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EARTH WORMS ARE PAID FOR THEIR ECOSYSTEM SERVICES: CASE OF INTRODUCING NOVEL LIVELIHOODS IN TO RURAL ECONOMY:

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BACKGROUND

Sri Lankan economy underwent a major policy change in 1977 from centrally planned agricultural import substitution type, more or less closed economic system, to export oriented, industrially led, open market economic system. Despite the above policy change, successive governments continued open market economic system. However, by now, Sri Lanka has been elevated into lower middle income country status by the global community. With the new economic identity, access to donor funding was restricted as donors are interested in the poorest developing countries. For the country's natural resources management, biodiversity conservation *etc.*, financial requirements need to be generated from the national economy by applying strategic resources mobilization mechanisms. Need to shift towards market based policy tools has arisen to create green jobs and sustainable livelihoods for needy groups and to assure long term sustainability. Therefore, this paper examined the possibility of introducing Payments for Ecosystem Services (PES), a type of economic instrument for soil biodiversity and ecosystem services (BES) as a means of implicit fund raising mechanism, so that twin objectives of conservation of soil biodiversity and novel livelihood options for people are possible. Earth worms were selected as the group of soil biodiversity, and a series of generic research questions were raised and answered exploring the contemporary literature available in the internet and other sources. Research work conducted in the University of Ruhuna was summarized for identification of suitable earth worm species. Their performance in contaminated soils was also examined. Experts consulted and their views on PES for earth worm ecosystem services were critically examined. Finally, a means of incorporating earth worm services into "*Divineguma*, a rural livelihood promotion programme was suggested with possible implications.

Key words: *Earth worms, Payments for Ecosystem Services (PES), Market based policy tools, economic instruments, Strategic resources mobilization, Divineguma Programme*

PAYMENTS FOR ECOSYSTEM SERVICES (PES)

Understanding the full economic value of ecosystems and biodiversity to those who benefit from them can encourage investment in their protection and enhancement. Payments for Ecosystem Services (PES) value ecosystem services conservation and increase income generation in rural areas, food security and sustainable development. PES schemes can be found in all continents. Most PES schemes revolve around three of ecosystem services: water and soil-related services; climate stabilization; and biodiversity conservation. Although PES schemes may be focused on the enhancement of one ecosystem service, interventions have multiple benefits; reforestation may target carbon sequestration but it will also produce positive impacts on water quality and biodiversity. Thus, there is a need to develop PES schemes that address bundled ecosystem services. Signifying fauna, flora and the habitats as ecosystem service providers, is a novel experience for Sri Lankan community. But, latest developments in the Millennium Environment Assessment identified four categories of ecosystem services and viewed components of biodiversity as natural capital or wealth suggesting tools towards inclusive growth.

Earthworms play a vital role in soil ecosystems and their presence to sustain a healthy soil was already highlighted by Charles Darwin in 1881. They represents > 80% of biomass of all terrestrial invertebrates in soil ecosystem and their communities give a clear indication of healthy soil. Their contribution to complex

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processes such as litter decomposition, nutrient cycling, soil aggregation and pedogenesis as ecosystem engineers is very important. Hence, presence of earthworms is beneficial to soil ecosystem, and the ecosystem services they provide are priceless. Earthworms inhabit in a wide range of soil types and horizons, thereby being classified in the ecological categories as epigeic species that are surface active and feed on decaying matters, the anecic species that feed on leaf litter mixed with soil in the upper layers and the endogeic species that feed on organically rich soil which they used to build permanent burrows in deep mineral layers. Earthworm activities in soil and associated process have largely contributed to their ecosystem services and could be used in rural livelihoods.

EARTH WORM CULTURE AS A NEW LIVELIHOOD VENTURE

Earth worms are not easily visible like other terrestrial fauna of birds, mammals *etc.* They are hidden inside soil or in decaying organic matter. Laymen's understanding and awareness are minimal about the valuable services provided by them. Although not a popular organism, their ecological functions cannot be sustainably replaced by other natural or synthetic means. As a policy decision, the Government is promoting organic means of plant nutrition for phased out reduction of fertilizer subsidy. Government appreciates rearing livestock such as cattle, goats, poultry *etc.* There are incentive schemes to promote livestock husbandry. If backed with strong policy directives, strategies and actions employing right tools with target groups, earth worms will mainstream their beneficial ecosystem functions into rural economies.

RATIONALE

Sri Lankan economy is operated by a vibrant services sector. There is a potential for in -cooperating earthworm services into economy. One potential way is to mainstream earth worm services in to rural livelihoods. Their ecosystem services can be identified, defined, valued and mainstreamed into national economy. Vermi-composting is one of the services derived and has the potential to make livelihoods more sustainable and enhance the sustainable livelihoods in rural areas in spite of spending 2% from the GDP to import fertilizer to distribute among farmers as a national fertilizer subsidy. Vermicomposting, using earthworms, is recognized as an eco-biotechnological process that can transform complex organic substances into stabilized, humus-like products. Earthworms accelerate the mineralization rate and convert manures into casts with a higher nutritional value and degree of humification than the composts resulting from traditional methods of composting. The increased mineralization and conservation of nutrient are due to the biocatalytic effect of earthworms in the decomposition and conservation mechanism. The extent to which vermicomposts influence soil properties and therefore soil restoration or soil losses, however, depends on the amount, type, and structure (functional groups, molecular weight, humification, *etc.*) of the added organic materials. Their effect on the maintenance of environmental quality will depend on the substrates used during the vermicomposting process. The application of organic matter to degraded soils is a good environmental practice and innovative green technology. Although vermicomposting is a viable recycling technique, it has very little popularity in soil waste management process in Sri Lanka, mainly due to the lack of large scale compost worm production.

OBJECTIVES

Overall objective:

To assess potential earthworm species and incorporate their ecosystem services into large scale vermicomposting practices to empower the rural economy. In addition we investigate the effects of vermicompost on contaminated soil aiming to increase the productivity of agro soil ecosystems.

METHODOLOGY

Identification of potential species:

A survey on earthworms was performed in selected home gardens and agro ecosystems in the Southern, Uva and Central provinces. Worms collected were classified according to the ecological categories as epigeic, anecic and endogeic species.

Identification of potential substrates:

Compost worm production was investigated in locally prepared artificial soils (AS) using paddy husk, saw dust and coco peat (composted & uncomposted). Adult earthworms of compost worms (*Eisenia sp* and *Perionyx excavatus*, n = 10, 6 replicates) were introduced into prepared AS and incubated under tropical conditions for 28 days. The moisture content of the prepared AS was set to 50% of the respective water holding capacities. After 28 days adults were removed and containers were kept for another 28 days for hatching of the juveniles. Mortality and mean number of cocoons (28 days) and juvenile production (56 days) were determined. Temperate artificial soil was used as the control substrate.

Effects of vermicompost on contaminated soils:

Selected vermin compost concentrations which caused a mortality of less than 50% were prepared using relevant the weights of contaminated soil and vermin composts. The mixture of soil was added into glass bottles with 750ml volume. Age – synchronized adult earthworms (300-600mg) were obtained from cultures maintained at the Department of Zoology, University of Ruhuna, Sri Lanka. Ten earthworms were taken, rinsed with water, blotted dry on filter paper and initial weight was measured & introduced into each bottle filled with mixture of vermin composts & contaminated soil of three replicates for each concentration. 5g of fresh frozen finely ground cow manure which was moistened to 50% (w/w) were added into a hole in the middle of the soil. The lids were not closed tightly to facilitate free exchange of air. The test containers were kept at 26± 20C and 12D:12L hrs photoperiod. Moisture loss from the test mixture was checked by weighing the test containers at weekly intervals & replenished as needed to maintain a moisture content of 50% WHC max. After 28 days of introduction, adult worms were removed by hand sorting and the final weight was measured for ten worms. The mixture was returned to same and kept for another 28 days for cocoon development. After 56 days, juveniles were extracted from the test mixture using a water bath at 60⁰ C and counted. The final endpoints studied were change of biomass after 28 days & number of juveniles produced after 56 days.

Establishment of vermin composting units and profitability:

Selected earthworm species and potential substrates were introduced to commercial vermin composting units and to selected households to assess the economics and profitability of the vermin compost use. Production costs were divided as variable and fixed costs, and project evaluation was carried out for each unit.

CONCEPTUAL OR THEORETICAL FRAMEWORK

Identified ecosystem services by earthworms will be used to commercial production of vermicompost. Vermicompost is a good replacement for artificial fertilizers in the short term and it will increase the soil fertility in the long term. Successful vermicomposting production depends on suitable species and potential culturing substrates. In addition, the quality of the vermicompost and its effects on contaminated soils can be quantified. Finally, such approaches can easily be used to empower the rural economies.

RESULTS/FINDINGS

The recorded earthworm fauna in study areas was dominated by Family-Megascolidae (43 species), Family-Octochaetidae (12 species) Family – Monilgastridae (6 species), Family-Lumbricidae (3 species) and Family - Eudrilidae (1 species). Family-Magascolidae consisted 56 % of the indigenous species including 12 endemics and exotic earthworm *Periyanix excavatus* was the dominant species. The highest abundance was reported with Family-Eudrilidae represented by *Eudrilus eugeniae*, an exotic species, followed by *Eisenia fetida* (Family- Lumbricidae). The recorded species such as *Eisenia fetida* and *Periyanix excavatus* have already been widely used in vermicomposting. The results indicate that artificial soils made from composted coco peat give similar performance in juvenile production of both compost worms tested and

may be used in mass scale compost worm production under tropical conditions. Experiments carried out to investigate the effects of vermicompost on contaminated soils found that 5% to 25% vermicompost was the suitable range of amendment and 50% and 75% amendments were highly toxic to the adult worms. Higher toxicity reported could be linked with high acidity and high mineral content in higher vermicompost amendments. Tests with growth and reproduction of earthworms indicate that the optimum amendment concentration was 5% amendment. Introduction of earthworm species *Eisenia* was very successful in both commercial and household units. Variable costs were carried with level of output but fixed costs only marginally varied with output.

CONCLUSIONS AND POLICY IMPLICATIONS

The conversion of earthworm ecosystem services into rural economy has a good potential. The applicability of such a frame work depends on species selected, suitable substrates and profitability. Novel livelihoods such as large scale culturing of suitable species and vermicomposting can be introduced in rural areas to uplift the social status. “Self - help groups” of rural women can be incorporated with activities such as vermicomposting and vermiculture aiming a better life and also aiming at a healthy environment and the promotion of sustainability.

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