



## Energy Service Companies using PVs for Rural Energy Provision in Eastern Zambia

By Anders Ellegård and Mattias Nordström, SEI

The location was a church in Eastern Zambia. It was October 1998. It was hot, and the sun sent glowing rays through small holes in the tin roof. The congregation was over six hundred persons from the surrounding villages. The occasion was a meeting to inform them about solar photovoltaics (PV) and a project being launched by the Zambian Department of Energy (DoE) and the SEI to form energy service companies (ESCOs).

### Will these things exhaust the sun?

A man in the rear of the church raised his hand and said: We have heard that we no longer can use petrol because it destroys the atmosphere and the environment. Now if we start using these solar things, can we be sure that they will not exhaust the sun?

We tried to answer as correctly as possible, saying that there is absolutely no risk, the sun does not get more exhausted from shining on a PV panel than on one's laundry or straight on the ground. But his question actually put our role in a new light. From his perspective, a *muzungu* comes with new ideas and technical gadgets, convinces local people to use them, and then leaves. The next *muzungu* comes along and tells him how dangerous it is to use the same gadget. We were not the first *muzungus* in the area.

What the question might teach us is that introducing new ideas and technologies takes time and commitment to make them work. It should also teach us to never forget the social and cultural fabric in which these technologies are to be implemented. In these respects it was an important question.

### The ESCOs project

The project narrated in this article aims at testing the commercial viability of the ESCO concept (see Box 1) in rural areas of Zambia. The basic question to be answered is whether private entrepreneurs can provide rural energy services that are reliable and sustainable. An important expected result of the project is a new framework for the promotion of private initiatives in the energy sector in Zambia. The project has also provided an opportunity to disseminate PV technology in Zambia in general, and in Eastern Province in particular.

One of the most important achievements of the project has been a strengthening of the national capacity to manage vari-



Photo: Anders Arvidson

A typical commercial ESCO customer in Nyimba Township – a small general shop with PV-powered lighting

ous aspects of PV systems, and a public recognition of the potential of photovoltaics. The existence of a consistent regulatory framework, along with capacity in government agencies and elsewhere to disseminate knowledge and implement regu-

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lations, is considered crucial. Without these parts of the puzzle, an introduction of PV systems on a larger scale could backlash.

At the national policy level, the project has provided significant field experience for the coordinating agency – the Department of Energy – as well as for the Energy Regulation Board (ERB). The ERB is responsible for (among other things) inspecting and licensing all electric installations in Zambia, and is charged with assessing the quality of the installed Solar Home Systems.

The DoE, which is responsible for developing Zambia’s energy policy, has learned about the real barriers and constraints in the introduction of private ESCOs based on photovoltaics. The DoE is more informed of the costs and limitations of providing rural energy services through PV-ESCOs and is better able to insure that expectations of clients are realistic. This increased awareness will enhance Zambia’s energy policy and contribute to the design of policy instruments and the choice of technologies to support rural energy provision.

More general national economic policies have also evolved, due in part to this project. The import duty on PV equipment has been removed in Zambia. License applications for establishing energy service companies for installing and maintaining PV systems are free of charge.

The Department of Physics, University of Zambia (UNZA), has a long history of research on solar energy. Through this project, there is now also the capacity to train electricians and technicians in the installation, maintenance and repairing of all components in a Solar Home System. Furthermore, the University technicians have acted as field support to the ESCO technicians who have graduated from the training course. There is now awareness about PV technology on the ground, and there is an emerging cadre of skilled technicians and experienced business managers in the Eastern Province where the pilot activities have been concentrated.

### **Business development**

What has been noticed so far is that the services provided by the ESCOs seem to



Photo: Anders Arvidsson

*Worker at a diesel-powered grain mill served with lighting by Nyimba Energy Service Company (NESCO), facilitating improved and extended operation of the mill.*

be more popular among small businesses than originally anticipated. These businesses include shops, restaurants/bars and mills, and some of the owners have said that they now have a competitive edge in the form of longer opening hours or the possibility to attract customers using loud music. Whether they will find the additional costs incurred to be worthwhile in the long-term remains to be seen.

During the coming two years, a number of important issues will be investigated. Arguably the most important is finding out the actual risks and costs involved in the ESCOs operations. This is crucial as it is the basis for a more accurate financial valuation of the business. In the present situation, credit institutions and insurance companies have no experience with small private companies providing

### **Box 1: The Energy Service Company Concept**

The basic concept of the ESCO is that the client buys an “energy service,” such as light in two rooms for at least four hours per day. The client does not buy the equipment. The equipment remains the property of the Energy Service Company, and it is the duty of this company to maintain it and see that it provides the energy services that are promised. The Energy Service Company is typically a private business, either created for

this purpose, or is an offshoot of an existing company. It is in the business to make a profit from supplying the energy services.

The client pays for the services provided, such as lighting or entertainment, on a regular basis. Furthermore, he/she is responsible for protecting the systems against damage and theft, and is not allowed to modify the installations in any way.

energy services in rural areas, are reluctant to provide commercial credits, and demand excessively high insurance premiums. Information on what technical components are most vulnerable as well as the preferred customer profile will be sought to facilitate effective design and efficient marketing of the PV systems.

At present, the project promotes two types of systems:

1. Traditional Solar Home Systems, with ESCO staff collecting monthly fees.
2. Pre-payment systems, where the customer buys a token or a code in advance to use the system for a fixed amount of services.

This permits a comparison with the potential benefits from pre-paid systems, which include a reduced risk of non-payment and reduced administrative costs for the ESCO staff.

### **Issues and challenges for the future**

After over two years of project implementation, it is still too early to draw final conclusions, but substantial experience has been obtained and a number of lessons have been learned, as summarised below. The experience thus far suggests a number of challenges that need to be addressed in future project development and efforts aimed at replication.

Initially, the project was conceived essentially as a credit mechanism, with some training components. However, extending credit for the purchase of solar PV systems proved to be very difficult. Local banks were not interested in handling these issues, much less take any risk of their own. Interest rates to be charged, if only to offset inflation, were exorbitant, and it was certainly not possible to create a regenerating fund from the paybacks.

The project aims to support the emerging market for solar PV in Zambia. The energy service companies should therefore use the existing local capacity for supply of PV systems and supporting hardware. Experience from the project shows that customers for all the systems were not readily available at the same time as the bulk deliveries of equipment



Photo: Anders Arvidson

*Farmers in front of the diesel-powered grain mill in Nyimba Township, now served with lighting by Nyimba Energy Service Company (NESCO).*

arrived. This raises the question of whether bulk procurement is appropriate in these circumstances, especially if the time required for customers to enter into agreement with the ESCOs stretches over several months.

In the future, an important goal will be to increase and encourage contacts between the newly established ESCOs and local suppliers willing and able to supply the equipment and/or technical competence that is needed.

### **Ownership**

Early on in the project, it was found to be impossible to expect rural consumers to pay fees allowing for repayment of capital under market conditions. However, as the project proceeds, a mechanism for transferring ownership needs to be designed. Whether or not subsidies should be included needs to be carefully studied. The motivation for subsidies, as well as their design and level, will have to be evaluated, and suitable actors to participate in the system will have to be identified.

### **Expansion**

Mechanisms for expansion of the ESCO businesses need to be created, both for new clients who wish to participate in the present fee-for-service system, and for customers who wish to purchase their systems up front.

The final challenge is for the project to be as light-handed and invisible as possible, in order to allow the local companies to be able to develop according to their own capacity and assessment of conditions. If this is successful, then there is a possibility that the project will make a real difference for the rural population in the future.

All things considered, exhausting the sun is probably one of the smaller risks in the project. ■

*Muzungu: white person*

**Contact: Mr. Mattias Nordström,  
mattias.nordstrom@sei.se**

# Village Power 2000 – PVs against Poverty?

Commentary from a bemused observer

By Gerald Leach, Stockholm Environment Institute

The Village Power 2000 Conference – subtitled *Empowering People and Transforming Markets* – was held at the World Bank in Washington DC during 4–8 December 2000. Like its predecessors in 1994, 1997 and 1998, this 4<sup>th</sup> meeting attracted a large and diverse collection of actors from the rural and renewable energy scene: practitioners and theoreticians, talkers and doers, bankers and bureaucrats, enthusiasts and critics (and at least one bemused observer) – a total of 566 participants from 61 countries who assembled to hear over 130 presentations in a little over three days. The meeting was sponsored by the National Renewable Energy Laboratory (NREL), the US Agency for International Development (USAID), Winrock International, the UNDP/World Bank Energy Sector Management Assistance Program (ESMAP) and the World Bank.

The core theme of the meeting was the familiar one of how best to bring modern energy services to the two billion people who now lack them. Alongside, in bold

brackets, was the sub-theme of using modern energy services as a tool for development and poverty reduction; in the words of World Bank President James Wolfensohn “how to respond to the needs of our two billion clients ‘in the dark’ to help them lift themselves out of poverty and out of drudgery and to empower them to attain a secure future.” Under these headlines the meeting included major sessions on the usual related topics:

- policies for scaling up rural energy services;
- financing;
- traditional fuels and household energy;
- gender issues and how to ensure equitable benefits;

- developing energy markets; and
- case studies of income generation resulting from village power projects. Typically, about 75 crowded minutes and five presentations were devoted to each of these broad topics. What key issues and themes emerged from this packed agenda?

First was the continued dominance of photovoltaics (PVs) as the chosen energy supply option. Other technologies were almost entirely ignored, except for short breakout sessions on small-scale, hydro, wind and biomass. Also ignored was the question of how PV solar home systems, delivering tens of Watts to individual consumers for basic services like lighting, might be scaled up into a community power system delivering tens of kilowatts and higher-load energy services. This was a curious omission for a meeting about village power: if PV cannot be scaled up, with reasonable costs for high-wattage energy storage, it will begin to look decidedly shaky as

off-grid communities increase their income and energy-using activities, and hence their demand for power – a principal, long-term aim of providing modern energy services in the first place.

A second dominant issue was the extraordinary amount of uncritical flag-waving for off-grid renewables (and PV in particular) as the answer to rural energy provision – and, by extension – rural development as a whole. Many speakers presented their implementation “success story”, sometimes only months after installation had been completed. One keynote speaker (who shall remain nameless) even claimed that PV could answer all rural energy problems, including the so-called fuelwood crisis. PV-electric cooking, at around US\$8,000 a kilowatt, seems an un-

likely contender to replace the zero-cost, multi-kilowatt, three-stone cooking fire!

One or two voices did, however, call for a more sober and self-critical approach. Where were the studies – or even the anecdotal stories – not only of project failures and near-failures and how to

avoid them, but also the serious, longer-term follow-up studies which might validate each claim that this or that project is a “success” and thus provides a

good model for widespread replication? Where also are the large-scale studies on the financial viability of PV and other renewables for village power: how many schemes, for example, have genuinely paid their own way, without (hidden) subsidies or losses for turnkey operations by developers? And how many schemes could pay their own way if they were to be extended to lower income levels in rural societies?

A third notable theme was the emergence of what one might call the high-tech poverty quick-fix: PVs coupled to computers and the internet to reach across the rich/poor world “digital divide”, not least to support rural education and income-earning enterprises. A one-day workshop on Rural Telecommunications and Digital Technologies explored many aspects of this topic, including PVs and computers for schools and businesses, use of the internet for “distance education”, and rural telecentres. In principle, this broad concept seems exciting though challenging – and entirely laudable. But in practice, as revealed during VP 2000 by several project examples, serious doubts set in.

Your Bemused Observer wondered at this point whether he was getting too old to live with rapid change. Or was it perhaps that he’d visited the wrong villages in the developing world? Nothing in his experience of rural poverty had anything to gain from this display of rich world

**PV-electric cooking, at around US\$8,000 a kilowatt, seems an unlikely contender to replace the zero-cost, multi-kilowatt, three-stone cooking fire!**

**“how to respond to the needs of our two billion clients ‘in the dark’ to help them lift themselves out of poverty and out of drudgery and to empower them to attain a secure future”**  
**- World Bank President James Wolfensohn**



Photo: Roger Taylor, NREI

*Participants at the Village Power 2000 Conference, held in December at the World Bank in Washington, DC.*

electronic playthings. But then he read the Greenstar brochure and knew that what he ought to feel was anger at so much misdirected goodwill and effort. Greenstar, a US NGO, plans to set up “self-contained solar-powered communities around the world. Each centre has internet connections, health facilities, including telemedicine, a classroom complete with distance learning equipment, and a business centre, through which we will operate commerce in native natural products, focussed on “digital culture” such as music and art that can be duplicated and transported easily. Solar arrays power the unit, preserve medicines and purify water. *E-commerce is the revenue stream that pays for the facilities and brings wealth to the community*” [italics added]. Are they seriously proposing that development should ride on the back of the fickle, easily-saturated and failure-prone e-commerce markets of the rich world?

Fortunately, a few voices of broad experience and wisdom were able to restore your Observer’s normal equanimity. Amongst all the loud and persistent energy-centred hype – a few people painted on a wider canvas. Robert Thompson, the World Bank’s Director of Rural Development, noted that the escape from rural poverty is at least twin-tracked: increasing farm productivity and incomes while also helping farmers take up off-

farm income activities. The priorities are education, health, and then infrastructure to link communities into the national economy, of which one component is reliable power.

Arun Sanghvi, head of the Bank’s African rural and renewable energy initiative, placed modern energy services in their true position: important but not decisive. Rural poverty reduction, he said, must be based mainly on non-farm income generation via small and medium enterprises engaged in, for example, crop processing and packaging for urban markets. Modern energy is needed for this as well as for the more familiar lighting and TV consumer end-uses. No society has developed without electricity, he noted, but electrification is not development. And while technology matters for rural development, it is not sufficient.

But the wisest words – and the most resonant warning against the energy-centric approach so prevalent at VP 2000 – came from the echo of a speaker at a rural energy and development meeting held three years earlier in the very same World Bank building. After much talk from participants of the need for new and specialised financing schemes for PVs and other high-cost renewables, Jacob Yaron, a senior rural development expert at the Bank,

**“No society has developed without electricity... but electrification is not development. And while technology matters for rural development, it is not sufficient”**

presented an authoritative review of rural financial markets. Subtly but firmly, Yaron questioned the waves of special pleading by rural energy devotees for favourable financial markets and

privileged access to credit. The provision of affordable financial services for rural populations, he said, has been a prime component of development strategy for many decades, as a major tool for accelerating growth and reducing poverty. Recently, the core approach of providing concessional loans to farmers has been replaced by much wider financing for broader rural activities to reduce transaction costs, integrate rural with general financial markets, and mobilise voluntary savings as the main capital resource for the rural population.

It seemed a very long way from that magisterial appeal for the maintainance of a broad approach to the raucous energy-centric technician’s market place of VP 2000. But then, as they say, all is change but nothing really changes. ■

**Contact: Gerald Leach**  
[g.leach@btinternet.com](mailto:g.leach@btinternet.com)

**For a complete agenda and more information about Village Power 2000, see:**  
[www.rsvp.nrel.gov/vpconference/vpconference.html](http://www.rsvp.nrel.gov/vpconference/vpconference.html)

# India's Biogas Promise: Does it Have a Future?

By Sudhirendar Sharma, Editor, Rural Energy Journal

India's quest for biogas technology dates back to 1897, when the Matunga Leper Home in Mumbai utilized human waste to generate gas for meeting its lighting needs. Recognising the efficiency of biogas, the Matunga Home used biogas for cooking and running an engine generator from 1907 until 1920. Apparently their sewage drain became connected to the city sewers in 1920.

In the decades to follow, biogas research and development occurred at various levels. At one level, the Khadi & Village Industries Commission (KVIC), a government-sponsored umbrella organisation for rural industrialisation, was engaged in developing new efficient models for biogas generation from biodegradable waste. At another level, researchers at the Indian Agricultural Research Institute (IARI) in Delhi were developing efficient systems for anaerobic digestion of cattle dung. Several models were developed by 1950, the most notable being Grama Laxmi III, which became the prototype of the KVIC floating dome model. With this successful design, KVIC began field implementation in 1961 and installed over 6,000 biogas plants around the country by 1973.

But the biogas programme got a real fillip in 1973 when Dr. E. F. Schumacher, the doyen of the appropriate technology movement who was then adviser to the Government of India, took notice of the successful biogas plants during his travels and informed Prime Minister Indira Gandhi. This came at a time when petroleum prices were increasing and deforestation was damaging India's resource base. Mrs. Gandhi saw biogas as an answer to these twin problems and promised in her Independence Day address to the nation in 1974, that solutions to solve the crisis were in sight. She later inspired the launch of the National Project on Biogas Development (NPBD).

## **The biogas project**

In 1974, the Government initiated a field dissemination programme to test the

performance of biogas under diverse conditions. The project was later formally launched by the Ministry of Agriculture with an outlay of US\$10 million in late 1981. After a few months the project was transferred to the newly created Department of Non-conventional Energy Sources. The project focused initially on 100 selected districts, and a modest target of 400,000 biogas plants was set for the Sixth Five-Year Plan period. The average success rate of the plants was close to 85 percent.

This pilot project paved the way for a nationwide programme. Studies were first conducted to estimate the potential of biogas. Based on the 1961 livestock census, it was estimated that biogas could generate 195 billion kWh of energy annually, equivalent to 24 billion litres of kerosene and 236 million tonnes of manure. A total potential of 18.75 million family-size biogas plants (1.7 cubic metre average capacity) and 560,000 community plants (142 cubic metre average capacity) was calculated based on the available dung in the country. The estimated potential number of family-size plants was later trimmed to 12 million.

The initial success of biogas dissemination encouraged the government to set ambitious targets for the subsequent plan periods. For instance, the 7<sup>th</sup> Five-Year Plan had an ambitious target of installing 1.5 million biogas plants by extending the project to cover all the districts. However, only 0.89 million were actually erected. During the 8<sup>th</sup> Plan a total of 0.96 million plants were actually installed. The 9<sup>th</sup> plan which extends from 1997 to 2002 aims to erect some 1.2 million family-size biogas plants. Nearly 20 years after the project was launched, 75 percent of the estimated potential is still unrealised.

## **The approach**

Being a welfare state, the approach adopted for biogas dissemination was subsidy driven. Till mid-1990, the entire project was subsidised, meaning that the total cost of construction of each biogas plant was

borne by the State. Even higher subsidies were given for mountainous, desert and tribal areas. Although cost varies from place to place, a 2 cubic metre family-size biogas plant costs anywhere between US\$ 133 to 155. After 1990 the government reduced the subsidy component to ensure that the intended beneficiary families do contribute. On average, each family now contributes US\$ 55 to 77 per plant.

There is a large bureaucratic structure that ensures dissemination of renewable technologies to rural areas. Based on the previous year's performance and the target for the entire period of five years, a target is set for the following year. The Project ensures that each State gets its own independent target and budget allocation. However, the entire machinery of implementation acts at three levels. First, the centralised control from where the targets are allocated and the subsidy is doled out. Second, the non-government services delivery channel that ensures community level participation and the implementation at the local level. And third, the research back-up institutions that are supposed to conduct research to improve upon the efficiency of the biogas system and provide necessary capacity-building support. Implementing agencies, however, get a service charge (called turnkey fee) for ensuring that the plants function to their capacity for the first 3 years.

Despite such well-laid out mechanisms for biogas dissemination, the performance of the project is disappointing. According to an evaluation of the biogas project conducted by the National Council of Applied Economic Research (NCAER) for the period 1985–1990, out of the commissioned biogas plants in the states of Rajasthan and Uttar Pradesh, only 45 percent were found to be working. This was considered impressive when compared to the dismal national average of 37 percent. The study further reported that some 1.84 million installed biogas plants were not functioning at that time. Since then, the situation has not changed much. Thus, the overall picture of the performance of the programme is mixed.

Moreover, no information is available on whether all the functioning plants are producing gas to their designed capacity. Also, there is no firm evidence that the entire slurry produced was being utilised as fertilizer. Consequently, the calculations made on fuelwood saving as well as nutritional enrichment of soil are far from fulfilled. The National Project on Biogas Development has failed to live up to its promised potential. Interestingly, it is not as if the reasons for poor performance of the project were not known to the government but the fact that serious efforts have not been made to address them. As a result, a technology that promised to support the environment and the rural energy scenario has yet to catch the imagination of those for whom it is targeted.

### What went wrong?

It is difficult to imagine how a carefully structured, environment friendly, community oriented project on rural energy could fail to deliver the end product. Tragically, that is precisely what has happened. In the absence of an internal mechanism of repairing and overhauling, problems were compounded over the years. Yet, there are significant lessons to be learnt for countries who plan to follow India's footsteps in developing a biogas programme.

1. In the haste to spread the technology to every nook and corner of the country, proper assessment of socio-economic and ecological factors was not conducted, which led to dilution and inefficient utilisation of resources. For instance, while Maharashtra State has over 400,000 biogas plants, a small state like Goa has installed less than 2,000. Yet, the support structure continues for both.
2. Feedback on operational problems related to running of biogas plants was not adequately addressed with the result that the fixed-dome Deenbandhu model became the lone surviving design. Interestingly, this model did not come from the research network of NPBD. Consequently, users did not have any design options to choose from.
3. On the operational side, the main stumbling block is the dung required for initial charging. At least 30 quintals



Photo: Anders Ellegård

*A peasant farmer in Gujarat standing by his biogas plant, which was erected with support from the national Indian biogas programme. The biogas plant is a Deenbandhu ("friend of the poor") model which is currently the most popular model.*

of dung are needed for charging a cubic metre plant. Often, many households find it hard to collect that much dung and/or wait for a hydraulic retention time of 42 to 52 days before any gas comes out. Research on alternate feedstocks did not go beyond the laboratory stage.

4. Poor performance and slow progress of the biogas project has led to reduced interest in the technology among renewable energy specialists. Centralised bureaucratic control and poor performing State nodal agencies have brought the downfall of an environment friendly technology. While subsidies are being phased out, there is no reduction in the overhead expenses on the project.

### Does it have a future?

India's Biogas Project does have a future if the project authorities wake up to the realities. The project can be brought back to life with the following radical interventions:

- Based on biogas plant performance over the last two decades, select districts/regions where biogas project should be vigorously pursued.

- Address operational and technical glitches by reorienting the research machinery and by encouraging private sector investment in biogas research.
- Invest in design research to make biogas suitable to different climatic conditions. Develop models that take into account local problems like low temperature, less availability of water, alternate feeding material and proper feedstock mix.
- Batch-fed biogas systems, kitchen waste biogas plants and human excreta based biogas systems (developed in the non-governmental sector) need proper incentives and encouragement for dissemination.
- NPBD must reorient itself to accommodate developments in the sector and introduce new designs for speedy implementation. Currently, it takes years before a new design is approved by the government.
- Re-assess total biogas potential by not only recalculating dung potential but the available human excreta and degradable biomass as well. ■

#### Contact:

**Dr Sudhirendar Sharma**  
[sudhirendar@vsnl.net](mailto:sudhirendar@vsnl.net)

**The Stockholm Environment Institute** (SEI) is an international research institute focusing on local, regional and global issues related to environment and development.

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Box 2142  
SE-103 14 Stockholm  
Sweden  
Tel +46 8 412 1400, Fax +46 8 723 0348  
E-mail [postmaster@sei.se](mailto:postmaster@sei.se)  
[www.sei.se](http://www.sei.se)

## New Report from SEI:

### *Sugarcane Resources for Sustainable Development in Luena, Zambia*

**T**his study assessed the role of sugarcane as a renewable resource to support sustainable development in the Luena region of northern Zambia. In addition to sugar, the production of ethanol from sugarcane and the options for bagasse cogeneration were explored through detailed analysis of a range of production scenarios and technical configurations. The market analysis addressed product strategies for sugar, ethanol, and surplus electricity, as well as flexible combinations of all three products.

Luena is a remote region for which new development alternatives are being considered by the Zambian government. Although the establishment of a sugarcane estate has been considered in the region for many years, this study is the first to take a broad perspective based on the goals of sustainable development. The study included two major components: (1) Techno-economic options; and (2) Social and Environmental Impacts. These components have been integrated using an interdisciplinary approach that recognizes the relevant linkages in a broad societal context and examines the major policy options for the region.

The report analyses which strategies are viable and how they might be implemented in a way that promotes sustainable development. The report should be of interest to researchers and policy-makers concerned with renewable energy options in southern Africa, as well as to anyone interested in regionally-based strategies and/or modern bioenergy options that harness a nation's domestic resources more efficiently so as to support sustainable development. ■

Contact: [francis.johnson@sei.se](mailto:francis.johnson@sei.se)

### *Sugarcane Resources for Sustainable Development: A Case Study in Luena, Zambia*

By *Deborah W. Cornland, Francis X. Johnson, Francis Yamba, E.N. Chidumayo, Maria M. Morales, Oscar Kalumiana and S.B. Mtonga-Chidumayo*

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