# Jamming Effects on Soil Degradation Course in Three Gorges Reservoir Region

## —Regarding The District Where Soil Is Originated From Efflorescent Granite As Example

***Huang Runquan, Dai Junhua, Hu Xingyi*** and ***Panlei***
Hubei Provincial Forestry Academy, Zhuodaoquan, Wuhan, Hubei, 430079 P.R.C.
E-mail**:** runquan@yahoo.com

***Zhu Junzhao***
Beijing Forestry University, Xiaozhang, Haidian District, Beijing 100083 P. R. C.

**Abstract**: Regarding The District Where Soil Is Originated From Efflorescent Granite As Example, this research studied effects of different jamming, such as deforestation, reforestation, setting apart the hills for tree planting, botanic belts and agroforestry, on soil moisture-holding capacity, soil aggregate stability, soil chemical characters and soil respiration. The result display: after deforestation, the first and second year, soil volume weight increases 0.1 annually, soil maximum moisture-holding capacity decreases 20% annually; In three years after deforestation, soil wet aggregate decrease 37.8% annually, dynamic change curve of soil organic matter and total N display like S in reverse, the maximum change velocity occurs in the second year to the third year; soil respiration quantity ranges from 0.9 g C/$m^2$/day to 7.4 g C/$m^2$/day under different jamming, the effects boosting up ability agroforestry> reforestation> botanic belts; deforestation do great destroy to soil respiration.
**Keywords**: jamming, three gorges reservoir region, soil degradation

## 1 Introduction

With development of economy and improvement of life condition, population in Three Gorges Reservoir Region increased rapidly in past five decades, so soil was overspent, resulted in serious soil degradation. But also with the construction of Three Gorges Dam, migrations from submerge area heightened the population density, and required infields for planting crops, this will lead to deforestation. So government of P.R.C. have inputting large amount funds for improving standard of living of habitants and enforces so many eco-environment preservation projects to prevent soil and natural vegetation degradation. This paper analyzes the impact of different jamming on soil and natural vegetation for adopting high efficient measures to deliver in this region later.

## 2 Materials and methods

### 2.1 Site

The experiment site, Quxi micro-watershed, lies in Maoping Town, Zigui Country, Hubei Province of People Republic of China, and is apart from Three Gorges Dam about 3 km, latitude from 110° 54′ 45″ to 110° 57′ 55″, longitude from 30° 51′ 24″ to 31° 27′ 48″, altitude from 40m to 632.1m, covers about 9.8$km^2$, with a kind of soil originated from efflorescent granite, a mean annual temperature of 18.0℃, and mean annual precipitation of 1,100m, but its distribution is uneven, precipitation during April to October account to 85 percents of a year, including three times rainstorm every year[1]. Solar energy and water resource are abundant in this micro-watershed, but annual evaporation quantum reach 1,421.5mm, so soil drought for long times that restrains to botanic upgrowth in gear happens frequently. Land use structure of this micro-watershed distribute as: 30 percents is forest, 40 percents is slope cropland, 20 percents is paddy field and terrace, the other is residential area and water area, among these, soil erosion is mainly originated from slope cropland. Tremendous hypsography, abundant incompact accumulation, and rainstorm, resulted in high sand carrying capacity current, mudcock flow occurring continually, and also other types of soil and water loss, such as apron landslip, collapse, gully erosion etc. All sand

generated by this micro-watershed directly runs into the reservoir that will decrease the minimum capacity and shorten its serviceable life. Soil types have yellow earth, yellow brown earth etc, average earth thickness is about 28cm. In this micro-watershed there has 1970 dwellers in 411doors, including 745 labor forces, in 1995, average everyone annual net income is only 450 Yuan(RMB) and mainly attain from economical forest, such as oranges, and labor.

### 2.2 Materials and jamming activities

After the construction of Three Gorges Dam and settlement of immigrants, eco-environment of Quxi micro-watershed is suffering from so many kinds of jamming, such as deforestation, transmigrates inhabitancy construction, quarry etc devastating activities and natural forest preservation, reforestation etc ecological recovering activities. This paper studied deforestation (DF), reforestation (RF), setting apart the hills for tree growing (SAHTG), botanic belts (BB), and agroforestry (AF) etc 5 kinds of main jamming in Three Gorges Reservoir Region. Botanic belts is a kind of biological measure that plants shrubs, trees, or grass along contour, in this research the botanic materials is *Fagopyrum Mill*; agroforestry in this research designated as intercropping crops and planting botanic belts in slopeland managed as orange orchard.

### 2.3 Tested parameters and analysis methods

Tested parameters including 3 kinds:

(1) Dynamic change disciplinarian parameters of soil physical character, such as soil moisture content, maximum moisture-holding capacity, volume weight, granular structure, soil wet aggregate and soil fractions etc;

(2) Dynamic change disciplinarian parameters of soil chemical character, such as content of N, P, K, and organic substance etc;

(3) Dynamic change disciplinarian parameters of soil respiration[2].

Rather, the data had been recorded in excel sheet, and anylyzed by SPSS.

## 3 Results

### 3.1 Influence of jamming on soil moisture-holding capacity

Jamming has prominent influence on soil moisture-holding capacity[3][5]. The influence of jamming on soil volume weight, maximum moisture-holding capacity reflects the change of soil moisture-holding ability. By testing dynamic change of hereinbefore parameters in the course of before jamming and after jamming 8 years, this paper has opened out the change disciplinarian of soil moisture-holding capacity.

Fig. 1 and Fig. 2 display: after deforestation, effected by poignant soil erosion, soil volume weight annually increased 0.1, maximum moisture-holding capacity decreased 20 percents in the first and second year, and in the fifth year soil appeared desertification trend, soil permeability boosted up, the ground's surface temperature topped to 72℃, these seriously restrict crops' upgrowth.

After reforestation, in the first and second year, soil continued to degrade, but with coming into being of crown and function of dead litter, after 2 years, soil volume weight decrease progressively; maximum moisture-holding capacity increased above 25 percents. And also according our research, in the prophase of reforestation, measures that can increase ground bestrow, such as preserving weed, planting shrubs or seeding grass etc, should be enforced for improving soil and water conservation capacity; Contrast deforestation to reforestation, we can conclude that they are not reversible process, loss of soil moisture-holding capacity is more easier and faster than recovering.

Dynamic change trend of soil volume weight and maximum moisture-holding capacity after setting apart the hills for tree growing shows soil moisture-holding capacity may be effectively enhanced, but at the prophase, it was slowly, from the third or forth year, it started boosting up, so that setting apart the hills for tree growing meliorates eco-environment is not accomplishing in an action, it need take measures to improve on structure of forestry ecosystem for advancing succession.

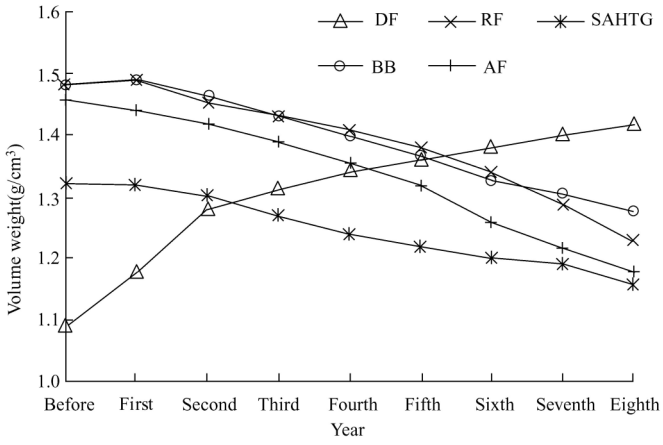


**Fig.1** Dynamic change of soil volume weight under different jamming

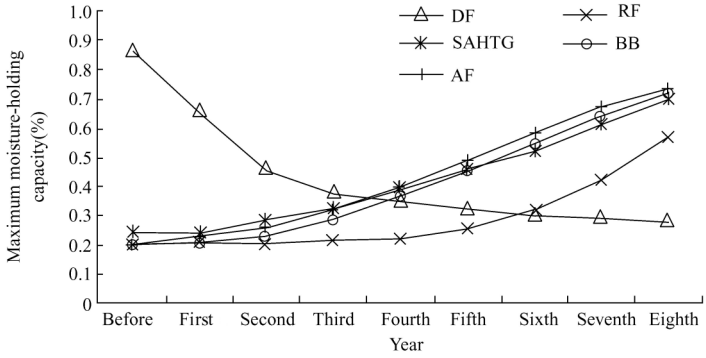


**Fig.2** Dynamic change of soil maximum moisture-holding capacity under different jamming

Own to holding up runoff, mud and sand to form gentle slope terraced land, botanic belts have better action on improving soil structure and preventing soil erosion [4][5]. In Three Gorges Reservoir Region, planting botanic belts in steep slope cropland can notably enhance soil moisture-holding capacity. From the second year, gentle slope terraced land had been shaped, soil volume weight average annually decreased 0.031, tiptop to 0.039; soil maximum moisture-holding capacity average annually increased 7.3%, tiptop to 9.3% in the sixth and seventh year. Its dynamic change was similar to setting apart the hills for tree growing, but in comparison with planting commercial forest, in prophase, function of improving soil structure and enhancing soil moisture-holding capacity were stronger, so that during the course of carrying into execution Reforestation in Slope Cropland Project, it was necessary and effective of planting properly shrubs or herbaceous plants as botanic belts for heading off sand and mud into Three Gorges Reservoir.

Agroforestry systems may utilize solar energy, water and fertility resource, ameliorate soil physical and chemical characters, control runoff and soil erosion, these functions have all-important effects on accelerating to continually improve to eco-environment and economical sustainable development of Three Gorges Reservoir Region [6,3,7]. As important soil and water loss place where were prior to slope croplands, slope lands that were planted oranges need to been rebuilt and managed scientifically. Fig.1 and 2 displays that after put into practice as agroforestry, soil structure of slope lands that were planted oranges were meliorated continually, soil volume weight and maximum moisture-holding capacity's change curve submit as S in reverse, velocity of change reached max at the sixth year, and then fell step by step, after 8 years, soil moisture-holding capability enhanced 25%, and soil productivity increased remarkably.

### 3.2 Influence of jamming on soil stability

Distribution of Soil granular structure and stability of soil aggregate are important parameters of soil structure, and soil wet aggregate stability index is the important parameter of reflecting soil corrosion stability. In Three Gorges Reservoir Region, rainstorms are high frequent and intensity, especially in the district where soil is originated from efflorescent granite, owning to its low soil wet aggregate stability index, once gully occurred on ground, it will be develop quickly form striae to gulch. Fig.3 displays dynamic change curve of soil wet aggregate stability index after different jamming: in three years after deforestation, because of exquisite soil and water loss, it decrease with a rate of 37.8% until the sixth year; reforestation couldn't improve soil structure and function immediately, just after three years, soil corrosion stability will be boosted with a rate of 8.1%, soil structure formed step by step; dynamic change discipline of soil wet aggregate stability index after setting apart the hills for tree growing was changing little in three years, and then increased with the speed of 6.3%, because of no other measures such as planting shrubs or grass, its function was not a patch on reforestation; Botanic belts and agroforestry improved soil wet aggregate stability index better than reforestation in prophase, thereinto, agroforestry was still better, but form the seventh year, its action was inferior to reforestation, it illuminated that agroforestry and botanic belts can but act as makeshift as reforestation, or reinforces to plant forest or shrubs for enhancing soil productivity and continually accelerating melioration of ecosystem.

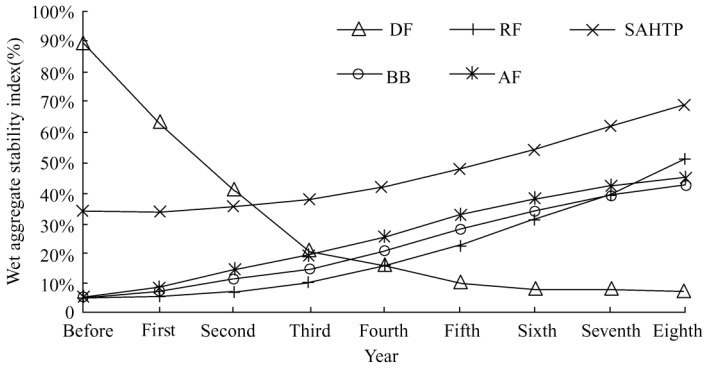


**Fig.3** Dynamic change of soil wet aggregate stablity index under different jamming

Size distribution of soil aggregate can effectively reflect ability of soil resistance to sputtering. This research indicates that deforestation may lead to rapidly destroy of soil dry aggregate in the district where soil is originated from efflorescent granite, after six years, soil had taken the shape of rope of sand. According observation on site, when raininess just was 0.15 mm per minute, sputtering happened; however, six years after reforestation, dry aggregates that grain diameter was larger than 12 mm accounted for 12.3% of total soil weight, together with shaping of crown, quantity of sputtering decreased markedly; setting apart the hills for tree growing can accelerate forming of big grain diameter dry aggregate, from first year to third, dry aggregates that grain diameter was bigger than 5 mm increased 3.2% annually, to the eighth year, it reached to 65.3%, that of bigger than 18 mm to 25.6%; botanic belts and agroforestry can accelerate forming of medium grain diameter dry aggregate, at the sixth year, those of from 2 mm to 12 mm accounted for 21.5%, 28.9% of total soil weight, affected by cultivation, content of big grain was little, furthermore soil mass was easy to sputter, so halting to cultivate can advance on sostenuto improvement of soil structure and function in agroforestry systems.

Fig.4 displayed different jamming do great effects on soil grain diameter distribution. Eight years after deforestation, content of coarse grain that diameter was larger than 1 mm increased 40.8%, however that of diameter was smaller than 0.01mm decreased 24.1%, soil emerged trend of coursing and desertification, fortunately, reforestation, botanic belts, agroforestry can availably keep within limits to coursing and desertification on slope cultivated lands, thereinto, agroforestry was best, next was reforestation, whereafter was botanic belts, this had affinity on cradling to botanic belts out of systems for stock, however branches, leaves clipping from agroforestry and litter of reforestation would be returned to system for mass circuit.

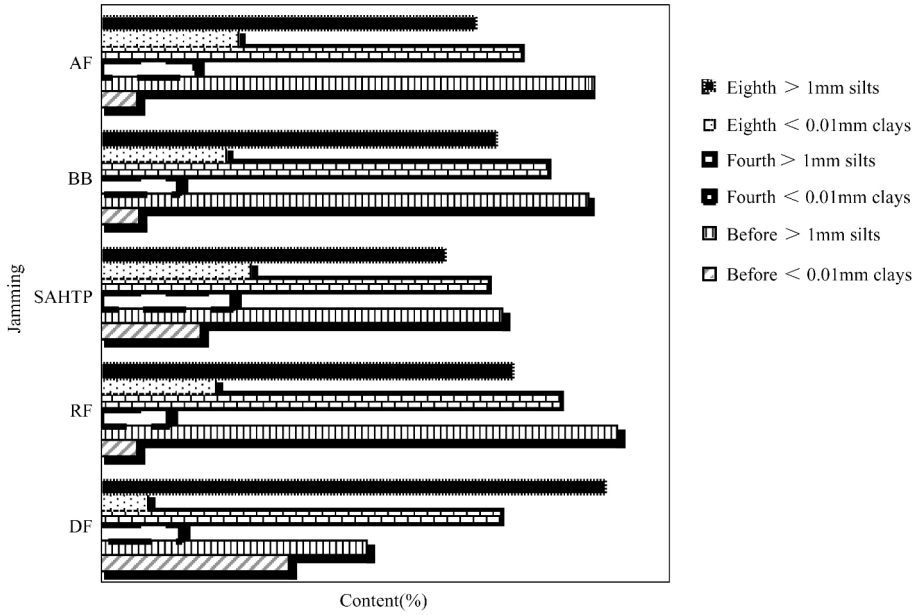


**Fig.4** Dynamic Change of soil size distribution under different jamming

### 3.3 Influence of jamming on dynamic change of soil chemical characters

Vegetation is an important factor of changing soil nutrient; jamming affects soil nutrient statement by acting to vegetation statement, substance and energy fluxion [8]. Deforestation and unfixed cultivation are jamming manner of destroying soil productivity, reforestation, botanic belts, agroforestry etc are important jamming measures on soil degradation. Fig. 5 and 6 displayed dynamic change disciplinarian of jamming on content of soil organic substance and total N. Content of organic substance is important parameter of reflecting soil nutrient, structure and productivity. After deforestation, dynamic change of content of soil organic substance and total N submitted as S curve in reverse, maximum of change velocity happened in the second year to third year, and also decreasing velocity of organic substance was larger than that of total N, in anaphase, it step down, this reflected fleetly destroying of soil productivity; content of organic substance and total N after reforestation only fleetly increased after forest structure had been formed in four years; planting botanic belts and agroforestry were propitious to restoration of soil productivity, former is better; setting apart the hills for tree growing can facilitate content of organic substance and total N increasing in direct ratio, this reflected unfaltering enhancing of mountainous soil productivity, especially in anaphase.

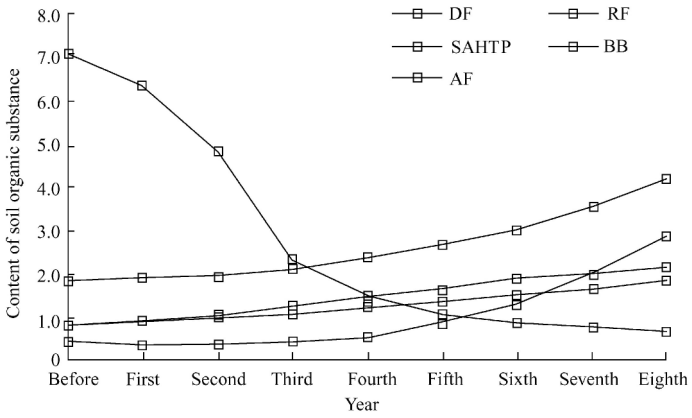


**Fig.5** Dynamic change of cotent of soil organic substance under different jamming

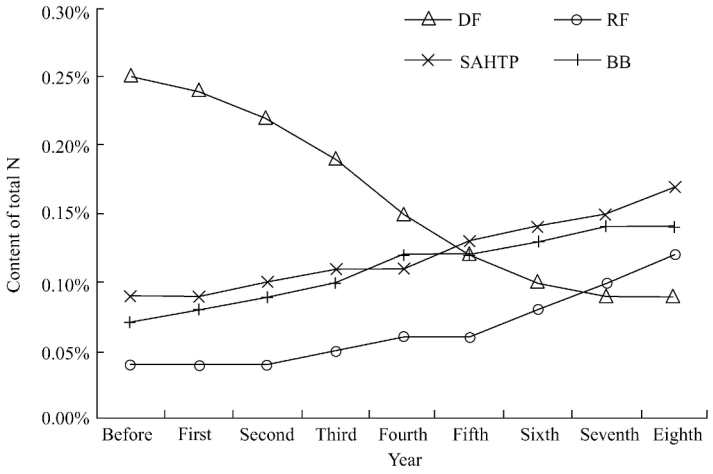


**Fig.6** Dynamic change of content of soil total N under different jamming

### 3.4 Influence of jamming on dynamic change of soil respiration

In Three Gorges Reservoir Region, soil respiration is the strongest in July, after October, it reduces markedly. From July to October, daily mean of soil respiration values from 0.9 to 7.4 gC/m$^2$/day (Fig. 7). According to this research, jamming has notable influence on soil respiration (P=0.05). All over experiments, soil respiration value of forest were prominently higher than other experimental site that has jamming, and it was the lowest in slope cultivated lands. Fig.7 displayed that agroforestry had the most prominent action on boosting up soil respiration, secondly was reforestation, thirdly was botanic belts; owning to disadvantageous affection on microbe, deforestation decreased soil respiration remarkably.

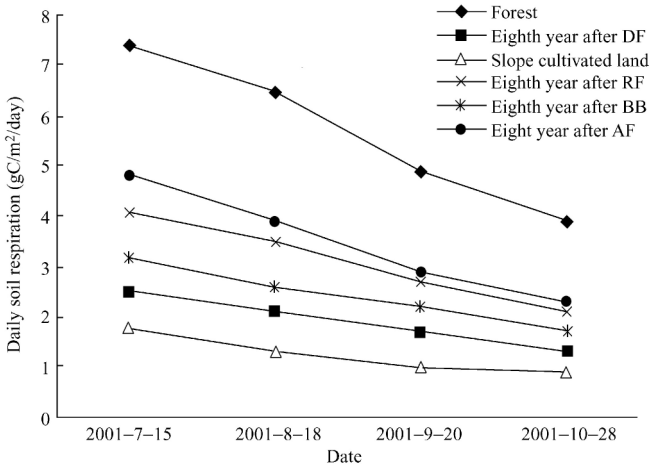


**Fig.7** Dynamic change of soil respiration under different jamming

## 4 Conclusion and recommendation

Different jamming has remarkable affection on soil moisture-holding ability in Three Gorges Reservoir Region. After deforestation, affected by exquisite soil and water loss, soil volume weight increased 0.1 annually, maximum soil moisture-holding capacity decrease about 20% annually, these leaded to soil moisture-holding ability descent remarkably.

Agroforestry, botanic belts, reforestation, setting apart the hills for tree growing can increase soil moisture-holding ability step by step, in prophase it was agroforestry, botanic belts, setting apart the hills for tree growing that increase faster, however, in anaphase, it was reforestation.

Deforestation will weaken soil aggregate stability, in the first three years, affected by exquisite soil and water loss, soil wet aggregate stability index descent in a speed of 37.8% annually, content of big size dry aggregate reduced remarkably. Reforestation, setting apart the hills for tree growing, agroforestry, botanic belts can increase soil wet aggregate stability index, boost up resistance to erosion and sputtering, in prophase, agroforestry was best while reforestation was best in anaphase.

Different jamming has remarkable affection on soil nutrient. After deforestation, dynamic change of content of soil organic substance and total N submitted as S curve in reverse, maximum of change velocity happened in the second year to third year, in anaphase, it step down; after reforestation its were only fleetly increased after forest structure had been formed in four years; planting botanic belts and agroforestry were propitious to restoration of soil productivity, former is better; setting apart the hills for tree growing can facilitate to enhance soil productivity, especially in anaphase.

Different jamming has remarkable affection on soil respiration. In Three Gorges Reservoir Region, soil respiration values from 0.9 gC/($m^2$ • day) to 7.4 gC/($m^2$ • day) form August to October. Soil respiration value of forest was prominently higher than other experimental site that has jamming, and it was the lowest in slope croplands. Agroforestry had the most prominent action on boosting up soil respiration, secondly was reforestation, and thirdly was botanic belts; deforestation may lead to decrease soil respiration remarkably.

Affected on soil physical and chemical characters by different jamming not only leaded to change of soil structure, but also between different characters have tightly tie up, so it is worthy of research more; this research on soil respiration of forest, especially slope cultivated lands and agroforestry, it just a step to forward, need research in more detail, such as studying on relation between soil respiration and soil degradation and productivity restoration. But also research on comprehensive utilization different jamming and how they affect soil structure and function, ecosystems' structure and function etc, will do great benefit to conserve, restore and rebuild degraded ecosystem, need more attention.

**Acknowledges**

The authors express their thanks to faculty and stuff: Mr. Shi-penggao, Mr. Yuan-kekai, Mr. Shi-yihu, Mr. Deng-zhongmi, Mr. Wang-wei, all members in experiment site, National Science and Technology Department, National Forestry Bureau, special thank give to Steven G. McNulty

**Reference**

[1] Huang-runquan etc, 2000, Analyzing ecosystem model of migrants resettled area in Three Gorges Reservoir Region and ecological environment construction countermeasures, Bulletin of soil and water conservation, **21**(4), 3-10.

[2] A. Tufekcioglu etc, 1999, Fine root dynamics, course root biomass, root distribution and soil respiration in a multi-species riparian buffer in Central Iowa, USA. Agroforestry System 44: 163-174.

[3] Tej. P. & Harold, R. W. 1994, Sloping agricultural land technology: A Regeneration Option for Sustainable Mountain Farming [M]. Katmandu: ICIMOD, 1-68.

[4] Sun-hui etc. 2001, Contour hedgerow intercropping for exploitation and conservation of slope cropland in mountain areas, Journal of mountain science, **19**(2), 125-129.

[5] Huang-runquan etc, 2000, The impact of the agroforestry structure of slopeland on distribution of soil nutrient in Three Gorges Reservoir Region, Journal of soil and water conservation, **15**(3), 46-48 .

[6] Huang-runquan etc. 2000, Sustainable development countermeasures of agroforestry systems in Three Gorges Reservoir Region (In Hubei), Forestry science and technology, (1), 34-37.

[7] Wang-lixian. K. N. 1995, Brooks. Soil and water conservation and environment protection in up and middle river of Yangze River. Beijing: Forestry Publisher House of China, 55-62.

[8] R. B. Mapa and H.P.M. Gunasena. 1995, Effect of alley cropping on soil aggregate stability of a tropic Alfisol. Agroforestry Systems 32: 237-245.