Chapter II Literature Review

2.1 Participatory approach in agricultural development

Agricultural institutions in the past have long relies mainly on the formal survey and quick rural visits to gather information on rural and resources. Samples of people selected from large population were asked using the same set of question. Research planning in local areas was set up based on the resulting data analysis. However, there were problems with questionnaire survey that question designers couldn't know which issues were important for local peoples so the important issues easily were removed or ignored (Pretty *et al*., 1997) that was the major limitation of question survey and results brought usually not satisfy as expectation.

In order to overcome these limitations, the development of participatory approach since 1970s has benchmarked in improving the approaching methods in rural development. In recent years, an increasing number of rural development and research project has applied the participatory approaches in analysis and evaluation the current problems within community. Results of these projects showed that the participation of local peoples is one of critical component of success in agricultural sector (World Bank,. 1994)

2.1.1 Participation concepts

Since the late 1970s, there has been a range of interpretation of the meaning of participation in development (Chamber., 1997). However, the meaning of participatory depends on particular context that has the way for interpretation.

With regard to rural development … participation includes people's involvement in decision-making process, in implementing program, their sharing in the benefit of development programs and their involvement in efforts to evaluate such programs (Cohen and Uphoff, 1997).

'Participation is a process through which stakeholders influence and share control over development initiatives and the decisions and resources which affect them.' (World Bank, 1994)

Cooperation of farmer in the implementation of the extension program by attending extension meeting, demonstrating new methods on their farm, asking their extension agent question etc (Van Den Ban *et al*., 1996)

Farmer participatory research has been defined as the collaboration of farmer and scientist in agricultural research and development (Bently., 1992)

Thus, participation is considered as a process whereby local people collaborate with external agencies and themselves to solve problems within community.

2.1.2 Participation in agriculture and PRA approaches

There are many types of participation in terms of operation, such as Farmer Participatory Research (FPR), Participatory Action Research (PAR), Participatory Rural Appraisal (PRA), Participatory Rural Appraisal and Planning (PRAP) etc have been widely applied in agricultural development. However, choosing the appropriate method to apply in particular situation, the surveyors should consider before implementation.

The Participatory Rural Appraisal (PRA) is considered as the effective way to address rural problems thank to its powers. The PRA consists of a series approaching steps to encourage and attract farmers to participate in sharing, discussing and analyzing the problems base on their perceptions. Moreover, PRA assists farmer to set up plans and to solve the local problems by themselves.

In terms of extension activity, “participation” has been used to justify the extension of stage control and to build local capacity and self-reliance; it has been used for data collection and interactive analysis. Participation often encourages local people to involve in analysis process and find out the problems and solutions within community. Moreover, participation encourages local people to sell their labor in return for food, cash and materials (Pretty., 1997)

Today, Participatory method likes Participatory Rural Appraisal (PRA) is a popular method used by agricultural researchers. Neubert. (2000), PRA are the tools for the short-term involvement of local peoples in a process of information gathering, analysis and probably planning for the community development strategies.

Loader *et al.* (1999) used PRA technique in assessing farmers' priorities and preferences in rice variety choices in Nepal. The tools were employed in assessing process including ranking, scoring matrix, paired comparison and informal question. The key performances in analyzing were group discussion and scoring computation. Finally, the favorable rice varieties were selected by the utility value of those factors, such as yield volume, taste, straw length, maturity and threshing.

To find out the solutions and increase the benefit of farm level, Dorward *et al.* (2001) introduced the Participatory Farm Management Method to assess the suitability of technologies for tomato production in Ghana. The conceptual framework for the whole process consisted of three steps: needs assessment, experimentation and dissemination. In the first step, needs assessment the constraints to crop yield were identified and analyzed by Causal diagram that helped to examine in detail the causes and effects of problems as well as the root causes that need to be address through research action. After that, the constraints were ranked to define the relative importance of each constraint, the ranking procedure was done by using scoring and ranking method that were commonly used in PRA workshop. Finally, the solutions were suggested for solving existing problems.

Agricultural extension works with participatory approach. Percy. (1999) incorporated the gender analysis and participatory approach in assessing the current debate in Ethopia. The purposes of case study to identify the constraints in agricultural sector and to build the capacity of project staffs and local peoples. In this case study, the PRA tools were employed to explore the resource and constraints in community. Firstly, the community resources were overviewed by transect walk and resource maps. Seasonal calendar was be used to describe the activities of clients groups in over time. Finally, voting and ranking were used to prioritize the constraints. The result of the case study showed that the participatory approach successfully fulfilled the project objectives through making the constraint picture of community by local peoples including man and women, old and young peoples.

Referring to agro-ecosystem evaluation in developing countries, Goma *et al* (2001) used bottom up participatory to evaluate the farmer practices and constraints in three projects. The first study related to the decline in soil fertility in the northern of Zambia. The second study related to new rice farming technologies in Bangladesh and the third study involved in tree species biodiversity in the Budongo forest in Uganda. The results indicated that interaction between local knowledge and scientific ideas has more effectiveness in developing indicators for soil classification in Zambia. With new rice farming technologies in Bangladesh, under participatory process farmers found out the main problems involved in rice production, such as poor soil fertility, weed infestation, high cost of chemical fertilizers. Finally, suggested solutions were set up for each problem. Similar with pervious results in Uganda, the participatory approaches have help local peoples coming up with agreements in preserving biodiversity in their forest.

In Vietnam, since 1997, the participatory approach was been applied in extension operation and the series of rural development projects, such as the Upland Program 2000-2001period, Social Forestry project, Sida project and the Poverty Reduction project of Vietnam. The results of these projects showed that the success in implementing projects depended much on the advantage of the participatory methods. The most important thing of participatory approaches is which has encouraged local people involving in solving agricultural problems and overcome the limitations of the conventional approach " top-down approach".

Phu. (2001) used the participatory approach in farming system analysis to identify the constraints that affected crop productivity in the rainfed area. The result of this study showed that the constraints, such as soil erosion and degradation, lack of water resource and traditional practices were strongly affected crop yield. Beside that, the farmers with poor knowledge and low education level also impacted to productive performance at the farm level. Finally, the solution for each constraint was assigned under farmers' consideration.

To identify the constraints and develop the research strategies for agriculture and forest sectors in the upland area of the north Vietnam, Trung. (2001) used the participatory approach for implementing in the whole stages of project. The achievements from project indicated that participatory approach not only identified constraints and topics researches in the future, but also encouraged farmers to directly involve in planning and implementing these researches in their farms. Moreover, the long- term benefits of this, local peoples can organize by themselves in using and managing land and protecting forest resource.

In order to strengthen the farmer capacity in land use and natural resources management, Tam *et al*. (2000) applied participatory approach in land evaluation and land use planning for paddy rice in Hoa Binh province in the northern of Vietnam. The research process included three steps, the firstly, PRA workshop was organized to develop the criteria for land evaluation process, such as soil depth, soil color, irrigated potential etc and then the field walk also undertaken by study team and local peoples. Secondly, farmer group discussion was organized to assign score for each criteria. Thirdly, the land suitability classes were classified based on overall score in the evaluated matrix. Finally, the result of land evaluation was used to suggest fertilizer use for paddy rice in different land types. The result also reported that the rice yield had increased from 15 to 20 percent thank to result of land evaluation.

2.1.3 Participatory method for identifying the constraints to maize production and dissemination of the new technologies

Participatory method that enable agricultural scientists and farmers working together for garthering and analyzing data to solve agricultural problems. In this progress, farmers' perception and their participation level are considered very important aspects, because that directly involve in sharing information and decision choice (Bellon., 2001).

Participatory approach has been worked well at the household and community level in terms of analysis and evaluation of maize production system. CYMMIT has incorporated participatory approaches into many projects related to maize development. The Oxaca project named " Conserving Maize Diversity", the Chiapas project " Linking Farmers' Local knowledge and Crop Management Decisions in Mexico", and the Chihota project " Improve Soil Fertility" in Zimbabwe," (Bellon., 2001). In these projects, the participatory approach has applied to diagnose the farmer's condition and evaluate the impact of factors to maize yield. In the Oxaca project, the core activities in the diagnosis component were field walk and group discussion. Researchers set up the hypothesis about the problems that farmers faced. Those problems were expressed in a causal diagram that provided a model of how the different factors interacted to maize yield through a brain storming exercise. In addition, the calendar of activities was developed for solving problems through listing all activities with time dimension for each types activity within growing season.

In the Chihota project " Improve Soil Fertility" the soil and crop taxonomy were done by farmers through developing criteria and describing the characteristics to determine the advantages and disadvantages of each soil type. From that, possible solutions to improve soil fertility for maize production were set up. The results from these projects showed that more sustainable and profitable yield from cropping systems through improved soil fertility technology was obtained thank to participatory approach (Bellon., 2001)

In order to find out the production potential, constraints, needs and alternatives for maize growers in the marginal areas of Thailand, Ekasingh *et al.* (2001) used the Rural Rapid Appraisal (RRA) and PRA method to collect data and analyse the effect of constraints to maize production. The result showed that the low output price, high production cost, labor scarcity, drought, and soil erosion were constraints affected maize production in the study sites. The research results also showed that the alternatives should be reminded to improve maize production consisted of choosing appropriate varieties, land conservation, planting method, fertilizer application and improve extension service.

In Vietnam, Thao *et al*. (2001) conducted a survey to evaluate the maize production situation in the northern of Vietnam. The PRA techniques were used to identify the potentials and problems that maize growers faced with. The tools used in analysis and evaluation consisted of resource map, transect, Venn diagram, semi-structure interview, matrix analysis and ranking. The result of survey showed that the local conditions (climatic condition, soil etc.) were suitable for maize production. In contrast, farmers in the upland area also faced with major problems, such as soil erosion, disease, and nutrient imbalance and other technical constraints that made the maize yield reduction and these factors have been directly affected maize.

Overall, participatory approach is considered as a good way to bring all participants come together and get an agreement for future development. Moreover, it could accomplish the aims of development projects more efficiently, effectively and cheaply.

2.2 Quantitative assessment in agriculture

Primarily, econometrics was mostly used in economic sector (Damodar., 1998). Now day, it has developed beyond in many other sectors, such as social, biological and agricultural sector (Thieu *et al*., 1998).

A production function, in agriculture generally, is a bio-physical concept which could indicate the relationship between the physical quantities of a crop grown and the set of inputs used to produce the crop under consideration.

The development of production functions is very important, especially in agricultural sector, because agricultural production depends significantly upon climactic or environmental factors or both. Agricultural production in developing countries, application of new and improved farming techniques, such as irrigation, fertilizers use, new variety etc has been lacking is popularity. Therefore, development production functions would permit agronomists either supply inputs for agricultural sector or handles agri-cultural crop, to adjust their production capacities. Moreover, production functions can be significant reference or planning tools for producers and policy makers for their ex ante and ex post decision making process in establishing, directing and setting necessary control in agricultural sector.

In agriculture, quantitative assessment mostly used in measuring the effect of input factors on output. The basic function form was employed is production function (Cobb-Douglas production function). The coefficients obtained after estimation could be positive or negative, the sign of coefficients is considered as critical points to suggest the alternatives for output management.

To manage the pesticide use for rice in Thai land, Praneetvatakul *et al.* (2002) quantify the amount of pesticide for rice by Cobb-Douglas production function. The production inputs consisted of seed, fertilizers, labor and pesticide. The result found that pesticide was overused in rice cultivation. It provided a good base for policy maker to make adjustments in pesticides use for rice in the future.

Exploring farmer practices in terms of fertilizer use for rice in the northern of Vietnam, Hien. (1998) used the production function to evaluate the effect of input factors on the rice yield,. The result of model informed that most of rice growers underused in fertilizer application. It implied that in order to increase the rice yield, farmer should invest more fertilizer for rice. In addition, the dummy variables, such as low education, low soil fertile, which have effected to rice yield follow the negative side.

Chinh. (2001) measured the technical efficiency of maize production in Red River Delta by Cobb-Douglas production function. The quantitative variables in model included nitrogen, phosphorous, potassium and labor. The dummy variables consisted of soil quality, varieties, education etc also entered in the model. The report noticed that the coefficients of nutrient application variables were positive values. It means that fertilizers used for maize were not yet get optimum level in the farmer practices and maize yield could increase when farmer increase fertilizers use. The dummy variable for education and hybrid variety were positive value, it noted that the education and hybrid variety were considered as the important factors in increasing the overall output of 11.2 percent and of 17.6 percent, respectively. The dummy variable for soil quality also has positive value, it emphasized that the maize yield would be increased about 19.0 percent of yield if maize were grown in the good soil instead of maize grow in the bad soil quality.

Examining the total production of wheat in the South-eastern region in Turkey, Ozsabuncuoglu *et al*. (1998) constructed production functions in different form, multiple-linear form, quadratic form and Cobb-Douglas production function form to evaluate the factor control that effected on the wheat yield, such as precipitations, irrigation, growing periods, sowing period temperature index, nitrogen, phosphorous and farm size. In evaluation, the result of models noted that irrigation in growing periods would be extremely value for increasing wheat productivity. Moreover, other factors, such as nitrogen and phosphorus significantly contributed to yield increase and the rest of factors, such as temperature index, growing and sowing period were non- significantly in terms of increasing yield.

One an attractive method was applied by (De Bie,:online) to quantify the yield gap due to yield reduction constraints is " Comparative Performance analysis (CPA)". Author has used data set from survey and constructed production function to quantify the sticky-rice yield gap due to yield constraints under impact of them to rice growth in growing season. The yield loss due to each factor constraint was quantified through the coefficients of production function and input data set, such as the average inputs used between the farmer practice and the best farms. Consequently, the model indicated the contribution of particular constraint to the overall yield gap.

2.3 Maize production system in developping countries

There are 140 million ha of maize grown globally, approximately 96 million ha are in developing countries. Four countries acount for more than half (53.6 percent) of the developping world's maize area: China, 26 milliom ha, Bazazil 12 million ha, Mexico 7.5 million ha and India 6 million ha. Although 68 percent of global maize area is grown in the developping countries, only 46 percent of the world's maize product of 600 million tons of maize in 1999 was produced, there due to low avarage yield in the developping countries. The average of maize yield in the industrialized countries was more than 8.0 tons per hectare while it was slightly less than 3 tons per hectare in the developing countries (Pingali *et al*,: Online)

In developing countries, maize is produced in the both temperature and tropical regions. There are 25 million ha (25 percent) of maize area in developing countries was grown in the temperature regions, most of which were found in China and Argentine. There are 70 million ha of maize produced in tropical regions, of which about 65 percent was grown in the tropical lowland, 26 percent in subtropical, and 9 percent in tropical highland (Pingali *et al*,: Online)

The vast majority of tropical maize was grown to meet subsistences requirement and had a little or poor access to improve technologies. There were less than 50 percent of tropical maize area planted with improved seed (hybrids or OPVs), the rest of area was planted with the "local" or "traditional" varieties so that the yield obtained in this region was quite low, which varied 3.0 tons per hectare. Recent years, because genetic improvements in tropical maize have resulted in significant shifts in the yield frontier, the yield can be increase around 5 tons per hectare for tropical lowland and the highland, and 8-10 tons per hectare for the subtropical regions (Pingali *et al*,: Online)

2.4 Constraints to maize production in tropical maize system

Research on maize and strategy for improve maize yield has been covered by CYMMIT network in the global scale. Agronomists working with maize have emphasized that there are two types of the constraints that usually involved in maize production consists of the abiotic and biotic constraint. These constraints were not only affected the maize area, but also affected total grain production in the global scale.

2.4.1 The abiotic constraints

Drought: all most of tropical maize area was produced under the rainfed condition, area where drought is considered to be the most important abiotic constraint to production. Edmeades *et al*. (1996) estimated that the effect of drought on maize production in the early 1990s across tropical environments about 19 million tons, it equalled to 15 percent of total yield loss. At that time, in Asia countries account for 7.82 million ha have affected by drought and total grain production lost about 4.0 million tons. In which, India registered the highest absolute area effected, 2.5 million ha and yield loss 1.25 million tons, follow by Indonesia and South of China with 2.2 and 1.15 million ha, and grain loss 0.85 and 1.43 million tons respectively. Vietnam has 0.12 million ha (24 percent) that are affected and grain loss 0.47 million tons by drought stress (Logrono *et al*., 1996)

Low soil fertility: The low soil fertility, low nitrogen is second abiotic constraints to maize production. Intensified land use and short fallow periods, coupled with the expending of agriculture into marginal land, which have contributed to a rapid decline in soil fertility and nitrogen content in the soil. The nitrogen deficiency directly affected the maize productivity for both yield and area. Logrono *et al*. (1996) estimated that in Asia countries have 8.39 million ha were affected by low nitrogen and yield loss was about 29 percent, equal to 8.6 million tons of maize, in which India have 3.0 million ha and yield loss 50 percent, equals to 4.5 million tons of grain, follow by Philippine and South of China was 1.8 million ha and 1.2 million ha and the yield loss 30 percent and 20 percent, equals to 1.23 and 1.05 million tons of grain, respectively.

Soil erosion: Inappropriate intensification of maize production system, particularly in the hillside of tropical environments, has resulted in high rate of soil erosion in many areas. Lack of investment in soil erosion control and widespread use of mechanized tillage system (including tillage with animal draft power) are most often observed in areas where population growth is rapid, right to land and land use strategy are poorly defined and farmers face an inappropriate policy environment (Pingali.: Online). The effect of soil erosion on maize yield depending on the rate of erosion; McDaniel and Hajek (1982) estimated that with slightly eroded level, the maize yield obtain was about 5.74 tons per hectare, at moderately eroded level, the maize yield was only 4.4 tons per hectare and yield reduction was 23percent. Mannering *et al*. (1985) showed that soil erosion affected the maize yield in different erosion classes in Midwest America, from none to slightly eroded level, the maize yield obtain was 7.3 tons per hectare, at moderate level, the yield obtain was 7.2 tons per hectare, but in the high erosion level, the maize yield reduced to 6.6 tons per hectare.

Lack of early maturing germplasm (seasonality) poses constraints to maize production, especially in intensive cropping system in low land. If early maturing varieties are available that allows Asia farmers to get a maize crop in addition to two crops of rice in irrigated paddy land or second crop of maize in the rain fed area. Unfortunately, early maturing maize varieties usually low yield and susceptible to many disease that reduced the growth rate of maize production in Asia countries (Beck *et al*.1996)

2.4.2 The biotic constraints

Disease has strongly affected maize yield, the *Downy mildrew* disease mainly cause by *Peronoscleronspora sorghi*, was a major disease in tropical maize. This can damage maize yield more than 80 percent of their crops depending on the infection level. The *Turcium Blight* that made yield loss from 15 to 20 percent of potential yield, the Gray leaf spot made the maize yield reduction about 30 percent of potential yield. Moreover, other diseases like *Maize Steak virus, Ban leaf and sheath blight*, and *Maize stunt* also made yield reduction from 10 to 50 percent of potential yield (Pigali *et al,:* Online).

Beside diseases, insects also always associated in maize production, the maize yield declined remarkably by insects attacking. There were many insects usually attacked in maize production system like *rootworms, armyworms, stem bores, grain borers* etc. The yield loss by insect attacking ranged from 10 to 30 percent depends on attacking levels and the particular growth stage of maize (Pingali *et al*., Online).

2.5 Maize production system in Vietnam

In Vietnam, maize is a secondary upland crop, maize production has trend to grow gradually from time to time. Especially, in the last decade of last century, the growth rate of maize was quite rapidly, the planted maize area has risen from 260,200 ha in 1961 to 389,600 ha in 1980 and 723,200 ha in 2001 (Table 1).

Before 1980, maize produced to mainly server for food demand. Especially, in mountainous regions maize was considered as a major food sources for minority peoples. From 1980-1990, maize produced for both food demand and livestock, the proportional maize used as food staff has reduced because rice could replace in that time. From 1990 up to now, maize has been mainly produced to meet the demand for of feed animal industry.

Table 1: Area planted and maize yield in Vietnam in 1961-2001 periods

Years	Area ('000.ha)	Yield (tons/ha)	Years	Area ('000.ha)	Yield (tons/ha)
1961	260.2	1.12	1982	381.4	1.15
1962	262.0	1.20	1983	378.3	1.24
1963	272.8	0.92	1984	386.5	1.38
1964	257.0	1.24	1985	397.3	1.48
1965	277.4	1.15	1986	400.9	1.42
1966	267.5	0.96	1987	405.6	1.38
1967	230.0	1.10	1988	510.5	1.60
1968	239.0	1.10	1989	509.4	1.64
1969	242.0	1.12	1990	431.8	1.55
1970	233.7	1.10	1991	447.6	1.50
1971	236.1	1.00	1992	478.0	1.56
1972	235.5	1.11	1993	496.5	1.78
1973	240.0	1.25	1994	534.7	2.14
1974	250.0	1.26	1995	556.8	2.20
1975	267.0	1.05	1996	615.2	2.50
1976	336.6	1.15	1997	662.9	2.49
1977	402.9	1.00	1998	649.7	2.51
1978	392.5	1.10	1999	689.9	2.55
1979	374.6	0.99	2000	714.0	2.70
1980	389.6	1.10	2001	723.2	2.90
1981	384.6	1.11	2002	Na	Na

Source: FAOSTAT, May 2002, note: Na: non- available data

At present, maize-growing area is divided into eight ecological zones. Zone I in the northeastern mountainous region have 113,000 ha of maize were grown during the spring season (January- June), zone II include provinces in the northwestern mountainous region, 43,000 ha of maize were grown in the spring-summer season (April- August), zone III Red River Delta has three different seasons supporting total of 220,000 ha. The spring season from February to June, autumn season from July to October, and winter is a main season for maize that staring from the end of September to the end of January in the next year. Zone IV in the northern-central region, 45,000 ha of maize were grown during two seasons, the winter- spring starting from November to April of the next year and the second is spring season from January/

February to May. Zone V located in the Central Highlands have 46,000 ha of maize were grown in spring-summer season from the April to August. Zone VI, Central-Coastal region produces maize about 28,000 ha during two growing seasons, the first winter-spring staring from November to April and the second spring-summer (April-August). Zone VII, the Southeastern region has 48,000 ha of maize; the growing season is spring-summer from April to August. Zone VIII Mekong River Delta has 11,000 ha of maize are grows in two seasons winter-spring starting from November and harvesting at April of the next year, and the spring-summer from April to August (Tinh., 1996).

In recently, maize production in Vietnam increase the both area and yield remarkably that thank to the hybrid maize program. In 1990, total corm area was planted 431,800 ha of maize, the hybrid maize area occupied 0 percent, the average yield 1.5 tons per hectare. In 1997, there were 662,900 ha maize were planted, the hybrid area occupied 43 percent and the average yield up to 2.49 tons per hectare. Estimation for maize production in 2000-2005 period, total maize area approximate about 800,000 ha, in which the hybrid maize area would be increased up to 70- 80 percent of total maize area (Uy., 1998).

Although hybrid maize area expanded rapidly and covered 100 percent of maize area in Red River delta and Mekong River Delta region, the hybrid maize only covered about 60-70 percent of maize area in mountainous provinces. The main reasons for this limitation is the cost of seed and chemical fertilizers are high so that farmers, especially, poor farmers not enough money to buy hybrid seed and fertilizers if government have no subsidization policies. Moreover, poor infrastructure systems in the high land area that made seed company and extension agencies could not regular access to the maize growers in the high land areas which also made the rate of development of hybrid maize was slower than the other regions.