option with the Indonesian caribou. This process should be supported by a buffalo milk processing industry, which would pay premium prices for this high quality milk often associated with healing properties and easy marketability in the urban centers.

Small Ruminants

Sheep and goats play an important role in the production of meat, especially for home consumption. With all its informal trading it is hard to collect reliable data. Figure 11 gives an overview of the production figures over the years 1983–1989.

There were 27.75 million goats and sheep in Indonesia in 2010 (PBS). Investments in goat dairy production are being made; goat milk is believed to be a cure for asthma and allergies. The breeds used are Etawal from India crossed with local breeds and Saanen. Goat milk's farm gate price is USD 2/liter.

Future developments

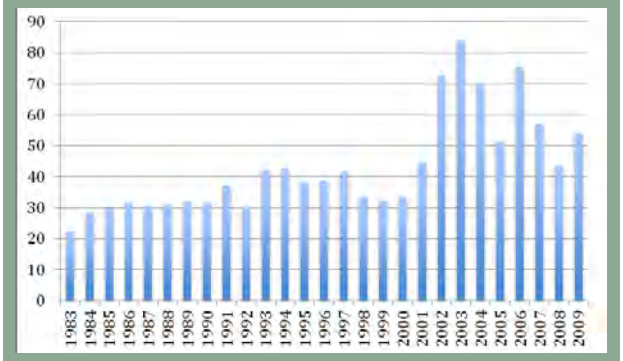
The beef sector development will have to be approached from a value-chain concept with a thorough analysis of the value addition in the various steps, but also from the cost aspects of each step. When the eastern part of Indonesia will be linked with better infrastructure to the Western parts where the bulk of the population is located, prices for local weaners will increase. Cattle breeding farmers then will have an incentive to better feed their animals, increase their fertility and reduce the mortality through better care and nutrition.

The policy of crossing local breeds with Brahman should be reconsidered, as it turns out that although superior for slaughter these crosses have poor characteristics: they have poor fertility and at times farmers find them hard to handle. Registration, performance testing and selection in the existing populations of Bali, Madura and Ongole will lead to rapid improvement in fertility and growth rate. The existing large variation within the population of these breeds and the strong farmers' interest in their traditional cattle will facilitate quick genetic progress. Breeding should focus on a locally adapted animal, capable to produce 1 calf a year on a mainly roughage diet. Once the initial effect of heterosis has weaned off, the indiscriminate crossing in a population usually leads to deception. The purebred cows could potentially be crossed with a terminal sire, such as Brahman or Limousin to produce both male and female heifers for feed lotting. Such crosses, however, should not be used for breeding afterwards. In this way Indonesia can reduce the exchange rate risk of the IRp against the Australian dollar, which determines whether feedlotting is profitable or not and promote more rational cattle keeping in the eastern parts of the country.

The contributions that the dairy and buffalo sectors can make towards increased beef production should be further developed. Each dairy cow produces around 0.4 bull calf per year (assumed 80% calving and that all heifer calves are used for replacement and herd increase), at 250kg carcass and 100kg beef, and with an estimated average lifespan of 5 years and slaughter weight after culling of 200 kg the total will be 140kg beef per year. At IRp 70,000/kg carcass weight this amounts to 9.8 million IRp, the gross return of 2,800 liters milk at 3,500 IRp/liter. Considering that the average yield is around 10l/cow day and a lactation period of 280–300 days it means that in net terms a dairy farmer earns more from his cow's beef production than from its milk production. Increased fertility and calving rates in all bovines will make a tremendous contribution towards beef production and availability.

The fact that the private sector has been slow in integrating oil palm plantations with cattle and the slow uptake of the practice in Malaysia, where programs to promote this integration started 10–15 years ago, should be carefully studied to see whether there are technical or economic arguments against this practice, which on first sight looks feasible. Feedlotters will have to take advantage of the latest research on how to reduce the emission of GHG in rumi-

FIGURE A3.11: GOAT AND SHEEP MEAT PRODUCTION (1000 TON)



Source: Ministry of Agriculture

nants (e.g. replacing urea with nitrate salts, totally mixed rations etc.).

Dairy development with cattle has grown steadily, but mainly because of more farmers being involved than increased production per farm. Farmers lack sufficient land to produce fodder for more animals and access to finance to pay for such developments. The existing arrangements between dairy industry and dairy farmers would benefit from increased involvement of financial institutions as a third party in the business of dairy development.

ISSUES FOR THE FUTURE

STRATEGIC DECISIONS FOR LIVESTOCK DEVELOPMENT

Indonesia has had three policy initiatives for beef self-sufficiency of up to 90% in 2005, 2010 and the current policy which is in effect until 2014. The government will have to make critical decisions whether self sufficiency in beef, poultry meat, pork and dairy can and should be achieved; in the process the costs of such choices should be measured against the benefits and the opportunity costs of alternative land use of lands dedicated to achieve the self-sufficiency policy. The drastic reduction of maize production in Lampung over the last years from 3 million to 0.5 million tons, whereby the freed land is now under cassava proves the point that if import is cheaper than local production it is better to import and go for the alternative crop giving higher returns. The current strategy in the poultry sector of reduction in the cost of and increasing the scale of production will work as long as there is a demand for the product and not an alternative cheaper supply. It is therefore important to monitor production, consumption and prices in neighboring countries to be prepared for the moment that the increased production will no longer be "absorbed" by the local market. For this type of analysis, prediction and action it will be important to have close public-private collaboration, which is developing in Indonesia between the Ministry of Agriculture and the various sector organizations.

FUTURE OF THE SMALL-HOLDER SECTOR

With the drives to reduce cost of production and increase the scale of production in especially the poultry and pig sectors it will be increasingly difficult for smallholders to remain competitive on the market for conventional products. The capital needed to keep up with the required technology goes beyond the smallholders' capacity. It is therefore important to further develop and strengthen the niche markets for specialty poultry and pork products. The kampong chicken holder organizations will increase their chick production and will have to get involved in the organization of processing and marketing of the birds. The non-chicken poultry can provide other niche market products. In the case of ruminants the expansion of smallholder cattle keeping would depend upon increased availability of land and credit. It is probably more realistic to increase the smallholders' role and participation in the goat and sheep value chains. Goat milk production in particular fits better in the smallholder farming system than dairy cattle: it requires less capital, space, fodder and feed. Smallholders will have to work together to create collective economies of scale. The KUDs in the current form are no longer able to respond effectively to today's requirements of farmers.

ANIMAL HEALTH AND FOOD SAFETY

It is internationally accepted that veterinary services should have a single line of command from the Chief Veterinary Officer to the field veterinarians. Veterinary services are not

only responsible to keep animals healthy, but also to prevent animals from infecting people with zoonoses. Only under such a structure could the Veterinary Services correspond to "the competent authority" as described in OIE's terrestrial animal health manual. In Indonesia the Veterinary Service is a department of the Livestock Production Services, with a director under the Director General of the Livestock Production Services. This position makes it difficult for the head of the Veterinary Service to interact with the Director General of Health. The decentralization has jeopardized the effective response to animal disease threats, the quality of vaccines has been compromised as the purchase changed from Western companies providing all guarantees to Chinese and Indian manufacturers because they are cheaper. The badly needed centralized system of decision-making and control in veterinary affairs has been broken. The right balance between centralized and decentralized system has to be determined. Only with a veterinary service with standard operational procedures and having one line of command can a country effectively and efficiently respond to animal disease outbreaks or threats.

The veterinary service will have to develop its capacity to address and respond to food safety issues related to products of animal origin. Especially with the ever-increasing role of corporations and the larger share of processed products this role is of great importance. Although big corporations maintain that they can work under a self-control system to assure food safety (a.o. HACCP) as well as controlling the health status of their animals, international experience shows that there is still a need for external control. The OIE through its PVS and GAP analysis and investment plan tools can assist member states in assessing and reorganizing their veterinary services.

Environment and animal welfare

With the increase in livestock production not being land-linked, the issue of responsibly storing for recycling or disposing of manure and other wastes (e.g. from slaughter houses) becomes an issue. The ban of no live birds in urban areas will have to be reinforced to make sure that birds will be slaughtered in future in poultry slaughterhouses under veterinary supervision and with appropriate systems for the disposal of offal.

Large-scale livestock farming enterprises in particular will have to make provisions for the handling of manure. Biogas production is one step to convert potentially very harmful GHG Methane into less harmful Carbondioxide. When manure becomes a tradable commodity from livestock farmers to (tree) crop farmers there is less risk for pollution of soil and/or water.

Animal welfare issues brought major quarrels to the beef cattle sector in 2011. This incident should be used as a driver to improve the situation. Within the livestock research institutions it is important for people to follow developments in Europe and America in the field of animal welfare and pick out what is applicable in Indonesia to avoid a growing gap in welfare standards. It is likely that more poultry meat will be exported from Asia to Europe in direct competition with the Americas. For this to happen (Thailand is currently already exporting both processed and fresh product), both animal welfare and environmental protection systems will have to be in place, applied and audited.

Annex 4—Research and Development

Agriculture in Indonesia stands at a crossing point in that it has great natural resources, a willing work force and growing industry and expanding markets within and outside of Indonesia that will enhance the economy of the country and reduce rural poverty. In contrast Indonesia is not well prepared to make the best use of the opportunities afforded to it. The following recommendations are made to aid in the continuing development of Indonesia as a substantial player in global agriculture.

Complete and implement a Roadmap for agriculture under the authority of a single ministry (a 'Coordinating Ministry for Food and Agriculture); the Roadmap, already under development by KADIN (the Indonesian Chamber of Commerce), will engage the broad range of stakeholders in the agriculture economy. The Coordinating Ministry' would be charged with eliminating duplication of efforts between ministries, eliminating non-critical activities, and focusing research and education efforts on priority goals set forth in the Roadmap. The Roadmap will identify key crops and goals for increasing production and profitability.

Create research facilities in the public sector to ensure that targets set forth in the Roadmap can be achieved. Research and equipment core laboratories should be established at one or more high quality institutions to advance research and development toward goals/targets set forth in the Roadmap. The laboratories would also useful to test and certify for animal and plant diseases and product content, at a high level of certainty. Ensure that new facilities have a plan for financial sustainability.

Establish a well trained workforce in research and education in modern sciences and technologies of agriculture. Significant investment should be made in training more Ph.D. and post-doctoral scientists at national and international laboratories of the highest quality in disciplines that comprise modern agriculture. Guarantee of suitable professional positions for the brightest and best Indonesian scientists upon completion of training should be ensured

Coordinate activities in research and technology with extension services; create opportunities through which extension services can be provided by both public and private initiatives in keeping with goals of the Roadmap. Increase the numbers of extension specialists that hold B.Sc. degrees; hire Ph.D. level professors that train extension specialists. Restructure ministerial authorities as necessary to accomplish these goals.

Establish mechanisms to fund research, development, education, extension through competitive grants programs (based on successful models in the U.S., Europe, or others) to ensure that funds are directed to achieve the goals of the Roadmap in fundamental and translational research. Engage potential donors, e.g., USAID, World Bank, JIRCA, Gates Foundation, and KADIN and others, to complement GOI funds.

GOI should increase support of research in this sector to an appropriate level based on its value to the GDP and to international trade of Indonesia. Targets of 0.5% of agriculture related GDP or 1.0% of the value of exported products may be reasonable.

Complete development and implementation of science based regulatory systems to oversee agriculture technologies and to facilitate adoption of safe and effective technologies utilizing the Facilities mentioned in #2 above. Eliminate non-tariff trade barriers in agriculture; ensure science-based phytosanitary procedures are modernized and capable of adapting to goals of the Roadmap.

Develop mechanisms to reduce or eliminate import tariffs on imported specialized equipment and laboratory supplies

for research to avoid escalation of costs and undue delays in research.

Prioritizing topics for agriculture. Discussions have been held on this process by various branches of government and agro-industry. Through the process the goals for research were established and included:

1. To improve varieties of ALL crops, including plantation, horticulture crops, fruit trees, root and tuber crops.
2. To improve yields of critical crops for Indonesia's food security and agriculture trade, in particular rice, maize, soya, oil palm, cane/sugar
3. To develop varieties that can withstand variable weather patterns and climate change
4. To improve and stabilize post-harvest value of harvested produce
5. To double aquaculture production
6. To improve extension services to improve productivity in small-scale agriculture

In addition to describing research priorities to improve production there is increasing emphasis on increasing nutrition by (1) reducing emphasis on rice as primary source of starch (high glycemic index) and increasing amount of cassava and other complex carbohydrates, and (2) increased consumption of vegetables.

To achieve research goals require both discovery and translational activities, for each of the crops, although there will be significant overlap in research between crops; for example, discoveries made with rice will, at some frequency, be transferable to maize and sugar cane.

Plantation crops

Palm oil: the palm oil research board has significant investment in research and will continue in this vein. They have established collaboration with Orion Genomics, a gene sequencing company in St. Louis, MO, USA; this will provide the background to their breeding and improvement programs for the near future.

Rubber: interestingly, rubber was not placed high on the priority list for R&D activities or for growth in the sector on the Roadmap.

Rice: major work in rice improvement will be done in the public sector, including in universities and in IAARD. However, the modest effort has not made significant advances in developing/releasing new varieties since the release of IR64 via collaborations with IRRI (International Rice Research Institute). Rapid advances and 'catching up' with the field will require significant collaborations with advanced breeding programs: for example, with the advanced programs in China, the U.S.A., Egypt, Philippines, and others. Improving production methods, including crop rotation, improving soil quality, and improving post-harvest storage will largely require development and applications of locally developed solutions. The goal is to improve rice production by 10% to 50% based on locale.

Maize: because maize is not widely cultivated and because current yields are low, the most effective way to meet the goals laid out in the Roadmap is a multi-pronged approach that requires: engaging multinational seed producers/technologists to acquire new traits (including biotech traits) in collaborations to introgress traits to locally adapted germplasm. Collaborations between university/institute/IAARD scientists and researchers in advanced labs to bring other necessary technologies and genetic traits to Indonesian maize, including training of additional Ph.D. level scientists, is of highest priority. Collaborations with advanced laboratories in developed countries that specialize in improving maize yields, resistance to drought and heat, and other traits should be sought: in the U.S., universities such as the University of Illinois, Iowa State University, and University of Missouri are outstanding.

Cotton: like rubber, the Roadmap did not place high priority on establishing a major role for cotton. Nevertheless, discussions with representatives of KADIN and sub-ministerial administrators continue to emphasize the potential to

increase cotton production as well as local fabrics/products industry. Successful growth of this industry will require collaborations with advanced technology providers (including multinational seed companies), and with advanced laboratories, as well as developing local capacity to continue to improve the germplasm.

Sugar cane: production levels are low because of poor production methods and outdated germplasm. There is university expertise in cane biotechnology that is moving forward in developing GM traits in this crop. Achieving the goals set out in the Roadmap will require more effective private sector: university: government R & D relationships, with research funding provided by mixed sources. Advanced genomics research should be initiated, including with advanced laboratories in the U.S., Brazil, China, among other countries. Several multinational companies (e.g., Bayer, Syngenta, others) have developed advanced technologies for sugar cane that might be acquired through collaborative and joint venture agreements.

Vegetables: the many challenges in improving the quality of vegetable seeds and developing varieties to withstand climate variability and biotic diseases, and retain high post-harvest value are significant. In general the vegetable seeds industry is not considered to be of high quality and many varieties are relatively old. Research conducted IAARD and university scientists includes improving germplasm. There would appear to be advantage to importing seeds of some vegetables and to establishing collaborations with advanced laboratories for others. For example, the Asia Vegetable Research and Development Center (AVRDC) could be engaged as a collaborator to develop modern high yielding varieties suitable for Indonesia. Training additional research scientists in advanced genomics technologies will be essential for continuing the improvement of vegetable seeds. For example, the University of California at Davis is perhaps the premier training ground for the genomics research in a range of fruits and vegetables, and are world renowned for training in plant biology and genomics, including seed biology.

Tea, coffee, cocoa: The goals to increase production will need to be met by replacing older with improved varieties. It is suggested that seeking collaborations in genomic sciences with advanced labs (e.g., in Montpellier, France, and others) will be valuable to improve varieties in coffee and cocoa.

Aquaculture: the goal to double aquaculture by 2025 will largely be met by increasing farming areas, and increasing the quality of seed. Most of the current high quality seed is imported although for some species seed is local. Research to prevent disease and parasites is conducted by MoF; collaborations with advanced labs to create improved vaccines and protocols for farming of fish and shrimps will be advantageous. To reduce dependence on imported feed local capacity must be developed, including by collaborations with advanced labs. Ministry of Fisheries laboratories provide leadership for the industry; it will be necessary to increase numbers of high quality staff to increase production areas around the country.

Optimizing staffing/capacity to achieve targets. The greatest challenges to meeting the targets for agriculture are: (1) lack of coordinated efforts between industry, government, and academic/university scientists to meet the goals set; (2) lack of sufficient numbers of trained scientists in the advanced tools in genomics sciences, especially in universities and IAARD outside of the Jakarta locations; (3) weak collaboration between scientists in universities/LIPI institutes in general.

The paucity of well-trained scientific staff in most if not all of the agriculture crops/fishes raises the question of whether or not it is possible for Indonesia to meet the targets outlined in the Roadmap. On the other hand because of the geographical distances between the many locations for agriculture and challenging infrastructures and weak budgets, it would be unwise to further consolidate the research infrastructure. Instead capacity should be expanded in strategic ways in areas of greatest anticipated production for the crops, i.e., maize, soya and cotton; it is essential to avoid the temptation to make each university equivalent in all areas of agriculture, and instead to develop universities with specific specialties.

Advancing genomics research as a basis for improving seeds. An attempt should be made to create a mechanism for establishing a country wide capacity in genomic sciences through creating a virtual center that provides technical advice and specific services as well as scientific collaboration to serve the goals that are set for agriculture. This will require:

1. developing a long term strategy for increasing the numbers and quality of research faculty in key topic areas (covering the research goals enumerated above) by hiring young scientists who have been trained in the relevant topics and fields at the best research institutions in the world;

2. ensuring access to broad band communications available between all research institutions that are involved either directly or indirectly in food and agriculture research, teaching, extension services;

3. creating an incentive to work collaboratively across institutional and disciplinary barriers;

4. developing funding sources (optimally these will be private:government:foundation partnerships) that fund foundational and translational research and extension directed to achieving short, medium, and long term goals in agriculture. This should be a competitive grants awards program, perhaps modeled on similar programs at the National Institutes of Food and Agriculture (USDA) and the National Institutes of Health (U.S.A.). This effort should be complemented by a program that would identify opportunities for meaningful and outcome driven research collaborations between researchers in Indonesia and those in advanced laboratories: the PEER program administered through USAID and the National Science Foundation is a good working example: in this program, funds for research for scientists from Indonesia would be funded by USAID to conduct a collaboration with a laboratory currently funded by the NSF, with additional funds for the U.S. laboratory provided by the NSF for the U.S. collaborating lab. A similar program should be set up with NIFA that is focused on agriculture. Other countries (Australia, Brazil, etc.) may have similar programs.

Research and education initiatives to reach targets: Achieving specific goals in agriculture that requires cooperation between multiple institutions, multiple governmental ministries (the Ministry of Agriculture, the Ministry of Fisheries, Ministry of Forestry, Ministry of Science and Technology, Ministry of Education, Ministry of Health) and industry will require substantial planning and uncharacteristic cooperation. Similarly, there are provincial and regional authorities to be considered. There are a variety of possible organizational structures that could be considered; before a structure(s) is implemented a careful needs assessment and full accounting of the parties and authorities, and of skills and technologies of scientists in country is required. An assessment should be conducted by the Indonesian Academy of Sciences or other august body within the framework of the Roadmap.

Following completion of the assessment specific research, technology and development (RT&D) strategies will be developed: the strategies will be different for each research target. Teams should be formed around each major strategy. Each strategy team should be jointly led by a 'seasoned' and a junior (each with outstanding qualifications) scientist, a member of the relevant ministries, and key member of the economic sector (for example producer cooperative, representation of seed industry or KADIN). Each team will be charged with prioritizing RT&D objectives and coordinating collaborative research (within country and with external advanced labs) for the conduct of research, outsourcing and importing technologies, building internal capacities, etc; each project should be guided by a logic model process and should establish short, medium, and long term goals. The teams should make extensive use of recent reports and other documents completed during the past 5 years as they can provide useful guidance and save time and effort. A line-up of teams may look like this:

1. Establish countrywide leadership teams to develop advanced breeding programs for superior varieties

of crops that contribute to food security, increase GNP, and increase incomes of producers; e.g., palm, cocoa, rice, maize, soya, (cotton?).

2. Establish countrywide leadership team for advanced breeding programs for horticulture and fruit crops. This team will have to balance commercial (including income generation and import substitution) and health/nutritional concerns.

3. Establish countrywide leadership team for aquaculture with focus on improving germplasm base, nutrition and health of farmed fish/shrimp, and expanding the farmed areas across Indonesia.

4. Develop key technologies that ensure success of advanced breeding programs, with focus on developing strategy for generating and using genomics information for each crop of priority.

5. Develop a countrywide team on soils and natural resource management, including fertility, resilience to drought and heat stress, soil retention, and overall soil health for each major crop production area; focus on research to increase productivity and reduce environmental impact of agriculture, and enhance water quality from farms.

6. Establish a national center for climate change and resilience in agriculture to guide the research enterprise and to serve the agriculture industry across Indonesia.

7. Develop team to establish and implement a strategy for education and modernized outreach/extension in all sectors of agriculture; including attracting and retaining undergraduates, graduate students, and faculty. Consider all options for developing a strong and sustainable extension service (public and/or private).

From this process it is likely that lead institutions and individuals for each of the teams will become evident relatively early in the process: effort should be made to distribute leadership across the strongest of research/university institutions or IAARD labs and to avoid concentration on Java.

Providing a science-based regulatory system for agriculture biotechnology. Many of the recent advances in agriculture have been through improved seeds and have involved a range of different technologies, including biotechnologies. Indonesia has, until recently, been largely on the outside looking in on the use of advanced seed technologies: for example, they have not yet developed processes and protocols that permit farmers to crop seeds developed by biotechnology. While much of the reluctance is rooted in a bribery scandal that occurred with a seed company (Monsanto Co.) representative and insect resistant cotton seeds more than a decade ago, the negative impacts have been long lasting. The GOI has, under strict regulatory frameworks, allowed the import of seeds and foods developed through biotechnology; biotech seeds, including seeds improved through genetic engineering, are widely used in animal feeds, processed foods, imported cotton materials, etc. In contrast, the GOI has not implemented a process that makes it possible to plant seeds developed through genetic engineering, notwithstanding the economic opportunities that can be achieved through improved seeds. For example, several multinational companies (including Monsanto Co. and Syngenta Co.; possibly Dupont/Pioneer) have applied for permits to produce corn seeds in Indonesia for markets in China and elsewhere, but thus far they are unable to do so although there are economic advantages to producers and others to produce 'seed corn.'

The impact of not having a sound and predictable regulatory framework for growing and marketing of improved seeds and foods derived from them is stifling foreign investments in agriculture in Indonesia, including those mentioned above as well as other companies. Furthermore, the lack of a clear path to market for GM seeds and other products is having a strong negative effect on local scientists and entrepreneurs. For example, there is a genetically engineered sugar cane that exhibits improved sugar content, yield, and with tolerance to droughty conditions. The team of researchers that developed the new variety have conducted multiple year field trials in several locations and demonstrated efficacy,

and there is market interest. Nevertheless, the regulatory bodies have not yet given approval for widespread trials and commercialization.

The lack of a clear approval process also makes it possible to impose non-tariff trade barriers on imported food and feeds, including non-processed and processed materials. This leaves open the opportunity for the GOI to invoke various types of protectionism under the cover of biosafety concerns. It is likely that this will be an ongoing source of friction in trade with the U.S., China, Brazil and many other countries that are adopting the use of agriculture biotechnology. This can be an impediment to meeting the food security goals of Indonesia as well as the agriculture industry in the country.

There is a process to approve field trails in place, although there are no clear reasons why some field trials are approved and others are not. The biggest impediment seems to be related to approval by the environmental ministry and is centered on environmental safety; there is discussion on the need to conduct 'social impact' studies, although what such studies entail is not described. Essentially, there is yet no path for commercial release of products. Some of the impediments are due to reluctance of the 'old guard' in the scientific review panels to facilitate the field release and commercialization of new seeds. It was encouraging to learn that some of the technical committees are being restaffed with younger scientists who are technically more knowledgeable than current members. While this may help to gain approvals for trials, it remains very unclear which ministry or government body will give final approval for release. Some individuals consider that the Ministry of Environment will give the final approval, while others indicate that final approvals are to be granted by the Parliament. The lack of clarity of process is evident and is stifling in its effect on innovation and in private sector investment in Indonesia.

Recommendation: The GOI should/must complete the development and timely implementation of science based regulatory guidelines for the use of seeds and derived products (food, feed, fiber, biofuels, etc.) that are developed with biotechnology.

Building a vibrant food and agriculture research enterprise will require significant investments. There is a need to increase funding for research and for a mechanism be developed to encourage joint funding for research by government, private sector, and international funding agencies or NGOs. This mechanism would increase directed funding and avoid the likelihood of funds being diverted to use in non-targeted research. Furthermore, it is recommended that the central government commit to increased spending for research immediately and to grow the research budget annually: currently, support for research in agriculture is about 0.02% of GDP generated by agriculture, one of the lowest levels in S.E. Asia and amongst the lowest in the world for an agriculture-based economy. An initial increase in commitment, to not less than 0.5% of the GDP credited to agriculture, will provide resources to recruit, train, and retain talented students and research and teaching faculty, and to increase and 'modernize' IAARD scientific staff. The 'stocktaking' exercise (described above) should lay out critical staffing needs (permanent faculty, research fellows, graduate students) for each of the priority research topics, and assign a time frame for increases. An increase in hiring in key areas (as established by the strategy teams) will increase the likelihood that targets set by the Roadmap and others can be met: it is highly unlikely that the goals to increase production can be met without additional modern and well trained research faculty in key geographical regions.

An increase in funds for research will also make it possible to construct new research facilities, in particular in areas outside of Jakarta and West Java, with focus on facilities proximal to regions in which land and sea areas devoted to agriculture and aquaculture will grow. Research facilities should be constructed as joint funding by central and regional governments to the extent possible.

It is strongly recommended that research funds for agriculture research be awarded via a competitive and peer reviewed process similar to programs used in the U.S. and the E.U., including in the IAARD. Competitively awarded programs can encourage creative thinking and innovation amongst the brightest and best and can help to encourage

the ‘retraining’ of less productive faculty. A peer reviewed research grants process also allows junior faculty to build research innovation programs. The program should include opportunities for single investigator projects (recommending 25–35% of the research budget); such projects can encourage cutting edge research with relatively high risk-high reward profiles. The remainder of funds should be awarded to collaborative and interdisciplinary research teams that focus on R,T&D targets set forth by the advising teams.

It is recommended that funding be guided by a formula that designates a percentage for facilities, scientific staffing, and research, as established by strategy teams (needs will likely be different for different commodities). A straw horse model would call for not more than 30% of funds dedicated to facilities and faculty, and 70% for research per se. Research grants should include funds for institutional running costs (indirect costs) and for the time committed by faculty for the research project, as well as for the usual costs to complete the research project.

It has been reported that funds awarded for research can be reduced by ‘administrative processes’ that stand between the awarding agency and the researcher. There is concern that some of the funds committed for research will be diverted to non-research uses in some universities whose budgets are otherwise constrained. There are also reports that imported research supplies and equipment can carry a heavy import duty and are subjected to unnecessary delays and other hindrances. Steps must be taken to eliminate barriers to purchase and use of research supplies and equipment.

Annex 5—Climate Change

Indonesia and its agriculture and food security is already witnessing the early impacts of Climate Change (CC) in key climate variables in Indonesia are generally in line with global trends and predictions as follows:[1]

1. Overall Global Mean Temperature (GMT) is projected to rise by 1°C by 2050, and in Indonesia, a surface temperature rise of 1°C –1.4°C has been observed since over the last century.

2. Overall Global Mean Precipitation (GMP) is projected to decrease in the sub tropics, and in Indonesia, rainfall variability has been experienced to have increased and precipitation decreased in recent decades, except in the Lesser Sunda Islands, and eastern Java and northern Sumatra.

3. Overall Global Sea Level Rise (GSL) is projected to be from 0.18M to 0.6M by 2100, and around Indonesia sea level has risen by 1–8 mm per year over the last 50 years, with the highest increase registered in the area of Belawan.

4. Overall extreme climate events are projected to increase. In Indonesia extreme climate events are normally associated with El Nino Southern Oscillation (ENSO). El Niño events have become more frequent and climate-related hazards have increased over the past 5 decades in Indonesia, the most frequent hazard is flooding, followed by landslides.

Climate Change Threats to Indonesia: Climate variables for Indonesia are predicted using 9 General Circulation Models (GCMs) and 32 scenarios of future social, economic and technology changes. Climate predictions are known for large variations among models and scenarios and as the modeling period extends into the 2nd half of the 22nd century, the accuracy becomes very limited. GCMs typically work with a 200 sq km resolution grid which is not very helpful in developing local predictions for an archipelago region like Indonesia. The Institute of Technology, Bandung (ITB) has developed Empirical Downloading Models (EDM) to allow for grids as small as 1 km sq. Projected future climate variables for Indonesia are:[2]

1. Temperature rise to 2050 is projected to be modest (around 1°C) but by 2100 it is projected to be from 2.1°C to 3.4°C.

2. Total rainfall is expected on average to increase by 2–3% in the first half of the century and then decrease in the 2nd half. By 2050, total rainfall is expected to increase, on average, by nearly 10 percent from April through June in Java and Bali, which produce 55% of Indonesia's rice, but decrease on average by 10 to 25 percent in July through September,[3] with significant difference among various models.

3. Sea level is projected to rise, with considerable local variations, by up to 70 cm by 2100.

Impact of Climate Changes on Agriculture

Climate variables affect yield potential of crops and livestock, but not always adversely. Rise of local temperatures affects performance of agriculture differently. In the temperate mid to high latitude zones where the bulk of world food is grown, longer growing seasons leads to increase the yield potential of crops and pastures for all crops. This trend is evident to about a 3°C rise, except for maize. On the other hand, in the low latitudes where most of the developing

1 ADB, Economics of climate change in SE Asia, A Regional Review, 2009

2 World Bank, Program Document, Proposed Climate Change DPL, 2010

3 Naylor et. Al. Assessing Risks of climate variability for Indonesian Agriculture, Proceedings of the National Academy of Science, May 2007

world lives, even a 1oC rise leads to significant loss of yield potential, a loss that becomes devastating as local temperature rise approaches 3°C. One factor adding uncertainty is the potential kicking in of the CO_2 fertilization effect, positive for crop and pasture yields, when CO_2 concentrations reach 450 ppm, expected in the latter part of the 21st century. Thus, overall global supplies of food are not likely to be affected at least to 2050, but food security in many regions and countries may only be secured through increased reliance on trade and, at the household level, through measures to increase incomes and provide social protection to deal with the impacts of climate change.

Indonesia is already feeling the impact from these climate threats, impacts which are likely to intensify. The strong El Niño event of 1997–1998 caused a reduction in rice-cultivated area of 700,000 ha and loss of 3.2M tons of milled rice. When ENSO effects are superimposed on the projected change in rainfall patterns, the likelihood of exceeding a 30–day delay in the onset of the monsoon, and therefore in the rice wet-season planting dates, increases significantly from 9–18% today to 30–40%. The predicted impact on rice production during Jan–Apr is a loss in yield of 6.5–11%.[4] Another study concludes that combined with changes in irrigation water and land availability; there is an expected loss of 10–20% to 2030.[5] Given that water balance in most of Java and the eastern islands of Indonesia is already in deficit for most of the year, increased planting is not possible unless massive inter-basin transfer of water is considered.

Sea level rise is a potential threat to Indonesian agriculture and fishery. Coastal areas contain much agricultural land, many settlements, and about 400,000 fish ponds. A 1 meter GSL rise, unlikely to happen till much after 2100, could flood 405,000 ha of coastal lands, particularly the northern coast of Java, the eastern coast of Sumatra, and the southern coast of Sulawesi, impacting agriculture through flooding, increased storms, and increased salinization of coastal aquifers. It is estimated that West Java alone would see a loss of rice of about 300,000 tons and 10,000 tons of maize.[6] Indonesia's coastal fishing, which is a key source of protein for the rural population, is more under threat from excessive human intervention rather than CC pressures and would recover under better management. However, with sea level rise, coastal aquaculture could suffer requiring operators to raise dikes to protect current production. Fisheries dependent upon healthy coral reefs face an uncertain long term future, depending upon how the reefs adjust to rise in sea surface temperatures and ocean acidification. Indonesia's 50,000 km sq. of coral reefs are already in dire straits, with only 30% in "good" condition.[7] Migration of marine fish away from East Asian waters is speculated as sea water temperature rises in the latter part of the 21stcentury.[8] Climate change, without adaptation, is projected to reduce Indonesian GDP by 0.22% under the wetter scenario while under the alternative drier scenario, the negative impact on GDP growth is slightly worse, largely on account of decline in agricultural and agro based activity, both without any adaptation. Production of cereal food crops is projected to decline on average between the two scenarios, by 0.53%, livestock by 0.6% and fishery by 0.2% while that of fruits and vegetables is projected to increase by 1%. Without adaptation, prices are projected to rise and net export performance is worsened by 0.4%. Food security, without more food imports and adaptation would deteriorate.[9]

Adaptation Strategies for Indonesian Agriculture

With adaptation using known techniques, these negative effects of climate change could be fully offset. Indonesian rice yields have doubled between 1960 and 2000, and while growth has slowed down somewhat in recent times, potential exists for further increases through completing unfinished sector policy reforms and through accelerated uptake of techniques known to farmers for improving crop yields under changing climate conditions. There is very limited potential to increase area on the most productive islands of Java and Sumatra. In fact, urbanization pres-

4 Ibid.
5 Widiyanti, CienciAgro, Vol 1 No 4, 2009
6 Boer R. et al, quoted in Indonesia 2nd National Communication on Climate Change to UNFCC, 2010
7 Boer R. et al, quoted in Indonesia 2nd National Communication on Climate Change to UNFCC, 2010
8 World Bank, Cost of Adaptation of Fisheries to Climate Change, 2010
9 IFPRI, Impact of Global Climate Change on Indonesia Economy, 2011.

Box A5.1: Climate Field Schools in Indonesia

It is established that consistent use of Southern Oscillation Index (SOI) information in designing cropping strategy helps improve farmers' income during ESNO years, with a switch to a non-rice rotation for the 2nd crop. The main challenge has been how to encourage wider use by farmers of this type of information and by local governments to provide timely support based on SOI information. Climate Field Schools (CFS) launched as a pilot in 2003 aim to transfer relevant knowledge to farmers through well trained intermediaries, with both the technical support of BMG and IPB. Once agricultural extension workers are trained in climate science, they develop and test specific modules with village/farmer groups at the CFS. Seventy percent of farmers reported an improvement in their ability to use climate data. CFS which started from a focus on rice, now extend to include all crops. Recent efforts have been made to translate global climate knowledge to generate localized climate information for 220 climate types. CFS had been expanded to 230 CFS covering 150 districts by 2008 and are to be implemented nationwide by 2012.

Source: World Bank, Adopting to CC, the case of Rice in Indonesia 2008 and Boer R. et al, quoted in Indonesia 2nd National Communication on Climate Change to UNFCC, 2010

sures will continue to put a squeeze on crop land and water. It is estimated that improvements from accelerated R&D investments, resulting in a 10–15 percent increase in crop productivity by 2050, would overcome any negative climate change impacts[10].

Autonomous adaptation measures typically are of the "no-regrets" type: they are good for the sector with or without climate change. They revolve around changes in cropping patterns, varieties and farm management and are already being practiced in Indonesia, primary among them being changing the planting dates as the onset of monsoon is delayed. Changing to varieties known for higher flood, drought

and salinity tolerance is a common adaptation practice. Raising walls of fish ponds or even relocation or changing fresh water intake further upstream to deal with salinity are common practices which will increasingly come into play. These practices are well documented[11] and generally ready for wider scaling up, with in some cases Government support.

Government support for autonomous adaptation is needed and starts from the timely availability of climate information and strengthening the ability of farmers to use it. Indonesia's program of Climate Schools has been notably successful in this regard (see Box 1). Farmers who use climate information through the program have consistently shown higher incomes than those who do not.[12][13] Increased investment in agricultural R& D would strengthen adaptation through development of suitable drought, flood, salinity tolerant crop varieties, improved crop and livestock management techniques including better disease control, better soil nutrition, and changes in planting times and irrigation methods. Provision of expanded livestock services to deal with increased likelihood of vector borne disease would be needed. Changes in the design standards of rural roads, irrigation systems, dykes and market infrastructure can help make the sector more climate proof. Adaptation strategies against sea level rise range from building protection through restoring mangroves, creating dunes and raising dykes, which can be very expensive, all the way to temporary or total evacuation in the most threatened and critical locations. Mangroves do provide natural protection against extreme events, but of Indonesia's 9 M ha of mangrove forests, 71% are judged to be damaged (Jakarta Post, Feb 8 2012) under threat from expansion of aqua-culture.

Some of these hard options could be quite wasteful should the climate risk not materialize to the extent projected. Notably, sea dykes and river embankments cost about $0.7–1.5/m height/km and if designs are aimed at 50 or 100 year projected flooding levels, can lead to huge expenditures in anticipation of sea level rise which may not be as high as currently forecast. Cost effective alternatives—"green" dykes which include a mangroves protective zone to increase dyke longevity—need to be considered. Above all, investments decisions have to be timed well based on careful monitoring of sea level rise.

Attempts made to estimate the potential costs of adaptation still have serious limitations in methodology and thus are seen as indicative only. No Indonesia specific estimates are

10 IFPRI, Impact of Global Climate Change on Indonesia Economy, 2011.
11 IFPRI, Impact of Global Climate Change on Indonesia Economy, 2011.
12 Wintaro, et al, LEISA Magazine 24.4 December 2008.
13 World Bank, Program Document, Indonesia CC DPL, 2010/

available. One study focusing on four countries of SE Asia (Vietnam, Indonesia, Philippines and Thailand) concluded that the costs would be about 0.2 % of gdp to 2020, mainly for R and D and construction of dykes.[14] Another study concluded that for all developing countries, cost of adaptation in agriculture, excluding those for dykes and embankments, would be about $15.16 billion per year to 2030 or about 0.12% of the combined gdp of developing countries.[15,16]

Risks in agriculture will still increase with climate change, in the form of crop failure and livestock/fishery losses due to increased floods, coastal erosion and livestock disease. Enhancing farmers' ability to absorb the increased risk due to climate variability, through programs of crop and livestock/fishery insurance, is another important measure Government can take

A Decision Framework to Optimize Adaptation Reponses

Systems are needed for prioritizing adaptation options which can take into account the severity, probability, immediacy of the climate threat as well as the costs, cost recovery options and social impact of the adaptation response. Indonesia is steadily undertaking the analysis needed to form the foundation of such a system, such as developing detailed local government level vulnerability assessments and potential inundation maps. A newly established Climate Change Trust Fund centered at BAPPENAS, is establishing criteria and process for allocating resources for climate protection projects including a system of fiscal transfers to local governments. Such a system would need to enable decision makers to examine each proposed adaptation action for its costs, benefits and social impact and consider whether autonomous actions by market participants (individual farmers or firms) or planned adaptation, soft or hard, by the state are needed. An overall framework could deal with impacts:

1. whose severity, probabilities and immediacy are all high, and there is little scope for recovery of costs from beneficiaries, by acting quickly through public expenditures in the most cost effective way;

2. with high probability and for which beneficiaries can absorb the costs against benefits to be received, by promoting autonomous actions by beneficiaries to minimize public costs and spread the burden of adaptation;

3. with low probability and immediacy, by pursuing soft measures and a sequential decisions approach to buy time for gathering more information;

4. and, which can produce similar results with "soft" options or reduce the need for "hard" direct public expenditure, by putting emphasis on the former to minimize public expenditures. Household food insecurity would tend to increase with increased climate variability. Delays in the monsoon onset date and a longer hunger season and price increase could push more people below the poverty line and there would be a need to strengthen social safety nets.

Institutional Capacity for Combating Climate Change

Policy making at the national level is at the Presidential level, with a secretariat, and involves all sectors. Road maps for mitigation and adaptations have been done and are being updated, pulling in national expertise through task forces. Technical capacity exists and is being further developed at three locations: the Ministry of Environment, BMKG and ITB, and is supported by donors through 1–3 years projects. The capacity is nascent but shows high sense of commitment by an effort to organize itself—perhaps inspired by the success of IPCC—through establishment of informal working groups and strong scientific networking. Given the heavy emphasis on decentralization, there is an attempt to replicate the national CC architecture at the provincial and district levels, some of which is quite appropriate. There is still room to better harness the national scientific talent into national policy making efforts. Further clarifying the role of different agencies for gathering, analysis, dissemination and

14 IFPRI, Climate Change, Impact on Agriculture and Cost of Adaptation, 2009.
15 IFPRI, Climate Change, Impact on Agriculture and Cost of Adaptation, 2009
16 World Bank Cost of Adaptation of Agriculture to Climate Change, 2010.

actual use of CC data, would be needed. Similarly, mechanisms for engaging with key sectors at the local government level would need to be strengthened as systems for fiscal transfers to local governments to manage climate change are put into place.

Climate Change and Food security Beyond 2050

With virtually no progress to reduce Green House Gas (GHG) emissions since Koyoto , the world may well be on way to a 4–7°C warming by 2100. The totality of climate actions now underway will not hold the world to 2°C rise by 2100. While the Koyoto commitments called for a reduction of GHGs by 5.2% below 1990 level by 2012, emissions globally have increased by 36% to date. Even the softer Copenhagen 2009 agreements which would have limited global emissions to 44 Gtons CO2e by 2020 are already showing a slippage.[17] In the energy sector, which accounts for 26% of global GHG emissions, half of the new coal plants which have come up in the last decade do not meet latest efficiency standards and none pursues carbon capture. Pace of improving energy efficiency of buildings, a win-win proposition, has been tardy worldwide. The one bright spot is renewable power—solar, hydro, wind and geothermal—which has been growing at 27% annually and keeping pace with aspirations. In the transport sector, which accounts for 13% of GHG emissions, vehicle efficiency has been growing at just 1.7% annually, compared to a need of 2.7%.[18] In the forestry sector, which accounts for 17% % of global emissions largely from reduction in tree cover, despite pilot efforts to promote reforestation and stop deforestation overall trends are not encouraging. In the agriculture sector, including livestock, which accounts for 14% of GHG emissions, there has been very virtually no attention to mitigation.

With a 3°C or higher rise, prospects for food production become unfavorable even in the high latitude regions and disastrous in the low latitudes. In the higher latitude regions, all major crops including pasture are projected to show decline in yields of 16–29%. In the lower latitudes, yield declines of the order of 20–40%. When an allowance is made for not yet fully researched carbon fertilization effect countered by increased prevalence of pest and disease as temperatures rise and increased loss of agricultural land to sea level rise,[19,20] the situation once temperature rise exceeds 3°C looks quite unmanageable.

The fate of Indonesian agriculture in the period beyond 2050 rests squarely on what the world does now to control GHG emissions. Indonesia's GHG emissions of about 2 billion tons of CO2e, make it the 3rd largest emitter of GHGs from all sources and are still increasing. GHG system has significant lags since these gases stay in the atmosphere for a long time. Thus, what Indonesia does now to reduce GHG emissions is critical to its own as well as global food security in the 2nd half of the 21st century. In 2009, Indonesia's announced a voluntary commitment to reduce its GHG emissions by 26% by 2020, a target to be increased to 41% with international help. Only 1% of that reduction is projected to come from agriculture sector and low GHG green technologies are known or even being piloted in rice irrigation, livestock management as well as in fisheries. By contrast, 51% of the planned reduction in GHG emissions is to come from the forestry sector and 37% from controlling emissions from its peat lands or swamp forests.

Global attention has naturally focused on Indonesia's forests. Forest cover has declined from 162 m ha in 1950 to less than 90M ha now and is declining at about 1–1.5 M ha per year. A substantial share of deforestation comes from planned land conversion to oil palm and pulp & paper plantations, with permits often issued by local governments. The sector is viewed favorably by government since it is a major source of employment, livelihoods, food security and exports. Financial returns from plantation and forest clearing can be high and global demand for palm oil remains strong. Combined with Indonesia's weak system of enforcement of anti-conversion laws, deforestation continues. Peatland conversion pose a special challenge because of how it is done: through the use of fires, which cause huge GHG emissions

17 World Bank, Adopting to CC, the case of Rice in Indonesia 2008
18 World Bank, Adopting to CC, the case of Rice in Indonesia 2008

19 Naylor et. Al. Assessing Risks of climate variability for Indonesian Agriculture, Proceedings of the National Academy of Science, May 2007
20 IFPRI, Climate Change, Impact on Agriculture and Cost of Adaptation, 2009

and continue despite this technique having been declared as illegal.

Global effort is underway to assist Indonesia to create a system for providing incentives to private owners of forest concessions and communities to preserve forest carbon through Reduced Emissions from Deforestation and Degradation (REDD). REDD is being funded by Norway and piloted by UNDP and the World Bank in Indonesia and when fully developed, could lead to potentially large global carbon payments. Indonesia has created a basic regulatory framework for REDD implementation and Norway has recently pledged a $1 billion grant to Indonesia to implement REDD. In addition, compliance with EU's timber import rules and US Lacey Act are moving large Western markets for Indonesia's timber towards legality standards and verification systems in turn putting pressure on timber producers. Similarly, development of a new peatland management and conservation strategy is underway.

BIBLIOGRAPHY

A Study under the Rice Policy Dialogue—Adapting to Climate Change: The Case of Rice in Indonesia (The World Bank, July 2008).

An Historical Perspective through a Food Policy Lens Land Use and Climate Change (Policy Brief (The World Bank) Camilo Gomez Osorio, Dwi Endah Abriningrum, Enrique Blanco Armas, Muhammad Firdaus: Who Is Benefiting from Fertilizer Subsidies in Indonesia? (The World Bank, August 2011).

Asian Development Bank. Prefeasibiity Study of an ASEAN Rice Futures Market, by Andrew Mackenzie. March, 2012.

Asian Development Bank. Indonesia - Strategic Vision for Agriculture and Rural Development. Manila. 2006.

Asian Development Bank/FAO. Productivity Enhancement for Tree Crops. (appraisal report on a smallholder tree crop replanting project, which was never financed by the ADB). Manila, November 16, 2005. Badan Pusat Statistik (Central Bureau of Statistics). Produksi Tanaman Pangan, Angka Ramalan III Tahun 2011. (Food Crops Production). November 2011.

Asian Development Outlook database; CEIC Data Company

Badan Pusat Statistik (Central Bureau of Statistics), Pendataan Sapi Potong, Sapi Perah, Dan Kerbau 2011 (slaughter, breeding, of cattle and buffalo).

C. Peter Timmer—Understanding Food Security and the Changing Role of Rice in Indonesia (a background paper for a project on food security organized by Bappenas, March 2011).

Badan Pusat Statistik (Central Bureau of Statistics), Pendataan Sapi Potong, Sapi Perah, Dan Kerbau 2011 (slaughter, breeding, of cattle and buffalo).

Badan Pusat Statistik (Central Bureau of Statistics). Produksi Tanaman Pangan, Angka Ramalan III Tahun 2011. (Food Crops Production). November 2011.

Bank Indonesia—The Role and Policy of Bank Indonesia in Supporting MSME Development : Presentation provided to the Centennial Team in 2012 by the Credit, Rural Bank and MSME Department

Barlow, Colin. The Role of Institutions in Planting Improved Smallholder Rubber, Australian National University, 2001.

Briones, Roehlano. Regional Food Security Study. Report submitted to Centennial Group Holdings LLC. June 7, 2012.

Bulletin of Indonesian Economic Studies, V. 44, No. 1 (2008). Rice Policy in Indonesia: A Special Issue, C.Peter Timmer and Neil McCulloch, editors.

Carl E. Pray and Keith Fugli: Private Investment in Agricultural Research and International Transfer In Asia (USDA Agricultural Economic Report No. 805, November 2001).

Dami Oil Palm Research Station. Dami Oil Palm DxP Seed. Kimbe, Papua New Guinea, 2012.

Diagnosing the Indonesian Economy: Toward Inclusive and Green Growth (Asian Development Bank, February 2012) DIS-IBIS World Industry Report: Agricultural and Plantation Products Wholesaling in Indonesia (24 October, 2009 Douglas L. Vermillion, S.R. Lengkong and Sudar Dwi Atmanto - Time for Innovation in Indonesia's Irrigation Sector (Asian Development Bank).

FAO—High Level Expert Forum: Climate change and bioenergy challenges for food and agriculture (Rome 12-13 October 2009)

Firman, Tommy. The Patterns of Indonesia's Urbanization, 1980–2007. chapter in The Dynamics of Indonesia's Urbanization, 1980-2006,

Fuglie, Keith and David Schimmelpfennig.. Introduction to the Special Issue on Agricultural Productivity Growth: a Closer Look at Large, Developing Countries. Journal of Production Analysis (2010), 33: 169–172.

Heryani, Erna, and Grant, Chris. Land Administration in Indonesia. Presentation at 3rd FIG Regional Conference, Jakarta, Indonesia, Oct. 3–7, 2004.

INDONESIA RISING. Policy Priorities for 2010 and Beyond: Revitalizing Agriculture in Indonesia (The World Bank).

Indonesia: Results Based Country Strategic Opportunities Programme (IFAD, 22nd December 2008).

Indonesian Palm Oil in Numbers (Ministries of Trade and Agriculture and the Indonesian Palm Oil Board, 2007).

IRRI. Rice in the Global Economy: Strategic Research and Policy Issues for Food Security 2010.

Ministry of National Development Planning/National Development Planning Agency: National Medium- Term Development Plan (RPJMN) 2010–2014 Book I—National Priorities (2010).

Morey, Phillip. Report on the Indonesian Investment Market for Horticultural Produce for International Finance Corporation, December 31, 2009.

Mohammed Chatib Basri, William Butterfield, John Mellor, Marialyce Mutchler, Stephen C. Silcox, John K. Thompson: USAID/Indonesia Economic Growth Sector Assessment (USAID September 2, 2008).

Natawidjaja, Ronnie S. Rice Price Instability: Impact on Agrifood Chains with Indonesian Perspective. Center for Agrifood Policy and Agribusiness, Padjajaran University, 2012.

Nigel Smith: Coconuts in the Mekong Delta—An assessment of competitiveness and industry potential, August 2009.

Nippon Koei Co.—International Development Center of Japa: Indonesia's Development and JICA Cooperation (September 2010).
Nippon Koei: Survey for Maximum Utilization of Irrigation Water in the Republic of Indonesia (April 2012).

OECD Agricultural Policy Reviews: Indonesia February 1, 2012.

Ota, Shingo. The History of the Japanese Community-based Fisheries and the Reasons for the Current Success. Office of the Overseas Fisheries Cooperation, Fisheries Agency, Tokyo, Japan.

Paul van Hofwegen: Food Security and the Water Futures of Java work in progress (PowerPoint presentation at the GoI/ADB/OECD International Workshop on Sustainable Water Management For Food Security Bogor 13 December 2011).

Peter Timmer: Managing Price Volatility: Approaches at the global, national, and household levels (Stanford Symposium Series on Global Food Policy and Food Security in the 21st Century (May 26, 2011).

Rajah, Roland, and McCulloch, Neil. Agricultural Growth and Poverty Reduction in Indonesia—a Synthesis of Recent Evidence. February 2012.

Raitzer, David, Roseboom, Johannes, Maredia, Mywish, Huelgas, Zenaida, and Ferino, Maria Isabel. Prioritizing the Agricultural Research Agenda for Southeast Asia: Refocusing Investments to Benefit the
Poor. Global Conference on Agricultural Research for Development. 2010.

Republic of Indonesia—Coordinating Ministry for Economic Affairs—Masterplan: Acceleration and Expansion of Indonesia Economic Development Plan 2011–2025 (2011).

ROUND TABLE "OECD REVIEW OF INDONESIA AGRICULTURAL POLICY"—Presentation by Achmad Suryana, Director General of Agency for Food Security—Bogor, 6 Maret 2012.

Sustainable Water Management for Food Security: An international policy dialogue on progressing water policy reform in agriculture, with focus on Indonesia (Rapporteur's Report)

Soekrasno, S, Nugroho, Iman Agus, and Simanjuntak, Modernization of Irrigation Schemes in Indonesia: A Strategic Need for Planning. Paper presented at the 63rd IEC Meeting, of the International Committee on Irrigation and Drainage, Adelaide, Australia, June 2012.

Timmer, C. Peter. Food Security and Political Instability in East and Southeast Asia. June 1, 2012.

The Asia Foundation—Local Economic Governance: A survey of Business Operators in 245 Districts/Municipalities in Indonesia, 2011.

The Asia Foundation—Transportation of Goods in East Nusa Tenggara: Problems and Costs, 2010.

The Asia Foundation—Local Budget Analysis: Study of 2007–2010 Annual Budgets in 42 Regencies and Cities and Five Provinces in Indonesia, 2011.

UNESCAP/The Centre for Alleviation of Poverty through Secondary Crops Development in Asia and the Pacific (CAPSA). Food Security and Poverty in the Era of Decentralization in Indonesia. Edited by
Rusastra, Thompson Bottema, and Baldwin. Bogor, Indonesia, 2008.

United Nations Development Assistance Framework—Indonesia 2006–2010.

USDA Global Agricultural Information Network: Indonesia Rice Update (July 18, 2009 and August 9, 2011)
Value Planning International, Inc Fujitsu Research Institute: Data Collection Survey on Priority Sectors and Developmental Issues Republic of Indonesia (March 2010).

WATER AVAILABILITY FOR AGRICULTURE: CHALENGE AND COPING STRATEGY (Agency for Agricultural Research & Development, Agro-Climatology and Hydrology Research Institute, PowerPoint presentation).

World Bank: The World Bank Group Framework and IFC Strategy for Engaging in the Palm Oil Sector, March 31, 2011.

World Bank—Project Appraisal Document: Local Government and Decentralization Project (April 23, 2010).

World Bank—Country Environmental Analysis: Investing in a More Sustainable Indonesia (2009).

World Bank and Agrifood Consulting International, Inc. Enhancing Food Security in ASEAN: Policy Reforms, Private Investment in Food Supply Chains and Cross-Border Trade Facilitation. Feb 1, 2010.

World Bank. Indonesia Economic Quarterly (Enhancing Preparedness, Ensuring Resilience) December 2011.

World Bank (team led by Enrique Blanco Armas). Indonesia Agriculture Public Expenditure Review 2010. 2010.

Yusuf, Hamid. Land Administration System in Indonesia. Presentation to the pre-17th AVA Congress, Siem Riep, Cambodia.

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