

## **CHAPTER 5**

### **THE INDICATORS FOR MEASURING SUSTAINABILITY AT THE FARM AND THE WATERSHED LEVELS**

In this chapter, indicators for measuring sustainability at the farm and the watershed levels for the citrus crop will be analyzed. At the farm level, the study determined 7 indicators and 8 indicators at the watershed level. This was explained in Chapter 3: topic 3.5.2.

#### **5.1 Indicators for measuring sustainability at the farm level**

Seven indicators for measuring sustainability were selected. They were annual equivalent value, hired labor, independence from external inputs, loan investment, yield variation, revenue variation and off-farm work. The indicators were used in this study as follows:

1. Annual equivalent value (AEV). This was an analysis of the citrus production returns on a growth period of 12 years. This allowed us to calculate the net present value and was used in the formula to evaluate the annual equivalent value. The decision rule for investment in citrus production includes investment where the present value of the revenue is higher than the present value of the payments. This leads to the net present value being positive. If the net present value was negative, this would discourage investment in citrus production. When the net present value was calculated, it was used in the formula to evaluate the annual equivalent value. The results found that the annual equivalent value in the uplands was higher than in the irrigated lowlands. The large farms using chemicals earned a higher annual equivalent value from citrus planted in irrigated uplands at 24,999 baht per rai. The large farms using chemicals and bioextract earned 24,629 baht per rai. The small farms using chemicals and the small farms using chemicals and bioextract earned

an annual equivalent value of 18,827 and 15,237 baht per rai respectively (Figure 5.1).

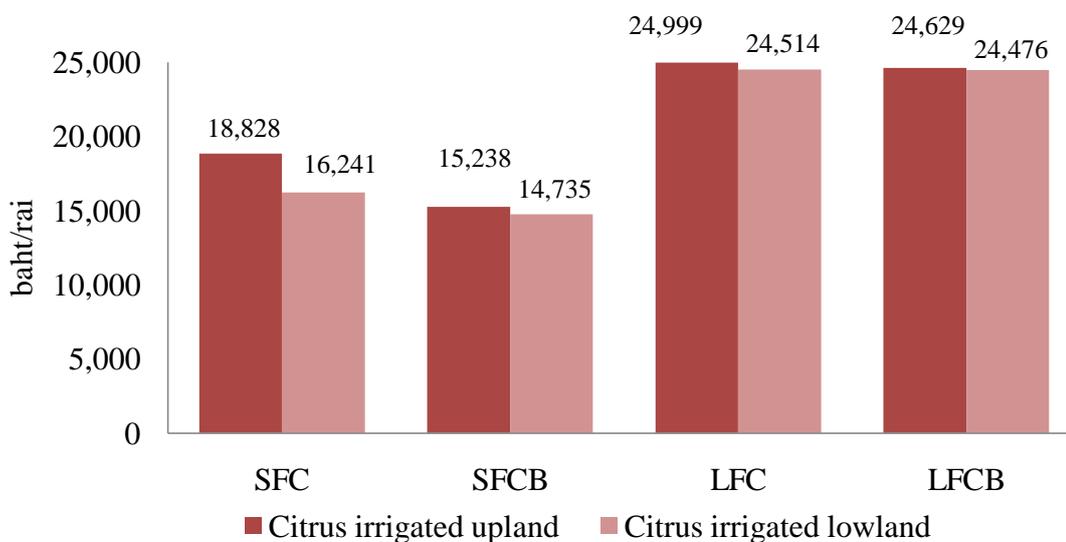


Figure 5.1 Annual equivalent value of citrus production at the farm level

2. Hired labor (HL). This included citrus production activities such as planting, irrigation, fertilizing, mowing, herbicide and pesticide spraying, pruning and harvesting. The results found that the largest user of hired labor were the large farms using chemicals and bioextract at 34 and 32 man-days per rai for the irrigated uplands and irrigated lowlands respectively. Small farms using chemicals and bioextract in the irrigated uplands accounted for 29 man-days per rai. The large farms using chemicals where citrus production was in the upland and lowland areas used about 23 man-days per rai (Figure 5.2).

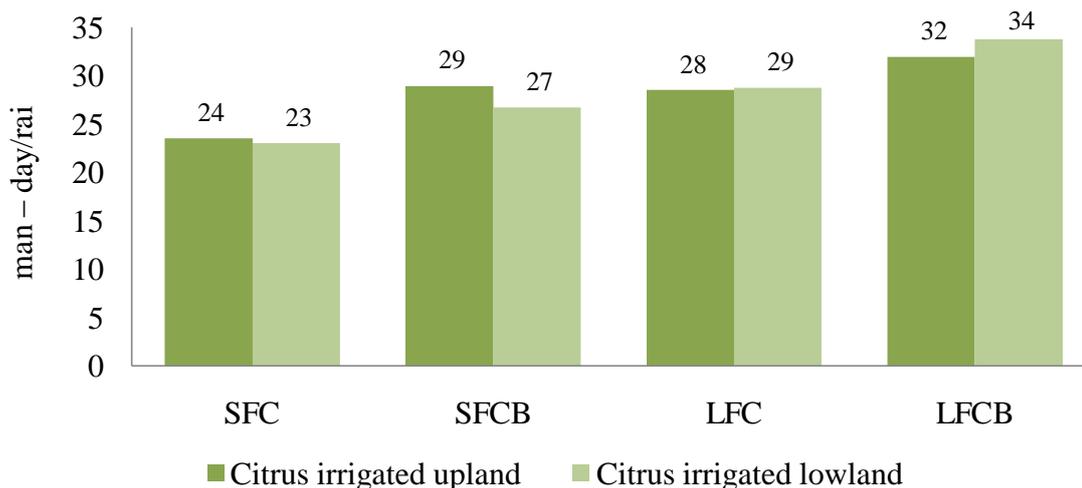


Figure 5.2 Hired labor used in citrus production at the farm level

- Dependence on external inputs (IEI). This measured the expenditure on chemicals, fuel, materials for production and fixed costs purchased from external sources. The study found that the expenditure was highest in the irrigated uplands for the large farms using chemicals at 29,514 baht per rai. This was followed by the small farms using chemicals and bioextract and the small farms using chemicals at 25,877 and 26,297 baht per rai. The large farms using chemicals were dependent on external inputs in the lowland irrigated areas at 25,451 baht per rai.

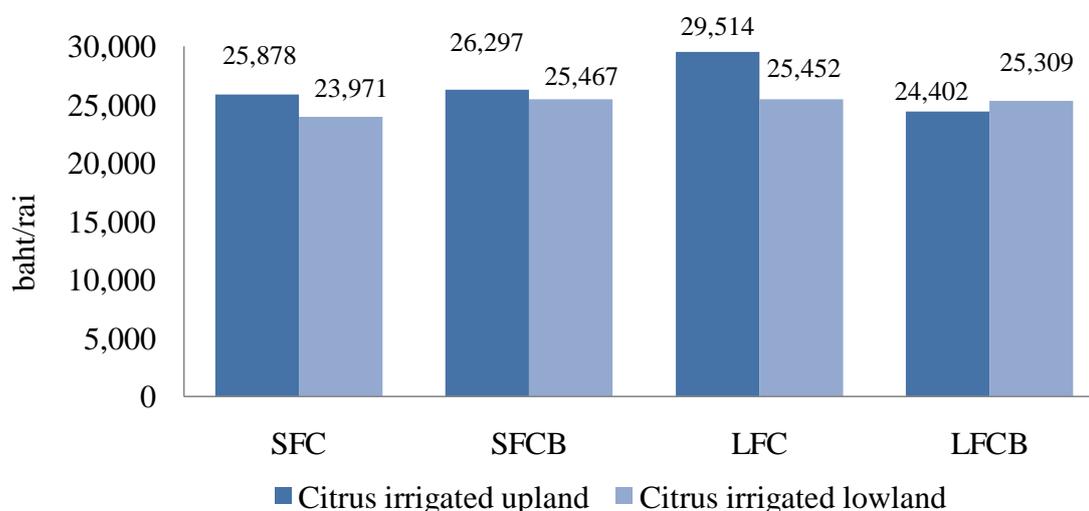


Figure 5.3 Dependence on external inputs used in citrus production at the farm level

4. Loan investment (LI) was analyzed on the basis of the cost of hired labor, chemicals, fuel, materials used for production and the fixed costs of permanent labor. It found that loan investment in citrus production was highest in the large farms in the irrigated uplands using chemicals and bioextract at 19,877 baht per rai. The small farms using chemicals and bioextract had an average investment of 17,711 baht per rai. The small farms using chemicals had an average investment of 16,599 baht per rai. The small farms in the irrigated lowlands using chemicals and bioextract had the lowest average investment in citrus production at 14,698 baht per rai (Figure 5.4).

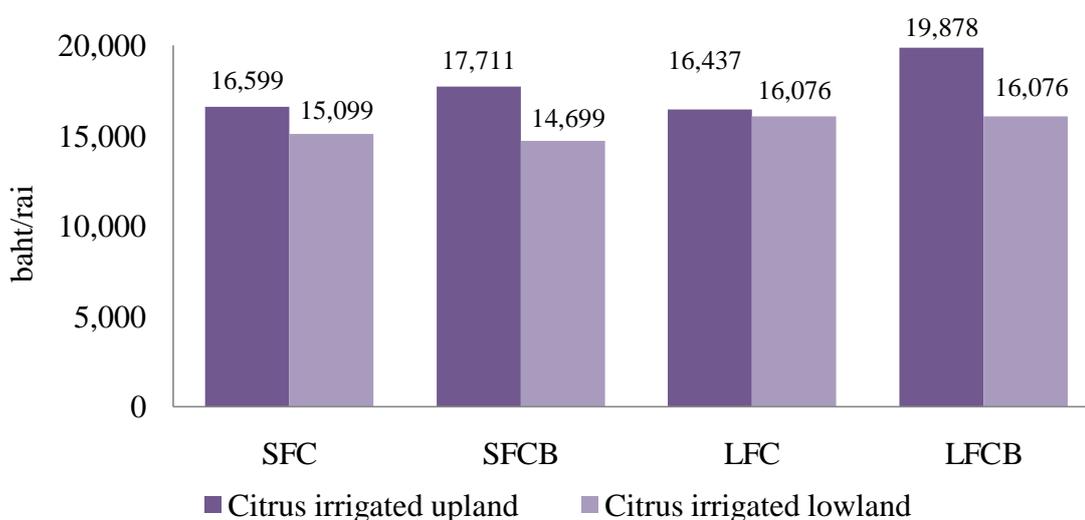


Figure 5.4 Average investments in citrus production at the farm level

5. Yield variation (YV) was measured based on the standard deviation on an average yield (kilograms per rai) in each year during 2009 to 2011. The yield variation was at a highest at 1,880 kilograms per rai of citrus production in the irrigated lowlands of the small farms using chemicals while the large farms using chemicals and bioextract had the lowest yield variation in the lowlands at 1,243 kilogram per rai (Figure 5.5).

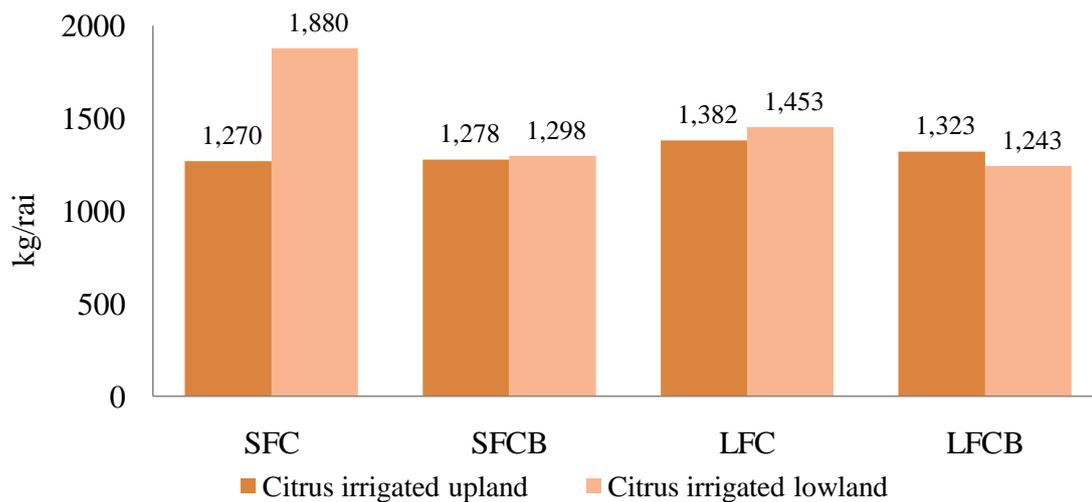


Figure 5.5 Yield variations in citrus production at the farm level

6. Revenue variation (RV) was focused on the measurement of standard deviation on an average annual revenue (baht per rai) between 2009 and 2011. The results found that the lowest revenue variation was found in the large farms using chemicals together with the large farms using chemicals and bioextract. The small farms had twice the revenue variation of the large farms using chemicals (Figure 5.6).

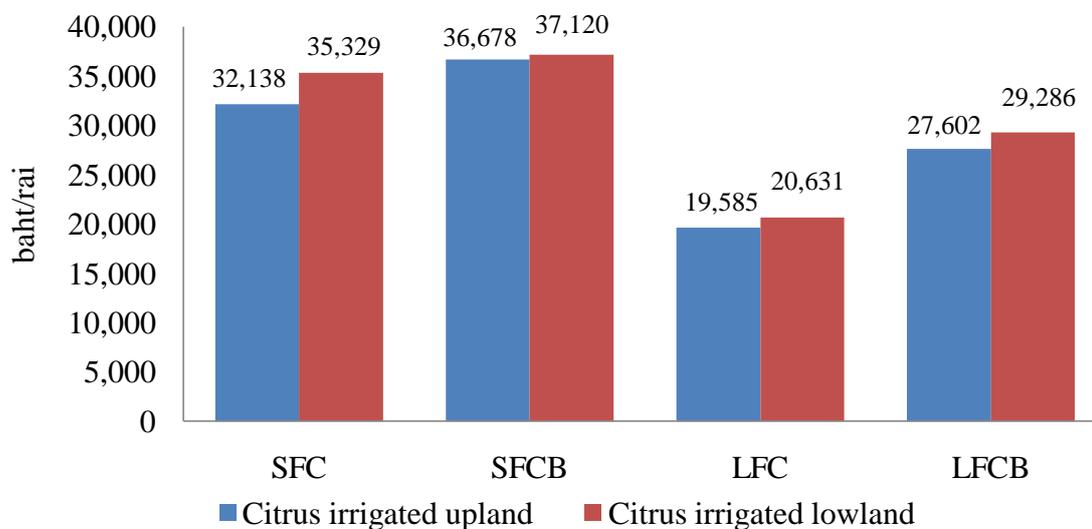


Figure 5.6 Revenue variations in citrus production at the farm level

7. Off-farm work (OFF). The household labor usually worked off-farm when they had completed their own farm work. This study determined wage rates for off-farm work at 200 baht per day and was measured by the optimal model for each farm type (man-days per year). The model will compare between the value of household labor used for their own crop production and off-farm work. When it is possible to earn more from off-farm work than the comparative value of working on their own farm, the model will be recommending off-farm work. If the model shows that working on their own farm and maximizing every resource is better management for their own crop production, it means that off-farm work is less worthwhile.

## **5.2 Indicators at the watershed level**

For the watershed level, there were 8 indicators and the results of the study are shown in Figure 5.7 and Figure 5.8.

1. Annual equivalent value (AEV) was an analysis averaging the citrus production returns from all the farms in a tree growth period of 12 years. The annual equivalent value of citrus production in the irrigated uplands and lowlands was calculated at 22,931 and 20,479 baht per rai respectively.
2. Employment (EM), the average figure for hired labor in every activity of citrus production in the irrigated uplands and lowlands was calculated to be 28 and 29 man-days per rai.
3. Dependence on external inputs (IEI) was measured by using the external production inputs and was found to be 25,637 and 26,573 baht per rai of citrus grown in the irrigated uplands and lowlands.
4. Nitrogen use (N) shows the lack of soil fertility. When nitrogen was put into the soil, the plant's roots could absorb it immediately. The study analyzed the amount

of nitrogen used based on an average compost input. The farmers used ox dung for citrus production in which 1 kilogram of ox dung contained 1.3 mg. of nitrogen (Department of Agricultural, 2013). For the chemical fertilizers, the amount of nitrogen was computed based on the fertilizer type as the amount of nitrogen in each fertilizer had already been calculated. The results from the computations for nitrogen use for citrus production in the irrigated uplands and lowlands were calculated to be 37 and 36 kilograms per rai respectively.

5. Expenditure on pesticides (EP) was measured at each stage of citrus production in the irrigated uplands and lowlands at 8,536 and 8,951 baht per rai respectively.
6. Soil erosion (SO) is an environmental problem and can affect plant growth and citrus yield. The results found that the average soil erosion only occurred in irrigated uplands at a rate of 0.26 tons per rai.
7. Revenue variation (RV) was focused on the measurement of standard deviation of the average revenue in each year from 2009 to 2011(baht per rai). It found the revenue variation to be 32,013 and 31,863 baht per rai of citrus grown in the irrigated uplands and lowlands.
8. Revenue from non-timber forest products (NTFP) was assessed from the forest exploitation by the farmers, i.e. bamboo cutting to make stakes for citrus branches, bamboo shoots and mushrooms. An average value for the revenue from non-timber forest production was 208 baht per day.

The indicator analyses for the 7 indicators at the farm level and the 8 indicators at the watershed level were calculated for citrus production in the irrigated uplands and lowlands. The results of the indicators will be used for the coefficients of citrus production for analysis by MGLP both at the farm and the watershed levels.

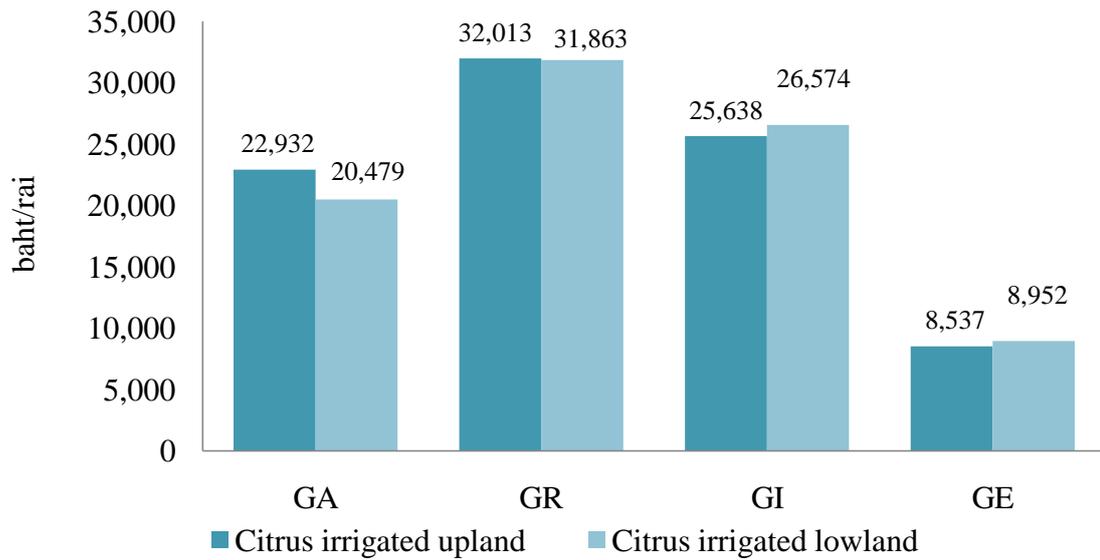


Figure 5.7 Annual equivalent value (GA), revenue variation (GR), dependence on external inputs (GI) and the expenditure on pesticides (GE) in the citrus production at the watershed level

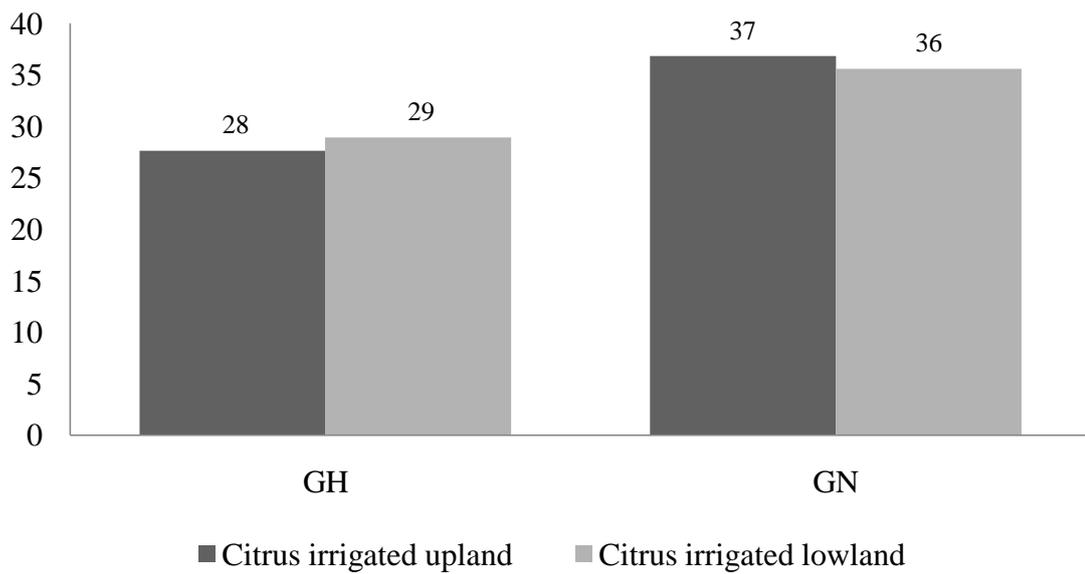


Figure 5.8 Employment (GH) (man-days/rai) and nitrogen use (GN) (kg/rai) in the citrus production at the watershed level