



Globelics

## **The Agro-food Sector in Catch-up Countries: A Comparative Study from Sectoral Systems Perspective**

(Draft in further revision)

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### **Research Objective**

Of the developing world's 5.5 billion people, 3 billion live in rural areas, nearly half of humanity (The World Bank 2008: 3). Of these rural inhabitants an estimated 2.5 billion are in households involved in agriculture, for example, 849 million, accounts for 64 percent of the country's population is in China, 560 million and 52 percent in India, 54 million and 66 percent in Vietnam. The figures for Brazil and Costa Rica are 26 million and 14 percent, and 800 thousand and 19 percent, respectively. Nigeria, which is included in the cases of the study, has 38 million of agricultural population accounts to 30 percent by 2004, reduced from about 60 percent in the 1980s through rapid urbanization in the recent decades (FAO Statistical Yearbook 2005-6, Tables A1 and A2). What about the prosperity of the vast pool of agricultural population in the developing world? What is happening to the sector in catching-up countries? What have been the roles of the agro-food sector and the relationship of it with catching-up of a developing country? What should do in policies for development with regard to

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this sector?

Mainstream development thoughts, from Lewis to Prebisch, put modern sectors at the center of catch-up in backward countries, with agriculture being assigned passive role. The lines of thoughts have been influential up to the present, although many progresses as regards the importance of the agricultural sector have achieved in the past fifty years. However study on agriculture has largely restricted in agricultural economics, and the pace of integrating the studies into development strategies and innovation policies has been slow.

This study looks into the development of the agro-food sector from a sectoral innovation systems perspective, focusing mainly on dynamics and mechanisms that brought about changes to the sector in the circumstances of technological progress and globalization. The study intends to fill the gap where innovation studies give little attention to the agro-food sector. We wish to shed a light on the feasibility and importance for the sector development and explore implications for development strategy and innovation policies in developing countries.

### **Theoretical background and analytical framework**

*The role of the agrofood sector in catch-up.* Agro-food industry has existed for thousands years. The sector is distinct from other sectors chosen to study in the catch-up project, such as automobile, telecommunication equipment, pharmaceuticals, and software, is in the fact that all other sectors are emerged in the contemporary time, based largely on modern scientific and technological progress. All other sectors played and are playing a leading or key role to the development of backward countries in the overall history of “catch-up” since “Modern Growth” rushed into the scene after the Industrial Revolution in England in the 18<sup>th</sup> century. Not surprisingly, the role of the agro-food sector for development and catch-up has long been a focus of debate in development theory and policy spheres.

Put it very shortly, in conventional development economics, agriculture is seen as passive sector. The role of the agriculture sector is thought limited, mainly in transferring labor, which is unemployed or semi-employed in agriculture, and capital, to modern sectors for the growth of the urban and the industry, which drives the growth to the nation (e.g. Lewis 1954). The theory by Prebisch (1959), which had wide influence in Latin America, emphasized the unequal relations between the “center” and the “periphery” in trade terms. He argued for the import-substitution (of industrial goods) strategy, because the price of manufactured goods increase over time and that of agricultural and raw material commodities the peripheries were major exporter decline over time, the scope of growth of the periphery (i.e. developing countries) by agricultural exporting is restricted. This line of theory took a similar proposition like Lewis’ that the role of agriculture to development is assumed passive and limited. As far as the argument on deteriorating terms of trade in agricultural products for the peripheries is concerned, we will see in our study that the Costa Rica coffee case gives controversial evidence: when being capable in combining unique natural endowments and scientific knowledge and farmers’ skills, agricultural export from a developing country is possible to move up to the higher end of the value chain.

In the past decades many progresses achieved in theory and practice with regard to the role of agriculture for development. In a succinct review, two senior agricultural economists at Cornell University (Sisler and Oyer 2000) concluded that agriculture should instead be considered as *development enterpiece* of economic development in developing countries.

The development of agriculture contributed to the provision of *subsistence needs* for an economy. This becomes even more crucial at the present time with the rapid increase in population and in food consumption caused by income growth in a number of previously poorer countries like China and India. Food price and food security/crisis becomes a hot issue in 2008, which has incurred consumer demonstrations in many countries and is the theme of a few international summits or

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high-level conferences.<sup>2</sup> Food security is, as recognized now in confronting with crisis, basically a national policy issue in associated with international trade regulations and coordination--any large economies with a substantial population to be feed cannot afford an ignorance of it from policy priorities,<sup>3</sup> provided that serious, especially international, market failures have proved in existence for the sector (e.g, Stokes 2008).<sup>4</sup>

Agriculture contributes to *job creation and poverty reduction*. Agriculture offers a source of livelihoods for an estimated 86 percent of rural people. It provides jobs for 1.3 billion smallholders and landless workers, gives a basis for “farm-financed social welfare” when there are urban shocks, and a foundation for viable rural communities (The World Bank 2008). In the development history, uneven income-distribution and massive migration from the rural to urban have triggered from time to time social and political unrests and that halted development process; To ease this daunting problem, it has been observed that the agriculture contributed as the most pivotal spots for the creation of jobs and the alleviation of poverty, it has been a central force for relatively smooth social transition, a very difficult policy area associated with development process (Sisler and Oyer 2000). The World Bank 2008 report confirms this (The World Bank 2008: 3-4), stating that the recent decline in the \$1 a-day poverty rate in developing countries—from 28 percent in 1993 to 22 percent in 2002—has been mainly the result of falling rural poverty, attributable to better conditions in the rural areas, while the urban poverty rate remained nearly constant. This is a warning to the common perceptions, which assumed out-migration of the rural poor as the central solutions. However, evidence shows that the large decline in rural poverty has been confined to East Asia and the Pacific, the number of rural poor in Sub-Saharan Africa has continued to rise. (The World Bank 2008). Sub-Saharan Africa should take a high

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<sup>2</sup> FAO convened The High-Level Conference on World Food Security on 2008 June, for example, refer to <http://www.fao.org/foodclimate/hlc-home/en/>

<sup>3</sup> Refer to FAO Special Programme for Food Security at <http://www.fao.org/spfs/en/>

<sup>4</sup> Staple food supply is not only an economic issue, but more importantly is a humanity and social issue. The statement “import staple crops is importing scarce land” which has been popular in mainstream economics in China is misleading. S P Schuklar from India holds a similar position, arguing for a flexibility in trade policies in order to preserve for the survival of smallholder farmers in populous and land resource-restricted countries like India and China. Source: author’s interview in Delhi, 2007 December.

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priority to mobilize agriculture for poverty reduction, and this fits to the Nigeria case that this study is included.

Agriculture is *a provider of environmental services* too. Agriculture uses natural resources, can create either good or bad environmental outcomes. It is by far the largest user of water, much of it extracted from underground; and agriculture is the source of agrochemical pollution, soil exhaustion. But agriculture is also a major provider of environmental services, in sequestering carbon, managing watersheds, and preserving biodiversity. With rising resource scarcity, climate change, and concern about environmental costs, managing the farming systems in connections with natural resource and environmental conservation must be an integral part of policies on agriculture for development (FAO 2007; The World Bank 2008).

Developmental economics and agricultural economics recognize as well that farmers are and should be considered as active player in economic activities. Factors such as strong local institutions, education, the participation of grassroots people, and the development of rural community, have incorporated into theorizing and policy-making (e.g. Schultz, Hayami 1999; Ruttan 2004 XXX). Science and technology plays an increasingly important role for the development of agriculture, as demonstrated in Green Revolution. The role of science and technology is well generalized in the “induced innovation theory” (Hayami and Ruttan 1971). Recently attention is given to gene revolution that might open new opportunities for the sector after Green Revolution (AFO 2003-2004).

However so much progress has achieved, the obsessed bias in favor of industry and urban development remains in common in development thoughts. In absolute terms, one sees a reduction of international financial support to agricultural development in poor countries since the 1990s (Enos 1995). Domestic investment in agriculture went down in many countries in the 1990s too. This tendency began to change only well into the 21<sup>st</sup> century, partly it is made under the push of the UN Millennium Program and by the efforts of international organizations such as FAO, and partly it is a

response of individual countries to the stagnation or worsening in food security, poverty reduction, social equality, job creation, and energy and environmental problems, which turned out to be grave even with rapid growth performance in general economic terms. There is every reason for re-examining the importance of the development in agriculture and in rural, if we expect for a balanced and sustainable development of the developing countries and the globe economy.

To sum-up the roles of the agro-food sector that have been achieved by far as the following

A, The provision of basic necessities and raw materials for the population and the industry. Food security and food quality received new and serious implications with rapid growth in population and with fast economic and societal transformation;

B, A pivotal sector in contributing to job creation and poverty reduction; it enhances the livelihood of the poor and social equality through the development of the sector itself directly in contrast to re-distributional approaches of wealth;

C, Modernization of the rural, and the society by and large, by farmers' participation in learning and technological and institutional changes;

D, Important player in the protection of environmental common goods;

Altogether, the agro-food sector is uniquely in comparison to other sectors, central to economic, societal, and ecological sustainable development.

Having had the background in mind from the quick review of the roles of the agro-food sector, our research takes a modest design. Rather than discuss broadly on the strategic importance of the sector, we concentrate *on the development of selected segments of the agro-food sector*. We want, by this design, to reveal in some degree of detail as what is really happening to the sector, its opportunities, dynamics and mechanisms for development, which are newly apparent in the circumstances of technological progress and globalization. When relevant we link the exploration of the sectoral development with strategic adjustment of development in certain countries

and their impact on poverty reduction and environmental protection.

***Sectoral innovation systems.***

This study takes a sectoral innovation systems approach. The perspective of innovation systems puts the creation, diffusion and application of knowledge as key to growth, that takes place through interactions between various actors of an innovation system (Lundvall 1992; Nelson 1993). Initially the focus of the IS perspective is on the level of nation state, latter-on industrial sector received attention to be an importance and informative branch of IS studies. Here a sector implies (Malerba 2004 13-17) a set of activities that are unified by some related product group for a given or emerging demand and that share some basic knowledge. A sectoral innovation system considers innovation as an interactive process central to the growth of sectors, in which learning and capability building transforms the actors. Innovation and learning is assumed taking place in the bearing of institutional settings and linkages/networks of the sectoral actors; and technologies and knowledge regime and R&D centers characterize the learning modes and process. Policies are considered important in triggering or impeding the learning and transformation. In short, by sensitizing specificities to an industrial sector, the SIS approach tends genial in the probe of particular details. It is obvious therefore that a sectoral IS approach is not alien to the insights developed in the agricultural economics and development economics, instead, it will be surely complementary to the latest advances in these disciplines. We expect that the analysis following the SIS approach will shed a light as *why and how* the agro-food sector being active in development, by exploration of the dynamics and mechanisms underpinning the learning and innovation and transformation.

The Catch-up Project particularly has particularly set up a “learning--capability and knowledge-base—interactions” framework (Nelson 2006; Malerba 2006; Malerba 2004). The major aspects of the framework adapted to the agro-food sector are the following.

*Evolution and characteristics of the sector.* We capture the major composition and features of the sectoral system--the producers, the distributors, the processors, and the network and institutions that shape the interactions between the actors in the development process of the sector. Tracing the process of institutional changes (Nelson 2006) is informative as how it was emerged and adapted through selection and dissemination that depicts an institutional learning trajectory. We give attention to distinctions between large-scale farm and smallholder farm, because features of network, distributional channels, and poverty reduction effects may differ wildly with different producer's and other actor's organizations. In most of the cases—Costa Rica, China and Nigeria, smallholder farms dominate, and in Brazil, large farms dominate with smallholder farms being in growing. We give attention to distributional agents including international trader and local trader; examine their role in bridging up supply and demand and in transferring technical information. This is especially sensitive to export-oriented sector. We capture major institutional change, including that which supports the market to work, provided that the development of market mechanisms is one of the most crucial aspects for the agro-food sector in the context of developing and transition economies.

*Sources and opportunities for growth.* Sources and opportunities for growth come from both demand and supply side. We give particular attention to the demand side for the agro-food sector, in contrast, for high-tech sectors scientific breakthroughs and invention at scientific laboratories have been observed more directly important. Expanding and ever sophisticated demands, increasing concern about food safety and living standards intrigues learning and technological upgrading and institutional change in the agro-food sector. We investigate the driving forces to the growth of the sector from demand side as where they come from, from international market or domestic consumers? What changes occurred in this regard in the past ten years or so under the WTO regime? How the changes in demand side conveyed or expressed themselves to trigger technological learning and institutional change? What were the differences in demand factors, which were from international or local market? What



were connections of international and domestic market in their impact on the growth of the sector?

From supply side in terms of technological progress, agro-food sector as well as other “traditional” sectors often uses general-purpose technologies developed somewhere outside (von Tunzelmann and Acha 2005); the sector, notwithstanding, is important in the national innovation systems as a massive “carrier” in application of new technologies and harnesses the benefits of technological progress. “Induced innovation theory” mentioned earlier captures this feature well, that the characteristic natural endowments and other factors determine or induce as what technologies appropriate and hence caused different trajectories. If so, how did this process happen? From where the technologies come from and what was the adaptive process? And, whether there emerges evidence in which the agro-food sector is becoming more active in itself in the creation of knowledge frontiers?

*Acquisition of technology: local R&D versus the supply of international companies, and transformation of knowledge base.* We distinguish between (1) product technology (new variety of crop seeds), (2) process technology (agronomic used in plantation), (3) technologies for quality control and distribution, and (4) technologies for food processing. Product technology is often embodied in seeds, increasingly incorporated with modern bio-scientific and technological knowledge, resulted from professional R&D, but farmers’ breeding through on-spot selection remains useful and contributing. Agronomic technology involves large part of tacit knowledge and skills, rather localized in plantation fields, meanwhile R&D in agronomy is important and indispensable. Technologies for distribution and quality control are often provided in the form of tools and equipment, integrating mechanical, optical and IT technologies, and the knowledge about the application subjects. In our study, different cases may focus on some which are most relevant, but not all, of the respects as mentioned. We explore: Where were the sources for the acquisition of necessary technologies? How the absorptive capacity was developed with regard to embodied

and external-sourced technologies? Was there apparent transformation of knowledge base for the sector? What were the responses by public R&D and the extension system and how they evolved during a time span of ten to twenty years—how capability and institutions developed to cope with the changes of the sector in knowledge and technological base?

*The role of government.* We differentiate the role of government into direct and indirect involvements. Indirectly it relates to the role in investment in knowledge and technological infrastructure services. Uniquely massive efforts made by the government might be devoting to the market-supportive institutional development, and other institutional change. Direct involvement might be in the initiative to structural change via administrative guidance and financial subsidies. What kinds of involvement have already taken place and what were experiences and lessons we could draw out?

### ***Global value chain***

The notion of global value chain complements to the sectoral IS approach in that it scrutinizes value added activities, which are progressively more dispersed across nation-boundaries in the present time.

Similarly to the IS perspective, a value chain describes the full range of activities consumers, which are required to bring a product or service from concept and design through intermediary processes and finally delivered to consumers. The concept and analysis of value chain was initially popular in business management (e.g. M. Porter). In the past decade, the idea of global value chain emerged from the disciplines of international trade and development studies (e.g. UNIDO 2002-3, GereffiXXX, KaplinskyXXX), in the background of globalization. What the global value chain essay contributes, relevant to our study, is the trends in which increasingly higher added-value is captured by intangible capabilities and knowledge, which may either

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be associated with seed breeding at the upstream end, or with the integration or management over activities in a value chain—these are “rents” from technological innovation or/and “rents” from managerial or institutional change. Final product exporting alone may not automatically bring about fair profits to the exporter, if the exporter does not care about capability building to move up into intangible assets-based activities. But some authors (e.g. Pietrobelli and Sverrisson (eds.) 2004) criticize that the global value chain does not give enough consideration about the opportunities and changes at the low value added side, hence with little information about how the low-end actors to improve themselves. We believe that the analysis on sectoral innovation systems would compensates for the weak part of the value chain essay.

Value chains are specific to certain product or service; and the structure or governance of a value chain changes over time as well. Analysis of global value chain offers important reference to, especially, export-oriented agro-food product; the coffee value chain is a good example. (Orozco and Diaz)

## **Research method**

### ***Comparative case study***

Comparative case studies help the identification of indicative trends, patterns and features by across-boundary observation, and by filtering out minor and idiosyncratic systems' behavior only uniquely grown in a particular policy and development space (Lars Mjoset, to be added, Bent Flyvbjerg 2001 Making Social Science Matter). From an evolutionary perspective and as it is so in reality, the world is heterogeneous and in ever changes. In face of such a world researchers in social and economic studies expect for their works, at the best, being in revealing trends, patterns, features, and casualties, instead of universally valid truth.

The study composes four country cases and a synthetic paper, all the country cases

and the synthesis are basically descriptive. We use quantitative and qualitative data, reports, papers, government documents from various sources, in order to answer the research questions following the “learning--capability and knowledge-base—interactions” framework. Authors of our group have been involved in survey and training in this area for many years, from which direct observations accumulated serve as important references.

### *Selection of cases*

With the broad coverage of the agro-food industry—cereals, meat, and fruits and vegetables as the FAO categorizes it, it is difficult to analyze the agro-food as *the sector*. Each segment, or even each agro-food product, is distinct in, among other things, factor composition and consumption elasticity; each is specific in driving forces and development dynamics. We chose the analytic unit being major or representative afro-food product, that is, soybean for Brazil, cassava for Nigeria, coffee for Costa Rica, and vegetables for China.

In the globalization era, one character to gauge potential meanings of the cases selected is their strategic orientation: domestic needs-oriented or export-oriented. The four cases get a balanced combination: Two—the Brazilian soybean and the Costa Rican coffee have the international market being the targeted orientation, and two—the Chinese vegetables and the Nigerian cassava aim manly at domestic needs.

<b>Country</b>	Brazil	China	Costa Rica	Nigeria
<b>Case subject</b>	Soybean	Vegetables	Coffee	Cassava
<b>Domestic demand- or export-orientation</b>	Export	Domestic	Export	Domestic

### ***Synthesis***

Synthesis summarizes the insights highlighted in country cases, and goes beyond the cases. It will be a collective action by the authors group and the project team. Synthesis draws upon the findings of country cases, makes generalization to the research questions above delineated through cross-country comparison.

### **Basic information of case countries**

We take several parameters to depict basic information of the case countries.

- (1) *The level of development*, measured by *per capita GDP*. The more developed the economy is, the less of the population bounded in the land, and the more developed institutions and supportive industries. Brazil, Costa Rica and China are of middle-income development countries, and Nigeria is in the low-income group.
- (2) *The labor-to-land ratio*, measures by *Per Capita Arable Land*, indicating one of the most important natural endowments for the agro-food sector. Brazil is the richest among the case countries, while China and Costa Rica are poor in arable land resource. By referring to *Per Agricultural Capita Arable Land*, the difference between Brazil and the land poor countries becomes even more striking, Brazil stands more than 10 times higher than China in this resource.
- (3) *Gini coefficient* indicates the status of wealth distribution. Brazil is the most unequal society. But there is the tendency in recent decades in which income gaps get widening in all the case countries.

<b>Country</b>	<b>Brazil</b>	<b>China</b>	<b>Costa Rica</b>	<b>Nigeria</b>
(1) Total National Population 2004 (1000)	180654	1320892	4250	127117
(2) Agricultural Population 2004 (1000)	25869	849417	803	37827
(3) Share Agri. population in total population	14.3	64.3	18.9	29.8
(4) Per Capita GDP 2004 (\$ constant 2000 prices)	3636	1441	4333	397
(5) Per Capita Agricultural GDP of the Agricultural Population (\$ constant 2000 prices)	1589	241	1867	364
(6) Per Capita Arable Land (ha)	0.32	0.10	0.05	0.22
(7) Per Agricultural Capita Arable Land (ha)	2.23	0.16	0.28	0.75
(8) GINI Coefficient	0.59 (1998)	0.45 (2001)	0.47 (2000)	0.51 (1997/97)

Source: various tables from FAO: Statistical Yearbook 2005-2006

(4) *The structural or specialization character*, measured by *Agricultural Production Index*. A country, having the production index of certain category equals to one, is at the world average of the category production; a country, with the index higher than one, produces the category more than the world average. Likewise, a country, with the index of certain category smaller than one, at, say, 0.5, produces the category of agricultural product at half of the world average. The index is made following UNFAO classification, it distinguishes the afro-food sector into three categories: Cereals, Meat, and Fruits/vegetables. Of the case countries, Brazil is specialized in meat production, soybeans have been used as important feed for meat production; Costa Rica is in Fruits/vegetables, coffee is in this category; China specialized in vegetables; and Nigeria has all the indexes lower than the world average.

**Table: Agricultural Production Index**

	<b>Cereals Index</b>	<b>Meat Index</b>	<b>Fruits vegetables Index</b>	<b>&amp;</b>
USA	3.68	3.21	1.08	
France	3.28	2.53	1.51	
Japan	0.26	0.58	0.53	
China	0.88	1.38	1.77	
India	0.60	0.14	0.84	
Brazil	0.23	2.70	1.11	
South Africa	0.76	1.03	0.79	
Russian Federation	1.50	0.86	0.63	
Nigeria	0.50	0.21	0.63	
Thailand	1.26	0.70	0.82	
Viet Nam	1.34	0.79	0.74	
Costa Rica	0.15	1.05	4.50	
World	1	1	1	

Source: reproduced based on FAO: Statistical Yearbook 2005-2006, TABLE A1: Total and Agricultural Population (Including Forestry and Fisheries), and TABLEs B1, B2, B3, Production of Cereals, meat and fruits and vegetables and Share of each category in World

Note: More countries--a few typical advanced economies and a few typical developing economies, included in the table and figure; for the purpose of putting the case countries in a broader scene of comparison.

(5) *International trade position* is measured by *Net total trade value and agricultural net trade value*. Brazil and Costa Rica have been important exporters of agricultural products. Especially Brazil's agricultural exports make up a lion's share for the total net (export) value of the country. Nigeria and China are net importers of agricultural products—the vegetable case of China and the cassava case of Nigeria are both domestic consumption oriented.

**Table: Net total trade value and agricultural net trade value**

	Net total trade value US\$ million					Agricultural net trade value US\$ Million				
	1979-1		1989-19		1999-20	1979-1		1989-1		1999-2
	981	91	01	2003	2004	981	991	001	2003	2004
USA	-28417	-113204	-427969	2	1	23214	18284	10913	8825	4019
France	-17753	-19154	-1011	-6801	-16731	3259	9606	9948	11470	12005
Japan	-3436	64942	87083	88010	8	-16612	-27940	-33436	4	5
China	-2717	16405	27776	34093	25741	-5571	-2727	-6896	7	2
India	-5099	-4058	-8891	-14153	-22272	1096	1879	1352	1601	1950
Brazil	-3391	10702	-2474	22419	30529	6325	6330	10351	17314	23617
South Africa	5552	5890	1293	-4380	-2520	1418	933	873	1076	771
Russian Fed	n.a.	n.a.	57070	60500	87145	n.a.	n.a.	-7017	-8655	6
Nigeria	5317	5907	7732	9034	16984	-1623	-334	-995	-1561	-1778
Thailand	-2615	-8275	5389	3759	1682	2853	4183	4641	6756	8096
Viet Nam	-960	-406	-848	-5051	-5051	-280	441	948	976	1345
Costa Rica	-395	-373	-477	-1585	-1971	550	716	1230	1211	1323

Source: FAO Statistical Yearbook 2005-2006, TABLE C5 Net Total Trade Value and Net Agricultural Trade Value (Exports - Imports)

To sum-up, we introduce “The three agriculture worlds” of developing countries, used by the World Bank (2008), which are *the Agriculture-based, the transforming and the urbanized*. The idea of three agricultural worlds or three groups gives a useful general cataloging to the great heterogeneity of the agrofood sector. The distinction of the three worlds is actually an aggregate account of development level, population pressure and agricultural endowments as some of the above parameters have suggested.

The agriculture-based countries are featured by high rural population share, high agriculture in GDP share, and low per capita GDP. Most of Sub-Sahara countries (and



South Asia countries) are in this group. The urbanized group refers to most of the countries in Latin America and the Caribbean, has lowest rural population share, lowest agriculture in GDP share, and highest per capita GDP. And finally, the transforming group embraces East Asia countries typically China and India, which enjoyed rapid economic growth in the past decades, and the growth momentum has moved the two countries of China and India from agricultural-based to the transforming group.

More important is differences in orientation and conditions for agricultural production among the groups. The agriculture-based rural has poorly developed roads and irrigation facilities. Modern inputs, such as chemical fertilizers, into agricultural production have been low. Their agricultural economic activities are mainly for subsistence, i.e. the majority of outputs used for farmers' own consumption. And this group, in referring to the Agricultural Production Index in the above, tends to be less specialized, their production level in all the three categories expressed tends positioned below the world average. Agricultural development can serve as grater multiplier to this group for the improvement in the rural poor by increasing cash crops, and for the economy as whole if agriculture-based value chain created and expanded into urban consumption and industrial utility.

Nigeria, although with rich mineral resources and having a dramatic reduction of rural population in recent years, it's agriculture fits to the characters of the agriculture-based group. For example, most of the rural residents engaged in subsistence agriculture, and the country is now faced with the bottlenecks from less developed infrastructure when they go with the recent cassava strategy to develop cassava processing (refer to the Nigeria country case). The selection of cassava, a staple crop, as the analytic subject for Nigeria is relevant from these background accounts.

Different from the agriculture-based group, the transforming group has been catching up in physical infrastructure and modern inputs for agriculture. Thanks to massive

industrialization, the livelihood of farmers is experiencing radical change largely in that commercial production increased rapidly and their income sources in fast diversification, much more from industrial and service jobs and other sources now. To cope with changed demands, agricultural structure moves to high-value added segments, such as vegetables that were not in the priority of agricultural R&D investment when China had to be living based on subsistence agriculture. The vegetable sector would be illuminating to reveal how a new sector--a sectoral system, emerged in the circumstance of double transformation: the transformation of agricultural structure and the transformation of the economic regime by and large from a centrally planned towards a market-oriented.

The major differences between the transforming group and the urbanized group seems are not in infrastructure and modern inputs, if not to mention that the transforming group may have used too much of some modern inputs such as chemical fertilizers. One of the differences is in the share of rural population; and another is in the strong export orientation of the urbanized group versus the transforming group. These can be understood as natural resources-induced and history-rooted. A further difference is in the public support to agriculture, especially in public spending for agricultural R&D. In terms of public R&D spending as a percentage of agricultural GDP, the Asia & Pacific group was on average at 0.41 (China was 0.40) for 2000, while the Latin America and Caribbean group was 1.15, of which especially Brazil stands out being 1.81, not much behind the developed countries group of 2.36 for 2000 (The World Bank 2008: 167, Table 7.1). This might be coming from strategic insights, or ideological preference, the Asia countries have shown the tendency very much in favor of high-tech manufacturing, so it was the prior area for public support.

The two cases located in the urbanized group are soybeans of Brazil and coffee of Costa Rica. They show something novel. The coffee sector in Costa Rica moves to high value added end of the market, rather than go down to the low end as many developing countries suffered in the squeeze of powerful multinational competitors.

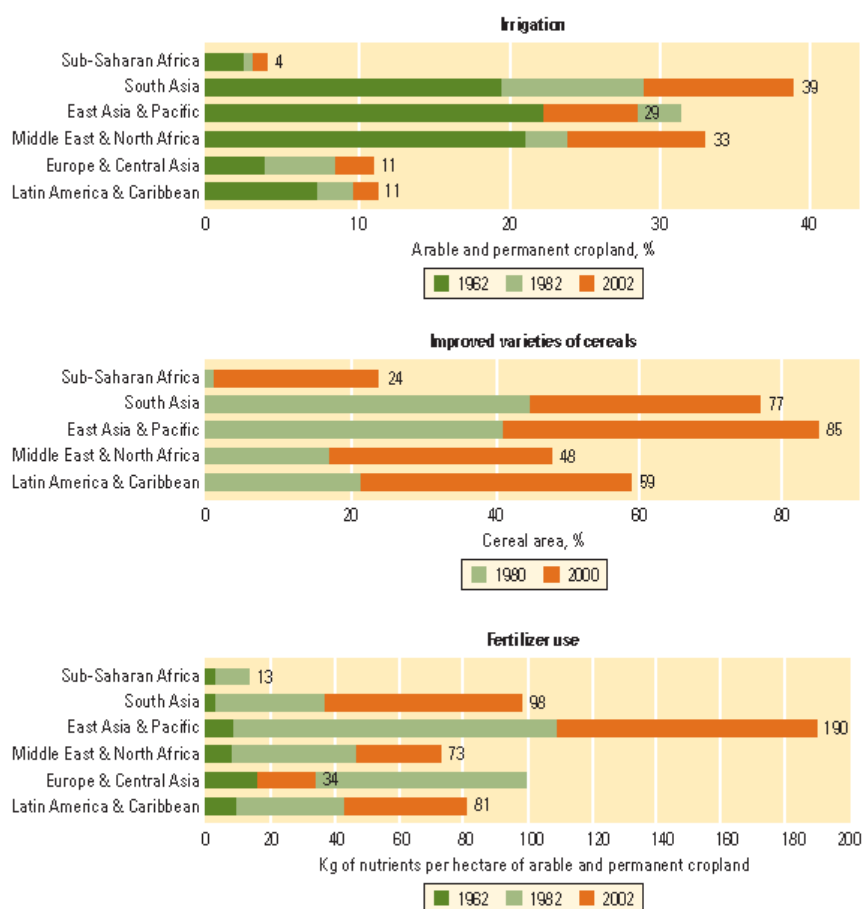
The soybean sector in Brazil expanded massively their presence in the international market, based on the capabilities in new variety creation and effective mass-production of soybean and soybean oil.

**Table: characteristics of three agricultural groups**

	Agriculture-based	Transforming	Urbanized
Share of rural population % (2005)	68	63	26
Share of agriculture in GDP % (2005)	29	13	6
Annual non-agriculture GDP growth (1993-2005)	3.5	7.0	2.7
Orientation of economic activities	Subsistence-oriented	Moving towards market-oriented and diversified activities	Market-oriented and diversified activities
Public spending on agriculture/agriculture GDP %	4%	About 10%	Higher than 10%
Infrastructure and modern inputs	Low	Improving infrastructure Highly use of modern inputs	Relatively modest use in chemical fertilizer
Case country in this study	Nigeria	China	Brazil, Costa Rica

Sources: Author reproduced based on The World Bank 2008 Tables 1.1; 3.2; pages 31, 39, 75-76

Figure 2.2 Modern inputs have expanded rapidly but have lagged in Sub-Saharan Africa



Sources: Evenson and Gollin 2003; FAO 2006a.

## Findings and discussion

### *The richness of evolutionary paths*

The cases chosen in the study, cassava in Nigeria, vegetables in China, coffee in Costa Rica and soybeans in Brazil, are all the fastest growing segments in respective countries, fit well to the agriculture worlds that they are located. The paths in which the sectors evolve show apparent differences in relation first of all to the differences among the agriculture worlds.

Cassava is one of the most important domestically produced staple crops. The sector, since it was initially introduced in early the 20<sup>th</sup> century through people's flow, such as immigration of emancipated slaves from Sierra Leone, was expanded in cultivation

first as a rural food staple before the 1980s, and then become additionally as a cash crop for urban consumption and limited industrial uses, mainly since the second half of the 1980s to around 2000. Recently the Presidential Initiative on Cassava Production and Export (PICPE, 2004) assigns more roles to cassava, tending to let it being as livestock feed and industrial raw material and with significant export. As an agriculture-based country, the initiative may have implied an important departure in strategic developmental thoughts, towards serious awareness of the importance of agriculture for sustainable social land economic development, although how the initiative will be successful remain to be seen.

Consumption of vegetables has higher income elasticity. It is not surprising that this segment got rapist growth in an agriculture-transforming country China following fast economic growth; and where the supply of staple cereals has got basically solid ground thanks to the accumulated investment in infrastructure and technology during the period of substantial agriculture before the 1980s. Two features characterize the fast emergence of the vegetable sector. First, it began from down-stream activities, namely, production and soon after marketing, while with some crucial upstream sources, mainly seeds (packaged product technology), acquired from international sources. Market system's development has been very central for opening an ever-larger platform for the interaction between production and consumption. R&D capability was building in parallel to the growth of the production and consumption system. Second, the evolution took accelerated paces that led the sector passes though the stages from primarily fulfillment of demand to the response to safety supply and green production, a process that was often evolved over much longer time as seen in many existing segments of the agro-food sector.

If the above two cases show some catching-up characters that they solve staple or basic needs in food-stuff supply for domestic consumption, and they are still in the development of local scientific and technological infrastructure with particular focus, the cases of Costa Rica's coffee and Brazil's soybean differentiate themselves more

apparently in moving to specialized divisions in international agricultural markets. Both the cases have grounded their competitiveness upon the capability in creating novelty and productivity frontier, in gourmet coffee of Coata Rica and in soybeans in Brazil. Brazilian researchers have, since the beginning, developed varieties of soybeans directed to biological nitrogen fixing in the soil. Together with improvement in plantation techniques, including the biannual crop system combining soybean and wheat, and the introduction of soil correction with the employment of calcareous, they in effect created a new technological trajectory of non-GM varieties with high yield and low fertilisers use.

However, the two cases of Costa Rica and Brazil distinguish to each other in their evolutionary paths towards specialization, as well. Although Brazil moved ahead in the booming international soybean market quickly in the past thirty years from a relatively ignored to become the second largest producer and exporter of soybeans with closing gaps with the world' largest United States, Costa Rica followed a way somehow differently not in terms of market share of bulk commodities but in terms of value added. Gourmet coffee from Costa Rica is now sold directly through e-commerce to the specialty consumers in the US, Japan and EU. The distinction between them can be considered as approaching towards competitive in mass markets versus that in high value niches. The nature of value chain of the two commodities—coffee and soybean, and the structure of the two sector systems of production and innovation are responsible for the differentiated paths.

In contrast to the soybean sector in Brazil where the dominant producers are large farms and large and integrated agribusiness enterprises, smallholder farms dominated the coffee sector in Costa Rica. The government of Republic of Costa Rica encouraged since the onset in 1821 for coffee cultivation and export, by various measures including offering free coffee plants, freeing taxes, and land grants. Unlike the division of labor prevailing in the coffee chain where coffee was growing in colonies earlier and the republics later of the “south”; and the imperial and

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industrialized countries of the “North” run processing, commerce, and consumed it, Costa Rica has from the start been engaged not only in growing, but also in processing with wet technology and involved to some extent in trading under an agrarian capitalist motivation. Wet processing tends to prefer for central processing plants (*beneficios*) with increasingly technical procedures, that gave attention to quality and the manner of harvesting, namely handpicking only ripe cherries rather than Brazil’s more industrial and less discerning style, and that urged the development of transportation for maintaining the freshness of cherries. All these were responsible for thick social networks and interactions and the local concentration of power around the coffee sector, which laid down a background for the sector evolving in a high quality trajectory.

***Great dynamics and changing competitive scenario.***

Opportunities for the development of the afro-food sector come from the dynamic new demands, the advances of technology, and from entrepreneurship of actors, their concerns about food security and safety and environmental protection, and proactive government policies, that pushed ahead institutional changes.

Demand has been one of the most powerful drivers, be it from domestic needs which is relevant for the Nigeria and China cases, or opened in the international markets which is more directly applicable for the Costa Rica and Brazil cases. The opening of new markets like that in China and India gives opportunity for Brazil that it was since the second half of the 1990s the Brazil soybean sector gained great momentum to growth based on its advantages in good technology and cheap (relative to the United States) land. As a result, Brazil increased the production from 24 million tons accounted for 19% of the world total in 1995/1996 to 61 million tons and 28% of the world total in 2007/2008.<sup>5</sup>

Demand serving as a triggering factor to the coffee sector takes a different way. That

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<sup>5</sup> Refer to OILS AND FATS IN THE MARKET PLACE at <http://www.lipidlibrary.co.uk/market/soybean.htm>, accessed on 10 August 2008

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can be understood as international organizations/association-coordinated re-structuring. In response to the latest coffee price crisis, which approached the worst in 2002, international organizations such as the International Coffee Organization (ICO) and the Food and Agriculture Organization of the United Nations are involved to promote specialization-based coffee trade, by differentiation of demand as well as production. Certified, or gourmet/specialty coffee niches are thereby created and Costa Rica, by taking the opportunity, is moving up to the high end of the value chain, based on whose accumulated strengths in high quality trajectory.

The scenario in relative strength or competitiveness in the agro-food sector changes over time from the dynamic evolution. One sees that Nigeria surpassed Brazil to become the largest producer of cassava; Brazil reduced cassava production while increased soybean almost to the same level as the US produces; China, as the original domesticated country of soybean, has been stagnant in that but increased and becomes competitiveness in vegetables; and Costa Rica enjoys the opportunity for specialty coffee niches.

### ***The Importance of institutions***

*Development of market institutions.* Institutions concern rules, norms and routines with which system's actors behave themselves in connection to the rest of the system. One of the most interesting observations in the study is the development of market institutions that underpinned the rapid emergence of the vegetable sector in China in the context of double transformation: the transformation of economic regime by and large and the transformation of the agriculture sector in particular.

Wholesales and their networking have been central in the development of market institutions in the vegetable case in China. Wholesale markets hold rules for transactions; they also offer physical conditions for the conduct of transactions such as sheltered space, transaction and storage facilities. Local authorities contributed to the necessary physical investment and managerial capacity for the construction of key wholesale centers; Villagers collectively opened relatively smaller and nearby



wholesale spots too. The Ministry of Agriculture played roles in regulatory and certification services, and by 1995 it began providing information services in price and supply-demand status based upon data from key wholesale centers, delivered by means of electronic techniques; this made an important step forward for the sector towards nationwide integration. Recently the wholesale centers are in addition assigned with the function in monitoring quality of vegetables in distribution, for this purpose, new capabilities are necessary in terms of more sophisticated information management and in cooperation with technological supportive system in testing and standardization. The market institutions developed have mediated the participation of dozens millions of vegetable planters, thousands millions of vegetable consumers, and a large number of specialized venders and blockers.

*Governance of the market..* Institutions evolve through complicated social interaction over long time, in this regard we see differences appear, comparing some case from the first two groups with that in the more developed “urbanized” group. A rapid development of market institutions for the vegetable sector in China, although constructed the major elements of the institutions, still leaves weaknesses to be further improved. Distributional effect and informational functions of the market remain low there, and more profoundly, vegetable pricing is to an extent formed arbitrarily with small producers squeezed to the lowest margins of profits. Governance of the market is crucial to balance the relationship among actors who have different strengths in influencing the operational rules and benefits distribution of a sector.

Thus in contrast, one sees in the Costa Rica case two events were important in the evolution of market governance for the coffee sector, where small planters got balanced place to large processing mills. The first was the creation of the government agency Institute for the Costa Rica Coffee (IDECAFE) in 1933, responsible for, among the major functions, regulating prices at which the mills purchase coffee cherries from planters. This was a result from many conflicts occurred in the 1920s and 1930s in which small farmers were struggling against powerful processing mills’

joint action in price setting. Later on in the 1960s, small farmers organized themselves into cooperatives. Some vertical integration of the value chain activities appeared under cooperatives, and small farmers enhanced their negotiation position with large processing mills, so that now the mills have to compete for getting their input from the growers.

*Long or short value chains, “thickness” in social networks.* The content, quality and intensity of interactions or links of a sector system bear on learning dynamics, which is to a large extent embodied in the sectoral structure, the choice of technology, and the way in which value chain of a sector gets expanded and deepened. Emerging sector like the vegetable sector in China began with segmented and short linkages, and the efforts for the market institutions development has been in effect aiming at the expansion of supply-demand networks. The linkage intensity of the cassava sector in Nigeria is shallow by far.

Choice of wet processing technologies of coffee in Costa Rica as has mentioned, which set forth greater momentum towards care about quality hence the manner in harvesting and transformation, together with enthusiastic engagement of Costa Rica elite people in various value-added activities of planting, processing, and trading of coffee, which hence laid the foundation of coffee economy-surrounded thick social network, attributed to an interactive dynamics in favor for a high-quality trajectory that Costa Rica embarked even from very beginning.

Linkages and learning dynamics can also come from diversification of products and cross-relations between sectors. The Brazil’s soybean sector is in this sense contains a long value chain, compared with other agro-food sectors such as rice. Diversification of product includes, in addition to raw beans and soy-oil, soy-meal that is processed, consuming more than half of the total output, mainly as feed input for the production of broilers and swine, which are also largely for exporting. This makes up close links between the two, the soybean sector and the meat production sector.

Capacity in food processing is, in some circumstance, an indispensable condition for

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the commercial development of a certain segment of agro-food, cassava is the case in point. Because cassava roots are perishable, can deteriorate within two or three days after harvesting; also because the roots contains toxic cyanogenic glucosides ingredient which has to be reduced to a level for safe consumption. There is no choice but selling cassava as a processed product for either foodstuff or industrial materials if the consumption takes place little away from the cropping field. Processing of cassava includes washing, peeling, grinding, screening, separating, sedimentation, bolting, storing and packaging, is water and energy intensive and with use of many machines, if the traditional farmer household women's laborious job of processing to be done in large scale and with higher and stable quality. Improvement in electric and transportation infrastructure, increase in mechanical engineering capacity therefore becomes one of the major challenges to the sector in Nigeria, if the ambitious 2004 Presidential Initiative on Cassava Production and Export is to be operational.

### ***Knowledge base in rapid change***

One of the most impressive findings from the study is that knowledge bases for the agro-food sector have been in rapid change in the recent decades, along with fast technological advances and increasingly intense interplays between scientific communities around the world. Biotechnology, i.e., the knowledge, the tools and methods developed in it, has been employed broadly mainly in new variety creation, facilitated the paces of agricultural "product" innovation fast than ever before. Also used broadly are technologies for food processing, information technologies for marketing and management and technologies and knowledge on green and environmentally friendly production and quality monitoring.

*Three modes in modernization and strengthening of agro-food knowledge base* are observed in the study, they match primarily to the categorizing of "three agricultural worlds".

*One mode*, which is observed in the cassava case of Nigeria, shows the leadership of international R&D. It can be called as international R&D led-mode. One of the most

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influential international institutions--the International Institute of Tropical Agriculture (IITA), located in Ibadan, Nigeria, belonging to the Consultative Group on International Agricultural Research (CGIAR) family, contributed to the development of a number of new cassava varieties including the famous TMS varieties, which have the merits in higher root yield potential and being tolerant to major pests. The international Root and Tuber Expansion Programme has been promoting the extension of new varieties of cassava in Nigeria among Africa countries. And loans from international sources such as the International Fund for Agricultural Development (IFAD) have been supportive in new cassava technology extension.

The division of labor between international and domestic R&D in Nigeria has thus far been that international R&D worked out innovative cropping technologies mainly new varieties and effective control of diseases or pests, and domestic S&T persons and organizations provided the capability base for spread of improved cassava varieties. Recently with cassava assigned with strategic importance, collaboration between the two lines of knowledge centers might be enhanced and elaborated, manifested in the fact that institutional construction of domestic R&D is in facilitation, it now embraces about two dozens in unit under the Federal Department of Agricultural Sciences or in the Federal and State universities. Worth noting is also the fact that the National Root Crops Research Institute (NRCRI), Umudike, a leading national R&D center, now pursues rather comprehensive objectives; this progress would deepen their capability for better collaboration with international R&D. Along with the R&D institutional development, institutions for extension and for financing and infrastructure development are all set up or enhanced.

*A second mode* of transformation of knowledge base is shown in the vegetable sector in China.

The China's experience is featured by a reliance on externally introduced technologies especially new varieties on the one hand, and intensive local adaptation and R&D capability building in parallel to the introduction, on the other. It is a rapid

introduction-adaptation mode, appearing in rapid structural change of agricultural production. Multinational companies either directly through sales of their subsidiaries opened in China, or indirectly through local seed agencies' importation and distribution, have thus far supplied a lion share, between 50-80 percent, of new varieties of vegetable. Local agricultural R&D centers played the role in selection of imported varieties as whether they are appropriate to certain soil and weather conditions. Meanwhile plantation skills that peasants had built up over generations lent a ground for the successes in employing imported seeds in production.

In the meantime, China has been devoting for the establishment of bio-agricultural R&D infrastructure for vegetable variety breeding capability building. The fact that China lagged behind international supplier in seed breeding has been a triggering factor for the efforts to improve the knowledge base for the vegetable sector, which was not the investment priority before the 1980s when the agriculture of China was basically a subsistence one focusing on the provision of adequate staple foods for the population. After some of 20 years such a knowledge infrastructure is in shape now. A system of R&D institutions on vegetables and flowers is formed, the core body of which embraces 33 units at the central and provincial academies of agriculture science. To be added are other some 20 centers or branches specialized in vegetables at the lower municipal/city levels. Furthermore, around 30 vegetable and gardening departments established in agricultural universities, and a number of research centers more generally on life sciences were created or improved in the prestigious Chinese Academy of Sciences and in top comprehensive universities.

A third mode is demonstrated in the Costa Rica coffee case and the Brazil soybean case where biotechnology-centered knowledge bases have entered a relatively mature stage, being able to create specialty goods and service or new technological trajectories in interplay with the opening of dynamic new markets and with the diversifying of new testes in the global economy. This can be understood as competitive and creative mode. Both the countries have established rather modern bioscience and biotechnology infrastructure since the 1970s, together with institutions

for financing and extension services established or consolidated. They developed as well complementary industries and knowledge and capability in processing, machinery, chemicals and so on. Now the Brazilian public agriculture R&D corporate EMBRAPA (Brazilian Enterprise for Agricultural Research, start in 1973) becomes one of the world's top knowledge centres in agriculture biotechnology, contributed non-GM varieties of soybean, which have the quality in high yield and low fertilisers use, responsible for the Brazilian distinct competitiveness in soybean. The Costa Rica Coffee Research Center (CICAPE), created in 1977, has contributed to the coffee sector with new varieties, organic coffee growing and environmentally friendly coffee processing technologies.

Investment in agricultural R&D that maintained in Brazil and Costa Rica at a level much higher than the levels of average Asia and Africa countries is a responsible factor for the strengths. International academic exchange played a role for the creative dynamics of the Brazil and Costa Rica mode as well. The Brazilian government, as Costa Rica did so, continued in decades subsidizing for advanced education and training abroad, some dozens of those who trained in United States thirty years ago are now leading scholars at EMBRAPA. And a third factor might be from their exporting agriculture tradition, that brought about strong incentives to compete for opportunities opened in emerging markets or in differentiated niches.

#### *The role of traditional knowledge*

Traditional knowledge is knowledge, which is accumulated based on experience over long time. Farmers make up one of the richest pools of traditional knowledge. Everywhere farmers' knowledge about the soil, water, eco-system of particular locus where they live, and their skills in planting have been an important basis for implementation of new varieties into field.

Traditional knowledge-based innovation--i.e., farmers' innovation, contributed in a considerable extent to the vegetable sector in China. That was a kind of simple, cheap, and effective greenhouse appeared in the late 1980s, as a result from purposeful effort

of a group of farmers. This green house has a thick soil wall in the north side to prevent from cold wind and board and transparent roof open in daytime and covered with strew shade in the night, in order to maintain fresh vegetable production in winter while avoiding the use of fuels (coal) for heating purpose. Soon after, this innovation, but not those more scientifically designed and some imported greenhouses, got widespread disseminated in the mid-China provinces with similar latitude. The population that supplied for vegetables with this greenhouses is about several hundreds of million.

Similarly in Nigeria, it is observed that cassava grating machines were often carried out by half educated, determined young men and women who needed to make a living on it. The processes they created were easy, convenient, cost effective and sustainable. And it is commented that by and large, the processing technologies developed by the government agencies in Nigeria have achieved limited adoption. Adegboye and Akinwumi (1988)

To cope with the rapid transformation and strengthening of knowledge bases for the agro-food sector, exploration and renovation of traditional knowledge will provide great potential. What derived from the observations in the study is that first, formal R&D needs to communicate with traditional knowledge where it bears up rich information also about the conditions and foundations for the applicability of scientifically developed technologies. Second, improvement of rural education enables practitioner farmers to better perceive, create, summaries, and employ both traditional and modern knowledge—Costa Rica might be the best in the case countries in universal compulsory education, which explains to some extent their good performance in the coffee sector.

### ***The role of government policies***

#### *Specific and changing focus and means of policy*

Government policies play very important roles for the agro-food sector. However the

conventional divide between public goods and private goods supply in order to rationalize public policy is inadequate to explain the complicated evidence shown in the cases. A better way, by understanding of development being a process in which institutions, factors and capabilities are created or renovated to open new evolutionary space, we go to look not only regulatory and infrastructure services of typical public goods nature, but also policies for the creation of missing factors or capabilities.

Policies that involve directly into the creation of factors and capabilities appear in the Nigeria case where some state government grants land to a key processing company for sustainable input of cassava. The state government also becomes a commercial partner of the company with equity share upon which it contributes capital investment in the company to renew its equipment. The rational lies in the fact that cassava-processing capacity is too weak to be a serious impediment to the cassava strategy. Similar cases is seen in Costa Rica but appeared much earlier some two hundred years ago when the government granted land and coffee trees for the birth of the coffee sector in the first place. To a less extent, such kind of grants or subsidies happened to the vegetable sector as well that the local government offered subsidies to farmers who agreed to turn to vegetable production.

Institutional development, a key area of public policy, is costly not only in regulatory construction but also in terms of investment in physical facilities. Thus the vegetable case in China shows enormous involvement mixed by public and private into the set-up of wholesale centers of vegetables, which afterwards were mostly privatized as private businesses.

Scientific and technological infrastructure has conventionally been the realm of public policy, and it remains so for developing countries by and large. However, in Brazil with the growth of agribusiness companies, about one third of variety building R&D for soybean is now carried out by private companies, in contrast, in Costa Rica, public R&D remains the dominant contributor, to be understood in its specific context.

A public-private mixture in the provision of agricultural extension services unfolded



in Brazil and to a less extent in China, caused partly by the trends where seeds contain packaged knowledge, and private companies especially multinational seed companies provide extension services as part of their marketing activities.

The changing scenario in institutional and infrastructure development, and in the creation of factors and building of capabilities, in which the means and focus are rather context and subject-specific and for which the public-private relations become rather intertwined, imposes great challenges to the formation and implementation of policies for the sector.

#### *Responsive versus proactive policies*

Responsive policies are observed in the vegetable case in China. Policy is adjusted in response to bottlenecks and impediments revealed over time, hence there appeared stage-wise movement in objectives and means of policies—the construction of production and consumption links of vegetables surrounding selected large cities; the expansion and networking of the segmented regional links to become a nation-wide system, and the pursuit for safety and quality supply of the sector, respectively in different stages. The merits of responsive policies come from concrete information indicated in the impeding problems; hence policy objectives and means can be formed focally towards handling the problems.

The Presidential Initiative on Cassava Production and Export (PICPE) of Nigeria, officially announced in 2004, is in line with proactive policies. The Initiative ambitiously sets the goals to raise the production level of cassava to 150 million tons by the end of year 2010 from around 40 million tons in 2004; with the intention to deepen the cassava cropping and processing system, by assigning the roles for the sector as a springboard for the structural and capability upgrading of the Nigerian economy and for a diversification of export structure. Their earlier experience with cassava offered a basis for the rationale of the Initiative, in which Nigeria tested the feasibility of growth of cassava and got experiences on cassava utilization.

The Second National Development Plan (II PND) of Brazil (from 1974 to 1980) in which oil production and substitution (in response to the first oil crisis), i.e., the alcohol-as-fuel programme, was one of the sectors to be created or expanded, and the establishment of the EMBRAPA was made for a backup to the programme, might be seen as another example of proactive policy. It enhanced institutional basis for agricultural biotechnology research, not only on sugarcane, which is the biological raw material for fuel alcohol production as a substitute for fossil oil, but also on soybean and other agricultural products.

Proactive policies have strategic vision underpinned. For the alcohol-as-fuel programme and the EMBRAPA creation, the strategic perspective has been in the exploration of biological resources to overcome the shortage of fossil oil deposit in Brazil. A strategic perspective of proactive policies has the merits in help for alleviating disturbances from internal or external pressures. Thus, although what will come out from the Nigerian Presidential Initiative remains to be seen, the results from the creation of EMBRAPA, and from the alcohol-as-fuel programme in Brazil become clear now—the agribusiness, and the sugarcane based fuel industry are among a few industries which are “ready to go” after thirty years development during which there was full of frustrations in the Brazilian economy in general and in the industries in particular.

## **Conclusions**

1, The agro-food sector in developing countries shows unprecedented dynamics in recent decades.

Population increase, economic growth worldwide although unevenly in speed and scope among regions and countries, the increase in affluence of consumers and their remanding tastes and consideration about health, the advances in technologies especially biotechnology and intense academic exchange, the higher degree of liberation of national agricultural markets, all contributed to the rapid growth and structural transformation of the agro-food sector.

2, Paths and patterns of the dynamics, with which the case sectors evolve, behave themselves in a great diversity. We observe that there are staple crop (cassava) as leading segment to growth versus higher-value product (vegetables) as leading sector to growth of the agriculture as whole in different circumstances. We also observe that towards new opportunities opened at the international market there are approaches by means of exploitation of advantages upon mass production (soybean) versus exploitation of advantages upon specialty production (coffee).

The diversity in evolutionary paths and patterns of the agro-food sector is very probably much greater than many other sectors such as automobile or computer software, because the natural endowment factors and social and cultural factors are much stronger and more directly involved into its development. More studies are definitely necessary—we should keep in mind that the four cases covered by this study is far from enough for understanding well of the sector.

3, Institutions matter especially for developing countries that opens space for actors to operate with each other and facilitates the formation of links. Of the cases studies, we observe that the development of market institutions for the vegetable sector in economic transition in China entailed comprehensive regulatory, managerial, and technological efforts, and physical investment.

Value chain structure of a sector embodies, to a large extent, the quality and intensity of interaction and learning dynamics of a sectoral system. With the cases we are able to distinguish “long” or “short” value chains and thick or shallow social networks. An engagement in food processing, and the existence of input-output or complementary relations with other sectors, are favorable for a sector to have higher interactive dynamics.

4, Knowledge base of the agro-food sector is experiencing rapid change, modern biotechnology, among other technologies, has been employed broadly in developing countries, mostly for the facilitation of new variety, often non-GM, creation. The “old” agro-food sector should no longer be considered as low technology sector even

in least developed countries.

The ways in which the agro-food sector modernizes and strengthens its knowledge base differ, according to the observations in the study. We distinguish “international R&D dominated” mode, “rapid introduction and adaptation” mode and “competitive and creative mode”, demonstrated in the respective cases. Traditional knowledge played important role in all the cases, we suggest agro-food policy to give high attention to the exploration and renovation of traditional knowledge.

5, The role of government policy proved in the study is very important. We observe that focus and means of policies for the agro-food sector have to be subject-specific and adjusted over time. In the developing context, policy may have to be involved in the creation of missing factors, which were in mature sectors assumed to private actors. Meanwhile, some evidence shows a tendency in which some conventional public functions such as in R&D and extension services are now provided by public-private combination. These changes make up challenges to policy capacity in developing countries.

We observe responsive policies and proactive policies for the agro-food sector, and explored the merits of the two lines of policies. A strategic vision with regard to the agro-food sector that underpins the line of proactive policies may have particular importance now, provided that the agro-food sector is closely connected to development sustainability, in economic, societal and environmental terms. Would the sector become one of pivotal sectors in the near future in the front of so many problems facing human being: population exposure, resource scarcity and environment crisis?

6, The analytical approach of sectoral innovation systems proved in the study productive and informative. By sensitizing specificities to a sector, the SIS approach tends genial in the probe of particular details. The analysis of driving forces indicated the type and feature of opportunities rather clear, they are unique to the agro-food sector. The analysis of the transformation of knowledge base is very illustrating. It

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shows several modes for the transformation and strengthening of knowledge base, and overall the analysis revised the conventional notion about the sector—the sector should no longer be considered “traditional”. The exploration of evolution of the sector showed important information about the dynamics behind it. A trace of the interaction between actors of a system and the relationship among various sources of knowledge, brings observation across national boundaries. All these findings detailed our understanding that contain useful policy implications relevant to the sector.

The analytical unit of this study was actually chosen at even a lower level, which is a product segment of the agro-food sector. This design proved appropriate, in considering the great diversity of the agro-food sector.

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