# Connotation of minor millet biodiversity and indirect payments in tribal homesteads in the backdrop of climate change.

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# CONNOTATION OF MINOR MILLET BIODIVERSITY AND INDIRECT PAYMENTS IN TRIBAL HOMESTEADS IN THE BACKDROP OF CLIMATE CHANGE

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## ABSTRACT

Unscathed agrobiodiversity remaining in-situ today is found on the small-scale farms and homestead gardens of poorer and developing countries (Brookfield, 2001). The indigenous traditional farming of Muthuvan tribe as the case of Finger millet or Ragi (*Eleusine coracana*), a minor millet cultivated in the Western Ghats in Kerala in the Indian South is one such classic example for in-situ agrobiodiversity management, based on organic farming systems. On such fields, the use of labour intensive, traditional production techniques have persisted throughout the period of controlled state farming and the market based large-scale farming. The homestead gardens close to fringes of 'South Western Ghats-the hotspot of biodiversity' also play a crucial role in tribalistic context, by contributing to the rural livelihoods in time periods and locations when markets or state institutions do not. This paper attempts to analyse the opportunity costs of minor millet cultivation incurred by indigenous tribe in scheming compensations for biodiversity conservation. It further discusses possibilities to deliver a tangible and hopeful alternative towards sustainable livelihood in the backdrop of climate change. The methodology involves use of 'Switching Regression model' in the estimation and comprehension of opportunity costs, and further looks at its relevance in traditional farming of underutilised minor millets in the tribal homesteads and is equated in terms of indirect payment for biodiversity conservation. The analysis of results concludes the importance of creating incentives for the conservation of agrobiodiversity, especially the on-farm diversity of underutilised crops and supporting poverty alleviation, and preventing welfare losses among vulnerable communities.

**Key words:** agro-biodiversity, muthuvan, minor millets, opportunity cost, payment, organic agriculture, tribal homesteads, sustainable livelihoods, indigenous people, climate change.

## INTRODUCTION

Unscathed agrobiodiversity remaining in-situ today is found on the small-scale farms and homestead gardens of poorer and developing countries (Brookfield, 2001). The indigenous traditional farming of Muthuvan tribe as the case of Finger millet or Ragi (*Eleusine coracana*), a minor millet cultivated in the Western Ghats in Kerala in the Indian South is one such classic example for in-situ agrobiodiversity management, based on organic farming systems. On such fields, the use of labour intensive, traditional production techniques have persisted throughout the period of controlled state farming and the market based large-scale farming. The homestead gardens close to fringes of 'South Western Ghats-the hotspot of biodiversity' also play a crucial role in tribalistic context, by contributing to the rural livelihoods in time periods and locations when markets or state institutions do not.

Conservation of existing biodiversity in agricultural landscapes and the adoption of biodiversity-based practices have been proposed as ways of improving the sustainability of agricultural production through greater reliance on ecological goods and services, with less damaging effects on environmental quality and biodiversity (MEA, 2005).

As mentioned earlier, the paper presents the conservation of minor millet 'Ragi' in tribal setting and explores its connotation as a global public good or services. It also addresses the synergistic relationship between agrobiodiversity conservation and climate change combat practiced by Muthuvan tribal community of the Western Ghats. By stressing the role of indirect payments in conservation and services, involuntarily offered by these tribal people, it further attempts to estimate the opportunity costs involved in this conservation process by employing 'Switching Regression model' and finally looks at the policy prospects of certification and eco-labelling as indirect market instruments for agrobiodiversity conservation.

**UNDERPINNING PRINCIPLE**

Since ancestral times, the community of Muthuvan inhabiting the Western Ghats biodiversity hotspot practiced cultivation of indigenous varieties of many types of minor millets and underutilised crops, especially the Ragi (*Eleusine coracana*) for survival and subsistence, with minimum ecological footprint. The traditional germplasm collection of minor millets saved in the indigenous tribal gene banks may have undergone little changes from the wild ancestor. Hence many traits of drought and water use efficiency embedded in the wild varieties remain as a research area for future varietal improvement during times of climate change.

Minor millet biodiversity is pivotal for these vulnerable and geographically isolated tribal people in two aspects, (1) in food security, (2) also the usefulness of their minor millet farming practices as a climate combat mechanism. Their traditional farming and biodiversity conservation practices are time tested environmentally sustainable livelihood mechanisms that remain intact until today. However, the cultural and behavioural bases of biodiversity conservation among these tribal people are fast changing with the influence of mainstream population. Presently, these sustainable agrobiodiversity conservation practises are under the threat of loss if not supported with optimum payment of incentives. Hence, it is apparently essential that the ecologically friendly farming practice of subsistence of Muthuvan tribal farmers in the Western Ghats, their knowledge of indigenous seeds and their conservation methods merit attention of global payment instruments of agrobiodiversity conservation.

## *Agrobiodiversity conservation paradigm and indigenous farmers*

In the recent past, the biodiversity and ecosystem conservation and associated payment efforts focussed largely on carbon sequestration and storage, watershed protection, protection of landscape aesthetics and non-domesticated biodiversity protection and forest conservation. A review of the Payment for Ecosystem Services (PES) literature covering hundreds of PES and PES-type schemes reveals that there is hardly any consideration of PES in the context of crop and livestock genetic diversity and only limited consideration of indigenous farmer contexts (inter alia, Landell-Mills and Porras 2002; Pagiola and *et al*. 2002; Mayrand and Paquin, 2004; Wunder, 2007; Ravnborg and *et al*. 2007; Dasgupta and *et al*. 2008).

By and large, forest biodiversity PES schemes focuses conservation of wild biodiversity, maintaining forest areas while halting the expansion of agricultural land (Narloch, 2009). In countries like India, at biodiversity hotspots and forest fringes, where thrust is on participatory forest management (PFM) and forest related biodiversity conservation, the involuntary agrobiodiversity conservation by indigenous farmers is often neglected. This ignorance on the part of policy focus has contributed to accelerated erosion of agrobiodiversity.

## *Significance of minor millets in tribal livelihood and culture*

The Ragi (*Eleusine coracana*) plays an important role in the Muthuvan way of living. They call it 'Kepa' and use it for preparing a pudding called 'Katty' which they use as food. For time immemorial, Ragi has met the nutritional requirements of these Muthuvans while many tribal communities of other parts of India have switched to modern diet following the mainstream population. The farming practices of Ragi (Kepa) are unique in many aspects as they use farm saved seeds and adopt organic practises, without using any synthetic fertiliser or pesticides. Muthuvan people are aware of the importance of mixed cropping. Accordingly they cultivate Amaranthus , other underutilised vegetables and mustard along with Ragi. They sow the seeds of Ragi and Amaranthus together with the onset of South West monsoon and the Amaranthus is harvested after one month of sowing while the Ragi is harvested thrice starting from August to December.

The Ragi seeds for the coming season are conserved indigenously by hanging them in bundles together with the straw over a platform of mud and clay with provision for smoking. The smoke prevents the attack of insects and other pests of seeds, and they remain viable for many growing seasons up to 4-5 years. But the tradition remains only in isolated Muthuvan patches like Edamalakudi and is fast vanishing among other Muthuvan hamlets.

## *Tribal strategy of conservation and climate change combat*

The Muthuvan use and conservation of indigenous Ragi varieties and organic farming practices are inherited from their ancestors. These are quite distinct and remarkable in terms of agrobiodiversity conservation and climate change combat. The usage of water-use efficient and drought tolerant indigenous varieties together with organic farming practices helps them adapt and mitigate climate change anomalies. In their farming one could find synergies between agrobiodiversity conservation and involuntary adaptation and mitigation practices against climate change.

At the same time, rain fed farming practices of Muthuvan community make them vulnerable to climate change as there are increasing concerns over the erratic rainfall pattern and delayed monsoon features in many parts of India. The conservation part of these tribal people often remains unrecognised and vulnerability of these communities to greater disasters of climate change due to their geographical isolation are matters of worry in the present and future times.

### THE STUDY SETTING

The study was done in the year 2008 and covered three tribal hamlets (settlements) located in the Western Ghats region which is one of the 25 biodiversity hotspots in the world (Myers, 1988). The tribal hamlets selected for study were situated in the Idukki district of Kerala state in Southern India. The first and second hamlets chosen for the study were Periakudi and Mulakuthara tribal hamlets of Edamalakudi in Munnar Forest Division under Devikulam village and the third one being, the 5$^{th}$ Mile tribal settlement in Munnar Forest Division under Mannan Kandam village.

The ecological importance of the geographical area and agronomic behaviour of these tribal people were the main determinants for hamlet selection. Edamalakudi is part of the dense shola forest of south Western Ghats and situated about 40 kms away from the nearest town Munnar. The forest inhabitants in Edamalakudi are the 'Muthuvans'- a tribe of the Proto-australoid group (Damu, 2003).

Edamalakudi has more than 30 Muthuvan settlements of which Edalippara, Mulakuthara, Periakudi, Puthukudi, Kanakudi, Shedkudi are the important ones. Unlike the Muthuvan settlements in other parts of the state, the Muthuvan tribe in Edamalakudi remains one of the most isolated indigenous tribes in the Western Ghats. This is mainly attributed to the extreme difficulty to reach the place as one has to travel more than 20 kms by feet through dense forest along steep slopes amidst of blood sucking leeches and insects. In fact these exertions of the mainstream population to access the place and reclusive nature of this indigenous people have helped them conserve their traditional customs, virtues of agrobiodiversity conservation and cultivation practices inherited from their ancestors.

In contrast to Edamalakudi, the 5$^{th}$ Mile hamlet lies in proximity to the Adimaly town. Therefore tribals inhabiting there had more chance to closely mingle with the mainstream non-tribal population, which had far greater impact on their tradition and farming practice. As a result, the 5$^{th}$ Mile Muthuvans practised input intensive conventional farming using modern varieties, including cash crops like Rubber and Pepper. Hence under this study we treat the Muthuvan community in Edamalakudi as '*Conservation farmers*' and 5$^{th}$ Mile Muthuvan community as '*Conventional farmers*'.

## CONCEPTUAL FRAMEWORK

Agricultural biodiversity or agrobiodiversity is imperative for human existence providing numerous use values and non-use values. Agrobiodiversity plays an important role in providing food security, as a base of tradition and culture and also in industrial and pharmaceutical use. In spite of this, agrobiodiversity at the ecosystem, species and genetic levels continues to be lost at a fast pace from many production systems throughout the world, with far reaching consequences, especially for poor indigenous farming communities. The prime constrains in recognising the conservation efforts of these indigenous people are the valuation and estimation of their services. For instance, the application of a compensation criterion would require detailed information about the opportunity costs from each individual provider, including all types of transaction and opportunity costs need to be identified and valued accordingly (Pascual, 2009).

The choice and use of any variety, be it local or modern, involves trade-offs and opportunity costs (Wale et al., 2005). Additionally, we argue that the farmer's decision on nature and kind of agronomic practices and the choice of variety and access to farm extension and market information also incurs opportunity costs and trade-offs which need to be accounted while implementing suitable payments. Under the present study, we took two categories of farmers (1) conservation farmers and (2) conventional farmers from the above mentioned Muthuvan community, but from two completely different tribal hamlets, with discrete agro-behavioural features and attitude towards traditional practices.

The Edamalakudi Muthuvan farmers (*Conservation farmers*) practise their age old traditional practices taught by their forefathers and use farm saved seeds. Their traditional cultivation practices are observed to be nearer to organic farming even though they lack the financial, physical and human capital as well as the bargaining power for organic certification. The decision not to switch to modern varieties or to input intensive agriculture has higher opportunity costs when comparing the gross benefits they accrue by doing so. The opportunity costs might be financial and non-financial; conversely, this study confines itself to gauging the financial opportunity costs only.

The magnitude of the opportunity cost also depends on the natural capital (environmental suitability), physical capital (agriculture inputs), human capital (education and labour), financial capital (equity) and social capital (farm extension and farm clubs). The more favourable these conditions for conventional farming, the larger will be the extent of the opportunity costs and the higher the payment for biodiversity conservation needed.

The conditions equally affecting the modern variety and farm saved indigenous variety will not affect the total yield and benefits there off (Wale, 2007). Therefore, factors which do not have a differential impact on total yield of modern varieties and farm saved indigenous variety will not be considered for opportunity cost estimation.

For the payment of agrobiodiversity conservation to be efficient and effective, we assume the need for two satisfying conditions, (1) where the willingness to pay (WTP) of the beneficiaries (consumers) must be equal or greater than the willingness to accept (WTA) of the tribal farmers which is as follows:

WTA Tribal farmer ~ WTP Consumer and (2) $P \geq OC+TC$, where 'P' is the payment and OC and TC are Opportunity costs and Transaction costs respectively. In the background of this conceptual framework we attempt to estimate the Opportunity Costs (OC) of indigenous variety cultivation of Ragi by conservation farmers.

**METHODOLOGY**

In the present study, we have employed three tools (1) structured interviews for opportunity cost estimation, (2) participant observation and (3) participatory rural appraisal (PRA) methods for studying the community tradition, food habits and customs. As cited above, the data for opportunity cost estimation was collected during 2008 using structured questionnaire and the samples were selected randomly. A total of 90 households were selected, 45 numbers each from Edamalakudi (*Conservation farmers*) hamlet cluster and 5th Mile (*Conventional farmers*) tribal hamlets. To estimate the average opportunity costs, we used an econometric model of '*heterogeneous treatment effect statistical problem* – i.e. a *'Switching Regression model'*. The advantage of using this heterogeneous treatment is mainly to avoid sample selection bias as well as to fuse the individual opportunity costs of the samples (Freeman *et al*, 1998).

Let us consider the simple linear regression equation:

$$Y_i = \beta_i X_i + e_i \quad (1)$$

Where $(Y_i)$ is the Gross Margin ( dependant variable ). Then following Maddala, 1983 and Wale, 2007, we can split it into two conditions and the Gross Margins generated by the two equations as:

$$Y_{1i} = \sum_{j=1}^{k} \beta_{1j} X_{ji} + u_{1i} \quad \text{(Condition 1)} \quad (2)$$

$$Y_{0i} = \sum_{j=1}^{k} \beta_{0j} X_{ji} + u_{0i} \quad \text{(Condition 0)} \quad (3)$$

*also,* $$C = \gamma_i Z_i + u_i \quad (4)$$

where the errors, $u_{1i}$ and $u_{0i}$, are assumed to be distributed normally and independently, with mean zero and constant variance, $\sigma^2$. The $\gamma_j$'s are unknown coefficients to be estimated and $Z_{ji}$'s determine in which condition the $i^{th}$ observation is generated. This model allows a full set of interactions between variety use status and the *X*'s. The $X_{ji}$'s refer to dependant variables. *C* is the function that determines the conditions i.e. condition 1 holds when *C*=1 and condition 0 holds when *C*=0. The size of the gross margin difference in the two conditions ($\hat{y}_{1i} - \hat{y}_{0i}$) is the indicator for the opportunity cost. The signs and magnitude of the coefficients in the two situations are indicators for the impact of the respective variables on the gross margin foregone or the financial opportunity cost. Most of these minor crops are not traded outside the farming communities, except on a very limited scale in the local markets (G P. Gruère, 2007). Hence, we used market price of Ragi prevailed in markets of nearby states like Karnataka and Tamil Nadu (with 2008 as base year) for estimates, since the surveyed Muthuvan community use produce for own consumption.

Then the general equation for opportunity cost is

*Opportunity Cost (OC) = [Gross Margin of Modern Variety (GMMV) - Gross Margin of Indigenous Variety (GMIV)]*

## RESULTS AND DISCUSSION

The Table 1. below reports descriptive statistics for the variables used later in the regression. The variables which are found to significantly distinguish *Conventional farmers* from *Conservation farmers* are education, experience in growing modern varieties (MVs), fertilizer use, field quality and gross margin per hectare.

The results of regression shows that experience with modern varieties, use of fertiliser, output price, education and rainfall are the most important factors governing the gross margin of conventional farmers while experience in conservation of seeds and traditional farming, field quality, proximity to the forest and rainfall are the factors affecting the gross margin of conservation farmers see Table 3.

The computed opportunity cost is rounded off to Rs. 1668/ha/landrace/year. This means that for the conservation of a single landrace (indigenous variety) under conservation farming in a hectare of land in any year, the total payment must include an opportunity cost of Rs. 1668. [For e.g. assuming 'N' landraces for each crop with three replications of 1 ha each, financial compensation cost for insitu/on-farm conservation of indigenous Ragi variety can be computed as (N∗1668∗3)].

It should be noted that this is only an indicative value of probable opportunity cost computed from, between two categories of tribal farmers belonging to the same community within or nearby the same agro-ecological region. However, the computed opportunity cost may vary with respect to social and geographic aspects of conventional farmer (large, medium or small and lowland, midland or upland) under a given study. Hence it is suggested to relate farmers of comparable features with respect to social and geographical attributes for estimating forgone income of agrobiodiversity conservation.

The average cost-benefit comparison of conventional and conservation farmers are given in the Table 2. The difference in net margin is Rs. 865/ha/season and this is indeed a significant amount for the geographically isolated, resource poor tribal population. As these differences in subsistence or farm income make them vulnerable to various risks and uncertainties. Nevertheless, payment of agrobiodiversity for the conservation efforts of indigenous community should help them cope with risks and may warrant as an insurance against uncertainties.

**Table 1.**

**DESCRIPTIVE STATISTICS**

| Variable and description | Mean & SD Conventional | Mean & SD Conservational | Effect on OC |
|---|---|---|---|
| Gross Margin/ha (dependant variable) (Rs) | 1970.38 (843.12) | -114.12 (466.12) | Insignificant |
| Experience in growing MVs | 4.3 (2.3) | - | + |
| Education in years of the farmer | 5.8 (2.6) | 0.45 (1.5) | + |
| Fertiliser used per ha | 75.4 (425.2) | - | + |
| Rainfall distribution (0=poor, 1=medium, 2=good) | 1.3(0.7) | 1.1 (0.6) | + |
| Input price index (included seed price) | 0.99 (0.3) | 0.83 (0.6) | - |
| Field condition (3=poor, 2=medium, 1=good) | 1.91 (.6) | 1.1 (0.7) | + |
| Household's proximity to forest* (Km) | 0.91 (123.5) | 0.13 (36.3) | + |
| Ragi price index | 1.02 (0.4) | 0.81(0.3) | + |

Source: Hamlet survey, 2008

Notes:

*Reserve forest

MV-Modern varieties

Prices used are for year 2008 fiscal (base)

**Table 2.**

**Average cost/benefit comparison of Ragi (*Eleusine coracana*) per hectare**

(as practised by the Muthuvan tribe)

| Components | Conventional (Rs.) | Conservational (Rs.) |
|---|---|---|
| Land Preparation | 750 | 600** |
| Seeds & sowing | 130 | 50** |
| Manures & Manuring | 250 | 50** |
| Weeding | 360 | - |
| Plant protection | 100 | - |
| Harvest and other Expenses (Rs.) | 600 | 600** |
| Total | 2190 | 1300 |
| Yield (Kg) | 920 | 530 |
| Gross Income (Rs.) @ Rs. 4.5/kg* | 4140 | 2385 |
| Net income (Rs.) | **1950** | **1085** |

Source: Hamlet survey, 2008

Note:

* average Ragi price during the 2008 fiscal year

** family/own labour and own farm yard manure

Prices used are for year 2008 fiscal (base)

The corresponding values were rounded off from the actual estimates

**Table 3.**

**Results of *Switching Regression***

| Condition 1 - Conventional farmers | | Condition 0 - Conservation farmers | |
|---|---|---|---|
| Variable | Coefficient | Variable | Coefficient |
| Constant | 597.3 (2.3) | Constant | 1212.52 (4.1) |
| Exp. in consv. Agbio | -123.7 (3.1) | Exp. in consv. Agbio | 376** (1.2) |
| Experience in MVs | 208.7*** (9.3) | Experience in MVs | -426.2 (2.3) |
| Education in years | 6.6 (0.27) | Education in years | 12.73 (0.46) |
| Fertiliser used per ha | 0.28(0.71) | Fertiliser used per ha | -0.34 (-0.53) |
| Rainfall | -207.6*(-1.27) | Rainfall | -286.6***(-3.7) |
| Input price index | -818.6***(-2.0) | Input price index | -783.1 (-1.2) |
| Field condition | -81.3(-0.68) | Field condition | -151.8***(-3.4) |
| Proximity to forest (Km) | 89.3(1.6) | Proximity to forest (Km) | 203.5**(3.1) |
| Ragi index | 245.1***(1.3) | Ragi index | 295.6***(1.4) |

**Computed OC (in Rs.) = 1667.632 ~1668/ha/year**

Notes: ***, ** and * show significance at 1%, 5% and 10% respectively.
Values in parentheses are the ratio of the coefficient to the estimated standard error.

## CONCLUSION AND POLICY SUGGESTION

The analysis of results concludes the importance of creating incentives for the conservation of agrobiodiversity, especially the on-farm diversity of underutilised crops and supporting poverty alleviation, and preventing welfare losses among vulnerable communities. The accurate estimation of opportunity costs can throw light in designing optimum policies and scheming of payment mechanisms (whether direct or indirect). The estimates of parameters involved in the decision of payment for compensation become more relevant, when the stakeholders have information of these which will support them in bargaining for equitable and efficient ways. The idea of compensating farmers may be controversial in both academic and political circles (Wales, 2007). Nevertheless, here we are not speaking about paying the money directly to the farmer in cash because it involves lack of sustainability and '*dough dependence disorder'*, thus leading to externalities and failure. In the recent and past, which had have happened to many tribal development schemes and programmes both by government of India and the states. These past experiences show direct payments are found contextually doubtful. Thus the thrust should be financial, market-based or labour- based incentives which are indirect in nature.

Looking for specialised markets for products of traditional varieties is another market-based incentive mechanism. It is also possible to create forward and backward linkages to improve the utilisation of traditional varieties of crops and commodities by value addition, organic certification or eco-labelling.

In case of agrobiodiversity conservation near the forest fringes or hotspots of biodiversity where endemism of flora and fauna are of greatest importance, there the possible framework should encompass *'participatory forest and biodiversity conservation strategy'* a participatory approach securing the interests of all stakeholders of forests and biodiversity. Here the options of linking the on-farm conservation by indigenous people with proven mechanisms like participatory forestry, food for conservation and rural employment guarantee scheme can be thought of and devised. Furthermore, as these indigenous communities are carrying out involuntary, in-situ/on-farm conservation, they often also deliver prospects to implement relatively low-cost conservation strategies through continued sustainable use. Such payment structure also has the co-benefits of contributing to poverty alleviation and sustainable livelihoods.

The geographical areas of agrobiodiversity, indigenous communities and traditional agronomic practices which are voluntarily or involuntarily following organic agriculture should be brought under the purview of organic certification with proper scrutiny. Since it may be of abundant significance to resource poor people like those in Edamalakudi to whom chances of organic certification are a world away, owing to lack of both financial and bargaining power. At the same time, such certified communities, geographical areas and practices should be periodically monitored to avoid incongruities in future.

Apart from organic certification, Agrobiodiversity certifications (ABC) and Agricultural carbon credits (ACC) are possible ways of incentive support. Similar to carbon credits, agrobiodiversity conservation credits (ACC) could be awarded to farmers who nurture wild and cultivated agrobiodiversity in their fields (Sthapit, *et al*.,2009), also to those who conserve agrobiodiversity or carbon friendly farming practices, such as no-tillage and resource conserving technologies. Here the task will be the assessment of agricultural carbon credits, which is also challenging in the case of agriculture sector of India as a whole. However, there are innovative strategies in the direction of carbon credits and trade like 'Budget approach' (WBGU, 2009), which India should analyse at polity, policy and political levels for climate negotiations and compliance.

In short, public – private partnership in conservation, product labelling and agrobiodiversity farm certifications and proper assessment of parameters in economic valuation and costs involved in conservation are needed towards efficient and equitable payments for agrobiodiversity.

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