CHAPTER 3

LITERATURE REVIEW

3.1 Agricultural system, tea system and key factors affecting yield

Production system includes components for yielding production, and having close relationships to around environment and heavily relied on climatic and natural conditions. It also is defined as reality has boundary, and consists of components, hierarchy, response feedback, and a process of transforming inputs to outputs (Dillon, 1990). Its inputs such as social, biological factors are transformed to biomass, yield and information. The system has properties including productivity, sustainability, stability, equitability, and can be studied by Farming System Research Approach (FSRA) (Conway, 1986). System properties can be measured by quantitative and qualitative index based on criteria such as productivity measured by crop yield per land area, stability is commonly measured by coefficient of variation (CV), and sustainability is measured by some criteria through years.

Generally, the process of transforming from inputs used to output is expressed by production function in agriculture. The relationship between physical quantities of crop production grown and set of inputs used to produce the crop under consideration by,

$$Y = f\ (X_1, X_2, \ldots, X_n) \qquad \ldots\ldots\ (1)$$

Where Y physical amount of crop, X_1, X_2,.., X_n quantities of respective inputs for producing a given amount of products (Ismail, 1998). Variables entered into model would be appropriate if factors are expressed strict relationships and emphasized inputs and output relation. Some key factors affecting yield but not controlled by farmers are so -called as exogenous variables. For instance, in tea production system, its output can be influenced by many factors, i.e., density of tea bush, shading trees, climate conditions, geographical location etc. In reality, tea is planted monotonously and intercropped with other forestry trees; this can contribute into protecting environment in terms of anti-erosion. Moreover, tea intercropped with shade plants has shown that its yield can be improved considerably (ADB, 1997). In China, perception of tea intercropped with shading trees was developed in 1980s. Shading trees were forestry and fruit trees. The results reported that tea with 50% shading tree had higher productivity than tea with 15% shading tree (Huang *et al.*, 2000). High productivity of tea can be obtained in appropriate conditions, i.e., plant density. Density may be ranged from 9,000 – 12,000 bushes per ha in Sri Lanka. Moreover, yield of tea is often affected by many other factors such as climatic conditions (temperature, rainfall, sunshine, drought, and frost), soil types, topographical location, and farm practices (Hans-Joachim, 1989). Other key factors or variables as inputs such as fertilizers, labors can be studied and put into the modeling. Fertilization was considered as input factor to produce the output, or conventional materials for production. Relationship between the yield and fertilizers has been studied by quantitative studies based on conducting the experiments concerning fertilizer application. It was found that there was clear relationship among fertilizers, i.e., nitrogen, potassium, phosphate rock, and yield of fresh tea (Eden, 1964).

Social factors can contribute in raising indirectly the yield; for instance, better education can improve farm management and raise technical and allocative efficiency of the individual, and education represented by number of years attaining school is used as proxy of potential productivity of the individual. An age is also used as measurement of experience (Abdulai and Refini, 2000).

3.2 Studies related to conventional and organic tea

Tea is planted in countries in Asia, in which Vietnam is one of the countries. Its productivity related closely to climatic and environmental conditions elevation, temperature, soil fertility, farm practices of farmers (Eden, 1964), however, is the highest when tea is adaptable to high elevation areas where appropriate temperature and rainfall (Kham and Hiep, 1996). Thus, some regions in Vietnam are considered to be ideal places where tea is grown dramatically, of which, the North Mountainous and Mid-hill regions are apparent to have most potential. As regards tea production, tea farmers completely manage and control, but in marketing, they sometimes sell tea products hardly and at low prices, though trade companies and tea corporations export most tea products. Vietnamese tea prices are also relied heavily on world tea price.

Organic farming is new trend which is appeared in recent years, firstly, it comes from developed countries, mainly European countries, next it expanded into Asia countries, India, Thailand, Vietnam. Organic farming can be carried out for many crops, as German Technical Cooperation having all organic farming guidelines for 11 major tropical crops such as rice, fruit, pineapple, tea, etc. (German Technical Cooperation, 1999). Detail guidelines are considerably easy for farmers to carry out in practice.

Characteristics of organic farming include: protecting the long term fertility of soils by maintaining organic matter levels, fostering soil biological activity and careful mechanical intervention; use of legumes and biological nitrogen fixation, as well as recycling of organic materials including crop residues and livestock wastes; careful attention to the impact of farming system on the wider environment and the conservation of wildlife and natural habitats etc. (Lampkin and Padel, 1994).

Organic farming in general as organic tea in particular need to be certificate on products by some quality certifying organizations, i.e., ACT of Thailand. In Vietnam, at present, tea farms certified as organic tea farms has given the organic tea certification by ACT (Thailand) for its tea products (Hoa, 2002). Organic tea probably is developed in Mountainous and Mid-hill regions due to tea farmers have qualification and skills in tea production better than other tea production regions. Organic farming often require skill of farmers in production and need to have appropriate support and assistances from government and related organizations. Operation of organic system is more difficult than other conventional production system due to it not use any synthetic chemical fertilizer and pesticides, tea yield may be less 5 -10% than one in conventional tea garden, but it is required more labor, i.e., man-days for maintenance namely weed control and pest prevention, and having measures to not allow pollution chemical residues from other neighbor systems, i.e., conventional tea, fruit crop, rice, etc.

3.3 System properties and sustainability development

Sustainability, sustainable farming systems and sustainable agriculture have been defined in quite a number of ways and on various levels. Three dimensions commonly referred to are ecological, economic and social in character. The definitions suggested by Conway (1987) offer a good conceptual base. According to this author, an agro ecosystem's performance can be defined with respect to four goals: productivity, stability, sustainability and equitability. Productivity is defined as the output of valued product per unit of resource input; stability is defined as the constancy of productivity in the face of disturbing forces that arise from normal fluctuations and cycles in the environment; sustainability is defined as the ability of an agro ecosystem to maintain productivity when subject to stress or shock; and finally, equitability is defined as the evenness of the distribution of the agro ecosystem's productivity among the human beneficiaries. All four concepts can be seen as reflecting the wider dimensions of sustainable farming systems.

Conway's definition has been expanded in scope, using a wider definition of farming-system properties by McConnell and Dillon (FAO, 1997), which includes: productivity, profitability, stability, diversity, flexibility, time-dispersion, sustainability, complementarity and environmental compatibility.

This wider definition of properties was found to reflect the various dimensions of sustainability even better than Conway's previous definition. Conway's inclusion of equitability is, however, appropriate for the review and should be added to the list above as the ninth criterion.

Agriculture is a complex of processes taking place within biophysical, socio-economic and political constraints, which control the sustainability of the farming activities (Yunlong and Smit, 1994). The concept of sustainable agriculture combines characteristics such as long-term maintenance of natural systems, optimal production with minimum input, adequate income per farming unit, fulfillment of basic food needs, and provision for the demands and necessities of rural families and communities (Brown *et al*., 1987). All definitions of sustainable agriculture promote environmental, economic and social harmony in an effort to attain the meaning of sustainability. The most relevant issue today is to design suitable technologies, as well as compatible strategies from the social, economic and ecological viewpoints that will bring about the necessary behavioral changes to achieve the objectives of sustainable agriculture. Sustainability is a concept and cannot be measured directly. Appropriate indicators must be selected to determine levels and duration of sustainability (Zinck and Farshad, 1995). An indicator of sustainability is a variable that allows describing and monitoring the processes, states and tendencies of systems at the farm, regional, national or worldwide levels. An indicator of sustainability must be sensitive to temporal and spatial changes, predictable, measurable and interactive (Liverman *et al*., 1988). Munasinghe and McNeely (1995) reported as important indicators the index of biophysical sustainability, soil and water conservation, efficiency of fertilizer use, efficiency of energy use, and productive permanence of the forest. Ramakrishnan (1995) included management practices, biodiversity and nutrient cycle. Harrington *et al*. (1995) distinguished between quantitative and qualitative indicators, with attention to processes, states or tendencies associated with sustainability. According to Smyth and Dumanski (1993), good indicators are measurable and quantifiable environmental statistics that measure or reflect environmental status or change in condition. In the present study, the concept of indicator was extended to system statistics that measure or reflect system status or change in condition, with emphasis on the national agricultural systems.

Indicators are selected on the basis of diagnostic criteria that permit the discrimination of factors, causes and effects controlling a system. The definition of criteria may be broadened to standards or rules that govern judgments on system condition, instead of only environmental condition. Agricultural systems can be analyzed at various hierarchical levels. For land evaluation and farming systems analysis, FAO (1992) distinguishes: cropping systems, farm systems, sub-regional systems, regional systems and national systems. Weterings and Opschoor (1994) consider geographical domains of sustainability and include continental and global levels.

Equitability can be used as an indicator of agro ecosystem performance that incorporates the social dimension. Social equity is a measure of the degree in which resources and products of a production system are equally distributed throughout the human population. This implies that equality of product availability (output) and equality of resource availability (inputs) are the preferred norm.

3.4 Previous studies related to technical efficiency

Stochastic frontier approach has been applied to study the productivity by many authors. Agner, Lovell and Schmidt (1977) employed stochastic frontier production model with basic data on the US primary metals industry (including 28 states) and US agricultural data of six years and the 48 co-terminous states. The results reveal that stochastic frontier was not significantly different from the average response function. Huang and Bagi (1984) used translog production function to examine technical efficiency of a sample of 151 farms in the Punjab and Hariana states of India by maximum likelihood estimation. The study showed that an average technical efficiency level close to 90%, while the performance of small farms vis-à-vis large farms was almost equal.

Bravo-Ureta (1986) estimated technical efficiency of dairy farms in New England region of the US using Cobb-Douglas frontier production function. He obtained technical efficiency ranged from 0.50 to 1.00, with mean technical efficiency of 0.82. The author concluded that technical efficiency of individual farms was statistically independent of size of the dairy farms as measured by the number of cows.

Kalirajan and Shand (1986) investigated the technical efficiency of rice farmers within and without the Kemubu Irrigation Project in Malaysia during 1980. Given the specifications of a translog stochastic frontier production function of the output of the rice farmers, the Cobb-Douglas model was not an adequate representation of the data. Maximum likelihood methods were used for estimation of the parameters of the models and the frontiers for the two groups of farmers were significantly different. They reported that the individual technical efficiencies ranged from about 0.4 to 0.9, such that the efficiencies for those outside the Kemubu Irrigation project were slightly narrower. They concluded that their results indicated that the introduction of new technology for farmers does not necessarily result in significantly increased technical efficiencies over those for traditional farmers.

Kalirajan (1991) used Cobb -Douglas production frontier to estimate technical efficiency for a random sample of farms located in the state of Tamil Nadu, India using maximum likelihood estimation (MLE). The study showed that management practices and contacts with local extension agents had a significant positive impact on technical efficiency.

Sriboonchitta and Wiboonpongse (2001) use stochastic frontier production model to study comparatively factors effecting on jasmine and non-jasmine rice in Thailand. The results indicated that crucial factors influencing jasmine rice yield are chemical fertilizer, labor, irrigation, severe drought and neck blast whereas those for non-jasmine rice are the same except labor and neck blast. Wilson *et al.* (2001) study technical efficiency of wheat farms in Eastern England, which is measured through the estimation of a stochastic frontier production function using data for the 1993 - 1997 crop years. The technical efficiency index across production units ranged from 62 % to 98 %.

Basnayake and Gunaratne (2002) using stochastic frontier production function in two forms of logarithm and translog to estimate technical efficiency and its determinants for 60 tea small farms in Sri Lanka using MLE and OLS. Average technical efficiency of tea farms was found to be 64.60%. Variables used in the stochastic frontier model are land, family labor, hired labor, fertilizer, chemical, dolomite and suggested variables in inefficient model were age of farmer, experience, education, dummies of occupation, clone, type of crop.

Rauzah (2002) using stochastic frontier production function to determine technical efficiency among manufactured industry in Malaysia with panel data of 29 manufactured sub-sectors. The results shown that technical efficiencies range from the lowest value 0.251 to the highest value of 0.972 during 1985 - 1986, detailed that found that petroleum and refineries sector had highest technical efficiency and wearing apparel sector had the lowest technical efficiency.

3.5 Comparison between conventional and organic systems

Comparing organic farming against existing conventional systems, is the one most frequently adopted by researchers and institutions new to the organic farming concept. Researchers may be seeking to establish that there are no (or negligible) differences between organic and conventional systems (Council for Agriculture Science and Technology, 1980; Buttel *et al*., 1985).

Comparison of farming system is an area of research that is problematic even in situations where the results are not likely to controversial. Problems may arise due to definitions, the objectives and design of the study, method and standards used for comparison, and the need to isolate factors that affect performance but are not necessary related to the systems being compared (Koeft, 1983).

Some organic versus conventional farm comparisons have considered yield (Berardi, 1978; Lockeretz *et al.*, 1981), energy efficiency (Bujáki *et al.*, 1995), and environmental impact (Teague *et al.*, 1995; Carriker, 1995). However, most work has focused upon economic factors. Lee (1992) neatly divides such comparisons into farm surveys, field studies and case studies.

Several organic versus conventional farm type comparison methodologies have been used, which are sample-groups, matched pairs, and clustered groups. For sample-groups comparisons, simple enterprise gross margin (Reganold, 1995; Cook *et al*., 1996) or net farm income (Ogini *et al*., 1999) have been measured, and other similar work reviewed by Roberts and Swinton (1996). For the latter, more sophisticated mathematical techniques such as linear and dynamic programming have been used but the majority of authors have utilized enterprise budgets. Two matched pairs farm type comparisons are shown by Klepper *et al*. (1977) and Shearer *et al.* (1981), both of which compare economic performance as gross margins. The clustered groups methodology has been used extensively in the social sciences as a means of deriving groups of similar phenomena having a number of different characteristics and has been used in studying whole-farm incomes of dairy farms in conversion to organic production (Haggar and Padel, 1996) and organic farm incomes (Fowler *et* al., 1998; Fowler *et a*l., 2000). There is a wide range of sample-grouped studies, ranging up to examples such as Ogini *et a*l., (1999) who compared eight organic with 120 conventional dairy farms. However, data from such studies need to be interpreted cautiously: (1) are similar numbers of farms assessed for each system-type? If not, as for Ogini *et a*l., (1999) above, the risk is that anomalous farms in the smaller group will distort the comparison; (2) are the background characteristics similar for the SG of farms studied (soil type, slope, land use history etc.)? Major differences will tend to confound any valid comparisons between sample groups. A study by Bender (2001), who compared traditional Amish and conventional farms, clearly showed that they could be separated more by their geological history (glaciated being more fertile than non-glaciated) than by farm-type. By contrast, matched-pairs help to overcome major differences in background characteristics and also lend themselves to multivariate statistics, such as canonical discriminant analysis (Armstrong Brown *et al.*, 2000). Some matched-paired comparisons, which have reported on just one pair, can also be very helpful (e.g. Davies *et al.*, 1995). Overall, the judicious choice of farms means that matched-paired studies can be a worthwhile means of comparison and this methodology deserves greater use in future. The clustered group method allows comparisons on 'non-system determined' factors and has the advantages over matched pairs in that specific circumstances of individual conventional farms do not distort the comparison.

Several studies focused on economic and financial comparison between conventional and organic. Lisa (2002) studied on an economic comparison of organic and conventional dairy production, and estimations on the cost of transitioning to organic production. It reported that total cash receipts for each operation were the same, but the overall expenses were higher for the conventional farms. Net farm income, once family living and Income taxes and depreciation were accounted for, showed a 45% difference in net earnings on a per cow basis. The average organic operation earned US$477 per cow while each conventional herd netted US$255 per cow. Kathleen *et al.* (1998) conducted comparison of organic and conventional corn, soybean, alfalfa, oats, and rye crops at the Neely-Kinyon Long-Term Agro ecological Research (LTAR) site. They examined the agronomic and economic performance of conventional and organic systems, using required practices for certified organic production, and indicated that cost per acre were the same but the premium prices of the organic products make the system profit per acre of organic was higher than conventional (US$744 per acre in compared with US$203.02). De Boer (2002) compared two production systems, organic and conventional, in term of environmental impact of conventional and organic milk production using life cycle assessment (LCA) method. Milk produced per ha on organic farms is only 70% to 80% of that on similar conventional farms. Budgeted direct costs were lower whilst fixed costs were higher whilst results from a small sample of organic dairy farms showed both lower direct and fixed costs. The price premium for organic milk is critical as without this organic milk production would be less profitable than conventional milk.

Liam (2002) reported that the net margin from organic cattle production was higher in both the budgeted scenarios and from actual farm data. Direct costs were considerably lower on organic farms with fixed costs slightly higher. Higher sale prices combined with additional organic REPS payments compensated for lower physical output per ha. The net margin from organic sheep production was 7% higher than conventional lamb production. Direct production costs were higher on the organic farms with fixed costs lower, which was the converse of cattle production. Organic cereal producers receive 60% higher prices for their produce than their conventional counterparts. Total costs of production are lower on organic tillage farms. The net margin per ha for organic cereals was estimated to be 25% higher for winter wheat and over 80% higher for spring barley. However these margins assume a high level of technical performance on organic farms coupled with a premium farm gate price and an additional €93 per ha REPS payment.