Abstract

The research on the effects of converting field crop to rubber (*Hevea brasiliensis*) plantation on sloping lands in Nan watershed was conducted at Huai Kok, Muab Sub-Basin, Nam Yao (2) Sub-Watershed, Du Phong Sub-District, Santi Suk District, Nan province. In 2014, the study area had a total rainfall of 1,562 mm. The highest rainfall recorded for August was362 mm. Soil series found in this study areas including Wang Saphung series (WS), Ban Chong series (Bg) and Li series (Li). Soil problems related to agriculture in Nan province can be classified into soil erosion, shallow soil, and soil on slope complex areas. In 2015, the total population in Du Phong Sub-District was estimated at 5,000 people. The total labor force (15-60 years old) was 2,465 people (45.34% of the total population). Farmers' income of Du Phong Sub-District was mainly from agricultural products. They are field crop, fruit tree, vegetables and livestock. Rice is kept for household consumption. Currently, farmers in the Muab Sub-Basin, Nam Yao (2) Sub-Watershed, Du Phong Sub-District, Santi Suk District have already changed land use from maize to rubber tree plantation on steep slope. The comparison of land use map in 2012 and 2007 showed the rapid expansion of monocultural systems based on rubber of Muab Sub-Basin. Moreover, during 2007-2012, paddy field decreased by 1.5% of the total area, followed by field crop (19.8 %), Orchars (11.2 %), disturbed deciduous forest (56.5 %) and deciduous forest (27.2 %) whereas para rubber plantation increased by 483.4 % of the total area, followed by land rotation farming (38.9%). Capital cost of rubber production for rubber farmers was about 7,200 baht per rai. Most of farmers in studied areas grew RRIM 600 variety. The results of converting field crop to rubber plantation on sloping lands showed that the monoculture rubber on steep slope without soil and water conservation methods did not reduce soil losses, water runoff and soil nutrient losses by erosion in comparison to maize with soil and water conservation methods. In addition, monoculture rubber without soil and water conservation methods had the highest soil erosion, runoff and nutrient losses by erosion as compared to maize and rubber plantation with soil and water conservation methods. This was because young rubber trees (1-5 years old) were still small and therefore the percent of crop cover was low compared with maize plantation. Reducing the impact of erosion problem can be achieved by using soil and water conservation methods e. g. bench terrace, intercropping rubber with other trees or crops, planting ground cover and no-weeding during the initial rubber tree growth (1-5 years). Using the net present value (NPV) of four soil and water conservation measures at Du Phong Sub-District, Santi Suk District, Nan province found that rubber intercropped with maize on upland area treatment (T4) for 20 period years of

project had the highest NPV of 36,757.69 baht per rai, which was effective measures to reduce soil erosion. Moreover, the highest return of value from the reduction of soil erosion was showed in the rubber intercropped with maize treatment (T4) compared to other soil and water conservation measures. The rubber intercropped with maize treatment (T4) had the present value of 14,175.53 baht per rai. However, the result from farmer's opinion poll showed that only 2.86 percent of farmer selected the rubber intercropped with maize treatment (T4) while 47.62 percent of farmers chose the bench-terraced rubber monoculture plantation treatment (T2). Farmers thought that the terrace benches supported for rubber tapping, reducing runoff and maintain soil fertility; however, the decision of appropriate soil and water conservation measures for each area may not be considered only with the present value of the alternative measures. The economic analysis of environment did not cover all aspects of the impact in particular policy decision. Therefore, it must take into account the impact that occurs to those involved in all sectors. The issue should be concerned including social justice, the use of local resources and promoting soil and water conservation measures on steep slopes and upstream areas.

For land suitability classification in the study area, the large majority of soil in the rubber plantation area are Wang Saphung series (WS) (90%). The slope ranges from 20 to >35% in the moderately deep soils (d3). The results of physical land evolution showed that field crops were the moderately and marginally suitability classes. Rubber plantation presented the marginally suitability classes (S3). However, the results of using economic parameters together with physical land evolution showed that rubber plantation presents the moderately suitability classes (S2) therefore it is worth to invest in this studied area.

For the assessment of runoff rate and the amount of runoff, the highest runoff rate and the amount of runoff were found under changing hilly area or upstream area for rubber plantation compared to natural forests. It may reduce the amount of groundwater in this area, and it causes the flooding in the rainy season and water shortages during the dry season. Thus, the rubber cannot replace natural forests.

The government policy should attempt to motivate farmers to efficiently use natural resources, for example, the government can allocate the land to poor farmers for agriculture and lease in a long term. Therefore, farmers realize the value of land, soil, water and forest conservation as natural input. The government must support for farmers that produce agricultural products in the way of conservation agriculture. Moreover, the government should

promote appropriate soil and water conservation measures to farmers. In addition, the government should not support only bench terrace, but they can be applied to other ways e.g. no biomass burn, integrated farming system or agroforestry with the young rubber (1-5 years old). Government organization may be introduced intercropping native plants with rubber plantation. The suitable intercrops in rubber plantation create income to farmers before the tapping time. Thus, farmer do not have to do the shifting cultivation and forest destruction for generating income before the tapping time. For promoting intercropping of rubber and agroforestry system with rubber trees, Sub-district Administrative Organization can collect plants that farmers offer or interest to grow with rubber trees. In this way, farmers can participate their concept with government agencies. Finally, government agencies and the private sector must support farmers in the market for their agricultural production. Moreover, the important investments are research and technology transfer to farmers that technologies appropriate to the community and the region. In addition, farmers can strengthen their skills through school, educational institution, agricultural extension center and government agencies.

The appropriate strategy for land use management on the steep slope and upstream area should be built up by farmer participation. About the guidelines for development of the upstream area, the public sector should be encouraged to communicate with the public and community leaders, farmers, land use and watershed stakeholders to understand the guidelines for development of the upstream area. We should have the community forum for farmers to reflect on the problem and find solutions to manage upstream activities between public and private stakeholders, which should encourage the private sector to play a role in the operation of the market, money, inputs for production and agricultural production model for sustainable environment.

Keywords: Nan watershed; soil erosion; Rubber plantation; Cost-benefit analysis