# APPLE PRODUCTION SYSTEMS FOR SMALL-SCALE FARMERS IN THE WESTERN CAPE

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The feasibility and consequences of small-scale (1-2 hectare) apple production systems are examined as a contribution to the dialogue on agricultural and rural transformation in the Western Cape. The most important constraint facing emerging farmers is assumed to be start-up capital. An expert panel of scientists and commercial apple farmers were drawn into an interactive, computer assisted dialogue to design alternative apple production systems requiring significantly scaled-down investment. Within imposed capital constraints, production technologies were designed using horticultural integrity and feasibility as criteria. Each model was then subjected to economic analysis. Net present values for 10 and 20 year orchard lives, internal rates of return and other criteria are applied. The analysis explores feasibility within the particular constraints of small-scale farming such as available household labour and risk averseness. One model passes most feasibility tests under a wide range of conditions. Assumptions within that model should form important considerations for small farmer establishment programs. Lastly, a portrait of a possible two hectare apple farm is presented.

*APPELPRODUKSIESTELSELS VIR KLEINBOERE IN DIE WES-KAAP*
*Die uitvoerbaarheid en gevolge van kleinskaal (1-2 hektaar) appelproduksiestelsels word ondersoek as 'n bydrae tot die dialoog ten opsigte van landbou en landelike transformasie in die Wes-Kaap. Beginkapitaal word beskou as die mees belangrike beperking wat opkomende boere in die gesig staar. 'n Kundige paneel wetenskaplikes en kommersiële appelboere is betrek in 'n interaktiewe, rekenaarondersteunde dialoog ten einde alternatiewe appel-produksiestelsels te ontwerp wat 'n beduidend kleiner belegging sal benodig. Binne die voorgeskrewe kapitaalbeperkings is produksietegnologieë ontwerp en hortologiese suiwerheid en uitvoerbaarheid is as kriteria gebruik. Elke model is toe aan ekonomiese analise onderwerp. Netto huidige waardes vir 10 en 20 jaar boordleeftye, interne opbrengskoerse en ander kriteria is toegepas. Die analise ondersoek uitvoerbaarheid binne die spesifieke beperkings van kleinskaalboerdery, byvoorbeeld huishoudelike arbeid beskikbaar en risiko-aversie. Een model slaag die meeste van die uitvoerbaarheidstoetse onder 'n wye verskeidenheid toestande. Aannames binne daardie model behoort belangrike oorwegings te wees vir kleinboervestigingsprogramme. Laastens word 'n voorstelling gemaak van 'n moontlike twee-hektaar appelplaas.*

## 1. INTRODUCTION

Western Cape agriculture must adjust to post-apartheid South Africa in two important ways. First, ownership of land, including agricultural land, must become more representative of society. Second, income must be redistributed toward the poor. If land reforms are to achieve gains in both dimensions, preference must be given to settling larger numbers of small-scale farmers rather than simply changing ownership of larger intact commercial farms. Accordingly, government policy is to develop and support a class of small-scale farmers across the country.

This desired new farm class will be viable only if the incomes generated compete well with off farm alternatives in terms of both income level and level of risk. In comparison to the rest of Africa, South Africa's relatively well developed economy provides the prospect of jobs for rural people, either through out-migration or in commercial agriculture. To create sustainable and adequate livelihoods on small farms within this setting, it is appropriate to look toward higher value cropping options.

This research examines the potential of micro-scale (1-2 hectare) apple production as a case study, with the thought that apples represent a horticultural enterprise that might meet both objectives. Apples provide an example of a high value tree crop suited to growing conditions in several areas of the Western Cape. Apples are an important commodity in terms of strong export earnings, low import requirements in production and significant backward linkages to off-farm agribusiness and to the general economy (Eckert and van Seventer, 1995). Apples are also an example of a complex, intensive production system with a major labour requirement.

Furthermore, apples were selected as something of an "acid test" because if small-scale models proved feasible for apples, then feasibility for other fruits can be implied. Other fruit species have certain characteristics which can make them more suitable than apples for small-scale producers. Apricots, for example, have 35 percent lower operating costs than apples plus lower establishment costs due to thinner tree densities and the fact that trellising is not required. Nectarines and peaches have shorter gestation periods before full bearing and table grapes are more labour intensive.

## 2. DEFINING CLIENTS AND APPROPRIATE TECHNOLOGIES

### 2.1 Characteristics of likely emerging farmers

Defining appropriate technologies requires specifying those particular characteristics of the target farm group which will, in their eyes, determine what technologies are acceptable or not. In what is called the "farming systems research and extension method," farmers are given deterministic roles in this process through the mechanism of on-farm trials. Much of the researcher's job involves studying farmer responses and in-field adaptations to technologies initially suggested. South Africa lacks a population of small-scale fruit farmers with whom to conduct such tests (Conradie, 1994). Thus, for this study, generally accepted small farm characteristics from global and southern African experience were adapted to the South

African environment in an effort to suggest characteristics of the post-land reform population of small-scale farmers.

An important and often unrecognized difference between rural environments in South Africa and in the rest of the world is the presence of a relatively well developed off-farm labour market and a cultural history of widespread dependence on this market by African rural households through the mechanism of oscillating migration.[1] Several studies have shown that many households in the former homelands, including those with land allocations, obtain little or no income from farming (Williams, 1987; Cairns & Lea, 1990; de Lange, 1991). Similar data led Low (1986) to postulate a set of rural incentives in which off-farm income dominates household labour allocation decisions and farming becomes a minor adjunct to household subsistence. Eckert and Williams (1995) found that less than 20 percent of rural households in the Mgwalana district of Ciskei were seriously involved in farming, an observation repeated in Transkei by Bembridge (1988), and that most households were only passive users of their farm resources.

These considerations suggest a farm typology which captures this on-farm:off-farm interaction. Households were conceptually classified by two criteria: the proportion of total income derived from farming and the absolute level of income. Essentially a 2 x 2 matrix results as shown in Figure 1. Larger values on both axes occur toward the top left-hand corner. Commercial farms and their technologies are used as the benchmark for this study. These farms have relatively high incomes with the major portion derived from farming. The typology, however, recognizes that even commercial farm households may frequently have additional incomes from off-farm sources. Where commercial farms provide only a fraction of total household income, this is viewed as "hobby farming." Such enterprises are a growing component of the rural scene in some Western countries as urban professionals, skilled technical workers and others seek the quality of life associated with agriculture and rural residence (Brinkerhoff & Jacob, 1986; Bolton & Chalkley, 1990). While technically these may be small farms, they are excluded from this analysis.

Among lower income farms, two additional terms are suggested. Both recognize that most poor farm households pool more than one income source if possible. The difference lies in the importance of returns from farming. Farms with relatively small percentages of agricultural income are designated as "supplemental farms" since farming only supplements a more important off-farm income. Off-farm employment dominates labour allocations, farming takes a lower priority and is fitted into the niches left after off-farm commitments. Field surveys by Eckert & Williams and by Bembridge found that most rural land holdings in the former Ciskei and Transkei were managed as supplemental farms. Supplemental farms are not the focus of this study, and, because of their low levels of resource use, probably should not be the focus of land reform programs either.

The fourth group, "supplemented farms," suggests small-scale farmers for whom farming is the main income source even though extra money may be obtained elsewhere. Farming is assumed to be the dominant interest and to override other alternative uses for labour. Since farming takes priority, off-farm jobs are fitted into gaps in farm activities or undertaken by family members with few farm responsibilities. These farms are the target group for this study on the assumption that farming commands sufficient attention within the household to sustain the labour and

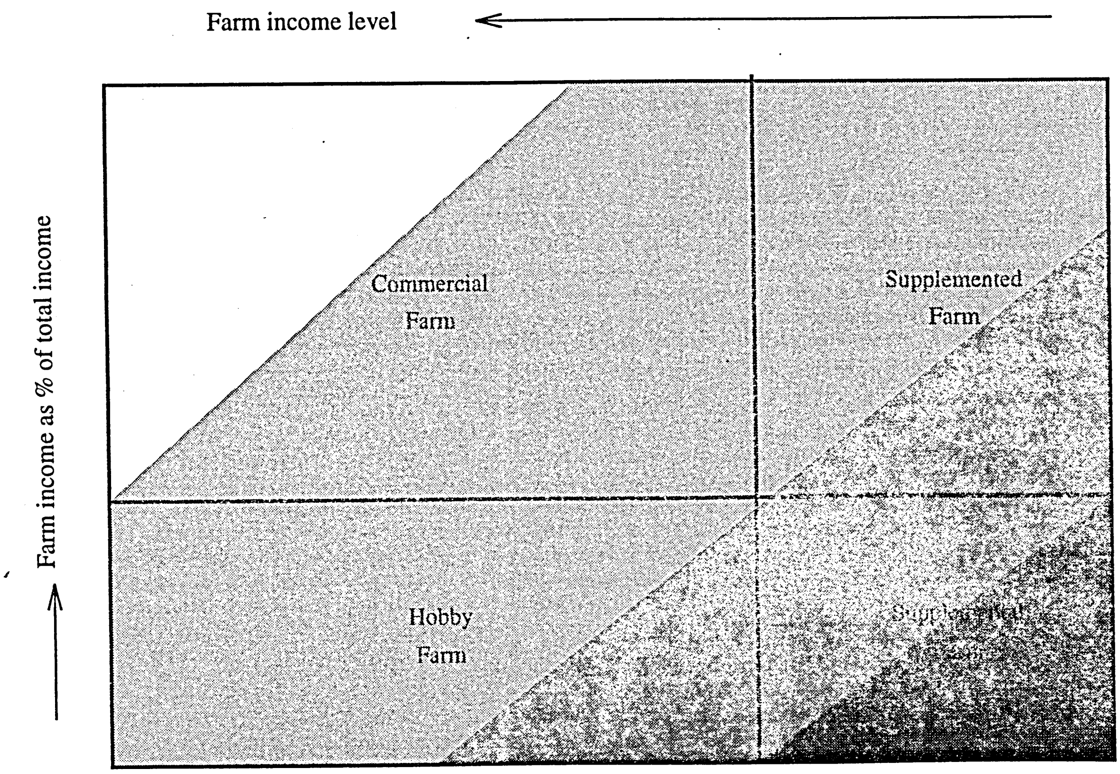


**Figure 1:** **Suggested farm typology and associated farm size**

management time allocations needed for successful small-scale farming, especially with complex deciduous fruit production systems.

This does not suggest that this incentive structure is permanent nor culturally determined. Rather, as Low points out, it probably reflects a rational response to an array of opportunity costs faced by different family members, both on- and off-farm. Improvements in the productivity of small-scale agriculture, in the availability of support services or reductions in the expected off-farm wage could, theoretically, rebalance the labour allocation equation. In such an event, some shifting from supplemental to supplemented farming could be expected. This study concentrates on farms assumed to be in the supplemented category since it is here that one expects to find seriously committed, smaller scale agriculturalists.

Little is known about the most likely beneficiaries of land reform except that most of them will be poor. From this, as well as from recent policy statements (Meyer, 1994), one would expect the dominant form of settlement to be small units. From African and global experience, small-scale, relatively poor farmers can be expected to show several generic characteristics. Among these are risk averseness, often severe capital scarcity plus limitations in the quantity and quality of land and other inputs. They farm with multiple enterprise, tightly interlocked farming systems, substituting family labour for capital where possible, avoiding risky or discriminatory markets and managing the farm within a whole household decision making context. The complexity of the resulting household-farm management unit can stretch managerial capacities, which are often constrained by limited education and access to necessary information. Returns per land unit may be higher than in commercial farming, but returns to labour are typically driven down toward labour's opportunity cost, which in more remote rural areas can be close to zero.

The unique South African environment suggests two qualifications to this view. First, in the homelands, a nearly complete lack of investment in rural and agricultural infrastructure during the years of apartheid reduced even further the possibilities of economically viable farming. In the Western Cape, the geographic focus of this study, such infrastructure is generally well developed. The issue for emerging farmers is one of gaining access. Second, a well developed off-farm labour market together with high (sometimes artificially so) wages gained by union activity in the last decade results in a high perceived opportunity cost to small-scale on-farm work. In this province, the most likely participants in small-scale fruit production are the present farm workers on commercial fruit farms. On more progressive farms, remuneration levels per male worker can total R25 000 per year; R10 000 in cash and R15 000 in the value of social goods provided. Increasingly in the Western Cape, spouses of permanent workers are replacing seasonal African migrants (Ewert and Hamman, 1995), adding another R5 000-R6 000 Rand to household incomes. In this environment, fruit production is one of the few options that can effectively compete for the time of those already employed.

## 2.2 Criteria for appropriate technologies

This discussion suggests the following characteristics for technologies that might be appropriate and adoptable for small-scale producers in South Africa (Eckert, 1995).

### *2.2.1 Divisibility*

Almost by definition, small-scale farmers require divisible inputs. Fertilizers, pest control chemicals, labour and management time are clearly divisible. In apple production, tractors, sprayers, packing equipment, cold stores and soil preparation equipment are less divisible, "lumpy" technologies. Strategies to provide hourly or daily hire services of these technologies, rather than the equipment itself, will be essential to small farm initiatives.

### *2.2.2 Capital saving*

One of the more important constraints to small-scale horticulture, and the primary focus of this research, is capital. Emerging farmers will probably face *de facto* and *de jure* limitations to their access to capital markets. Furthermore, their own perception of possible risks to newly acquired land and social roles mean that capital will be used as sparingly as possible.

### *2.2.3 Labour saving*

Relative capital scarcity does not mean that labour is cheap. Reasonably high returns to labour are required if farming is to compete for labour with non-farm options.

### *2.2.4 Management extensive*

Appropriate technologies for small-scale farmers must be management extensive where possible since household members will likely be involved in off-farm work and household responsibilities as well. This consideration is particularly important during the early stages of the transition. For a population that was historically prevented from most management experience, farm management skills will have to be built up over time.

### *2.2.5 Stable rather than high yielding*

Small farmers globally often chose lower yielding but stable systems and technologies in order to ensure a minimum acceptable subsistence level of living. In apple production, one would expect stability to be sought through avoiding experimental cultivars and clinging to proven varieties and methods. In other words, a desire for stability lead to targeting stable markets with long-term proven potential rather than markets depending on the variable fashions of particular consumers.

### *2.2.6 Exploits niches*

Small farmers are likely to exploit niches in space or time in order to utilize all resources fully. Production niches in small farm agriculture often involve intercropping. Specialty crops and intercropping are not necessarily incompatible as is sometimes alleged. In fact, specialty crops are often part of the complex intercropping pattern of small-scale deciduous fruit production. Chilean small holdings provide a good example. Five to ten tree crops, ten to fifteen annual crops and three or four animal species are often found together on one hectare farms. Tree crops include, *inter alia*, avocado, grape, apricot, cherry, apple, quince, fig and non-fruit species like pine, bamboo and cypress (Altieri & Farrell, 1984). Market niches are typified by roadside markets, door-to-door sales, and "pick you own" farms. In South Africa, the informal market absorbs a significant portion of the lower quality apple crop. Some of the fruit is distributed by hawkers operating from coloured rural areas (Conradie, 1994). An issue that remains to be investigated, but which could support communities of emerging fruit farmers, is whether coloured or black farmers have a comparative advantage in serving markets in the townships based on socio-cultural factors.

### 2.3 The design process and the resulting

With these criteria as a base, a group of experienced apple farmers from the Langkloof region and scientists from Infruitec in Stellenbosch were drawn into an extended process of dialogue and exploration of alternative small-scale apple options. The central objective was to scale down investment or pre-bearing costs from the full input commercial example to levels of half or one-quarter of full input costs. Within these imposed investment constraints, several alternative technologies were evaluated for each step in the start-up and running of an apple orchard. Horticultural consequences of each possible choice were debated in depth so that final designs were based on an interdisciplinary mix of horticultural and economic criteria. Details of the full process used, a modified Delphi process applied within an expert system, are reported in Conradie, *et al.* (1995).

Ultimately, a family of six technologies emerged, each with the concurrence of experience farmers and fruit scientists. Model A represents full input technology as currently recommended for Langkloof. Pre-bearing costs total R44 573 per hectare. Reduced cost options were designed with pre-bearing costs at 70, 43, 41, 33 and 23 percent of this investment level. Commercial farmers in Langkloof are in the process of upgrading from systems approximating model B to those suggested by model A. This paper presents economic assessments of these options. Full horticultural specifications of each production system may be found in Conradie (1995).

## 3. MICRO-ECONOMIC ASSESSMENT

### 3.1 Economic and production characteristics of alternative models

Table 1 summarizes cost components as well as physical and economic performance measures of the alternative production systems. Pre-bearing costs include initial investment plus running costs until harvests begin. In most cases, scaling down on these costs results in an extended nonbearing period. Thus, savings on investment are partially offset by accumulated running costs during the pre-bearing period. Further, lower initial investment leads to smaller trees with a reduced bearing surface. Average annual yields over the life time of the orchard are reduced accordingly.

The search for economically viable alternatives to full input systems involves finding horticultural technologies that reduce investment costs without fully offsetting reductions in expected yields or extensions in the onset of bearing. Comparing models B through E illustrates several key points. Model B, the commercial technology of the recent past, achieves its first harvest in the third year and its first full crop in year six. These performance measures are extended by one and two years respectively in model E. Yet, the year in which positive cash flows occur drops from year eight to year six across the same spectrum due to substantially lowered interest costs on investment and pre-bearing running expenses. This is particularly important if NPV and other economic performance indicators are to be calculated over a ten year planning horizon.

Although the design panel were asked for at least one option at or below 25 percent of full investment cost, the

**Table 1: Costs, physical and economic performance indicators of alternative apple production systems designed for Langkloof, South Africa**

| | Production Systems | | | | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| Total pre-bearing investment[a] | 44573 | 31414 | 19249 | 18451 | 14739 | 10073 |
| Soil preparation and fertilizer | 6097 | 6648 | 2409 | 3971 | 2184 | 1007 |
| Trees | 21333 | 11407 | 2933 | 3259 | 3259 | 2200 |
| Irrigation system | 6000 | 6000 | 6000 | 6000 | 2600 | 1000 |
| Labour | 1323 | 1857 | 1833 | 1941 | 4395 | 5075 |
| Other | 9820 | 5502 | 6074 | 3280 | 2301 | 791 |
| Bearing period costs (10 yrs) | 87830 | 79725 | 71931 | 76323 | 46901 | 52828 |
| Fertilizer (PV) | 6713 | 5813 | 3718 | 5813 | 4127 | 5263 |
| Spray chemicals (PV) | 26185 | 20694 | 24593 | 20029 | 9965 | 11321 |
| Labour (PV) | 19521 | 25354 | 18804 | 25354 | 12520 | 20551 |
| Other (PV) | 35411 | 27864 | 24816 | 25127 | 20289 | 15693 |
| Year of first crop | 2 | 3 | 3 | 3 | 4 | 4 |
| Year of first full crop | 6 | 6 | 6 | 7 | 8 | 10 |
| Yr. of 1st positive cash flow | 7 | 8 | 7 | 7 | 6 | 12 |
| Average tons/ha (10 years) | 48.5 | 33.8 | 32.3 | 33.8 | 25.0 | 14.3 |
| Average tons/ha (20 years) | 59.3 | 46.9 | 41.5 | 46.9 | 35.0 | 24.7 |
| Fruit price (R/ton) | 771.64 | 796.46 | 729.46 | 796.46 | 655.77 | 564.01 |
| NPV 10 years (R/ha) | 118715 | 64112 | 69137 | 84233 | 53023 | (10293) |
| NPV 20 years (R/ha) | 323761 | 233036 | 193159 | 253695 | 153297 | 32304 |
| IRR 10 years (%) | 25.6 | 19.8 | 27.7 | 31.0 | 31.2 | 1.8 |
| IRR 20 years (%) | 30.0 | 26.4 | 32.4 | 35.9 | 35.8 | 14.1 |

[a] Land, water system and infrastructure costs excluded

expert group expressed serious reservations about model F on horticultural grounds. Their concerns focused on questions of viability in view of the very low yield levels and the absence of subsystems such as automatic sprinklers which serve to control variability. Economic results in Table 1 confirm their suspicions. The NPV for model F over 10 years is negative and IRR is only 1.8 percent, wellbelow the opportunity cost of capital. Even measured over 20 years, the IRR, while positive, is clearly not competitive with other options. These findings effectively define a lower boundary somewhere between models E and F to downscaling apple technology for small farm acceptability. Model F is omitted from further consideration in this paper.

### 3.2 Analysis with net present values

NPV calculates the present value of a future stream of net returns per hectare. Thus, it is a measure well suited to evaluate investments with long gestation and pay-back periods such as fruit production. It also serves to prioritize mutually exclusive options because the measure indicates how much, in present value terms, is added to investor wealth by the project (Weston and Copeland, 1986). Ten year NPVs from these production systems range from R118 715 for model A to R53 023 for model E. If, as can be assumed for larger farms, land is limited and capital easily accessible, the commercial investor will likely opt for systems in descending order of NPV/hectare, ie. A-D-C-B-E in that order. Note that models C and B reverse positions if a 20 year planning horizon is used. On the other hand, if capital is the most limiting resource as has been assumed for small-scale farmers, then maximizing returns on investment becomes the governing criterion and the order of choice is given by IRR rankings, ie. D or E-C-A-B.

The small-scale farmer has an additional consideration, his risk averseness, and this suggests a third criterion for ordering technology choices. Ten year net present values as a percent of pre-bearing investment are 266, 204, 359, 456 and 360 percent respectively for models A-E. Returns of 350-450 percent above initial outlays suggest an important cushion against uncontrollable variation in production or marketing. If South Africa's emerging small farmers behave as do limited resource farmers elsewhere (Gutierrez and Eckert, 1991), they will likely forego maximum returns in favour of low risk at a reasonably high but not maximum net return. One could expect the order of choice to be D, then C or E, with A and B ruled out because of their expense.

### 3.3 Internal rates of return

The IRR allows the decision maker to compare orchard profitability with other farm and non-farm investment options by ranking choices by returns to capital. However, the analysis thus far has been incomplete because of the exclusion of land and infrastructure costs. Principal costs in this regard include the value of the land itself, whatever portion of the value of off-farm irrigation systems is passed on to farmers, and other infrastructure. Note that packing sheds, a major infrastructure expense, were already included in base budgets. Table 2 presents IRR calculations for various assumed land and infrastructure costs. Prices included in the table bracket those found in actual practice. Undeveloped orchard land with water has recently sold for R15 000 in Langkloof while in the Elgin-Grabouw area, with its closer proximity to the Cape Metropole and perhaps more complete exhaustion of available apple area, prices range from R20 000 to R30 000 (S. Smith, personal communication).

It is clear from Table 2 that including land and infrastructure most affects the economic results of the lower investment options. Accepting an IRR = 10% as a minimum threshold to provide for repayment of capital and a management/entrepreneurial return, all systems are viable in a ten year planning period with land costs of R20 000. However, B drops out at R25 000, and C and E fail to meet the arbitrary minimum returns test at land costs of R30 000. At land and infrastructure costs of R30 000, new farmers face a choice between models A and D. The small, capital constrained farmer will likely chose model D.

### 3.4 Efficiency frontiers

Figure 2 plots selected IRR values from Table 2 for four different land and infrastructure cost levels. Each cluster of points represents models E to A when read from left to right in order of increasing cost. Following Calkins et al. (1984) conventional "efficiency frontiers" are added for each cost level. An efficiency frontier is a line across an array of results that connects points each of which is successively better than the previous point. Options falling.

**Table 2: Internal Rates of Return for Apple Production Options with Alternative Values for Land and Associated Infrastructure**

| | Production Systems | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| IRR over 10 Years | | | | | |
| Excluding land | 25.6 | 19.8 | 27.7 | 31.0 | 31.2 |
| Land @ R10 000 | 21.1 | 14.4 | 19.1 | 21.6 | 19.6 |
| Land @ R15 000 | 19.1 | 12.2 | 16.0 | 18.3 | 16.0 |
| Land @ R20 000 | 17.3 | 10.3 | 13.3 | 15.5 | 13.2 |
| Land @ R25 000 | 15.7 | 8.5 | 11.0 | 13.0 | 10.7 |
| Land @ R30 000 | 14.2 | 6.8 | 8.8 | 10.9 | 8.7 |
| Land @ R40 000 | 11.4 | 3.7 | 4.9 | 7.0 | 5.2 |
| IRR over 20 Years | | | | | |
| Land @ R20 000 | 21.0 | 17.7 | 18.7 | 21.9 | 18.7 |
| Land @ R40 000 | 16.9 | 12.7 | 12.2 | 14.7 | 12.4 |

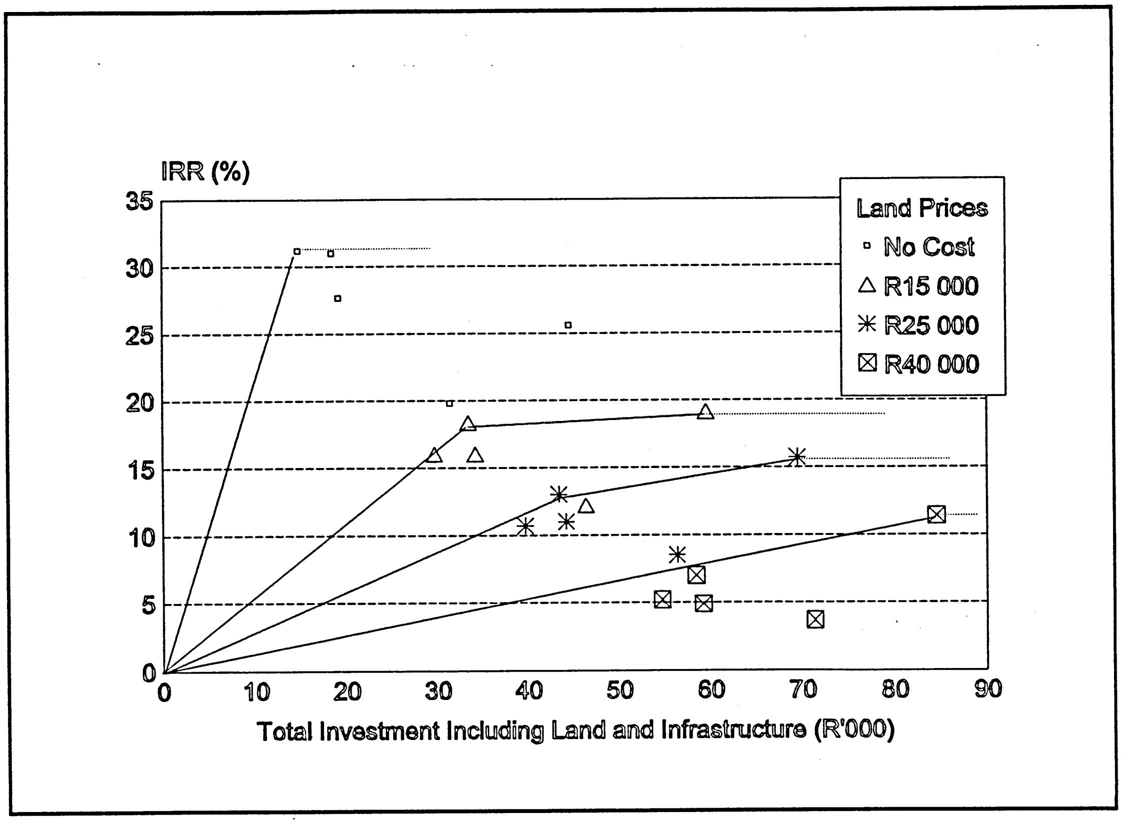


**Figure 2: IRRs for alternative investment levels including land and infrastructure costs**

below these lines are considered inferior choices, both from individual and aggregated planning perspectives. The point representing model C with land costs of R15 000 illustrates this point. C is inferior because higher returns could be obtained with about the same investment by using model D, or the same approximate level of returns are available with less investment through model E. The efficiency frontier for land priced at R15 000 demonstrates an important generic conclusion. If capital is plentiful, A becomes the logical choice because it produces the highest IRR. If however, institutional or self imposed barriers constrain capital access to below that required for model A (R59 573/ha at this land price), then model D becomes the choice that combines feasibility within the capital constraint with optimality in terms of returns on investment. If capital is further constrained to below the model D level of R33 451 per hectare, model E could be considered since it lies only a negligible distance below the efficiency frontier.

Figure 2 illustrates a second important point, ie. that land and infrastructure costs affect lower cost options the most. If land is free, say, fully subsidized by the state, then the efficiency frontier includes only model E, although model D is a very close second. The full investment model A is well below optimum. As the price of land and infrastructure rises, the various models shift in relative position. At R14 000, the efficiency frontier (not shown) includes models E, D, and A. At R15 000, model E has dropped marginally below the frontier. Between R15 000 and about R38 000, the efficiency frontier includes both models D and A. Within this range, technology choice would be dictated by capital constraints that farmers actually face. If the costs of land and infrastructure exceed R40 000 per hectare, the commercial, full investment technology of model A is the only optimum economic choice.

## 4. LABOUR USE CONSIDERATIONS

In addition to technical feasibility, and the constrained maximization of returns on capital, a third criterion is important for small farm options in South Africa. For reasons discussed above, farming enterprises must generate returns to labour that are judged acceptable by the farm household within an incentive structure that includes the off-farm opportunity cost of labour. Farm returns do not need to exactly match off-farm wages but they must be competitive in an environment where off-farm wages may be high and the residual time for leisure and household responsibilities scarce.

A fourth criterion, also concerning labour, comes to bear on the question of feasibility. Appropriate technologies will have labour requirements that fit largely within the labour supply of the farm household. This criterion is supported by the finding in the former homelands that active farming occurred only in households with 1-1.5 more adult males at home that the norms in the local area (Eckert & Williams, 1995).

### 4.1 Labour supply and demand

Table 3 summarizes labour inputs needed during bearing years by each production system being examined. In two of the lower cost options, B and D, significant savings were achieved by substituting labour for capital with the result that labour requirements in these cases are nearly 50 percent higher than model A. Nearly all of this difference is caused by the use of hand thinning of flowers in addition

**Table 3: Average Weekly Labour Requirements (Hours) by Horticultural Season for Alternative Golden Delicious Apple Production Systems**

| | Production System | | | | |
|---|---|---|---|---|---|
| **Months, (season), no. of weeks** | **A** | **B** | **C** | **D** | **E** |
| **Bearing Years** | | | | | |
| May-Aug (dormant) 17.6 wks | 36.7 | 36.7 | 43.5 | 36.7 | 27.3 |
| Sept-Oct (flowering) 8.7 wks | 19.2 | 116.2 | 18.2 | 116.2 | 9.8 |
| Nov-Feb (growing) 17 wks | 54.5 | 56.4 | 55.6 | 56.4 | 50.5 |
| Mar (harvest) 4.4 wks | 103.4 | 88.6 | 88.6 | 88.6 | 65.9 |
| Apr (maintenance) 4.3 wks | 1.6 | 1.9 | 7.4 | 1.9 | 5.3 |
| Total (person hours/ hectare) | 2202 | 3014 | 2291 | 3014 | 1736 |
| **Pre-bearing Years** | | | | | |
| Total (person hours/ hectare) | 933 | 681 | 657 | 681 | 1083 |

to the sprays normally used for chemical thinning. Should the hand thinning of flowers replace the chemical sprays, models B and D would be examples of labour being substituted for capital. However, the expert panel decided to add hand thinning to chemical thinning of flowers. The reason is that apart from thinning a large percentage of fruitlets, the chemicals also improve fruit finish. Golden Delicious apples are susceptible to two kinds of skin blemishes, both of which prevent fruit from being exported. Stem-end russeting and retiform russeting are caused by different mechanisms and appear independently of each other. Stem-end russeting can only be prevented by selective hand thinning of flowers. Models B and D are examples of insuring against poor fruit quality at the cost of 1.5 times the regular labour input.

Except for this factor, the remaining seasonal labour requirements are substantially similar. This reflects the judgement of the expert panel that serious downscaling of operating costs during the bearing years involved too much risk to the quantity and value of the product.

Three labour supply scenarios were developed to assess whether these models could be accommodated by an emerging farm household. Or, stated alternatively, how many hectares of each model were feasible within the family's own labour supply. All scenarios reflect the basic assumption that the newly settled farm families will be drawn from worker families on existing commercial apple farms in the vicinity. We further assume that families will seek to maintain at least one person in formal employment on a commercial farm, even after their own farm starts to produce. The low labour requirement during the non-bearing years makes it possible for both husband and wife to remain fully employed during this period.

Several benefits can be derived from such a strategy. Maintaining existing ties with commercial production ensures income during the pre-bearing years and a stable source of supplemental income thereafter. It also produces capital for investment and recurrent expenses. However, the possible benefits extend well beyond the pecuniary. People with experience and skills gained as farm workers are more likely to succeed on their own farm. If a person retains his/her job, training can continue and the commercial farm becomes a place to learn of new techniques before it is adapted to the smaller own unit. Full time employment also builds a relationship of trust between owner and worker. To the worker who then starts his own farm, this trust could conceivably extend to contractual relationships wherein the commercial farm provides equipment services, input transport, economies of bulk input buying, and access to packing sheds and through them to export markets.

The first labour supply scenario consists of a nuclear family with adult female and male present. One adult works off-farm (as a farm worker) full time and the other farms their own land full time. The family member with the off-farm job is assumed to contribute three out of every four Saturdays, two weeks of annual leave during winter and some limited "overtime" to the family unit. Overtime consists of one hour daily during the week from November to February. The annual labour available for their own farm totals 2989 hours. In scenario 2, both adults farm their own land full time (52 weeks of 48 hours each) for a total of 4992 hours. Scenario 3 combines the first two by supposing a three adult household with two of them working the family farm and one in full-time off-farm work but with spare time spent on the family farm as in scenario 1.

Figure 3 combines the first and second labour supply scenarios with the labour demands of one hectare of model D. Labour requirements are indicated by the unshaded area in the foreground. Shaded areas in the background indicate the labour supplies of scenarios A and B respectively by showing the amount of surplus person hours per week. Where the unshaded area rises above the backgrounds it indicates that labour availability did not fully cover requirements. Thus, between September 1 and October 31 (the flowering season), neither family labour scenario covered requirements for the activities of thinning and pruning of one hectare. If two adult workers are available on farm (Scenario B) an additional 20 person hours are required per week during this season. It should be remembered that model D substituted hand thinning for chemical thinning of flowers. The severity of this seasonal peak does not appear with other low cost models except model B. Labour scenario B was, however, able to meet the harvest labour requirements of one hectare whereas Scenario A was not.

These findings do not imply that model D or others are infeasible. Rather they simply state that even a one hectare farm may need to obtain additional labour occasionally. From the point of view of labour supply as suggested here, all models are feasible on one hectare farms if modest augmentation of labour supplies is possible from local employment, school children, extended family members, etc. Under this assumption, two hectare model D farms are feasible for labour scenarios 2 and 3 which have at least two full-time adults on the farm. Two hectares using model C and E technologies can also be

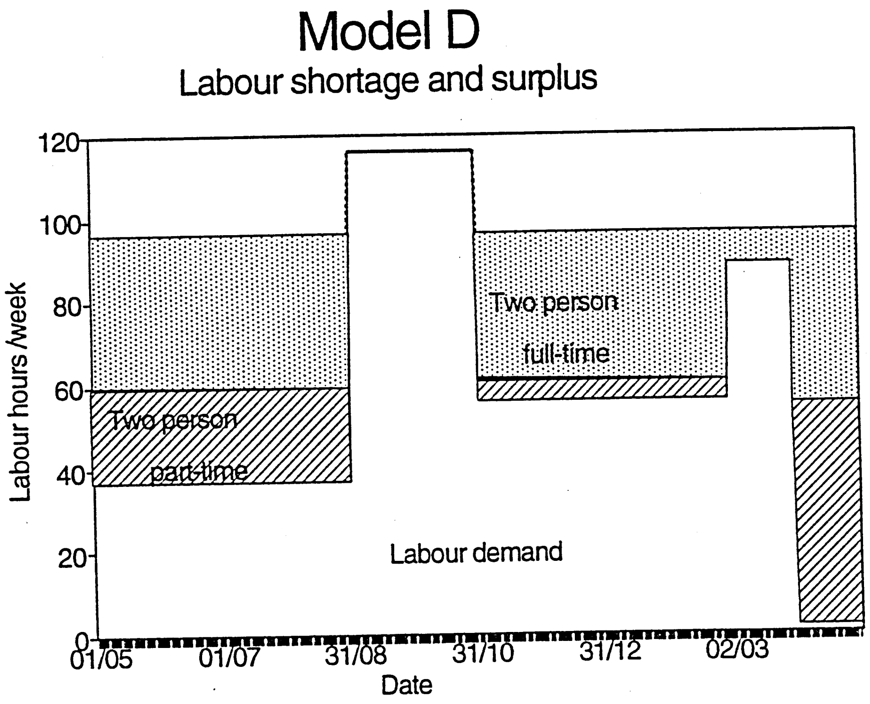


**Figure 3:** **Model D - labour shortage and surplus per horticultural period for a full-time and part-time labour supply scenario**

managed under labour scenario 1 if modest supplemental labour is available.

### 4.2 Returns to labour

There is little reliable data from which to determine the exact opportunity cost to self employment in the rural Western Cape. Permanent employment as farm labourer on dryland farms in the Swartland is generally priced at R1.50 per hour (Directorate of Agricultural Economics, 1994). Cash remuneration on irrigated fruit farms can easily reach twice that figure. On some of the more progressive fruit farms, the value of housing and social goods provided can exceed the cash wage, although this is not the norm. Rural non-farm employment for black and coloured individuals can be in the range of R10-20 per day depending on a number of factors (personal discussions with Gabrie van Eden, CFG; Deon Swart, Kromco and Johan Hopkins, Unifruco).

Table 4 estimates returns per hour from the various apple production systems. Figures in the table are residuals after debiting a nominal wage of R1.50 per hour in the base budgets. Thus, if the small farm family provides their own labour as assumed here, total returns would be R1.5 per hour higher than those shown in Table 4. Estimated returns compare favourably with other rural employment options discussed above. If one views the technically complex business of apple production as a professional specialization within the agricultural field, labour returns at rates estimated in Table 4 can be viewed as an appropriately high rate of professional remuneration.

## 5. MACROECONOMIC CONSEQUENCES

Scaled down technologies, while necessary to accommodate capital constraints of emerging farmers, imply lower spending on investment goods and annual farm inputs. This will be reflected in economic activity

**Table 4: Hourly Returns to Labour and Management for Small Farmers in Alternative Apple Production Systems[a]**

| | Production System | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| Land @ R10 000, r = 5% | | | | | |
| Average gross margin | 23194 | 13807 | 12583 | 14639 | 9144 |
| - imputed rent | -2596 | -1779 | -1266 | -1125 | -881 |
| Returns to labour and management | 20598 | 12028 | 11317 | 13514 | 8263 |
| , total labour hours | 2202 | 3014 | 2291 | 3014 | 1736 |
| Imputed hourly wage rate[a] | 9.35 | 3.99 | 4.94 | 4.48 | 4.76 |
| Imputed wage rates[a] | | | | | |
| Land = R15 000/ha | 9.24 | 3.91 | 4.83 | 4.40 | 4.62 |
| Land = R25 000/ha | 9.01 | 3.74 | 4.61 | 4.23 | 4.33 |

[a] These values are over and above the R1.5/hr already included in base budgets

**Table 5: Macroeconomic Effects on Agribusiness of Investment with Low Cost Options vs. Full Investment (Model A) Orchard Development on New Land[a]**

| | 100 Hectares of Production Systems | | | |
|---|---|---|---|---|
| | B | C | D | E |
| **Farm investment spending (Rand mil.)** | | | | |
| Agricultural machines | -.591 | -.607 | -.796 | -.839 |
| Mining (lime) | 0 | -.169 | -.061 | -.247 |
| **Employment in off-farm sectors (person years)** | | | | |
| Agricultural machines | -16.7 | -17.2 | -22.5 | -23.8 |
| Mining | 0 | -5.2 | -1.9 | -7.6 |
| **GDP in selected sectors (R mil.)** | | | | |
| Agricultural machines | -.918 | -.943 | -1.237 | -1.303 |
| Mining | 0 | -.232 | -.083 | -.338 |
| **Average gross margin** | | | | |
| (in million Rand over 20 years) | -.840 | -1.548 | -.840 | -2.281 |
| **Average annual foreign exchange earnings** | | | | |
| (in million Rand over 20 years) | -.602 | -1.194 | -.602 | -1.637 |

[a] Effects of lowered spending in the pre-bearing years only

changes in off-farm agribusinesses and the general economy. Thus, an assessment of macroeconomic consequences is important to complete the picture. Two perspectives can be taken. First is the consequences of subdividing existing apple farms on which pre-bearing investment has already been made. The second is to ask what are the consequences of using the various low investment models as opposed to model A on newly developed land. Since the really large differences between models are found in pre bearing investments, macroeconomic impacts of subdividing established bearing orchards are less severe than with new land. These calculations for subdividing farms are developed in Conradie (1995:84) and are not repeated here.

Viewed from an aggregated regional planning perspective, the limiting factor becomes land suitable for appleperspective raises the question of maximum sustainable use of the nation's scarce resources. This section explores the off-farm consequences of developing new land with low investment models as opposed to the full investment model A. Table 5 assembles data to reflect development of 100 hectares. With deciduous fruit, one hundred hectares could be taken as an appropriate project size to capture efficiencies in land preparation and water system development.

The figures in Table 5 reflect the impact on the off-farm economy of lowered investment spending during pre-bearing years. These figures represent most of the macro-economic opportunity loss of choosing lower cost options. For example, investing in 100 hectares of model D spends R857 000 less, resulting in 24.4 fewer jobs in industries supplying investment goods and an opportunity loss of 1.32 million Rand of GDP. Furthermore, gross margins will average R8 400 per hectare less over 20 years and foreign exchange earnings will be R6 000 per hectare lower than they could have been under model A.

Thus planners of land reform face some clear choices. Microeconomic gains by newly settled farm households will be partially offset by opportunity losses in the larger economy as a whole. Of interest is the fact that 57 percent of the GDP losses and 60 percent of the employment losses will occur outside the Western Cape (calculations from Eckert & van Seventer, 1995).

## 6. I HAD A SMALL FARM IN AFRICA[2]

It is difficult to choose a single recommendation for appropriate small-scale apple production technology. As shown in most tables above, analytical results and economic optima depend on several factors such as land prices, interest rates, and others. Nevertheless, it is instructive to explore the full results of one of the scaled down options as a means of pulling together the analyses above and relating them to rural development and land reform considerations.

Model D emerges from the above discussion as the most desirable low cost option under many conditions for several reasons. At R18 451 per hectare, prebearing investments are only 41 percent of model A. Over either ten or twenty years, net present values from D exceed all other scaled down options and the internal rate of return is essentially equal to that of model E in top position, exceeding model A as well as all others. For model D, the ten year NPV exceeds pre-bearing investment by 450 percent, more than 100 percent higher than any other option. For risk averse small farmers, this provides an attractive extra cushion against uncontrollable variation in any of the components of net revenue. Model D can be adopted by any family composition which includes two adults working full-time on their own land, with only modest additional hired employment required during the bearing years. For reasons discussed above, if a third family member can retain employment on a commercial farm in the same field, significant additional advantages could accrue. Model D lies on the efficiency frontier for a broad range of land prices, from roughly R10 000 to R38 000 per hectare. Within this range, if any capital constraint precludes the full investment needed for model A, model D is the next best optimum choice. Finally, model D is fully competitive with other scaled down options with respect to returns to family labour and management. Returns estimated in Table 4 should compete well with opportunity costs derived from the off-farm labour market, especially for rural residents.

For this illustration, assume two hectares of orchards established with model D technology, fully planted with Golden Delicious apples. As noted above, other cultivars, or combinations of cultivars or fruit species can be less demanding. Further, a mixture of cultivars spreads out the labour peaks. However, if small-scale fruit production works with Golden Delicious apples evaluated on the basis of only ten years' results, it should work with other apple cultivars and with other fruit species.

Two hectares will require that the farmer sink R36 902 into his land before any harvest is possible. During the pre-bearing years, labour requirements can be easily managed by one member of the family while one member retains full employment off-farm. This study has not explored possibilities of earning income from the two hectares by intercropping or livestock during the pre-bearing years although there is historic precedent for such farming systems in Langkloof (MacVicar and Loxton, 1963). The orchard starts bearing in year three with the first full crop and the first positive cash flow occurring in year seven. Thus, in the third year, seasonal labour requirements, except for harvest, shift to those of the bearing years configuration given in Table 3 above. As harvest tonnage rises toward full production levels, harvest labour requirements expand until reaching the annual pattern shown in Figure 3.

Over 10 years, including the non-bearing years, this farm will average 67.6 tons of apples annually with a gross value of R53 841. Gross margins will average R29 276 over these same ten years. The net present value of ten years' results, including losses in the early years, is R168 466, exceeding pre-bearing outlays by more than 450 percent. Net revenue could decline by 17 percent for unforeseen reasons before any other low cost option becomes competitive. Both these factors provide much needed income security.

Assume that once the orchard begins to bear, a third adult family member moves onto the farm, shifting the labour supply to scenario 3 levels. This farm family will put 4 462 hours of their own labour into their two hectares per year and create an additional 1 566 person hours of employment for friends or neighbours. The farm family's income would combine R6 693 of wages paid to themselves (@ R1.5/hr.), R27 028 as the surplus for management and risk taking and approximately R7 500 from the one off-farm job for a total of R41 221 per year. These figures represent average results over ten years in which two are non-bearing and four produce diminished yields from immature trees. Averaged over years 7-20, the full bearing period of a 20 year orchard, the two direct wage payments remain the same but the average annual margin for management and risk taking (assuming land at R15 000) rises to R66 122. For these years, annual family income is R80 315. At this income level, it is conceivable that the small farmer might shift to the management mode of larger operators and hire most or all of his labour, becoming, in effect, a mini-commercial operator.

## 7. SUMMARY AND CONCLUSIONS

This analysis has shown that small-scale Golden Delicious apple production could be considered as a viable form of rural and agricultural reconstruction. It was suggested that if it worked under this most demanding crop, feasibility with a number of other apple cultivars and fruit varieties could be assumed. An expert panel of apple producers and scientists developed what they believed were horticulturally viable options requiring substantially less than full commercial prebearing investment. These models were subjected to stringent economic tests for acceptable net present values and internal rates of return. Compatibility with assumed characteristics of emerging, small-scale, supplemented farmers was assessed.

One model (model D) emerged as particularly robust in that it dominates the order of choice under a wide range of conditions involving capital scarcity or rationing. For a family of three adults, two hectares using this technology are manageable primarily with family labour. During the first 10 years of establishment, household incomes average approximately five times the current poverty line, a figure which rises even more for the second ten years of orchard life.

To restate important qualifications mentioned earlier, these models employed several important assumptions regarding access. Access was assumed for small-scale emergent farmers to investment and operating capital, to the same markets now used by commercial farmers, to hourly or daily hire services of key agricultural implements and machinery, and to a source of technical knowledge and recurrent training. This paper assumes that credit institutions will serve these new clients without penalties related to transaction size or to unwarranted perceptions of risk. It further assumes that new farmers will be drawn from better skilled apple farm labourers and that a collegial collaboration can be developed with their present employers during the settlement period and beyond. Thus, most of the rest of their needs for access are assumed to be met via this relationship. In this scenario, the parent farm serves as machinery pool and shares extension information and new technology. Market access was assumed by budgeting for membership in established packing sheds, and again assumes no penalty to smaller producers. Informal perceptions at Unifruco and Infruitec that the substitution of skilled hand labour for machines in key operations could produce higher exportable percentages of fruit are encouraging in this regard.

It is believed that a significant portion of the social and economic advisability of a growing population of micro-scale fruit farms depends on solving these infrastructure and access problems in least cost means such as suggested here which open access to existing commercial and governmental services. At the other end of the development program spectrum, if government must intervene to create new marketing channels, manage fleets of farm vehicles and establish parallel financing systems, overall benefits could evaporate quickly.

**NOTES:**

1. The role of apartheid and its predecessor poilicies in enforcing this dependence is recognized but it is not germane to the central argument here.

2. With apologies to Isak Dinesen for borrowing and amending his inspiring opening line from Out of Africa.

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