

Chapter VI

Summery of the finding and recommendations

This chapter is allocated to present summery of the results, recommendations and limitation of the study. At the beginning overall summary of the study and summery of the result under different criteria and overall sustainability are discussed. At the end of the chapter, some recommendations based on finding and limitation of the study is presented.

6.1 Summery of the finding

Dry zone upland farmers use ground water to cultivate banana. They use two types of irrigation methods to convey water from wells to cultivate plots. Some farmers use traditional surface irrigation and some use new method; drip irrigation. Government and nongovernmental agencies try to promote drip irrigation among shallow well farmers as a water saving method. In the literature there were some comparison study surface irrigation and drip irrigation with many crops and many places in the world. But case of banana cultivation with surface irrigation and drip irrigation of dry zone upland area in Sri Lanka is still not subjected to overall comparison. Sustainability is multidiscipline concept. When use level of sustainability to compare the systems its cover most of the criteria in system performance. When one wants to popularize new technology like drip irrigation, information on overall system performance with new technology is impotent factor. Results of this type of studies can be used to clarify farmers' adoption, to justify the resource allocation for training and extension activities on drip irrigation, validate government subsidies and lone program on drip irrigation. Not only that also it is providing guideline to farmers selecting of crops for shallow wells lands. It means field studies which concerning all direct and indirect benefits are necessary to determine overall feature of the utilization

of drip irrigation and surface irrigation under banana cultivation in this area. This study tries to reduce that knowledge gap fulfilling following two objectives. Objective of the study are to find out levels of sustainability indicators on utilization of drip irrigation and surface irrigation under banana cultivation and to assess overall sustainability on utilization of drip irrigation and surface irrigation method under banana cultivation.

The study has selected nine household level sustainability indicators under three criteria: socioeconomic, agronomic and ecological criteria to assess overall sustainability in two irrigation methods under banana cultivation. Field survey was conducted to collect information on selected indicator at household level. Hundred and two household were subjected to survey to collect information. From that 48 household come under drip irrigated banana systems and 54 households come under surface irrigated banana cultivation system. Using analytical hierarchy process, weights for selected indicator were assigned at Stakeholder workshops. For that purpose, two workshops were conducted, one for surface irrigated banana stakeholder and other one for drip irrigated banana stakeholders and obtained weights for all selected indicators.

To fulfill first objective of the study independent two sample t-test was utilized to compare mean of the each indicator in two systems. To compare overall sustainability of the two irrigation methods, sustainability indexes were calculated for two systems. The household level indicator values were normalized using the empirical formula. That normalized values for individual farmers in two systems were converted to average values for the systems. Based on empirical formula that average values multiplied weights, which assigned at AHP workshops. Consequently, obtained weighted average normalized indicator values for the systems. At the end, these weighted average normalized indicator values were aggregated at system level and constructed composite sustainability indexes for two systems. These sustainability index values used to compare overall sustainability of two irrigation methods under banana cultivation. Finding of the study are elaborate under socioeconomic sustainability criteria, ecological sustainability criteria, agronomic sustainability criteria of the two systems and overall sustainability of the two systems.

6.1.1 Socioeconomic sustainability

Socioeconomic sustainability of the drip irrigated banana cultivation is higher than surface irrigated banana. It is reflected by average values of socio economic sustainability indicator of the drip irrigated banana system. Drip irrigated banana system has 595,003 rupees per hectare of net profit per year, 258 rupees per cubic meter of water productivity and the same time 0.19 of coefficient of variance of monthly income fluctuation of banana field. Nevertheless, in surface irrigated system has 179,420 rupees per hectare of net profit per year, 55 rupees per cubic meter of water productivity and 0.79 of coefficient of variance of monthly income fluctuation from banana field. Due to higher level of net profit, higher level of water productivity and lower level of income fluctuation, drip irrigated banana cultivations, socioeconomic more sustain than surface irrigated banana cultivation. Social participation of farmer is not playing vital role to determine socio economic sustainability in both drip irrigated banana and surface irrigated banana.

Net profit is higher in drip irrigated banana cultivation because of higher income and comparatively low cost than surface irrigated banana.

Drip irrigated banana give higher yield consuming low amount of water, consequently, water productivity of the drip irrigated banana is higher than surface irrigated banana. Survey results show majority of the farmers in both systems said there were no changing trends on amount of water pumped and yield from banana fields. It is imply existing water productivity of drip irrigated banana lands is stable during last five years.

Farmers who use surface irrigation to cultivate banana face higher income fluctuation through out the year. Soil moisture stress during peak drought period is considerable higher in surface irrigated lands than drip irrigated lands, because surface irrigation farmers use long irrigation interval during peak drought due to scarcity of water. Insufficient soil moisture will effect on fertilizer uptake from soil. Combined effects of lack of soil moisture and lack of fertilizer uptake yield may be reduced during drought and after drought period. In term of sustainability of ground water utilization, drip irrigated banana play vital role. Drip irrigation save ground water in significant amount. Quantity of water saving is not only effect on individual

farmer also influence on ground water balance and reduce externalities on other ground water consumers.

6.1.2 Ecological sustainability

Drip irrigated banana farmers' used 3.12 folds of total fertilizers as proportion of recommendation. In case of surface irrigated banana farmers used 5.67 total fertilizers as proportion of recommendation amounts. When consider agro chemical usage, drip irrigated banana farmers used 1.25 liters of glyphosate and surface irrigated farmers used 3.9 liters of glyphosate for weed control.

Due to low level of chemical fertilizer usage and agrochemical usage drip irrigated banana lands show higher ecological sustainability than surface irrigated banana. But soil salinity development is not significant effect in both systems.

Most of the farmers in drip irrigated banana system use fertigation unit to apply urea and MOP to their banana plantations. General fertilizer recommendation for banana is 1437 kg per hectare per year and application frequency is three times per year. Even though, drip irrigated banana farmers used some fertilizer more than recommended amount, their total fertilizer usage is less than total recommendation amount It is about 1249 kg per year and majority of the farmers use fertigation to apply urea and MOP.

Instant of using this recommendation of urea and MOP, drip irrigated banana farmers use little amount of fertilizer with higher frequency. They do not use special effort to apply fertilizer. While irrigation is done, fertilizers apply through the drip irrigation systems. When fertilizer is applied there is no soil moisture stress for banana plants. Therefore, efficiency of fertilizer uptake is going up. This type of split application of fertilizer gives good result than bulk application. Fertilizer is not remained in the soil and no extra water in the soil. Consequently, amount of leaching out of fertilizer is going down. End result is ground water and soil pollution by chemical fertilizer will going down. Therefore, low amount of fertilizer application not only give benefits for individual farmer also, it helps to protect soil and ground water ecology.

When consider country economy almost all the fertilizers are imported spending foreign exchange. So, reducing utilization of chemical fertilizer will help to save foreign exchange in the country.

In the mean time surface irrigated banana use comparatively higher amount of chemical fertilizer and higher amount of water. Surface irrigated farmers used almost all the fertilizer more than recommended amount. Therefore, total fertilizer usages in surface irrigated banana farmers are higher than recommended amount. It is about 2,366 kg per year.

They use long irrigation interval and manual fertilizer application. When they apply the fertilizer, apply as bulk than fertigation. The benefits, which can get by using fertigation, will not get by using manual fertilization. Due to using higher amount of irrigation water, fertilizer can be leaching out the root zone and can be mixed with ground water. In fact, in term of ecological sustainability, surface irrigated banana has low sustainability than drip irrigated banana.

Drip irrigated banana lands used low amount of agrochemical than surface irrigated lands. Specially, drip irrigated banana farmers use low amount of herbicide to control weed in their fields, because of drip irrigated banana land show low weed infestation than surface irrigated banana cultivation. In term of ecological sustainability, using low amount of agrochemical is better, because extra amount of agrochemical and agrochemical residual can harm to human health and other ecological balances.

6.1.3 Agronomic sustainability

Wetting pattern of the field in two irrigation system are different. When doing drip irrigation only wet surrounding area of the bush. But in case of surface irrigation, entire field is flooded. This type of wetting pattern will help to increase weed infestation of the field. Drip irrigated banana land has 3.37 of weeding frequency and surface irrigated banana lands demonstrated 6.87 of weeding frequency during one year period. Therefore, based on low level of weed infestation of the banana field, drip irrigated banana show higher level of agronomic sustainability than surface irrigated banana. The average values of lodging tolerance in both systems are not

statistically significant difference. Therefore, lodging tolerance of banana plants in both systems do not added any difference on agronomic sustainability.

Weeding is important agronomic practice in any crop field. When weed infestation is rapid farmer should control weed in their field to get good yield. So, sustainability production will depend on weed management in the fields. Surface irrigated banana lands has high amount of weed infestation than drip irrigated banana lands. Farmers who use surface irrigation do effort to control weed in their banana fields to prevent yield reduction.

For surface irrigated banana lands are used more labor to control weed. It causes to increase labor cost for cultivation. When labor is not available and weed infestation is rapid, they use chemical to control weed. Herbicides increase cost of cultivation and created negative effect on ecology. Therefore, utilization of low amount of herbicide gives benefits for individual farmer as well as society. Almost all agrochemicals are imported using forging exchange like chemical fertilizer. When reduce the utilization of agrochemical helps to save forging exchange for the country.

6.1.4 Overall sustainability

Sustainability index reflect overall sustainability of the systems. At the end, using existing indicator values of the systems and weights, which assigned by stakeholder the study constructed overall sustainability index at system level to compare two systems. In drip irrigated banana cultivation demonstrated two time higher overall sustainability index than surface irrigated banana. While drip irrigated show 0.64 as their overall sustainability index, surface irrigation banana cultivation show 0.32 as their overall sustainability index. Eventually, this results realized drip irrigated banana cultivation has higher level of overall sustainability than surface irrigated banana cultivation in upland area of Anuradhapura district.

6.2 Recommendations

The study realized drip irrigated banana cultivation has more overall sustainability than surface irrigated banana cultivation in Anuradhapura district

upland area. Drip irrigated banana cultivation under drip irrigation gives more financial benefit than surface irrigated banana lands, drip irrigated banana use less water and less chemical fertilizer and herbicide. It implies drip irrigated banana cultivation helps to protect environment and ground water. Based on the finding of the study few recommendations are suggested

6.2.1 Subsidies and credits

Even though, drip irrigated banana show high level of sustainability than surface irrigated banana, majority of the farmers who cultivate banana under shallow well use traditional surface irrigation to convey water from wells to banana plots. Main reason is drip irrigation technology is needed higher initial capital. It is about 180,000 rupees per hectare. Most of the dry zone upland farmers unaffordable this much of initial capital.

At the introduction stage, subsidies and grant had been given by provincial ministry of agriculture and central government department agriculture to promote drip irrigation among agro well farmers under different projects. Results of the study show drip irrigation with banana cultivation in this area gives more financial benefits to individual farmer and also gives ecological benefits. Ecological benefits are not only for individual it also provide benefits for present and future society.

Therefore, in societal point of view restart of the subsidy projects are justifiable and it will help to enhance individual farmer economy as well as ecology of the country.

Apart from the subsidies, credit program can be applied to overcome scarcity of initial capital for start banana cultivation with drip irrigation. Because drip irrigated banana cultivation give higher profit than surface irrigation banana cultivation. Farmers can repay within few years their credits.

Therefore, agricultural authorities can coordinate this type of credit program collaborate with government banks to motivate banana farmers under shallow wells to practice drip irrigation.

6.2.2 Training on drip irrigation

Two training institutes doing training on drip irrigation in this area: In service training center at Mahailipallama (under provincial council) and Farm Machinery training center at Pulliyankulama (under central government). Training has been conducted on drip irrigation during the past 10 years. Lot of resources was allocated for these triaging programs. Both provincial agriculture ministry and central government department agriculture conduct several field demonstrations to popularize drip irrigation among agro well farmers.

This resource allocation can be justified, because drip irrigation gives benefits to individual as well as society. The district has increasing trend of utilization ground water. Farmers construct agro well through out the district without concerning ground water balances. Relevant authorities try to control well excavating, using some rule and regulations. Only rule and regulation not capable to protect ground water in this area because still, majority of the existing agro well farmers use traditional surface irrigation method to cultivate crops, this method consume higher amount of water. So, continues training programs need to increase awareness of the benefits of drip irrigation. When farmers training are doing, training officer can use this result to emphasize benefits of drip irrigation. Not only that, farmers want to select crop under shallow wells with drip irrigation, trainers and extension officers can use the study result to help selecting crops for them. The study realized banana cultivation with drip irrigation under shallow well has higher overall sustainability than surface irrigation. In the future with rule and regulation and this type of guidance will help to sustainable utilization of ground water in this area.

6.2.3 Increasing sustainability of the systems

The study realized, with drip irrigation low amount of water and low amount of fertilizer gives higher benefits, because drip irrigation always keep soil moisture in favorable to plant and prevent soil moisture stress. If we can reduce moisture evaporation through soil, we can protect banana plants from soil stress further more.

Mulching is best method to prevent soil moisture in the cultivated fields. Farmer who use drip irrigation to cultivate banana can use mulch to reduce evapotranspiration. Available soil moisture will help to fertilizer uptake. As the result of that, farmers can use low amount of fertilizer than existing usage. Low amount of fertilizer will helps to increase ecological sustainability and socio economic sustainability due to decreasing cost of cultivation. These phenomena will helps to increase overall sustainability of drip irrigation farmers further.

Not only that but also, mulching will help to reduce weed infestation of drip irrigation field. It will help to reduce cost of labor fore wedding and agrochemical usage in the systems. It also increases socio economic sustainability and ecological sustainability of the drip irrigated banana system. At the end it will helps to increasing overall sustainability of the drip irrigated banana system.

Not only for drip irrigated banana also can surface irrigated banana cultivations apply mulching. Mulching will help to reducing soil moisture removal and weed infestation of the banana cultivation. Finally it will help to increase existing overall sustainability of the banana cultivation with surface irrigation at dry zone upland banana farmers.

6.2.4 Future research

When consider ecological sustainability of the systems, the study has considered only used amount of chemical fertilizer and agrochemical during one year. But extra amount of chemical fertilizer and agrochemical or residual are subjected to bio degradation with time and this phenomena reduce the harmful effect on environment and human and animal health. When consider ecological sustainability accumulation amount chemical fertilizer and agrochemical in ground water, surface water bodies and soil are precise measurement. Therefore, continuous monitoring of ground water quality, surface water and soil are needed to get future decision on ecological sustainability of the area.

Even though, the farmers were asked to their experience on changing trend on observable sustainability indicators in their fields, trend of soil salinity development

on soil surface is hard to observe. So, continues studies are needed to observe nature of the soil salinity accumulation with the time.

The study considered only banana cultivation under two irrigation methods to determine sustainability. However, some farmers cultivate vegetables using shallow well water with surface irrigation and drip irrigation in upland area of the district. So, future researches are needed on vegetable cultivation with two irrigation methods to assess overall sustainability of dry zone upland area of the district.

6.3 Limitation of the study

For normalization purpose of raw values of the indicators, a score range procedure was applied. In term of sustainability, there are no recommendations or standard range for the indicators. The study has used existing maximum and minimum values of each indicator in the sample to construct range for normalization purpose. If any farmer get one as their normalized values for indicator it does not imply absolute sustainability is best for that farmer and if any one get zero as their normalized indicator value it does not imply that farmer has lowest absolute sustainability. This study has used sustainability indicator values and sustainability index only to compare two irrigation methods under banana cultivation. Therefore, the result of the study shows only comparative overall sustainability of the two systems in the district.