AN ANALYSIS OF COOPERATIVE BIODIESEL PRODUCTION BY SMALLHOLDERS IN KWAZULU-NATAL, SOUTH AFRICA

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Abstract

The South African biofuels industrial strategy promotes a development-oriented strategy with feedstock produced by smallholders and processed by traditional producer-owned cooperatives. This study examines a proposal to apply this strategy to small farmers in KwaZulu-Natal, using soybeans as feedstock for biodiesel production. First, it is argued that value-adding cooperatives established under South Africa's Cooperatives Act would fail to attract the capital and expertise needed to process biodiesel owing to ill-defined voting and benefit rights. Second, a mixed integer linear programming model is used to check the viability of producing biodiesel from soybeans, viewed from the perspective of the smallholder as grower and co-owner of the processing plant. It is concluded that smallholder participation would require a rental market for cropland, co-ownership of the processing plant in an investor-share cooperative, information and training, and a high level of price support.

Keywords: South African biofuels strategy, rural development, smallholder marketing cooperatives, subsidies

Subtheme: Marketing and Trade

Introduction

The South African (SA) government actively encourages the use of traditional marketing cooperatives to promote the development of small-scale farmers (Ortmann & King, 2007a, 2007b) by providing "dedicated support for development-orientated cooperatives" (Lyne & Collins, 2008: 183). Consequently, it is not surprising that the SA biofuels industrial strategy, with its primary objectives of poverty alleviation and economic growth in the predominantly rural former homelands (Funke *et al*., 2009), adopts cooperatives as the preferred organisational vehicle to integrate smallholders into the domestic biofuels industry (DME, 2007).

The purpose of this study is twofold. First, it argues that the type of cooperatives permitted by South Africa's Cooperatives Act will not attract the capital or expertise required by smallholders in the province of KwaZulu-Natal (KZN) to establish and manage biofuel processing plant. This argument is based largely on theory drawn from the New Institutional Economics (NIE), and in particular the literature relating to ill-defined property rights in traditional cooperatives (e.g., Cook 1995**).** Second, it uses a mixed integer linear programming model to examine the economic viability of producing biodiesel from soybeans grown by smallholders in KZN, viewed from the perspective of the smallholder as grower and co-owner of the processing plant. Soybean is the only potential biodiesel feedstock identified by the national biofuels strategy that is grown on a reasonable scale in KZN.

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The next section provides relevant information about South Africa's Cooperatives Act and explains why cooperatives established under this legislation are unlikely to integrate smallholders into value-adding processing and marketing activities. This is followed by a brief description of small-scale agriculture in KZN and a section comparing the results of the programming model across large and small farm systems. The paper concludes with some policy advice.

Cooperative models to integrate smallholders into value chains

South Africa revised its Cooperatives Act in 2005. One of the main purposes of the new Cooperatives Act (Act 14 of 2005) was to facilitate public support for development-orientated cooperatives established to assist disadvantaged groups (Ortmann & King, 2007a). Lyne and Collins (2008), however, argue that the new Act is counter-productive as it entrenches the flawed institutional arrangements of a traditional cooperative. Cook (1995) identified five institutional problems of traditional cooperatives - the free-rider, horizon, portfolio, control and influence problems – and attributed these problems to patronage-based returns, redeemable (and therefore non-tradable) equity shares, and egalitarian voting rights. Causal relationships between these characteristics of a traditional cooperative and the institutional problems identified by Cook (1995) and their detrimental effects on equity and debt capital have been well documented in the NIE literature and are not discussed here.

Persistence with an organisational model that constrains access to capital will most likely limit the role of smallholder marketing cooperatives to one of contracting with a processor. This single contract would replace the numerous small contracts and high transaction costs that the processor would face if it attempted to deal with many individual small growers. Thus, establishment of a traditional cooperative (horizontal integration) could give smallholders access to processors via contractual arrangements (vertical coordination) but only in areas where processors operate. Elsewhere, these cooperatives will have to integrate vertically into processing but this will almost certainly require a shift away from traditional cooperative status in order to attract the capital needed to finance plant and equipment, and the expertise needed to manage it. Recent empirical studies in KZN concluded that recently-established traditional cooperatives are inappropriate vehicles for promoting rural development (Chibanda *et al*., 2009; Nganwa *et al*., 2010).

In a large-farmer setting, institutional changes that better align voting and benefit rights with levels of individual investment have strengthened incentives for patrons and banks to finance cooperative assets. Cases of cooperative laws being modified to permit 'hybrid cooperatives' and of traditional cooperatives adopting non-traditional voting and benefit rights have been well-documented in recent literature from developed countries (Hendrikse & Veerman, 2001; Chaddad & Cook, 2004; Bekkum & Bijman, 2006; Lyne & Collins, 2008). These institutional innovations are a response to increasingly competitive and discerning food markets where value must be added to products in order to maintain prices and market share. Value-adding requires substantial investment in plant, equipment, branding and promotion that traditional cooperatives struggle to finance.

Chaddad & Cook (2004) propose a typology in which traditional cooperatives and investment-owned firms (IOFs) are at two opposing extremes. They identify three cooperative models where ownership rights are limited to member-patrons: proportional investment cooperatives (PICs), member-investor cooperatives (MICs) and New Generation Cooperatives (NGCs). All of these models alleviate the internal free-rider problem by strengthening proportionality between investment and returns. The NGC also alleviates horizon and control problems by selling tradable delivery rights to member patrons. This model is popular in the USA where it is often used by farmers to establish cooperative processing plants for biofuel (Jensen *et al*., 2004; Kenkel & Holcomb, 2009).

Although South Africa's new Cooperatives Act provides for NGCs, it is unlikely that poor smallholders will find this model useful for processing biofuel as they lack the necessary capital and expertise.

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NGCs, like PICs and MICs, do not sell shares to non-patrons and therefore cannot enter into equity-sharing arrangements with strategic partners. The Worldwatch Institute (2007: 312) suggests that the most efficient means to accelerate an expansion of biofuel production "is for governments to create a policy environment that is conducive to private-sector investment in the development of these fuels". This shifts attention to Chaddad and Cook's (2004) two remaining cooperative models: cooperatives with capital seeking entities and investor-share cooperatives (ISCs).

The 'cooperative with capital seeking entities' or 'Irish model' draws external capital into a subsidiary firm that is co-owned by the cooperative and the external investor(s) (Chaddad & Cook, 2004). However, creating a co-owned subsidiary does not address institutional problems within a traditional cooperative. Members still have little incentive to invest in their cooperative in order to increase or even maintain its shareholding in the subsidiary. Over time, control of the subsidiary may shift to the external investor(s), bringing investors and patrons into conflict over the distribution of benefits.

In contrast to the Irish model, ISCs issue "separate classes of equity shares in addition to the traditional cooperative ownership rights held by member-patrons" (Chaddad & Cook, 2004: 357). In essence, non-patron investors are permitted to purchase non-redeemable, tradable equity shares that provide market-related returns in dividends and capital gains, but which confer no or limited voting rights to ensure that control remains with patrons. While such arrangements can certainly improve a cooperative's access to capital and expertise, they sacrifice the advantage of inexpensive supply contracts (Sykuta & Cook, 2001) enjoyed by NGCs where investment is proportional to patronage (Bekkum & Bijman, 2006).

Ideally, the SA government should help to integrate small-scale growers into the biofuel industry by facilitating equity-sharing partnerships between groups of smallholders and strategic partners in the private sector. In this regard, however, Lyne and Collins (2008: 193) conclude that "unfortunately, South Africa's new Cooperatives Act prevents prospective partners from taking up equity in a development-oriented cooperative, and the idea of using a cooperative to warehouse members' shares in an investor-owned firm does not free its members from the problems created by ill-defined property rights." Even in the USA, where farmers are relatively well endowed with financial and human capital, growers producing feedstock for biofuel are moving away from the NGC model towards organisations that more closely resemble ISCs (Kenkel & Holcomb, 2009). Both theory and evidence suggest that South Africa's new Cooperatives Act should be amended to support the establishment of ISCs.

Small-scale agriculture in KwaZulu-Natal

Subsistence farming has long been a feature of rural households in the former homelands of South Africa. While the vast majority of these smallholders derive only a small proportion of their total income from agriculture, a significant number are highly dependent on farming activities (Lyne, 1989). Farmland is seldom privately owned in the former homelands, and is administered by tribal authorities who allocate land to household heads. These land allocations confer use rights but households are not permitted to sell land (Lyne & Nieuwoudt, 1991; Kille & Lyne, 1993).

The rural areas of the former KwaZulu homeland (hereafter referred to as Ngonyama Trust land) are characterised by high population pressure and uniformly small farm sizes (Crookes & Lyne, 2001). The vast majority of these land allotments are less than two hectares in size (Lyne, 1989; Hendriks *et al*., 2009). Nevertheless, it is "patently obvious" that the land is not farmed intensively (Thomson & Lyne, 1991: 288). Nieuwoudt (1990) contends that these very small farm sizes imply that profits from agriculture, even under optimal technological conditions, are likely to be unattractive when compared to potential wage employment.

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Widespread under-utilisation of land in an area where land is scarce and labour is abundant has been explained by the absence of an efficient rental market for cropland (Lyne, 1989; Thomson, 1996). When a household (i) values land for the social security that it provides, (ii) earns more from off-farm wage work than it can from cultivating a very small farm, and (iii) cannot lease land to other households that do rely on farming, it will tend to leave cropland idle as there is no opportunity cost attached to under-utilisation. Lyne (1989) estimated that 22 percent of arable Ngonyama Trust land was left idle. Consequently, average crop yields are typically very low. Crops are grown primarily for home consumption. Staples like maize, dry beans and potatoes feature prominently (Hendriks *et al*., 2009). Whitehead (2010) asserts that smallholders in KZN have little or no experience cultivating soybeans.

Poverty is severe in the Ngonyama Trust lands. In their recent study of the Embo community, Hendriks *et al*. (2009: 27) conclude that "these rural households have very small farms, produce food largely for subsistence purposes, and have per capita cash incomes less than US$ 2.00 per day – most of which comes directly or indirectly from wage earnings, state pensions and welfare grants". It follows that even a large group of smallholders willing to invest in a producer-owned firm would struggle to finance biodiesel processing plant.

Economic analysis of growing soybeans for biodiesel

The Department of Minerals and Energy's criteria for licenses to manufacture biofuels (DME, 2009: 2) require that "the production of feedstock under irrigation will only be allowed in exceptional circumstances and a detailed motivation will have to be provided". It further advocates that feedstock must be cultivated and/or sourced from the former homelands, which is consistent with the primary objectives of the SA biofuels industrial strategy of poverty alleviation and the stimulation of economic activity in the previously disadvantaged regions.

Sparks *et al*. (2010) developed a mixed integer linear programming model to evaluate the economic feasibility of soybean-based biodiesel production on commercial farms in KZN. The model incorporated 10 years of production data for various crops and tillage practices, as well as possible risk-averse behaviour of farmers by maximising the criterion $E–\theta\sigma$, where E is expected farm gross margin, θ is an aggregate risk-aversion parameter, and σ is the standard deviation of farm gross margin (Baumol, 1963; Hazell & Norton, 1986: 91-93). Integer activities ensured that soybeans would not be processed on-farm if the quantity produced did not warrant the variable and fixed annual costs of the processing plant. The model could select from plants of different size, and permitted market purchases of soybeans to make full use of processing capacity. The model was validated both in terms of simulating observed enterprise mixes and the rental rate of cropland in KZN. It was determined that the solution with $\theta=2$ best simulated observed rental rates (at 4.48% of the market value of cropland). This large (440ha) commercial farm model developed by Sparks *et al*. (2010) was modified to represent a KZN smallholder system.

The smallholder model initially assumed that each farmer operated no more than one hectare of land for grain production. Irrigated land was excluded from the model in view of DME policy requirements. In reality, very few smallholders have access to irrigated land and - where they do - tend to use it for vegetable crops rather than grain crops. As in the large farm model, soybeans were not permitted to exceed the area planted to maize. This constraint provides for necessary crop rotation and a degree of food security on small farms. Smallholders were also assumed to face the same prices, use the same technology, achieve the same yields and display the same level of risk aversion as the large commercial farmer modelled by Sparks *et al*. (2010). On the processing front, it was assumed that smallholders would supply a processing plant that they co-owned as an ISC, and that (as shown by the large, commercial farm model) a total arable area of 440 hectares would be sufficient to warrant a small processing plant – provided that the solution allocated at least one-third of this land to soybean production.

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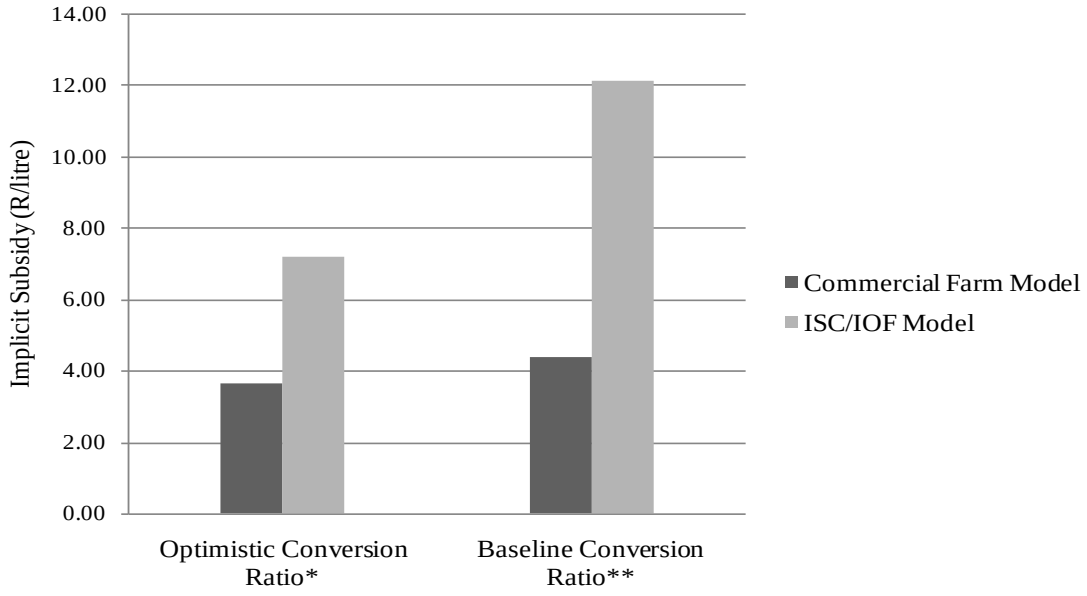
The smallholder ISC model was then solved iteratively to find the soybean price at which a co-owned processing plant would become viable. This occurred at a price of R3800 per ton of soybeans, *ceteris paribus*, and the solution for each (1ha) farmer included maize (0.47ha) and drybeans (0.2ha) as its main food crops. Figure 1 compares minimum levels of government subsidy needed to draw soybeans (as feedstock for biodiesel) into the linear programming solutions computed for the large commercial farm (Sparks *et al*., 2010) and smallholder ISC models. Under the more realistic baseline conversion ratio, the minimum level of government intervention (subsidy) needed to produce biodiesel from soybean cultivated by smallholders in the ISC model is estimated at R12.14 per litre. This is nearly three times as much as the minimum subsidy estimated for the commercial farm model (R4.37/litre). A similar situation exists under an optimistic conversion ratio, where the levels of subsidy are estimated to be R7.22 and R3.64 per litre for the ISC and large commercial farmer models, respectively.

Higher levels of subsidy required for the smallholder system reflect the exclusion of irrigated land and a greater proportion of the arable area cropped to drybeans for food security purposes. It could, however, be argued that the level of subsidy estimated for smallholders is understated because dryland crop yields observed on small-scale farms in KZN tend to be much lower than those observed on large commercial farms (Lyne, 1989: 9; Whitehead, 2010). More fundamentally, the expected farm gross margin (E) generated by one hectare amounts to just R3159 per annum – despite the government subsidy. It seems unlikely that this level of earnings would be attractive to small farmers as they could earn substantially more by working as unskilled labourers on a large commercial farm. In addition, the costs of developing ISCs with large numbers of resource-poor shareholder-patrons (upwards of 400) may be prohibitively high. The largest of the cooperatives studied by Nganwa *et al*. (2010) in KZN had a total of 105 members.



* and ** assume yields of 180 and 120 litres of soybean oil per ton of soybeans, respectively

Figure 1: Minimum levels of subsidy estimated for large and very small farmers growing soybean for biodiesel production in KwaZulu-Natal (2009/10 = 100)

It has long been argued that a rental market for Ngonyama Trust lands would encourage voluntary transfers of use rights from non-farming households to emerging farmers, with positive outcomes for equity, income and the adoption of land-saving farm technology (Nieuwoudt, 1990; Kille & Lyne, 1993). Empirical studies and "action research" conducted in various wards have shown that rental

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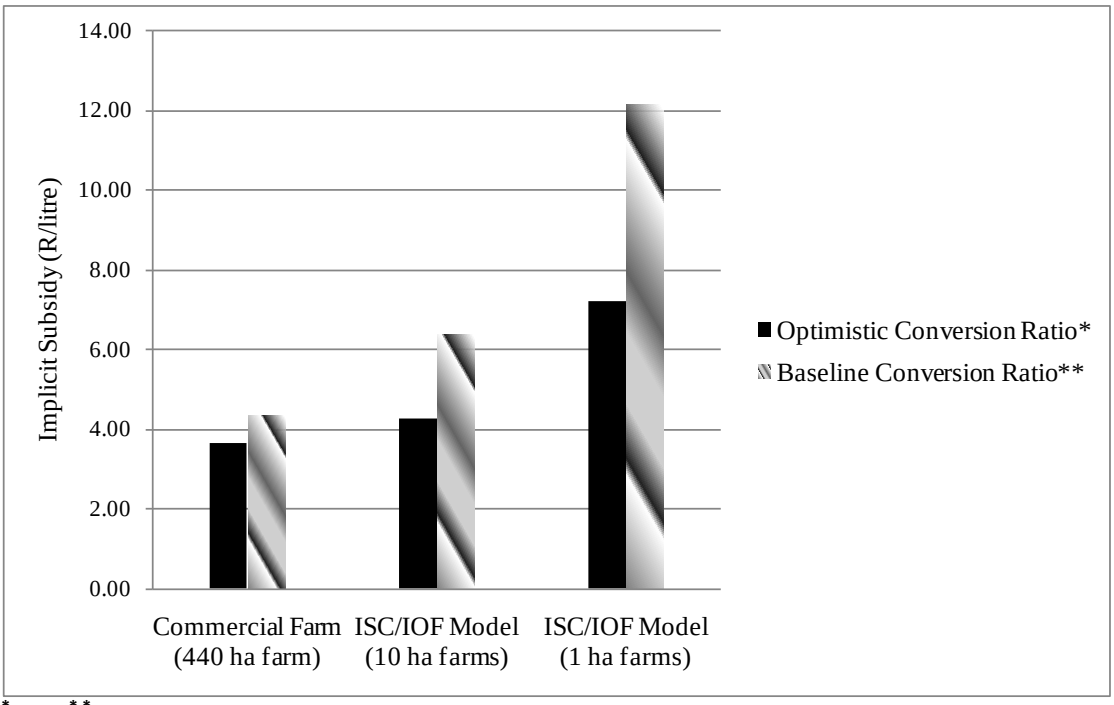
markets for cropland can be activated with only small adaptations to existing tenure arrangements, and that these markets allowed emerging farmers to grow their operations while generating rental income for other households too poor to farm (Thomson, 1996; Crookes & Lyne, 2001). Figure 2 compares the earlier smallholder ISC results with those estimated for a similar ISC model where emerging farmers have hired idle land from neighbours and increased their arable areas operated from one to 10 hectares. In this case, expected annual farm gross margin (E) increases from R3159 to a meaningful R29838 per annum, and the number of shareholder-patrons declines to a much more manageable number (44). The required level of subsidy is estimated to fall almost to the level required for the large commercial farmer, the remaining difference reflecting mainly the absence of irrigation land.



* and ** assume yields of 180 and 120 litres of soybean oil per ton of soybeans, respectively

Figure 2: Minimum levels of subsidy estimated for large, emerging and very small farmers growing soybeans for biodiesel production in KwaZulu-Natal (2009/10 = 100)

Conclusions

While the SA government undoubtedly recognises the importance of promoting rural development in the former homelands, the new Cooperatives Act provides only for traditional cooperatives. As a result, development-orientated cooperatives are denied access to the capital and expertise that strategic equity partners could provide, and without which it will be difficult to achieve the objective of integrating smallholders fully into the biofuel value chain. This research supports recent calls for the Cooperatives Act to be amended to support ISCs. It follows that the biofuels strategy proposed for South Africa should also be amended to recognise smallholder ISC processing models. In addition, more general problems constraining economic development in the Ngonyama Trust lands need to be addressed if cooperatives (or other forms of business organisation) are to play an important role in pro-poor development initiatives. These problems include uncertain property rights and poor physical infrastructure that limit access to information and markets, including land rental markets.

With regard to the production of soybeans in KZN as feedstock for biodiesel, the results of this study show that local processing would require on-going subsidies - regardless of whether the soybeans are grown on large or small farms, or whether irrigated land is used or not. The results also suggest

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that smallholder participation is unlikely in the absence of a rental market for cropland as prevailing farm sizes are too small to make commercial production of soybeans a worthwhile proposition – even with high levels of subsidy. Preconditions therefore include a rental market for cropland, support for smallholder organisations like ISCs that encourage investment by patrons and strategic equity partners in processing plant, and extension and training for small farmers who typically have little experience in the production of soybeans.

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