

dissemination can be contemplated. There is a strong commitment to continue fulfilling this vision, to continue working with the wider community with the multi-disciplinary expertise of the universities at hand and unique oil expelling and engine testing facilities in Nepal and Britain.

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Credits:

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Rather than focussing on the economic viability of plant oil as a fuel, however, this vision recognises that it is the overall system of fuel production on which economic viability is accurately evaluated. By-products such as oil cake have an additional commercial value as fertiliser as do increased crop yields arising from the cultivation of living fences to pre-empt browsing livestock. In the longer term it should be possible to market a nutritious animal fodder from oil cakes in which case fuel oil would be a lesser value by-product from oil cake production.

Energy analysts refer to 'social costs' when evaluating the real costs of energy production; these being real costs to a society that arise from energy supply over and above the market price for the energy. Social costs are not insignificant. Loss of economic activity from fuel shortages during the trade and transit impasse with India in 1988 is a social cost as is health care arising from illness due to the urban air quality in Kathmandu. The Intergovernmental Panel on Climate Change are warning that 'Many parts of the world have recently suffered major heat-waves, floods, droughts and extreme weather events leading to significant loss of life and economic costs. While individual extreme weather events cannot be directly linked to human-induced climate change, the frequency and magnitude of these types of events are expected to increase in a warmer world'.

This vision acknowledges, conversely, a 'social value' as being a real economic benefit to a society arising from the production of energy. Rural enterprise based on oil seed resources would promote social stability and cohesion in a nation ill at ease with the fruits of 'development' with opportunities for entrepreneurs, manufacturers and employment. At the same time this would relieve the pressure in the cities from urban drift and stimulate rural-to-urban linkages for wealth generation in both the rural and urban context. Indigenous fuel and fertilisers would help to reduce imports and so conserve foreign currency reserves as well as promoting a national self-reliance.

Environmental protection has a social value. Utilisation of plant oils for rural energy would both conserve and enhance natural forest resources as well as reducing the consumption of agricultural residues for fuel. Agricultural residues and oil cake would then be available to boost crop yields and at the same time reduce the consumption of costly and imported chemical alternatives. Cultivation of plants around field boundaries boosts crop yields by pre-empting browsing livestock; root systems and leaf-shed improve soil stability and quality. Clean, available fuel impacts positively on health and on drudgery and ultimately economic productivity.

Mitigation of carbon dioxide emissions has a social value on local, national and global scales. It is a tragedy that the impacts of climate change are an imposition from elsewhere on a country lacking resources and so least able to deal with its consequences. As well as taxation of the carbon produced from the combustion of petroleum products, the large-scale cultivation of forests dedicated solely to carbon storage is high on the international agenda. It is very likely that international support will be forthcoming for sustainable energy systems in 'developing countries' and many would argue that the industrialised countries have an obligation in the circumstances. Cultivation of a crop that not only stores atmospheric carbon but also yields a high-grade carbon dioxide neutral fuel may prove to be attractive to the international community and at the same time facilitate a sustainable national programme of expansion in the longer term perhaps initially by providing a subsidy on plant oil to reflect social value and to stimulate both end use and resource enhancement.

There are multi-disciplinary technical refinements that are yet required in cultivation, agriculture and in the technology of seed processing and end use etc. which require financial investment before wider

processing by-products are of equal importance in this vision. The use of oil cake as a fertiliser in rice cultivation has been very encouraging in this respect returning equal productivity to imported chemical alternatives.

Resource enhancement is central to the vision. Clearly resources will need to meet demand but equally we should look to the generations of farmers who have realised benefits to crop production by cultivating living fences around their lands to pre-empt browsing livestock. Resource enhancement has other important attributes too: root systems enhance soil stability during heavy rain or dry and windy conditions and since leaves are shed each year there will be improvements in local soil quality. This vision advocates cultivation alongside trails, roadsides and river margins as well as in National Park Buffer Zones and in marginal lands so food production is not compromised. In the first oil seed energy plantation in the country some 40, 000 sajiwan plants have now been established on marginal lands at Khairanitar in Tanuhun District in co-operation with the Women's Development Section of the Ministry of Local Development and the Institute of Forestry and a further 40,000 plants are to be introduced this year. In this initiative oriented specifically to the welfare of women it is expected that after 5 years the oil yield from these plants will rise to meet the annual diesel requirements of 15 agro-processing mills and may be several times higher.

Improvements in air quality are crucial in this vision. Indoor air quality is a serious concern for much of a population engaged in subsistence agriculture, especially women, while local air quality has become a serious concern with industrial growth and global air quality is threatening the fabric of life itself. Plant oils are clean burning and have much to offer on all these scales. When used as a substitute for fuelwood, agricultural residues or kerosene in cooking and illumination there is potential to improve respiratory and eye health and reduce the drudgery of solid fuel collection and utensil cleaning in the rural household. As a diesel substitute, exhaust smoke levels are lower and because there is little, if any, sulphur in plant oils, emissions of sulphur oxides and hence acid deposition are markedly reduced.

Climate change is a most serious threat facing the global community and whilst this threat has arisen from industrial activities elsewhere, the effects will be experienced, and may already be manifest, here. All living plants sequester carbon dioxide from the atmosphere during photosynthesis and all hydrocarbon fuels, including plant oils, release carbon dioxide on combustion. The carbon dioxide released by plant oils during combustion, however, is a part of the carbon sequestered by the living plant from the atmosphere during growth, the remaining carbon being stored in the woody stems and root system, consequently, atmospheric carbon dioxide levels are actually reduced by storage in the plant for its lifetime (a 'carbon sink'). As a diesel substitute further reductions are realised by offsetting the carbon dioxide released from petroleum products.

There are concerns regarding the economic viability of plant oil as a fuel. Seed collection is a very significant cost in the production of plant oil but this has halved in a single year as cultivation is becoming more organised and for this reason will continue to fall. On the other hand the cost of petroleum products continues to rise in the international market with devastating effect on poor countries lacking their own resources. Prices will continue to rise, not only because resources are finite and consumption is increasing but also because of international concern as the evidence continues to suggest that recent catastrophic global weather patterns are attributable to climate change and that worse is to come.

In a Nut Shell: Wealth, Health, Energy and Environment.

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Plant oils extracted from a diversity of non-edible seeds and nuts are a valuable energy resource which could be utilised for energy supply requiring only modifications to existing technology. These oils are capable of fuelling Diesel engines, cooking and lighting appliances and may be processed into other products such as soap, molluscicides and bio-pesticides or used as feedstock for small-scale industrial processes. As well as providing a clean, renewable substitute for imported fossil fuels, conserving the dwindling forest resources and other biomass, the residue which remains after the seeds have been crushed is potentially a nutritious animal fodder and can replace chemical fertilisers and so help to preserve the role of organic fertilisers in traditional farming systems.

Sajiwan (*Jatropha curcas* L.) is one such oil-bearing perennial that can attain the dimensions of a small tree or large shrub and is distinguished by an ability to propagate vigorously from either seed or cutting, be resistant to drought and be tolerant of poor soil quality. Sajiwan (translated as 'long life') can live up to 50 years and has many names and traditional uses throughout the country. It may be most familiar as a living fence around agricultural land or as a natural toothbrush or as a popular entertainment for children who delight in blowing bubbles from the sap. Climatic conditions are favourable for the cultivation of sajiwan in about 30% of the country so there is immense opportunity to encourage its cultivation.

Utilisation of these oil-bearing plants for energy supply has attracted considerable attention recently. Much of this interest, unsurprisingly in the wake of rising oil prices and choking urban air pollution, has focussed on the novelty of an operating Diesel engine that has been undergoing endurance testing to 1000 hours in the oil expeller and engine testing facility at The Research Centre for Applied Science and Technology (RECAST) under Tribhuvan University. Some 250 trouble-free hours have now been achieved with natural sajiwan oil; a clean and renewable diesel substitute.

This is undoubtedly a first and a significant achievement but more than this it reinforces a vision in the management of oil-bearing resources in which complementary social, economic and environmental initiatives can be driven by the production of clean renewable fuel oil. Some years ago this vision inspired the modification of engine testing facilities at Oxford Brookes University and a programme to investigate the performance of a range of plant oils. These, the first tests ever conducted with indigenous oils revealed in particular the potential of natural sajiwan oil as an engine fuel and formed the scientific basis for the current endurance testing programme at RECAST. The Green Energy Mission and Development and Consulting Services, Butwal (manufacturers of the Sundhara Oil Expeller) were instrumental in supplying oils for these early tests.

In this vision the promotion of end uses for the oil, such as fueling Diesel engines, is crucial because they will stimulate a demand for resources and so promote economic enterprise in rural areas in cultivation, seed collection and processing as well as those activities associated with end use and in the production of related technology. The use of sajiwan oil in a 30% mixture with kerosene to fuel cooking stoves and as a pure, clean-burning, fuel in certain types of wick lighting as well as in the manufacture of soap has proved to be successful too. End uses, for example, associated with oil seed