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Technology Transfer in Agribusiness

Celia L. Umali

Abstract:
This paper deals with the technology transfer mechanisms in agribusiness in Asia. Agribusiness is a broad sector but in this study emphasis is placed on the small producer who has an important role to provide the food for an increasing population. The conceptual framework and development goal of technology transfer in developing countries are clarified. There are many stakeholders in the technology transfer process, namely, the government, private sector, farmers, NGOs, and international agencies. The role that each of these participants plays as well as the different instruments used in transferring technology to the farmers are outlined. In recent years there is a paradigm shift from the traditional to the participatory model of technology transfer. The characteristics of these paradigms, the elements that can contribute to a successful technology transfer and the scenario for technology transfer are also presented.

Introduction
The important role of agribusiness in the economies of many countries in Asia can not be underemphasized despite the industrial restructuring that has occurred. Agribusiness in Asia is still a source of growth for the economy in terms of source of income, employment and value added specially in the rural areas. Thus the development of this sector hopes to improve productivity to attain self sufficiency and surplus, better income distribution, increase employment and improve the standard of living of the people who still depend on this sector. Recent trends call for agribusiness to be conducted in such a way that it is balanced with sustainability and the environment.

1 Sustainable development is the management and conservation of the natural resources and directing the technological change making sure that the present and future needs of next generations of people will be protected. Thus sustainable agribusiness means conserving the land, water, plant and animal resources while engaging in different activities. Likewise, the business operations have to be environmentally friendly, technologically appropriate, and economically and socially acceptable.
Agribusiness is a very broad sector. Agribusiness by definition covers all operations involved in the manufacture of farm suppliers, production on the farm, storage processing and distribution of the farm commodities and items made from them. The participants in the agribusiness system can be categorized into three groups: input aggregate, production aggregate and the processing and distribution aggregate (18). The input aggregate is composed of the manufacturers and suppliers of farm inputs (i.e., seeds, feeds, breeding stocks, fertilizers, farm equipment and machineries, etc.) (Figure 1).

The production aggregate is made up of the farmers and producers engaged in the production of crops, livestock and fishes. The processing and distribution aggregate include the grading, standardization, storage, transportation and the food processors who perform additional value added activities such as processing, canning, packaging and distribution; and the wholesalers and retailers who sell the
products to the consumer. There are many participants in each agribusiness aggregate which differ in size, level of technology, sophistication, management capability and ownership style. Hence agribusiness may range from a small farm producer to a local small and medium processor to a big multinational corporation engaged in any of the agribusiness activities.

For this paper however, focus will be placed primarily on the small farm producer although all the agribusiness participants are equally important. The farmers in Asia are subject to more risks and more transaction costs. They engage in small scale and less specialized agriculture and are geographically dispersed. Agricultural production is always at the mercy of the weather and natural calamities. It is seasonal and requires a gestation period thus there is the yield lag vis a vis demand. Due to the perishability and bulkiness of agricultural products, the farmers have to deal with risks of loss of value and quality deterioration which then lead to increased transaction costs in terms of transportation and storage.

The farm sector has the vital task to provide the food needs of an expanding population, projected to reach more than 8 Billion by year 2025. In Asia many people still depend on small scale agriculture for their livelihood. Increased food production to meet the growing basic needs now relies on the development and transfer of technology and improved farming skills. Land is scarce in the Asian Pacific region which accounts for merely 30 % of the world's total cultivable land but houses 70% of the world population. Constrained by limitations in the expansion of land for cultivation in Asia, new technology is now one of the driving forces behind agricultural productivity and growth.

Against this background, this paper deals with agricultural technology transfer mechanisms to farm producers in Asia. The first part will explain the concepts and goal of technology transfer. The second part presents the different stakeholders and their roles as well as the different modes by which technology is transferred. The third part discusses the new paradigm in technology transfer and its characteristics as well as the factors that can contribute to a successful technology transfer. And the last part will analyze the scenario for technology transfer.
Technology Transfer in Agriculture

Concept

The agricultural knowledge and information system of the Food and Agricultural Organization (FAO) and the World Bank advocates an integration of extension, research and education that promotes mutual learning, and generates, transfers and uses agricultural technology, knowledge and information (Figure 2).

Figure 2. Agricultural Knowledge and Information Triangle

In this triangle the farmer is the at the core. Education, research and extension activities are done to provide the farmer with knowledge. In this triangle the farmer is not just the recipient but he is a partner (4). What binds the educators, the farmers, the researchers and the extension agents are the overarching development goal of increasing farm productivity, improved farming system and better income and welfare. Taking this framework, the extension part of the triangle will be considered and from here on will be referred to as technology transfer.

Firstly, the terms agricultural technology and technology transfer will be clarified. The United Nations Food and Agriculture Organization (FAO) indicated that technology has many components: hardware (i.e. seeds, breeding stocks, etc.), software (i.e. technique, know-how), humanware (i.e. farmer, extension agent),


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orgaware (i.e. farm management) and product and commercialization aspect (13). Technology transfer then can be defined as the process by which the farm producer can have access to these technologies. The United Nations Environmental Protection Organization has a broader definition of technology transfer which is the process by which know-how, experience and equipment flow among various stakeholders: farmer, government, private sector, NGOs, research and academic institutions, etc. It is the process of knowing how to understand, use and replicate the technology, likewise involving the ability of the recipient to be able to select and adapt to local conditions (16).

**Stakeholders**

Technology transfer involves multi-sectoral institutions which are linked into an interdependent relationship. Table 1 shows the players and the roles they play. More often in Asia the responsibility of transferring technology lies on the government who sets the groundwork in terms of setting the policies, programs and the budget. International donor/funding agencies (World Bank (WB), Asian Development Bank (ADB), Australian Development Assistance Board (ADAB), Canadian International Development Assistance (CIDA), German FTZ, British Department of International Development (DFID), Sweden International Development Assistance (SIDA), Swiss Development Cooperation (SDC), etc.) usually provide bilateral grants for either farmer assistance projects that involve technical assistance, design and delivery or as part of an integral part of community or watershed projects. In terms of technology generation, researches are undertaken by na-

<table>
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<th>Roles</th>
<th>Stakeholders</th>
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<tr>
<td>1. Stage maker</td>
<td>Policy maker, politicians</td>
</tr>
<tr>
<td>2. Fund providers</td>
<td>National government/ international donor agencies</td>
</tr>
<tr>
<td>3. Generators</td>
<td>National/international agricultural research agencies</td>
</tr>
<tr>
<td>4. Adoption facilitators</td>
<td>Government extension agents, NGOs, private firms, farmers</td>
</tr>
<tr>
<td>5. Users</td>
<td>Farmers</td>
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tional agricultural research centers (NARCs) as well as international research institutes (i.e. International Rice Research Institute (IRRI), Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT), International Livestock Research Institute (ILRI), Centro Internacional de la Papa (CIP), etc.). These international institutes work closely with the NARCs as far as technology generation is concerned. The entities that are in actual contact with the users (farmers) include the numerous government extension agents, NGOs and the private firms who serve as

Table 2. Modes of Technology Transfer

<table>
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<tr>
<th>Country</th>
<th>Institutions</th>
<th>Instruments</th>
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<tbody>
<tr>
<td>Indonesia</td>
<td>Government, University, Private firms</td>
<td>Publications, Meetings (seminars, Workshops), On-farm trials, Field day, Visit to research institutions by farmer and extension agents</td>
</tr>
<tr>
<td>China</td>
<td>Government depts., Agricultural banks, Commercial organizations, Research and extension Department, Farmers associations</td>
<td>On-farm testing</td>
</tr>
<tr>
<td>Vietnam</td>
<td>Local government, Farmers organization NGOs</td>
<td>On-farm trials, Mass media, Leaflets</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>Government NGOs, Private firms</td>
<td>Training and visit Workshops, On-farm testing</td>
</tr>
<tr>
<td>Taiwan</td>
<td>Government University, Farmers association, Private firms</td>
<td>Training programs, Field Visit, Field demonstration, Seminars, Farmers discussion</td>
</tr>
<tr>
<td>Philippines</td>
<td>Government University, Private firms, NGOs</td>
<td>Training programs, Mass Media, Demonstration farms/On farm trials, Contract growing</td>
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technology transfer facilitators. The facilitators in Asia use different modes in the process which can range from training programs, demonstration farms, farmers discussion to contract growing schemes (Table 2). All these stakeholders work in synergy with the government who act as an important coordinator to help the small farmers on social and equity grounds.

Alongside these players exist the enabling externalities that would enhance the flow of technology transfer. Government coordination or policies in terms of prices of inputs and outputs, infrastructure development (i.e. rural road, transportation and communication), credit etc. influence a farmer's decision to adopt the new technology. With adequate infrastructure post harvest handlers, assemblers, wholesalers, and distributors would have the incentive to get involved in the technology transfer per se or indirectly as farmers will adopt the new technology if they know that they can bring their produce to the market at the right time and at the right price with minimum losses. Continuous education of the players could serve a good purpose in this whole technology transfer process. It would be beneficial to the extension agents and farmers to undergo training not only of the technical aspects but also about input mobilization, production systems, farm management, and self improvement to make sure that the new technology are utilized productively keeping in mind resource conservation.

**Agricultural Technology Transfer: Shifting Paradigm**

Traditionally the top down technology transfer has been widely applied. This means that research results from government research institutions like colleges and universities are transferred to the farmers in a unidirectional flow (Model 1). The farmers' participation however is weak. This top down approach, sometimes referred to as the expert driven technology transfer, barely involves the farmers and roles of the researcher, the extension agent and the farmer are rather rigid (9). This model according to Chambers (8), however ignored the socio-cultural, and agro-ecological aspects of agricultural production. There are now calls for participatory approach to technology transfer that would also at the same time promote sustainable agriculture (Model 2 and Table 3). In this model, the interest of the farmer is foremost. The latest technology transfer is called the "Beyond Farmer First Approach" (7). In this concept the farmer is the heart the technology transfer and he participates in the research and extension of technology. It also involves the training of the extension agents and the farmer on the new technology. The guiding principle here is that the farmers know their needs and have local
Model 1. Top-down Technology Transfer (Traditional Concept)

Model 2. Participatory Technology Transfer (New Concept)


capabilities and practices (sometimes indigenous knowledge) so that it is important for the farmers to be actively involved as partners in the research and technology transfer process and not merely as laborers.

Table 3. Traditional and New Concepts in Technology Transfer

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<tr>
<th>Functions</th>
<th>Traditional Concept</th>
<th>New Concept</th>
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<tbody>
<tr>
<td>Decision making</td>
<td>Centralized</td>
<td>Decentralized and adaptive</td>
</tr>
<tr>
<td>Planning and delivery of</td>
<td>Fixed design and packages</td>
<td>Changing design</td>
</tr>
<tr>
<td>technology and service</td>
<td>Supply push</td>
<td>Demand push</td>
</tr>
<tr>
<td>Response to external change</td>
<td>Collect a lot of data</td>
<td>Act urgently and</td>
</tr>
<tr>
<td></td>
<td>before acting</td>
<td>monitor results</td>
</tr>
<tr>
<td>Field learning</td>
<td>Learning by visiting rural</td>
<td>Learning by feedback and</td>
</tr>
<tr>
<td></td>
<td>areas, survey</td>
<td>feed forward Adaptive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and reciprocal process</td>
</tr>
<tr>
<td>Linkages</td>
<td>Weak link</td>
<td>Institutions formally and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>informally linked</td>
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It should be noted too the different farmers have different needs, different capabilities and the farming system can be location specific. Hence the extension agent gets feedback from the farmer during the transfer of technology and is then relayed to the researcher, to the extent of involving the farmers in defining and resolving their problems. Campbell (7) states that to empower the farmer, assistance in capability building with regards to participatory planning, organizing, motivating people, mobilizing resources, etc. is important.

Agricultural technology transfer or extension does not strictly mean the flow of technology per se from the researcher to the farmer. According to Farrington (15) it has broader functions which include 1) Examination of the socio-economic conditions and agro-ecological conditions of the farmer and their potentials and constraints; 2) Direct contact between farmer and extension agent to transfer technology or indirect contact through contact farmers or voluntary organizations; 3) Feedback to researchers about farmers' reaction to the new technology to refine future research; 4) Develop linkages among the different institutions involved such as researchers, government planners, NGOs, farmers organizations, banks and private sector; 5) Monitor and evaluation of the technology transfer at the farm level.

Looking at the technology receiving agent, the farmer will adopt the technology transferred first if his situation allows him to adopt the technology in his production function. Of course the farmer has to look at his own skills and farm resources, either fixed or variable resources, the economic benefits and risks involved. And in many developing counties credit is very important for the farmer to have access to resources and equipment needed to use the new technology. The farmer is thus exposed to a more complicated decision on whether or not to use the new technology and how to use it.

The transfer is successful if the recipient of technology (i.e. farmer) can choose, acquire, adapt, produce and maintain the technology and if it is the appropriate technology being transferred. Care has to be taken that the technology is suitable to the needs of the farmer, hence, it has to be technically and economically feasible, socially acceptable and environmentally friendly (14). The adoption and diffusion of the alternative technology will be enhanced if it would bring in income to the
farmer. Without this incentive, the technology will be dropped. This has happened in some developing countries in Asia where the technology transfer is part of a rural development project on an ad hoc basis which is subsidized by the national or local government or financed by international donor agencies. Once the project ends and subsidy ceases, the practice is dropped.

Traditionally in line with the government's drive toward rural development in Asia, technology transfer has been a role of the public sector, it being a public good. National and local government have the responsibility to transfer technology to the farmers. However due budgetary constraints this has changed. More recently therefore, in less developing countries, in Asia for example the role of disseminating technology to the farmer has involved other institutions like the farmer themselves or the private sector.

**Farmer to farmer technology transfer**

This mode presumes that the farmers know which new technology suits them hence they can be involved in diagnosis, testing and dissemination. Technology can be transferred by the farmer to another farmer specially those farmers who will dare experiment on new crops or cropping method with some advice from the extension agent. Farmers can be important agents themselves.

In the Philippines, the Farmer-Scientist Bureau program has been initiated in line with the farmer centered participatory model of development. The involvement of the farmers in research and technology are actively sought in partnership with the scientists. A national network of demonstration farms which are managed by the outstanding farmer leaders will become the showcase of the commercial viability of using a new appropriate technology. As such the farmer is not only a recipient of the new technology but his new role in production, technology promotion, transfer and adoption will be emphasized. Once the outstanding farmers who will join the program are selected and the program operationalized, a farmer to farmer advisory service in the different regions of the country would be set up and this could help the LGUs as far as technical advice is concerned. The farmer to farmer technology transfer includes the conduct of farmers training, operation of demonstration farms, cross farm visits and others.
Private sector-farmer technology transfer

This may include a local trader or wholesalers in Thailand in the case of soybeans or in the Philippines in the case of vegetables who would purchase the farm produce in bulk. The local trader even influences the crop and the variety the farmer can produce and what they are willing to purchase and at times is an important source of informal credit for the farmer. The private sector can be an agent for technology transfer through the contract growing arrangements between well-established firms and small farm producers. In this scheme, the contracted farms will be exposed to “business like farming techniques”. This has been practiced in the poultry industry in the Philippines and Thailand by domestic agribusiness firms. The agribusiness firm provides the chicks, feeds, veterinary advice to the farmer who in turn provides the poultry housing, labor and management. The chickens are then all absorbed by the contracting firm at a contract price. In the Philippines well known domestic firms such as Magnolia, Swift and Vitarich have embarked on this arrangement. A similar form is practiced in Thailand by Charoen Pokphand Co. (CP). The scheme includes guaranteed wage for the farmer and a guaranteed purchase price for the chicken. CP procured breeding chicks from Ann Arbor of the US which are provided to the farmer together with feeds, at times loan, and the technical information from company staff who visit the farms twice or three times a week. The success of the CP poultry raising scheme and the technology transfer that goes with it has been recognized in Thailand. Now Thailand exports processed chicken all over the world.

In the Philippines, multinational companies such as Dole used to own large tracts of land to grow fruits. But due land reform, Dole now subcontracts the growing of bananas and pineapple to farmer beneficiaries of the land reform program in Southern Philippines. The farmers grow bananas and pineapples using the stocks provided by Dole and using Dole technology. Southern Philippines is a conducive site for vegetable growing but is constrained by poor technology, poor transportation infrastructure and poor marketing systems. Just recently, a seed caravan was launched which means the government, private firms and farmers work together to spur development of the vegetable industry in the region. The commercial seed companies such as Pilipinas Kaneko Seed corp., Ramgo Seed Co., Tropi-CuKe Inc., etc. provide the vegetable seeds to be used in several field trials as well as the
technical advice. The sites of the trials have been selected by the local government agriculturist and the participating farmers will provide the land and labor and will likewise evaluate the performance of the various new varieties of vegetables. Upon harvest there will be a field day and market matching with farmers, seeds company representatives, buyers and local leaders present. Vegetable farmers stand to benefit from this project since they will have more options from which to select which new crop varieties to grow given the result of the trials and this allow them to make informed choices. The scheme can be looked at different angles. From the seed company, the project may be seen from the input subsystem side. However it also involves technology transfer and market development.

These institutional arrangements are not left without criticisms. Scholars claims that they only satisfy the profit maximizing motives of the large companies at the expense of small producers. Other problems include the lack of coordination, manipulation of prices and standards and delays in payments (18). These drawbacks on the part of the small producer can be reduced with appropriate and timely government intervention in terms of policies and incentives such as credit, information support, infrastructure development and institution building.

However the success of the technology transfer rests on the enabling factors such as training of the extension agents and the recipients. Also infrastructure such as good roads is an important incentive for the farmer to adopt the new technology knowing that his produce can be transported to the market. Likewise, radio and television can be good media for disseminating information and educating the farmers. Many cases in Asia indicate that farmers point to the lack of funds as one reason for the non-adoption of a new farming techniques. And lastly government incentives for stakeholders and the farmers are important for effective technology transfer such as capability building of extension agents as well as the local government units, subsidized credit, and institution building such as the strengthening of the NARCs and other local research institutions.

Future Trends in Technology Transfer

The scenario for technology transfer in the years to come include: decentralization, private sector participation, global technology transfer and sustainability of agricultural production and the promotion of the technology that supports this.
Many countries have embarked on a policy to decentralize government functions empowering local government units such as the province, city or town to plan and direct their activities. And this approach has been applied to technology transfer too. According to the World Bank decentralization will promote local financing, formulation of projects and local capability building which will be more responsive to the local needs of farmers. In this case too the transfer agent will be accountable to the small producer and thus will be responsive to their needs. In the Philippines, agricultural technology transfer has been devolved to the local government units (LGUs) since 1991. LGUs include provincial, city and municipal governments as well as the local community. The decentralization of this function was to promote participatory, bottom-up planning. But the devolution is not free of problems as far as financing and personnel are concerned. Local government officials have to be trained on their new roles. In Indonesia agricultural research and extension are being devolved but there are problems between the local and Central governments where still much of the decisions are made.

In 1990 FAO reported that there are around 550,000 public servants involved in technology transfer in developing countries at a cost of US$4.5 B (18) In recent years the public spending for agricultural research and development and technology transfer have been reduced in developing countries in the 1990's due to fiscal constraints. Hence hope lies on the involvement of the private sector for the farmers to have access to technology. The involvement of the private sector in agricultural research and technology transfer is although discouraged with the absence of intellectual property protection for seed varieties and breeding stocks as well as machineries. Moreover research and development usually take a long time and maybe costly too.

In previous years, agricultural research, development and technology transfer have always been done in isolation by individual countries. But recently there exists now a global network system whereby research efforts are linked globally to alleviate problems in the agricultural sector. The National Agricultural Research Centers (NARCs) in the developing countries, the International Agricultural Research Centers (IARCs) created under the auspices of the Consultative Group on International Agricultural Research (CGIAR) and the research institutions in advanced countries play important roles in the system through bilateral and multilateral
agreements, contracts and research networks. It is assumed that agricultural research done in one country may have international application and may serve useful to other countries as well. The technology researched and developed in the IARCS (i.e. IRRI, CYMMMT) are channeled through the NARCs for adoption and transfer of the appropriate technology to the local farm producers. Rice technology developed at IRRI for example is disseminated to Filipino farmers in coordination with PhilRice, a NARC.

The increasing demand for agricultural products can not be answered anymore by enlargement of the acreage for cultivation. Rather needs have to be met by increases in yield or better post harvest to reduce losses and wastages. Yield growth has been attributed to a large extent to genetic improvements in crop varieties and animal breeds as well as better management practices, irrigation, increased use of fertilizers and other chemicals. It is thus important to strengthen technology transfer to improve production capacity, increased food variety, quality and security and at the same time achieve a balanced between agricultural development, resource utilization and conservation (16). Agricultural production intensification however can have negative impacts (3). For example intensive agricultural production can be detrimental to the environment through deforestation, soil nutrient depletion, chemical pollution and loss of genetic diversity. With intensification of agriculture in Asia and the environmental problems that this brings, there is now a shift in thinking on how technology transfer has to be done. Hence care has to be taken that sustainability of agricultural production is upheld during technology transfer. One simple step towards this direction is the training and education of the participants to promote and utilize ecologically sound and sustainable agriculture. Moreover, the government has to provide the leadership in institutional adjustments, research, education and capacity building, information dissemination, regulations, etc.

Concluding Note

In spite of the rapid industrial restructuring in Asia, the agribusiness sector, especially the farming sector, is still an important source of growth for the local economy. The role of the small farmers as providers of food can not be ignored. With this important task and the risk they are faced with due to the nature of agricultural production, the farmers are at the heart of programs the aims of which
are to increase productivity, improve income distribution and the standard of living of the people in the countryside where majority of the population in Asia still reside. One of the more important programs to attain this development goal is technology transfer. The stakeholders involved in this process are the local policy makers and politicians, fund providers, technology generators, adoption facilitators, and the users. Different modes of transfers are used by the facilitators in Asia such as training programs and workshops, demonstration farms, field visits, leaflets, farmers discussions, contract growing, mass media, etc.

To enhance the flow of technology though there are enabling externalities that include government coordination as far as prices and infrastructure development are concerned, credit as well as education and training of some of the participants. In the past decade there has been a paradigm shift from the traditional to the participatory concept of technology transfer. Technology transfer has to be more responsive to the needs of the small producers so their reactions and participation are very important to consider. There has be strong linkages and forward and backward feedbacks between the institutions involved in the technology generation and dissemination aspects. The adoption and diffusion of alternative technology by the farmer though depend on its technical, economic and social feasibility. Traditionally in line with the rural development program of many governments in Asia technology transfer is a function of the public sector. However due to many constraints, the role of disseminating technology to the farmers has been to some extent taken over by farmers themselves or by the private sector. In some countries like the Philippines and Indonesia, local governments have been empowered to do technology transfer role. Decentralization of technology transfer was conceived on the basis that those at the local level know best the local needs thus they can be more responsive to the needs and at the same time accountable to the farmers. Now there exists a global network system whereby international research institutions all over the world are linked internationally and researches done elsewhere can have international application in other countries. In this respect the NARCs have to serve as the conduit for the adoption and transfer of the appropriate technology to the local farmers. With limited land for expansion, intensive agricultural production can be detrimental to the environment thus sustainability of agricultural production, resource conservation and environmental protection should be upheld during technology transfer.
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