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Sowing Seeds of Success - Harvesting Underutilised Crops: The response of a commercial farm to changing terms of trade, to Peak Oil and to Climate Change.

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Abstract. A new political environment, the reality of climate change, an awareness of Peak Oil and rapidly changing terms of trade resulting from globalisation, required a commercial farming operation in South Africa to re-evaluate its farming practices and product portfolio, to develop and adopt new approaches and to successfully reposition the farm. An integrated, diversified and dynamic approach has led to better utilisation of the crops grown on the farm - both traditional and novel/underutilised. Making use of available research and development at the institutional level, as well as engaging in private/public/community partnerships, has generated positive results – both financially and for the wider community.

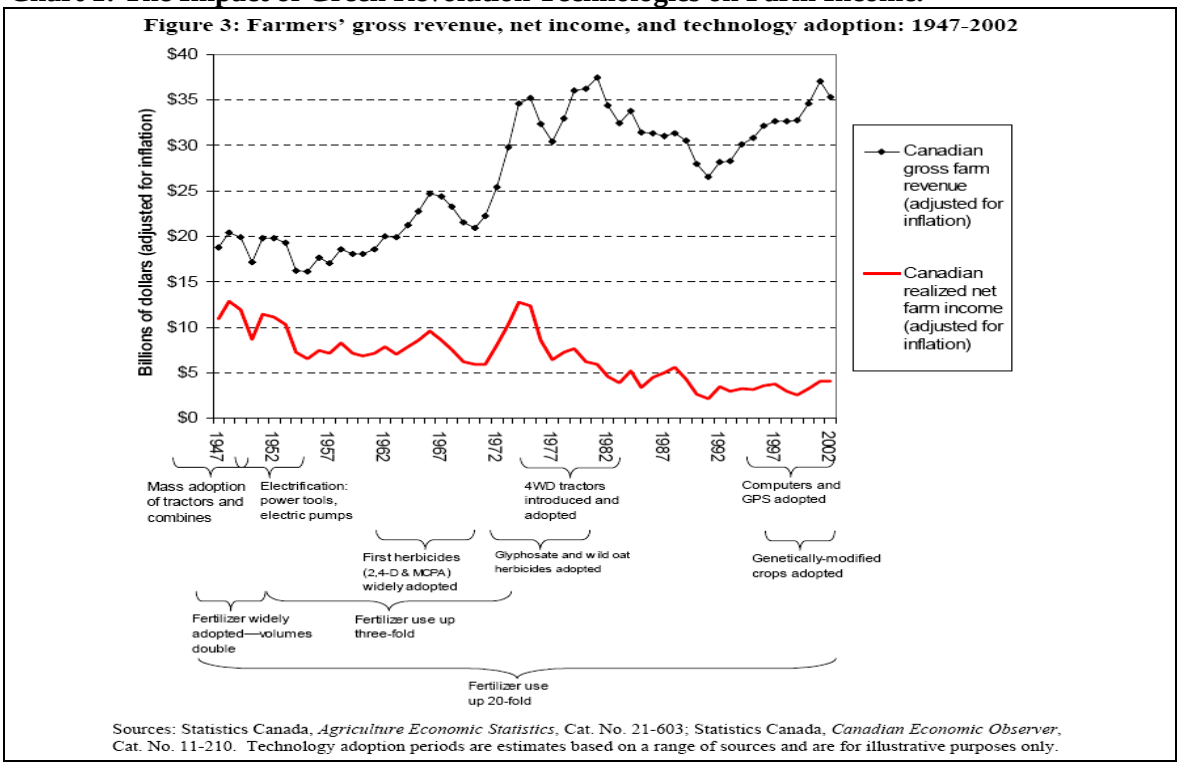
Introduction

Kirklington Farm has, since 1911, been owned, managed and worked by the same families. Situated in the picturesque Eastern Free State of South Africa, near the town of Ficksburg, the area has a temperate climate: summer (November to March) temperatures fluctuate between 10 C and 36 C and winter (May to August) –15 C to 25 C. Rainfall, occurring predominantly in the summer months, averages 650mm per year and with an altitude of 1700m above sea level and with a large range of soils, makes this area ideal for the cultivation of a variety of crops including large and small grains, oilseeds, fruit, vegetables and livestock. The farm weathered the changes in agricultural practices from manure and bone meal to lower input farming in the 1990's when the sustainable approach was expanded upon to include organic and biodynamic methods and by 2006 was farmed wholly organic on 1000 hectares generating positive returns economically, environmentally and socially. I need to apologise for the, at times, disjointed nature of the paper, a result of taking a complex and highly integrated, diversified, live 3D image and converting it to a plain 2D format. I am alone responsible for any misunderstandings or misinterpretations.

Background

Following World War II, Kirklington experienced the Green Revolution and for a period of three decades crop yields doubled and even trebled, however the honeymoon was not sustainable and from the 1970's Green Revolution practices were causing a number of seriously negative outcomes namely, degraded soils, chemically resistant weeds, insects and diseases; polluted ecosystems and humans; nutritionally unsound commodities and relentlessly shrinking financial margins. See chart 1 below.

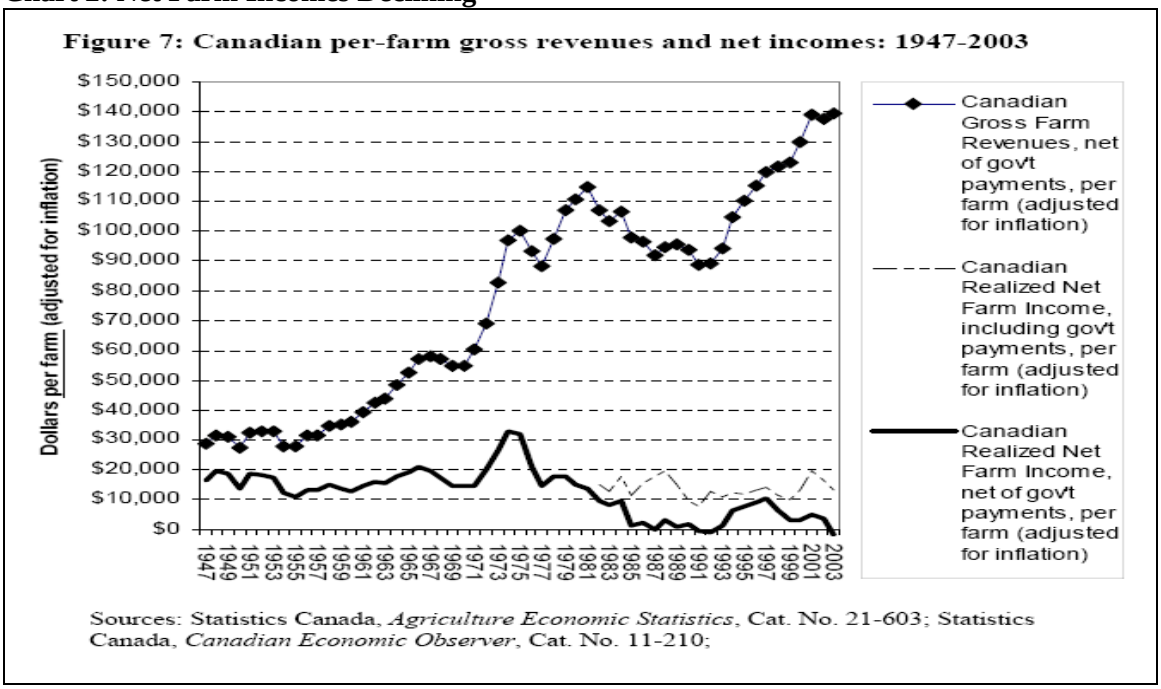
Chart 1: The Impact of Green Revolution Technologies on Farm Income.



Sources: Statistics Canada, *Agriculture Economic Statistics*, Cat. No. 21-603; Statistics Canada, *Canadian Economic Observer*, Cat. No. 11-210. Technology adoption periods are estimates based on a range of sources and are for illustrative purposes only.

The Brown Revolution, driven by the agrochemical and seed industries, was introduced to Kirklington in the 1980's with the mix of crops remaining much the same, i.e. maize, wheat, sunflower, grain sorghum in rotation and beef cattle and sheep. Despite these new technologies and increases in chemical fertilisers and poisons which increased yields, net profits continued their downward spiral. Supported by government subsidies and practicing low input sustainable agriculture (LISA), Kirklington survived into the 1990's, but climate change in the form of unseasonable extreme droughts and floods coupled with democratic elections and a new government introducing globalisation and withdrawing subsidies, meant a new course had to be charted for survival of the whole farm organism.

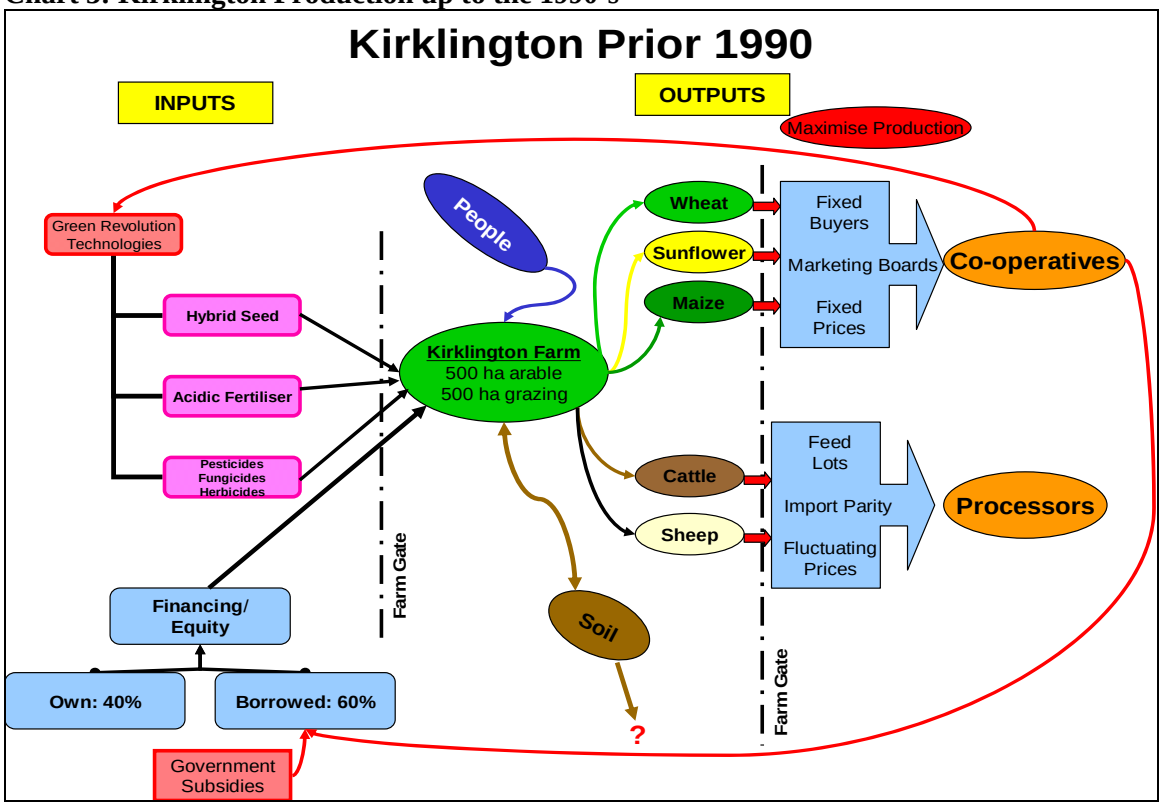
Chart 2: Net Farm Incomes Declining



Sources: Statistics Canada, *Agriculture Economic Statistics*, Cat. No. 21-603; Statistics Canada, *Canadian Economic Observer*, Cat. No. 11-210;

When researching Kirklington financial records I found a definite reversal in terms of trade during the previous decade: the economics of chemical farming were changing for the worse and producing commodities was becoming increasingly risky without a concomitant increase in return. Input prices were rising continuously, driven by agri-industry corporations' predatory pricing policies. For example, in the seed market five major seed firms now produce over 80% of the crop seed sold internationally. They are Monsanto, DuPont, Dow, Syngenta and Bayer.[1] Similar concentrations of power in the fossil fertiliser and poisons industries existed with large areas of cross holdings, partnerships and agreements. At the farmers' gate stood the same faces, but this time buying the farmers' produce at continuously declining prices. We were not alone in our dilemma; globally farmers were experiencing comparable problems. (See chart 2 above) Finally I realised, chemical farming is "violent" farming, based on a system of unremitting exploitation of all factors of production, which is linear, short-term focused and unsustainable. See Chart 3 below which maps the stylised conventional industrial agriculture model including the inputs and raw outputs; the reliance on external capital and information and the degradation of the most important resource, the soil. This is a far cry from the example nature gives.

Chart 3: Kirklington Production up to the 1990's



Travelling in the USA in 1988/89 provided me with an insight into the potential of commercial organic and biodynamic family farming which promised the possibility of reversing the negative trends by producing a higher value product (nutritionally and financially) at a better price with a long-term reduction in costs. Wider research (see quote below) indicated that profitable and sustainable commercial organic farming was feasible and desirable with accompanying benefits for the community (employment, local healthy food and the multiplier effects of money retained in the local economy) and ultimately spiritual fulfilment especially in the realm of bio-dynamics.

"In 1989, the National Research Council of the USA National Academy of Sciences issued a highly significant report on "Alternative Agriculture" which was defined as **a system of food and fibre production that applies management skills and information to reduce costs, improve efficiency, and maintain production levels through such practices as crop rotations, proper**

[1] The Next Agricultural Revolution. Revitalising family-based agriculture and rural communities. Dr William Heffernan, Ph.D., Professor Emeritus, University of Missouri, Rural Sociology, USA.

integration of crops and livestock, nitrogen fixing legumes, integrated pest management, conservation tillage, and recycling of on-farm wastes as soil conditioner: and biofertilisers. The report encouraged the collective adoption of these practices by U.S. farmers as the best alternative to the continued and intensive use of chemical fertilizers and pesticides which have often impaired the quality of our soil, water, and food.
Again, in 1993 the National Academy of Sciences left no doubt as to these earlier concerns when the National Research Council released a report on "Pesticides in the Diets of Infants and Children" which concluded that people in this age group could be at considerable health risk from consumption of foods containing pesticide residues.
Both of these reports have raised considerable speculation about the future of our chemical-based agricultural production system. A growing consensus of consumers, environmentalists, legislators, and many farmers is that our current farming practices will have to change considerably to achieve a significant reduction in pesticide usage in U.S. agriculture. The ultimate goal of sustainable agriculture according to the National Research Council, and other sources as well, is **to develop farming systems that are productive, profitable, energy conserving, environmentally sound, conserving of natural resources, and that ensure food safety and quality.** Consequently, the leading question that U.S. farmers are asking is, "How can I make these changes, reduce my chemical inputs, and achieve an acceptable level of economic and environmental sustainability?" A successful transition from chemical-based farming systems to a more sustainable agriculture will depend largely on what farmers do to improve and maintain the quality of their agricultural soils. Indeed**, soil quality is the "key" to a sustainable agriculture**. Not surprisingly, the alternative agricultural practices advocated by the National Research Council are mainly those that can improve and maintain soil quality. Experience has shown that the transition from conventional agriculture to nature farming or organic farming can involve certain risks, such as initially lower yields and increased pest problems. Once through the transition period, which might take several years, most farmers find their new farming systems to be stable, productive, manageable and profitable without pesticides."[2]

The agriculture I envisaged and wanted to create had to depend more on knowledge and understanding of nature, including human nature, and less on capital and access to technologies developed to extract wealth from the user, and by focusing on the four pillars of sustainable business: social, environmental, financial and spiritual, I would be maximising the Quadruple Bottom Line (QBL) and successfully achieving our goals.

Education, skills and experience were the immediate challenges, however having had no formal chemical agricultural training, I found it easier to realise organic farming works, making the learning process faster than usual.*" Free your brain and your behind will follow" Farmer Tom Frantzen, USA ATTRAnews USA*[3].

Based on these ideas, facts and ongoing research we decided to pursue the organic way with an organic and precautionary approach based on the Precautionary Principle (see Information Box 1 below): slowly- to learn and live the "new" initiative- the starting point being the soil and its neglected and underutilised crop, soil life, followed by seed, and so up the growth chain to the final edible crop.

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[2] "Beneficial and Effective Micro-organisms for a Sustainable Agriculture and Environment". Dr.Teruo Higa, Professor of Horticulture, University of the Ryukyus, Okinawa, Japan and Dr James F. Parr, Soil Microbiologist, Agricultural Research Centre, US Department of Agriculture, Beltsville, Maryland, USA. International Nature Farming Research Centre, Atami, Japan, 1994.

[3] ATTRA*news* is the newsletter of ATTRA - National Sustainable Agriculture Information Service is managed by the National Centre for Appropriate Technology (NCAT), US Department of Agriculture.

Information Box 1: The Precautionary Principle

1. Scientific uncertainty should not automatically preclude regulation of activities that pose a potential risk of significant harm (Non-Preclusion PP).
2. Regulatory controls should incorporate a margin of safety; activities should be limited below the level at which no adverse effect has been observed or predicted (Margin of Safety PP).
3. Activities that present an uncertain potential for significant harm should be subject to best technology available requirements to minimize the risk of harm unless the proponent of the activity shows that they present no appreciable risk of harm (BAT PP).
4. Activities that present an uncertain potential for significant harm should be prohibited unless the proponent of the activity shows that it presents no appreciable risk of harm (Prohibitory PP). From ".wikipedia.org/wiki/Precautionary_principle"

Materials and Methods: The Silent Revolution

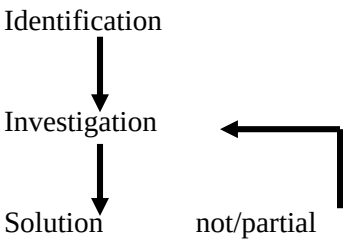
"To be sustained over a short term, the enterprise must be profitable; to be sustained over a long time period, the management of the natural resources such as soil and water must be considered." ATTRAnews ibid.

The conversion period was finally stretched over 10 years in order to accommodate the timely and costly research, experimentation, trials and market developments which were virtually non-existent in South Africa while government agricultural departments were pursuing the illusive industrial agriculture model.

At the outset the decision to grow crops, which had a history at Kirklington, organically, meant a reduction in risk of inevitable experimental failure, financial loss and critique from across the fence. Based on successful trials, the market would be investigated for an offset point for the crop and simultaneously a search for new and underutilised crops would occur followed by research and development.

A holistic method of experimentation introduced many variables requiring an open mind and tolerance for failure and unpredicted success. The identification of critical inputs and research areas including seed, soil and soil life, fertiliser and bio-fertiliser, cultivation techniques, pest, weed and disease and harvesting led us to reading numerous books, scientific papers and liaising with institutions (e.g. Small Grain Institute of the Agricultural Research Council) technical colleges and universities (e.g. Free State and Stellenbosch) including overseas institutions (e.g. Elm Farm Research Centre, UK). Many problems cropped up and were solved by following the format in Table 1 below.

Table 1: Technical Problems: Process and Solutions



Identification	Investigation	Solution
Information on organics, soil, soil life	Enquiries ex farmers, internet, advisors, institutions, universities.	Old Farmers handbooks; new books; internet; farmers; farm walks; advisors; institutions.
Regulations	Search as above	Internet; farmers; certifiers

Market for in-conversion	Contact traditional markets, farmers markets,	Retailers; farmers markets Municipal markets.
Inputs: seed, fertilisers, machinery	As above and own resources	Internet; farmers, advisors, own planning
Technical experience	Industry info.	Trial & error; costly industry information
Training	None	In house
Irrigation	Industry	Trial & error; costly industry information
New technology	Magazines, internet, farmers, advisors	Trial and intuition.
Weeds, pests & disease	As above	Least cost option of present equipment and resources or borrow, lease.
Value adding	Market, farmers, advisors, internet, magazines	Thorough research and development.

Upon reaching a critical point of knowledge confidence, practical trials were commenced where factors such as cultivation effect on weeds, on germination time, incidence of pests and different methods of control and the harvest quantity and quality were monitored and recorded. These factors are listed below.

Objectives and parameters used and measured during trials of old and new crops:

Soil

Objective: To transform the soil from a disease inducing to a disease suppressing state; get the soil alive with earthworms and other soil life; improve nutrient status and water absorbing capacity.
Parameters: cultivation type (e.g. plough, minimum till); effect on soil (soil life, structure, organic matter, water retention capacity); effect on seed germination; outcome on weeds and pests; effect on harvesting.

Seed

Objectives: To identify suitable crops, cultivars and varieties for successful cultivation.
Parameters: time & rates of application; inoculants- microbial and chemical (permitted); depth of planting and placement; mixed & strip crop seeding.

Fertiliser

Objective: To determine the optimal type and application method(s) of fertiliser and biofertiliser.
Parameters: type (precision &/ broadcast); rate; depth of application; relation of application to seed; green manure; post emergence fertilising and foliar feeding.

Pests, weeds and diseases

Objective: To establishment the best method of control and if necessary.
Parameters: daily/weekly monitoring; critical thresholds for action; action type (organic poison, microbial exclusion, farm remedies, cultivation); catch crops, intercropping, strip cropping and weeds as indicators of soil structure and nutrient status.

Equipment

Objective: To identify the implement best suited for the job.
Parameters: conventional; adapted, new.

Harvesting

Objective: To determine the effectiveness of the previous parameters.
Parameters: yields; quality, time.

The First Trials

A conventional dry land crop, asparagus, lent itself to organic production rather easily with manageable production problems and became a good organic cash crop in the short term.

Peach and apricot trees, planted conventionally, though using some organic techniques (e.g. manure, lime-sulphur), were targeted for conversion in 1991.The following 5 years were an organic experiment on 11 hectares of fruit, applying as many of the above objectives and parameters. The focus was the soil: initially large quantities of composted sheep manure were broadcast (up to 40 tons/ha per annum) to combat nitrogen deficiencies as indicated by yellowing leaves. Pernicious scale was dealt with by spraying milk (lactic acid) but was replaced with much cheaper effective micro-organisms EM. See Information Box 2 below on EM. Early season aphid infestation was sprayed with a mixture of khakibush/Mexican marigold (Tagetes minuta) extract and molasses; again EM replaced this remedy with EM fermented plant extract (EMFPE) based on khakibush, garlic and chilli. The inter row area was tilled to provide a fire break and reduce competition from grasses and weeds for moisture and nutrients, however as the soil status improved over time, this area was allowed to grow and mown occasionally, becoming a habitat for many predators (spiders, ladybirds, birds and snakes).

Over the years the soil improved dramatically as soil samples indicated the presence of large quantities of earthworms and other soil fauna and flora. The final results were pleasing with above industry average yields and brix (sugar) levels allowing us to gain access to the German baby food market. Subsequently the increasing factory production costs and high cost of transport forced us to change our marketing strategy and focus on the local market through a "pick-your-own" plan where buyers picked and transported their own fruit enabling us to generate good profits shared with the fruit manager.

My choice to use EM as opposed to various other similar products was based on the concept of "appropriate technology", i.e. a technology which is effective, efficient, economical and safe, i.e. it satisfies the precautionary principle. I have not found another source of mo's which can compete with EM. For example the EM application cost per hectare per year on the orchard is R200 (US$29).

Information Box 2: What is EM?

As an alternative to agrochemicals (i.e. chemical fertilisers and pesticides), Professor Teruo Higa, developed the concept and technology of Effective Microorganisms (EM). EM has been shown to be effective in replacing agrichemicals, especially when applied in combination with organic amendments. EM is a mixed culture of aerobic and anaerobic beneficial, naturally-occurring, microorganisms that can be applied as inoculants to enhance the microbial diversity of soils and plants which, in turn, can improve soil health and the growth, yield and quality of crops. (Higa and Wididana, 1991a). EM contains predominant populations of lactic acid bacteria, yeasts, actinomycetes, photosynthetic bacteria and other organisms that are mutually compatible and co-exist in liquid cultures. Higa and Parr, 1994.

Parallel to the fruit project, trials on other traditional conventional and underutilised crops were conducted on 3,5 hectares and included: wheat, maize, sunflower, rye, triticale, grain sorghum, barley, spelt, soyabeans, cowpeas, vegetables (potatoes, butternut, radish, sweet corn, fine beans, mange tout) green manures and forage crops (serradella, Japanese radish,).

Through the biodynamic and organic network we embarked on medicinal and essential oil plant trials which were grown on separate fields as these required long term analysis.

Pasture trials were and are conducted in situ where a field is identified for pasture establishment. Trials with pasture mixes (livestock salad bars including poor man's lucerne, serradella,

eragrostis curvula, Smuts finger grass, rooi grass (Themeda triandra), chicory, sheep's burnet, yarrow and dandelion) as opposed to monocrop pastures are a work in progress.

Experiments with organic remedies for the livestock, cattle and sheep, proceeded with the aim of doing away with poisons, and ranching toxic-free, rather than specifically directed at achieving organic status. Diatomaceous Earth (DE. See Information box 3 below) was identified as a non-chemical anthelmintic added to livestock feed and also applied externally for control of lice, ticks and flies. EM was also tested as an additive to water and feed to improve the animals' health.

Information Box 3: What is Diatomaceous Earth?

"Diatomaceous earth is made from the remains of fossilized marine algae called diatoms. The product is mined and reduced to powder form. This powder acts as tiny pieces of glass that tear the shells of insects and other arthropods." The Control of Internal Parasites in Ruminants. Jean Duval, agronomist, M.Sc. January 1994. Ecological Agriculture Projects, McGill University (Macdonald Campus),Ste-Anne-de-Bellevue, QC, H9X 3V9 Canada.

Results and Discussion

During the initial years of trial and error, the conventional side of the farm, particularly the livestock, provided seed finance for the experiments until viability was established (commercial production) or discontinuation.

Regular and continual, recorded observation supported by intuition was vitally important. I initially ignored that "little voice", it being unscientific, but I soon learnt it was one of the most powerful tools I had, freely at my disposal, to use and the number of times it has literally "saved the day" are too numerous to mention. In all my networking and advice I strongly advise the use of intuition.

Once success with a trial crop was achieved both financially and productively, the larger scale planting was embarked upon dependent on market requirements, i.e. we never planted a crop that was not sold (off farm and/or on farm) beforehand.

The search for markets occurred simultaneously with the trials and successes in order that upon a crop coming "online" it could be sold 100%. This 100% objective generally required value adding.

Example of R & D: Organic Rye and Rye Flour

Rye was identified as a promising crop to grow commercially and process as rye flour as none (both conventional and organic) was produced in South Africa for human consumption. A retailer partnered with us to provide a ready market on completion of trials and commercial harvest. Rye had for many years been grown as green forage for the livestock in the dry winter months and had shown itself to be hardy and robust, resistant to aphids and rust, producing at least 2 tons/ha when allowed to grow to maturity for seed.

Treatments

Soil preparation included two methods: (1) traditional mouldboard plough and attached harrow and (2) chisel plough and harrow. Both systems applied effective micro-organisms (EM) via sprayers to the soil during the operation.

Chemically untreated seed was precision planted with inoculation of EM (i.e. soaked in a dilution of 1:100 H_2O for 30 minutes to provide prophylactic protection against soil pathogens) and without on each of the two soil prep methods at a depth of 10 mm at a rate of 25 kg/ha, apart and above the drilled fertiliser (4 cm and 10 cm).

Fertiliser in two forms was applied: a commercially available organic fertiliser (Talborne Prescription Mix Fertiliser) at recommended rates of 200kg/ha and farm composted sheep manure inoculated with EM at 10 000kg/ha. The former was split applied with seed drilling on half of (1) and (2) and the compost before soil preparation on the remaining halves of (1) and (2). See Chart 4 below.

Foliar feeding of EMFPE occurred twice on the 8 replicates of 0.37 ha, providing disease and pest protection simultaneously (competitive exclusion). Being a winter crop, weeds were not a problem particularly in the ploughed section, though weeds were more active in the chisel ploughed part, but did not pose an economic threat. (Note: weeding of small grain winter crops has become necessary in some years or fields where weed seed banks are high; a combine harvester head reel tines mounted on a frame worked effectively at removing 80-90% of weeds at stooling growth stage).
Harvesting of each of the 8 trials was separate and then compared.

Chart 4: Layout of Field Trial Rye.

<table>
<tr><th colspan="8">Field Trials: Rye</th></tr>
<tr><td colspan="4">Mouldboard Plough with EM (MBP)</td><td colspan="4">Chisel Plough with EM (CP)</td></tr>
<tr><td colspan="2">Seed with EM</td><td colspan="2">Seed only</td><td colspan="2">Seed with EM</td><td colspan="2">Seed only</td></tr>
<tr><td>COF</td><td>Compost</td><td>COF</td><td>Compost</td><td>COF</td><td>Compost</td><td>COF</td><td>Compost</td></tr>
<tr><td colspan="8">EMFPE Spray overall</td></tr>
</table>

COF = Commercial Organic Fertiliser
EM = Effective Micro-organisms
EMFPE = EM Fermented Plant Extract

Observations and Results

The MBP plots exhibited more even germination due to a finer and moister seedbed. This factor was discounted in years of good autumn rains when the CP method was as effective in even germination (even plant growth is necessary if blind-harrow weeding at a later stage is required). Germination of the EM treated seed was two days ahead of the untreated seed. The EM seedlings were thicker and more robust than the untreated. This confirmed research of the beneficial effects of EM on seeds and seedlings in terms of protection from soil borne pathogens and the positive impact on the growth through provision of nutrients and other beneficial substances such as hormones, enzymes, vitamins and lactic acid.

The seedlings planted with drilled COF were greener than the applied compost plots initially indicating that the fertiliser was more available. By the time of stooling, the plants were more uniform in colour. In terms of cost the drilled COF was less expensive as one less field operation was required, but the farm produced compost was cheaper as a fertiliser. The decision became one determined by time, availability and quantity of the two fertilisers.

The EMFPE spray had a visual impact in terms of increased vigour, growth and colour.
Good spring rains meant sufficient moisture for seed maturity and the MBP plots at harvest yielded 2500 kg/ha compared to the 2300 kg/ha of the CP plots. There were not significant differences in yield between the treated and untreated seed. The quality of seed of all plots was good and on milling the flour proved to be good enough to replace imported rye flour.

An economic assessment of the input costs indicated that the compost plots were more expensive, at R500/ha for compost whereas the COF cost R400/ha and coupled with the lower yield meant

the COF method was financially the better option. However, it is important to note that the impact of the compost on soil health was far greater adding organic matter and micro fauna and flora which benefits would be longer term and not readily measurable immediately. (1US$ = 7 Rand). Storage of the reaped seed was initially in large silos where pests (weevil and flour moth larvae) became a problem, solved by packing in 50 kg bags and treated with DE which mechanically kept the pests at bay.
Together with organic wheat and later maize and barley, the rye was stone milled on farm in a new plant adding significant value to the raw crops. By-products of the process were used for the livestock.

Current Activities

"Love what you do; live with intention; always learn; don't forget to play." Organic Salad Producer .ATTRA USA

Our present basket of products and output has evolved and changed as the market and our expertise has developed. Looking at Chart 5: Kirklington 2007, which logs as many of the activities, actions, products, and factors outside the farm gate, the noticeable difference with the pre 1990 farm chart are the huge number of extra activities taking place; in particular the recycling of energy as far as possible and reducing the energy leaving the farm. At the core of the farm organism are people who drive and give direction to the farm based on respect for nature. Information, knowledge and experience are indicated and by following the flow of the chart the successful outcomes are seen. There are still significant inflows from outside the farm, but some are necessary and others are under the spotlight to reduce. The huge value and premium we put on networking, making new friends and exchanging thoughts and knowledge is not emphasized, however it is probably the most essential aspect of all the important parts of the whole organism in constant flux.

Asparagus: A Past Cash Crop

Dramatic changes have seen the South African asparagus market become almost totally organic, with the largest asparagus producer in the Western Hemisphere being organic and selling organic into the conventional market. As a small producer we climbed out when the big fish arrived and looked for other products to produce and sell. This experience subsequently applied to fresh vegetables we produced for a retailer.

Our lesson: the ability to transform as market forces change is fundamental to success and the age-old adage: increasing diversity lends stability and reduces risk, has come back into its own.

1.Livestock

The cattle and sheep enterprises are operated extensively on four farms (two leased) utilizing low-input organic methods to provide the market both local and urban with quality weaners and lamb/mutton/wool. Feed is 100% outdoor grazing on veld (natural pasture), planted pasture and planted forage supplemented with protein and carbohydrate licks in the dry winter months.

Diatomaceous earth (DE) was identified as a non-chemical anthelmintic and added to livestock feed and also applied externally for control of lice, ticks and flies and complemented with the application of EM5, an EM derivative producing esters which disrupt external parasites' internal digestive systems.

The inclusion of EM and derivative, Bokashi (EM fermented bran) in the drinking water, feed and licks promoted better feed conversion and enhanced microbial life in the stomach enabling better health and returns on feed. See Table 1: Winter Production Lick Kirklington below.

The sheep are corralled nightly on old straw where the combination of manure, straw and EM creates an immediately available organic fertiliser which is recycled onto the arable lands without composting, providing nutrients, structure and mo's to the soil. Maize and sunflower oil cake, grown and processed on the farm, are available in the dry winter months as part of their ration providing protein, carbohydrates and nutrients, further recycling and adding value to farm products and by-products. Note: compost was made from the sheep "waste" for a number of years in windrows 30 meters by 4 meters by 3 meters using a front end loader, water and EM, however, the experience with EM in Thailand indicated that composting was not necessary as the EM suppressed most pathogens (e.g. E.Coli 0157) and fixed volatile nutrients rapidly, and so we discontinued the expensive compost program.

New interest in organic meats from speciality outlets indicates a new market where value adding will be necessary allowing the capture of more of the value chain in the livestock cycle.

Table 1:Winter Production Lick Kirklington				
				KG
Ingredient	**R/kg**	**kg**	**Cost**	**%**
Oil Cake	1.30	50.00	65.00	6
Sulphur	2.22	5.00	11.10	1
P12	2.67	75.00	200.25	9
Salt	0.40	175.00	70.00	20
MaizeMeel	0.60	450.00	270.00	51
Feed lime	0.33	50.00	16.50	6
Bokashi	2.00	25.00	50.00	3
DE	3.00	20.00	60.00	2
MEM	2.00	25.00	50.00	3
Total		**875.00**	**R 792.85**	
Cost/kg			**0.91**	
RDI & Cost		**0.65**	**0.59**	
Cattle	**Bulls**	**Cows**	**Calves**	**LSU's**
Kirk	5.00	80.00	27.00	90
Pbg	6.00	191.00	16.00	205
Swlte	0.00	58.00	0.00	58
				353
Sheep	**Rams**	**Ewes**	**Lambs**	**LSU's**
Kirk	13.00	650.00	280.00	157
			Total	**510**

2.Cash Crops: Barley, Rye, Wheat, Triticale and Sunflower

(See Kirklington Organic Farm Production 2004/5 Table below for details of crops, land number and size, application and date thereof, yield and expected yield.)

Cereals entail more intensive farming involving expensive inputs trialled over a number of years and continuously tweaked on the land (changed, improved, increased or discontinued) to improve yields, reduce costs and influence the bottom lines.

For example, the inclusion of EM into the planter drilling units enabled us to place EM with the seed and fertiliser providing even greater microbial life in the growing-soil zone which had the positive spin-offs of less disease and higher levels of nitrogen fixing allowing reduction in commercial fertiliser application (for small grains the fertiliser was reduced from 200 kg/ha COF to 100 kg/ha supplying 7 kg/ha of N. The final harvested yield was 1700 kg/ha with a protein content of 13% in a drought year when average yields for the district were 1500 kg/ha).

As part of the growing program, crop rotations and strip cropping are practiced depending on the weather, particularly rainfall and time of seasons. A normal year had allowed us to strip plant sunflower and soyabeans with fishmeal and mo's inoculated into the soil, in rows of four. Two cultivations with a rolling harrow simultaneously kept weeds at bay and applied EM and a good growing season allowed us to reap a decent crop of 1000kg/ha soyas and 1200kg/ha sunflower seed realising a good profit as inputs were low.

Barley, rye, wheat, maize, soya beans, dry beans and triticale are stored on-farm and stocks are drawn as the market or farm demands either as various grades of flour or whole grain; packaged in 12,5kg and 25kg bags the grains and value added products are despatched by courier countrywide. Various retained seed for our own use for planting is stored separately with DE and wormwood (Artemisia afra).

Increased production of organic sunflower was investigated and trialled as for the winter crops, though the market size and pricing differed in terms of higher price (100%) and much smaller volumes. Planting using an adapted Monosem precision vacuum planter which concurrently accurately placed COF and EM inoculated seed alongside, followed by a spreading of diatomaceous earth on the surface (cutworm & beetle deterrent), enabled rapid and accurate planting. The same system applied to other large seeds: maize, cowpeas, soyabeans and lupines.

The sunflower is stored on-farm, cleaned, pressed or decorticated (dehulled), filtered, packaged in 5 l to 25 litre containers and despatched to local distributors, shops, processors and consumers.

The increase in the price of oil with news of Peak Oil added significantly to input costs in crop production and the feasibility of a larger oil press and bio-diesel converter were investigated. The numbers made sense and these were purchased having a capacity of producing 900 litres per day, well in excess of our peak daily requirements. The by-product of oil cake and glycerine are utilised on farm in livestock feed and cleaning machinery respectively.

The arable soil at Kirklington has improved over the 17 years I have farmed and the proof is in the more stable yields and improved quality of crops. Looking into the soil itself shows varying results depending on that particular soil's history. The orchard soil, for example, has shown dramatic improvement in terms of structure, organic matter, humus and life. This shows up in the earthy smell given off when digging under the trees; the huge numbers of macro soil life (earthworms, beetles, spiders, and centipedes), the tilth and in the sweetest fruit with virtually no pest damage.

The arable lands are not as robust and healthy, but improvements in structure due to discontinuance of fossil fertilisers and poisons, requiring less mechanical disturbance and the use of EM manure, organic fertilisers and bio-fertilisers have made a significant contribution: the soil pH is rising without additions of lime. Soil life is noticeable, especially when working the land when earthworms appear before and after planting.

Generally the growth of the soil and its crop of life is satisfying and continues to move in the right direction.

Kirklington Organic Farm Production 2004/5						
Crop	**Land**	**Size**	**Month**	**Application**	**Reaped Yield**	**Expected 2004/5**
Fruit:	K9	11	Jan	Cattle Manure Compost @ 2 tons/ha		
Apricot			Feb	Cattle Manure Compost @ 2 tons/ha	5 tons	10 tons
Peach			Dec	Sheep Manure Compost @ 5 tons/ha	30 tons	50 tons
			2*mnth	EM fermented plant extract(FPE) @ 1 liter/ha + 300l H2O		
				Weed control: mechanical mowing & sheep in winter.		
			June	Spray EM FPE		
Wheat	K18	20	June 04	Seed: own @ 25 kg/ha with EM		40 t
				Talborne Organic Prescription Fertiliser Mix @ 100 kg/ha		
				Weed control: mechanical combine harrow		
				Pest control & foliar feed: EM FPE @ 2L/ha + 300l H2O		
	K24	26	June 05	As above		55t
Rye	K18	20	July 04	As above		40 t
	K8(a)	3	July 05	As above		6t
	K7	7	July 05	As above		14t
Sunflower	K18	20	Sept 04	Sunflower seed: own @ 2,5 kg/ha		20t
				Talborne Organic Prescription Mix @ 100 kg/ha		
				Weed control: mechanical sweep & rolling harrow		
				Pest control & foliar feed: EM FPE @ 2 L/ha + 200l H2O		
Sunflower	K31	9	Sept 04	Talborne @ 100 kg/ha		7t
				Seed: own at 3kg/ha		
				Weed control: mechanical sweep& rolling harrow		
				Pest control & foliar feed: EM FPE @ 2L/ha + 200l H2O		
White Maize	K8(a)	2,1	Nov 04	Conventional untreated seed @ 8kg/ha plus EM Sheep Manure @ 20t/ha		6,3t
Yellow Maize	K24	4	Nov 04	Conventional untreated seed @ 8kg/ha plus EM Sheep Manure @ 20t/ha		12 t
				Weed control: mechanical rolling harrow & sweep		
				Pest control & foliar feed: EM FPE @ 2L/ha + 200l H2O		
Soya Beans	K18	5	Dec 04	Own seed @ 50kg/ha Sheep manure @ 5t/ha treated with EM		5t
Dry Beans	K8(a)	2	04-Dec	Own seed Plus EM Sheep manure @ 5t/ha treated with EM		2t
				Weed control: mechanical sweep		
				Pest control & foliar feed: EM FPE @ 0.5l/ha + 200l H2O		

3. Fruit: Apricots and Peaches

As explained above, external factors (exchange rate and processing costs) have changed the marketing of the fruit from export orientated to local and urban. The orchard has matured and with gentle management, including limited pruning, prophylactic sprays, slow harvesting and value adding, is now a cash cow. Weather still plays a major role in primary production (drought, hail & frost) and after harvest practices (drying fruit). To combat drought we continue mulching the tree drip lines with grass bales (Eragrostis curvula) and thinning the immature fruit more heavily while hail is steered away using Basotho cultural methods. We have found that spraying an EMFPE with a predominance of pine needles provides protection against frost for the swelling buds.

4. Medicinal Crops

The potential for certified organic medicinal plants looks promising and 15 hectares have been planted providing work for 30 local women.

5. Essential Oils

A trial of roses for extraction of rose oil for the fragrance industry was started in 2005 in partnership with an international firm specialising in organic and biodynamic perfumes.

6. Forage crops: Green Feed, Japanese radish, Cowpeas.

The production of sheep and the rotation of crops in the organic production plan require the farm to grow various winter and summer feeds for on-land utilization.

These are low input crops geared at achieving maximum forage per hectare in order to convert sunlight to feed to beef and mutton and thereby adding significant value to the original inputs. The benefits of rotation, sheep manure and nitrogen-fixing plants are valuable by-products of this process.

7. Soil, Grass and Environment.

The main objective of organic farming is to grow the soil. Based on this premise the farm organism is not only naturally geared to accomplish this, but also managed to continually improve this natural tendency.

Experience at Kirklington has shown the improvement in grass growth and palatability by following this goal. The same applies to arable lands converted to pastures as to natural veld/pasture.

Present practices include broadcasting EM manure (livestock manure inoculated with effective micro organisms), spraying EM during rain or soon after at rates of up to 100 litres multiplied EM per hectare, reseeding mono-culture pastures by drilling in mixtures of legumes, herbs, broadleaf plants and grasses as mentioned above and high impact grazing on the lines of mimicking indigenous wildlife feeding patterns.

Livestock grown on good pasture or veld is more thrifty and able to weather parasite pressures economically.

Ultimately the whole farm environment has improved and continues to recover, substantiated by the return of fauna and flora previously thought lost to the farm. The most prominent is birdlife, especially raptors which are so necessary for the balance in Nature. Guinea fowl flocks are numerous and are excellent indicators of pests in newly planted fields, where they scratch for grubs and beetles.

8. People.

All people at Kirklington have benefited by the conversion to organic family farming in areas such as health, wealth, learning, experience and wisdom. A marked reduction in sick days was a measurable benefit, moreover we all felt better without the toxic chemical loads we absorbed during the years before abandoning the industrial conventional system. This meant we were able to increase our personal work load benefiting us and the farm. Most of our food for the farm community is farm produced and fresh, either raw or processed just prior to consumption. The benefits of none toxic food, higher vitamin content of freshly ground flours contribute to the Quadruple Bottom Line. It is our vision to continue this process.

8. Research and Development

This vital area continues to enjoy significant attention in terms of new, underutilised and lost crops such as sesame, millet, sorghum, hemp, black velvet bean and flax. The application of biodynamic principles has been conducted over many years and now gathers momentum in a more regular fashion.

Challenges

Creativity is the most underutilized tool in the toolbox and at Kirklington is becoming a standard part of the process in dealing with the ups and downs that have been many and continue to appear as the playing field changes.

Major stepping-stones now facing us, organic farmers and chemical farmers are land reform, the cost of oil and globalisation.

Land Reform.

We have discussed this issue at length within the farm community and recognise the political need and aspirations. Our approach, as with all things organic, is slow and cautionary.

The technical details of ownership, entities and who benefits have become secondary factors and we feel will come into their own over time. The most important facet is the ability to farm successfully, sustainably and happily.

Our idea is to build managerial and ownership capacity slowly through mentorship over a number of years or for as long as we feel it is necessary until the farmer feels confident to continue solely or as partners.

The concept of LISA is paramount to all areas in this approach.

Cost of Oil

Despite many conflicting opinions, our research and feeling is that this is one of the most important factors to manage in the short, medium and long term.

The Kirklington experience has undoubtedly shown the importance of living as far as possible within the available on-farm energy resources, for to stray from this goal entails endangering the QBL.

The impact of increasing oil prices is felt throughout the farm organism and we are actively pursuing policies to reduce the impact and multiplier effects.

These include bio-diesel (sunflower) mentioned above, solar and gas (methane) energy for heating, cooking and weeding, animal traction, on-farm engineering (lathes, motor rebuilding and blacksmithing) and brainstorming.

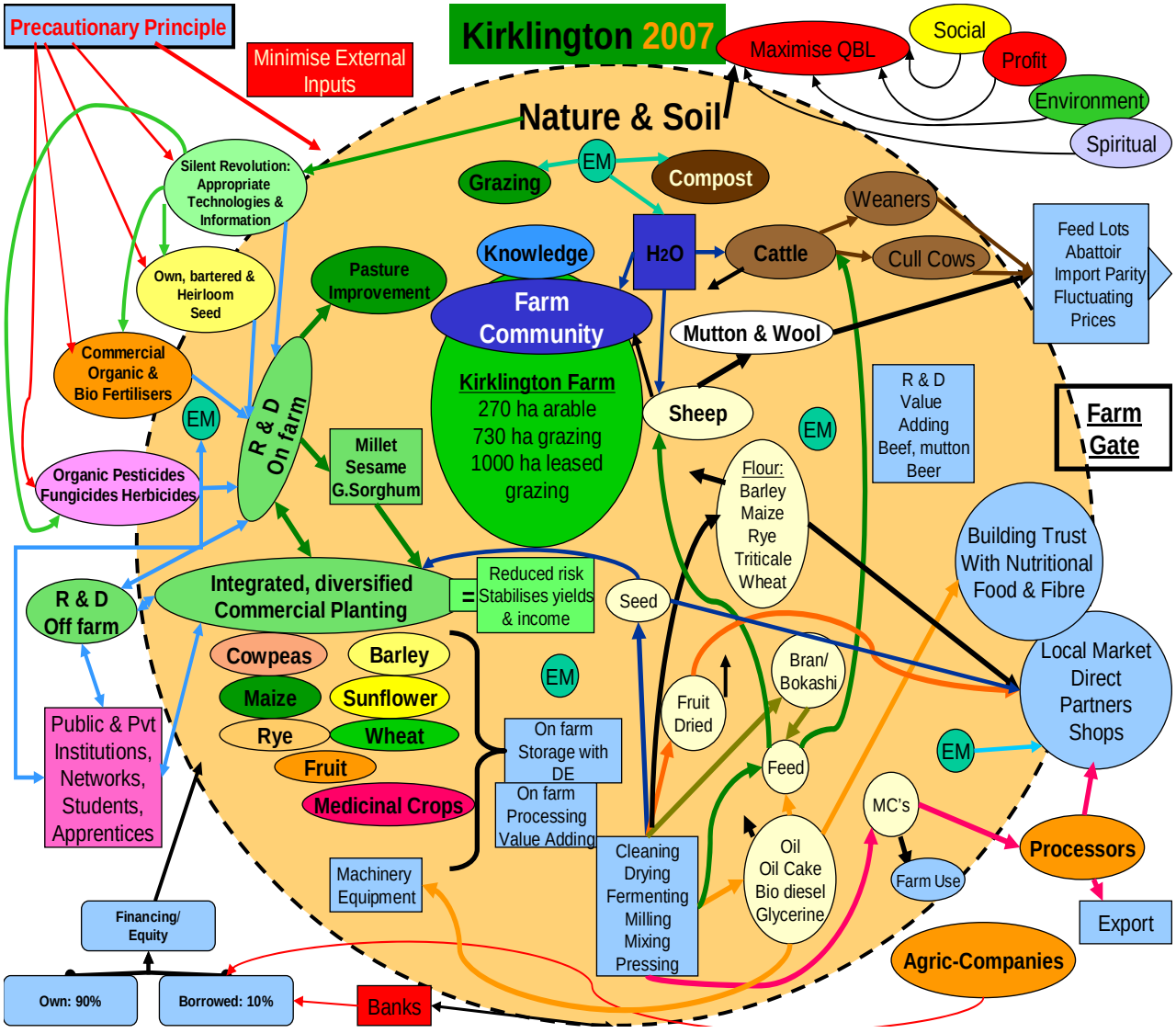
Globalisation

This field is like a kaleidoscope, ever changing with dark areas which are pitfalls for the unwary.

We have had to continuously modify, change and transform our marketing strategies to remain in the market. This has been planned and managed successfully.

The greatest challenge is the impact of the global village and industrial organic. Our immediate response has been to reduce our risk in faraway markets and increase our presence in local markets. Rebranding our products is one consideration we are implementing (e.g. “Family Farm Grown”).

Chart 5: Kirklington 2007.



Discussion and Recommendations

Today's industrial agriculture based on the green and brown revolution technologies (fossil fertiliser, genetically modified seeds and toxic poisons) is recognised to be totally unsustainable and is fundamentally different to sustainable agriculture in that it substitutes capital for labour and off-farm technology for management whereas sustainable agriculture is based on knowledge of how to work with nature and not dominating her.

It is clearly apparent that commercial (and subsistence) farmers face seemingly insurmountable problems, in particular, their source of seed. Corporate seed merchants are geared to short-term profit maximisation and monopolisation and as such their interests (patenting seeds) and farmers' interests are not compatible. As we have discovered, the greatest need among today's and tomorrow's farmer is cost-effective, appropriate technology seed which "requires an agriculture which is holistic and integrative, not specialised or segmented. It is dynamic and site specific (terroir), not standardised and routine. It is interdependent and management intensive, not management extensive and centralised in control. The farm is clearly biological rather than mechanical in nature."[4]

Cost effective, appropriate technology seed is one of the many inputs desperately needed by farmers to replace the industrial input model. In order to achieve this, seed and other inputs need to be locally based, developed and conserved in farmers/community/government partnerships (FCGP) and internationally protected where the rights to the seed genes are held in the public domain and not removed and patented by multinational corporations.

Resembling a well integrated, diversified farm, the FCGP would need to go beyond just seed, but operate locally and beyond, networking with as many interested researchers, farmers and community members as possible, providing practical, easily understandable information and seed for trials and commercial growing.

Knowledge of other inputs and outputs would complement the work of the FCGP seed business, including place-based management practices from successful farms that reduce costly inputs to serve as models for change including focusing on research and development on biologically-based pest and disease management and capturing best practice data for future use.

To developing comprehensive market information enabling farmers to make informed crop and marketing decisions and assisting in developing closer, more trusting and synergistic relationships with retailers and consumers and regulators would be FCGP value adding.

The FCGP would provide farmers with tools to compile directories of food systems, biofuels and carbon-based waste products to better understand relationships between crop production, food consumption, energy and nutrient production and supply assistance with formation of farmer/community based cooperatives.

Reorganising regulatory agencies along these lines in order to complement the preceding processes would be integral to the FCGP's role.

Finally, establish programs to link students with farms and new farmers with mentoring older farmers.

[4] Dr John Ikerd, Professor of Agricultural Economics at University of Missouri. The Next Agricultural Revolution. Revitalising family-based agriculture and rural communities.

Conclusion

The transformation of Kirklington into a highly diverse, stable and integrated unit has been exciting, daunting, frustrating and satisfying. The starting point was the recognition and acceptance of the problems and challenges facing commercial farming locally and globally, principally farming inputs, seed and fertiliser, followed by thorough research and networking to find solutions and pursue established goals. On-farm research and development yielded successes and also required changing goals or parameters where failure was apparent, followed by commercialisation of the crop, value adding and sale to trusted consumers or partners. Topics of present importance include inputs, land reform, continuing research of bio-diesel and globalisation. The farm as an organism has grown and matured, yet the process continues.

"Guns are too callous, bombs too ruthless, and knives too blunt to cut the darkness of these times. Our activism demands a poetry that holds out for nothing less than poesis- a participation in the beauty of making and re-making reality." Alistair McIntosh, Love and Revolution pp 11.

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