Agricultural residues for bioenergy in Senegal

Kyrke Gaudreau, Robert B. Gibson, Roydon A. Fraser

Introduction

How sustainable is it to burn peanut shells as a cooking fuel in Senegal? Using agricultural residues as a cooking fuel is a potential means of addressing deforestation and eliminating the hazards related to collecting fuelwood, and properly designed cookstoves can reduce the health impacts related to cooking with the three stone fire (GIZ 2011; Hrubesch 2011). Given that Senegal has lost almost half of its forest cover since the 1960s (Tappan et al. 2004), the need to provide the forests some respite is all too apparent. Focusing on the Peanut Basin of Senegal, this paper reports on a research project that explored these interactions and considered the broader implications for how best to approach the evaluation of apparently desirable options for improving ecological stewardship and human wellbeing through cookstoves that burn peanut shells.

Through the assessment process it rapidly became apparent that two important and interrelated constraints would hamper the assessment objective as it was defined. First, the general question of burning peanut shells in cookstoves in Senegal is one that cannot be appropriately addressed at the project scale. There are too many strategic level considerations that represent key challenges and opportunities that must be addressed simultaneously and in an integrated manner. Second, Senegal and its various governing institutions do not have established criteria for evaluating initiatives such as peanut residue cookstove programs, to ensure that they are conceived and designed to promote progress towards sustainability.

This paper outlines an application of Gibson's (2006) sustainability assessment to address both these concerns. First, we describe key interrelations across the energy and agricultural sectors of Senegal to illustrate the need for addressing strategic level concerns in a project level assessment. Second, we briefly describe the development of the sustainability criteria for the energy and agricultural sectors, but given the limited space we cannot provide the criteria in this paper.

Burning peanut shells in the face of complexity

Senegal is a west African country where the population, now approximately 13 million, is growing by 2.5 percent per year (UNDP 2010). The country ranks low on the human development index (144th place out of 169 countries), although its GINI index has shown improvement (and currently stands at 39). Over half the population lives below the poverty line, and many live in extreme poverty (Diaz-Chavez et al. 2010; UNDP 2010). Senegal's economy is characterized by a structural deficit and high unemployment (IYF 2009; UNDP 2010). The country is rapidly urbanizing (Fall et al. 2008). Approximately 100,000 youth who enter the job market each year and wait on average four years to find employment (OECD 2008; IYF 2009; UNDP 2010).

Senegal remains heavily reliant upon traditional bioenergy, primarily fuelwood and charcoal for cooking, and is overexploiting its resource base (MDE 2007). The overuse of wood and charcoal

'IAIA12 Conference Proceedings'
Energy Future *The Role of Impact Assessment*
32nd Annual Meeting of the International Association for Impact Assessment
27 May- 1 June 2012, Centro de Congresso da Alfândega, Porto - Portugal (www.iaia.org)

for cooking has worsened deforestation and desertification, and when coupled with overgrazing and agricultural expansion, has led to an almost 50 percent reduction in forest cover since 1965 (Tappan et al. 2004).

Senegalese agriculture is primarily rainfed, and based on small farms growing peanuts, millet, and/or sorghum (OECD 2008), although peanuts have been the primary cash crop for decades. Despite being largely agricultural, Senegal suffers serious food insecurity, which is expected to worsen in coming years due to increased cost of imported staple foods (notably rice and dairy products); declining yields due to reduced soil fertility as a result of intensive and improper peanut farming practices; and the reduced export earnings from peanuts on the world market (Brown 2008; Diaz-Chavez et al. 2010; UNDP 2010). Senegalese agriculture is undergoing a transition of sorts, as the economic importance of peanuts has fallen drastically in recent decades. Despite their decline, peanut farming still employs up to 1 million people and uses 40 percent of cultivated land, and no viable alternatives currently exist (OECD 2008; Diaz-Chavez et al. 2010).

Burning peanut shells in stoves is an attempt to address deforestation, but deforestation is a complex endeavor. We will focus on two factors here. First, deforestation is due to declining agriculture, as the decrease in soil fertility and livelihood opportunities have encouraged farmers to abandon their fields and clear forests in the southeast so as to renew farming (Tappan et al. 2004). Using peanut shells as a fuel source potentially eliminates their ability to be used as a soil amendment, and provides an incentive to keep removing residues from the fields; although the extent to which agricultural residues are sufficient to improve soil fertility in all contexts is uncertain, and in many parts of Senegal peanut shells are burned as waste product. Second, forest pressure is increasing due to the government's cancellation of a national subsidy on LPG (liquefied petroleum gas) for cooking, which has resulted in increased charcoal and fuelwood consumption, especially in urban areas (Fall et al. 2008).

Towards sustainability assessment

The problems described above are two-fold. First, this is a project level assessment that extends deeply into strategic level considerations, including soil fertility, deforestation, and urban-rural dynamics in Senegal. Determining the potential for burning agricultural residues requires us to expand the scope of assessment to address the interrelationships between the agricultural, energy, economic and cultural systems of Senegal. Second, what is lacking from the current discussion of cookstoves and peanuts in Senegal is an explicit and integrated set of criteria by which to assess potential energy and agricultural practices and opportunities, and ideally promote mutually reinforcing positive gains in Senegal. While both government and non-governmental organizations have outlined important strategic issues regarding the energy and agricultural systems (e.g. MDE 2007; CSRE 2008; UNDP 2010), recognition of these issues has not been integrated and elaborated into an articulated understanding of what is needed for a more desirable future for Senegal. Addressing these two problems is no easy matter, whereas ignoring them invites failure.

To address these two problems, we adopted Gibson's (2006) sustainability assessment, which belongs to a family of integrated assessments that attempt to identify and evaluate the potential effects of alternative undertakings and find the best options for progress towards sustainability (Devuyst 1999; Pope et al. 2004; Gibson et al. 2005). Gibson's assessment framework has been applied to various energy systems at both the project and strategic level (Gaudreau and Gibson 2010; Winfield et al. 2010). Gibson's assessment is based on beginning with established and generic sets of generic sustainability criteria and adapting the criteria to the particular case and context. Criteria specification is an iterative process in that specifying criteria helps organize the findings into relevant themes, which then help inform further criteria specification. In these regards, both the process of assessment (criteria specification) and the substantive outcome (the final criteria set coupled with the findings of the analysis) help inform decision-making.

The researchers adopted a case study approach that synthesized information from a variety of sources, notably document analysis and literature reviews, key informant interviews, and participant observation and site visits. The key informants were drawn from a wide variety of expertise, including academia, local and international non-governmental organizations, private industry and individuals involved in agriculture and energy in Senegal. The interviews were structured to address considerations that relate to the full suite of requirements for progress towards sustainability, although the questions were open-ended to allow for the elucidation of unexpected insights that are often instrumental in guiding such exploratory research. Several of the respondents were available for follow-up interviewing during the iterative process.

To help interpret finding, the sustainability criteria were organized in a table based on Gibson's sustainability assessment framework. Furthermore, an initial set of observations relating to the Senegal case was developed (you mean "were listed") and organized in the same manner. A sample set of the criteria and observations are provided in Tables 1 and 2.

Table 1 –Selected sustainability criteria for energy-agriculture applications in Senegal

Resource Maintenance and Efficiency
Ecological efficiency and effectiveness of energy systems • promote ecological means of energy production with a positive energy return on investment • enhance energy system efficiency and effectiveness (e.g. matching energy quality to end-use)
Prudence, precaution and adaptation
Promoting resilience and adaptive capacity and avoiding lock-in • ensure sufficient resilience and adaptive capacity in food and energy production as well as in broader society to accommodate increasingly variable conditions (e.g. drought, increased fossil fuel prices) • seek mutual gains in resilience and efficiency

Table 2 – Selected evaluations of energy and agricultural undertakings

Resource maintenance and efficiency
Ecological efficiency and effectiveness of energy systems • Charcoal is currently produced by inefficient means by workers with generally low vested interest in resource stewardship, although improved methods exist (Hrubesch 2011). • Increasing energy supply (e.g. wood, charcoal, electricity) may promote increased usage due to suppressed demand. Such extra energy consumption is not necessarily for productive purposes, which may potentially increase household expenditures while not increasing income.

Prudence, precaution and adaptation

Promoting resilience and adaptive capacity and avoiding lock-in

- Locally available drivers for adaptive change are addressing many problems in an integrated manner (e.g. eco-villages, market gardening) (Gensen 2010), many of which are being locally led with international support.
- Agricultural dependence on erratic and declining rainfall coupled with inability to purchase inputs increases yearly variability, and complicates long term planning that must account for both poor years and seasonality (Brown 2008).

Discussion and conclusion

The research project discussed here began with a narrow question: how best to design cookstoves to be fueled by peanut shells and other agricultural residues. Consideration of the larger context of soil fertility decline and deforestation led to an expansion of the question to whether such agricultural residues should be burned in cookstoves. In the end, that question too merits expansion, at least to cover comparisons of a range of promising options in the context of the full suite of sustainability-related issues at the intersection of agricultural and energy systems in Senegal, including issues such as jatropha for biodiesel production, and increasing food security through crop diversification and improving soil fertility.

The results of the assessment indicate that while burning residues instead of wood or carbon could directly reduce some pressures on forest resources, on the whole this option appears generally unadvisable because of the loss of a key means of preserving soil fertility. In certain situations, it may be advantageous to allow for the burning of agricultural residues. For example, peanut shells are oftend stored outside of centralized processing plants and they cannot be feasibly returned to the fields for soil enhancement, and are currently considered by many to be a waste product. A sustainability-based assessment might find it preferable to use them to fuel energy systems for cooking or electricity production. But even here, careful consideration of implications and alternatives is needed. Some of the peanut producer cooperatives in Senegal have begun to lobby for decentralized peanut processing, and it is important to ensure that energy production from peanut shells at big centres does not hinder the decentralization of agricultural processing. Equally important, given the shifting nature of agriculture in Senegal, it is important that the use of residues for energy applications does not lock Senegal into one specific form or agriculture, or any specific crop.

There are other ways by which Senegal may address the interrelated issues of cooking energy, soil fertility and deforestation. Two alternatives that emerged during the assessment are the use of biochar/biocharcoal (which may be applied as a soil fertility amendment or used as a replacement for charcoal); and a renewal of the subsidy on liquefied petroleum gas (which was removed due to economic reasons and for being ineffectively operated). If properly undertaken, a cooking gas subsidy may serve as a useful fossil energy bridge that provides the time for alternatives such as biochar/biocharchoal to adequately develop. Whether it is biochar/biocharcoal, liquefied petroleum gas, or some other alternative, there is a need to make important decisions that are suitably informed by a comprehensive set of decision criteria covering the full suite of requirements for progress towards sustainability. Ideally, the criteria and results emerging from this research can play an important role in this regard.

References

Brown, M. (2008). The Impact of Climate Change on Income Diversification and Food Security in Senegal. Land Change Science in the Tropics. W. Jepson and A. Millington, Springer US**:** 33-52.

CSRE (2008). Lettre de Politique de Développement du Secteur de l'Energie (février 2008) Dakar, Commission de Re´gulation du Secteur de l'E´ lectricite´ du Se´ne´gal (CRSE)**:** 19.

Devuyst, D. (1999). "Sustainability Assessment: The Application of a Methodological Framework." Journal of Environmental Assessment Policy & Management **1**(4): 459.

Diaz-Chavez, R., S. Mutimba, et al. (2010). Mapping Food and Bioenergy in Africa. A report prepared on behalf of FARA. Ghana, Forum for Agricultural Research in Africa..

Fall, A., S. Sarr, et al. (2008). "Modern energy access in peri-urban areas of West Africa: the case of Dakar, Senegal." Energy for Sustainable Development **12**(4): 22-37.

Gaudreau, K. and R. B. Gibson (2010). "Illustrating integrated sustainability and resilience based assessments: a small-scale biodiesel project in Barbados." Impact Assessment and Project Appraisal **28**: 233-243.

Gensen. (2010). "GENSEN - Global Ecovillage Network Senegal." Retrieved July 29, 2011, from http://gensenegal.org/.

Gibson, R. B., S. Hassan, et al. (2005). Sustainability Assessment - Criteria and Processes. London, UK, Earthscan.

GIZ. (2011). "PERACOD - Programme pour la promotion de l'électrification et de lèapprovisionnement durable en combustibles domestiques." from http://www.peracod.sn/.

Hrubesch, C. (2011). Les énergies renouvelables – les bases, la technologies, et le potentiel au Sénégal. Dakar, Senegal, GIZ - Peracod.

IYF (2009). Private sector demand for youth labour in Ghana and Senegal - Ghana and Senegal study findings, International Youth Foundation.

MDE (2007). System D'Information Energetique au Senegal: SIE-Senegal. Dakar, Senegal, Ministere de l'Energie**:** 56.

OECD (2008). Country Study of Senegal. African Economic Outlook.

Pope, J., D. Annandale, et al. (2004). "Conceptualising sustainability assessment." Environmental Impact Assessment Review **24**(6): 595-616.

Tappan, G. G., M. Sall, et al. (2004). "Ecoregions and land cover trends in Senegal." Journal of Arid Environments **59**(3): 427-462.

UNDP (2010). Senegal - Rapport National sur le Développement Humain - Changement climatique, Sécurité alimentaire, and Développement Humain. New York, United Nations Development Program**:** 150.

Winfield, M., R. B. Gibson, et al. (2010). "Implications of sustainability assessment for electricity system design: The case of the Ontario Power Authority's integrated power system plan." Energy Policy **38**(8): 4115-4126.