Farming Systems in the Tropical Areas of the World

A report for

By Aaron Sanderson

2011 Nuffield Scholar

March 2011

Nuffield Australia Project No 1112

Sponsored by: Grains Research Development Corporation©

Scholar Contact Details

Aaron Sanderson
22/30 Martinez Ave
West End, Qld 4810

Ph: 0428 186 497
Email: aarao43@gmail.com

In submitting this report, the Scholar has agreed to Nuffield Australia publishing this material in its edited form.

NUFFIELD AUSTRALIA Contact Details

Nuffield Australia
Telephone: (03) 54800755
Facsimile: (03) 54800233
Mobile: 0412696076
Email: enquiries@nuffield.com.au

586 Moama NSW 2731

Foreword

Northern Australia is a region of the world that has the classic monsoonal climate characterized by a summer wet season and a dry winter rainfall season. There is currently a renewed interest in further development across the North of Australia to take advantage of the perceived vast areas of arable land and abundant water supplies. The following topics have been investigated in regards to this:

- What other areas of the world have a similar climate and what do their agricultural farming systems look like?
- What crops do they grow?
- What do their rotations consist of and what are their major issues?

I initially applied to Nuffield as a direct result of moving between two different farms and finding that I had to re-apply all my knowledge to areas that were initially simple to me. I moved from broadacre farming in Central Queensland to The Burdekin in North Queensland. Although this is only a very short distance when looking at a map, I was extremely surprised to find that I had to relearn simple farming techniques. These techniques include weed control, crop nutrition and machinery management, especially for irrigation and operations during the summer wet season.

My travels throughout the tropical world included cropping areas in north central Thailand, south eastern India, southern China, parts of the Philippines, and a handful of separate places in each of Brazil and Mexico. I also spent time travelling across far north Queensland in Australia to compare my travels overseas. As many of these locations were in countries with developing economies, agricultural operations were often very different to what we in Australia would expect to see as a farming business.

Acknowledgements

It's a big call to spend four months away from home and business so I would like to thank:

- My wife Tonia for her support at home.
- My parents, Brian and Rhonda who play an important role in both the farm business and family life.
- Ken Dowell who helped keep the wheels turning around the place while I was gone.
- My boys, Louis and Clay, who in between football and soccer and all the other things that you do, took my absence in your stride and just got on with all the things that needed to be done from your points of view.

Everyone who stepped up to the plate and enabled the show to go on which allowed me to make the most of the Nuffield opportunity.

Thank you.

A special thank you to the Nuffield organization and especially Jim Geltch for making this opportunity firstly available and secondly as amazing as it could be. I have been told numerous times how fantastic the Nuffield experience is and my own involvement was nothing short of being the same.

To the people with whom I shared the global focus amazing race, I couldn't have asked for a better group to share the experience with and I will treasure our friendship over the years to come.

To all the people around the world that, often on short notice, offered their time, their insight and often their homes to allow me to partake in this experience. You can visit a place, kick the dirt, look at the bricks and mortar, but it’s the people you meet along the way that make all the difference.

And certainly by no means last, thank you to GRDC- without you this is just simply not possible. To have the foresight and commitment to a program like this is fantastic for our grain industry as a whole and while you provide the needed funds to enable it to happen, rest assured that the personal development of people in our industry in this way is an experience that money alone cannot buy.

Abbreviations

CIMMYT - International Maize and Wheat Improvement Centre

(Centro Internacional de Mejoramiento de Maiz y Trigo)

GRDC – Grains Research and Development Corporation

LEM - Luis Eduardo Magalhaels

US – United States of America

MAP – Mono-ammonium phosphate

Ha – Hectare

PVC – Poly Vinyl Chloride

Kg – Kilogram

T/ha – Tonnes per Hectare

Executive Summary

This report looks at the farming systems employed in the production of field crops throughout the tropical regions of the world. It then goes on to examine any parallels and similarities to the farming system utilized in the northern part of Australia.

The key findings suggest that northern Australia is unique and quite different to most other parts of the world when this topic is examined. For instance:

The monsoonal type weather pattern is in effect in northern Australia, but the duration and amount of precipitation is often quite a bit less than many other areas where field crops are raised.

Partly because of this we tend to concentrate on farming the more fertile heavier clay based soils that hold moisture better, and then machine trafficability becomes an issue during the wet periods.

There is a severe lack of labour in the north to undertake farming tasks, which is at odds with most of the tropical world where manual labour is a feature. Supply of this labour is becoming a problem but as far as general population goes, people are in abundance.

Farming systems in the third world countries have not changed a great deal in generations.

The exception to this is Brazil that has embraced research and development, and coupled with abundant natural resources, has emerged to become one of the world's production powerhouses.

Australian farmers do a remarkable job as far as efficient production systems go. While looking over the fence is always good for a reference point, in this case there are not a lot of take home ideas to be gleaned from most of the farming areas in the tropical world. The exception is perhaps Brazil who, with large areas of well drained soils and abundant rainfall over a six month wet season, have mastered the art of running large, technologically advanced farms in this environment and will continue to improve with very organized research and development programs.

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Objectives

These questions were considered:

- What do agricultural operations in areas of the world with similar climates to North Queensland look like?
- What crops do they grow?
- What are their major issues and how do they overcome these?
- Could this information be utilised in future development across Northern Australia?

Introduction

Farming systems throughout tropical areas of the world vary greatly, despite the fact that most crops produced are relatively common. Differentiating factors around the world heavily influence each aspect of the farming system throughout its production life. Some of the major influences include soils, climate and precipitation. In addition, cultural and historical development plays a large role in defining how these systems look today.

These areas of the world, which fit between the Tropic of Capricorn and the Tropic of Cancer, generally have a consistent, mild climate and distinct wet and dry seasons. The duration and intensity of the wet season is possibly the greatest influence on the farming system. Couple this with the water holding capacity of the soil or the ability of the soil to drain excess water away and it becomes distinctly clear that large heavy machinery is not going to be suitable. Then, taking into account the cultural aspect of the area, we find that perhaps the holdings are very small and that large machinery is both unsuitable and unaffordable. These details strive to illustrate just how different and complex farming systems can be around the world. This does not mean that these parts of the world cannot produce good high yielding crops – on the contrary. It is remarkable that high quality crops can often be produced with so little.

This paper primarily focuses on an area of the world that has similar climatic conditions to Northern Australia. North Queensland is a region of the world that has the classic monsoonal type climate characterized by a summer wet season and a dry winter rainfall season. There is currently a renewed interest in further development across the north of Australia to take advantage of the perceived vast areas of arable land and abundant water supplies.

Climate

The tropical areas of the world fall into the region between the Tropic of Capricorn in the South and the Tropic of Cancer in the North (between latitude 23 degrees North and South) and have an incredibly strong monsoonal weather pattern. These areas have a distinct delineation between wet and dry seasons in terms of rainfall, have large quantities of rain and high intensity, but do not have great variations in temperature (Attard, 2007).

Figure 1

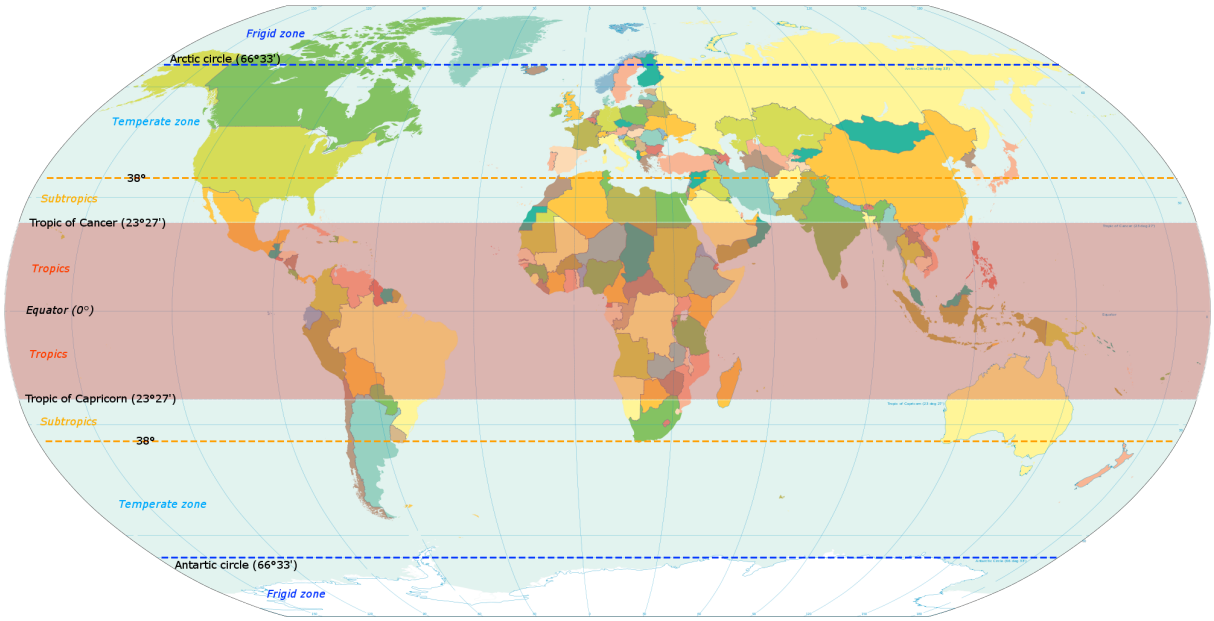


Illustration of the tropical regions of the world; Wikipedia July 2013

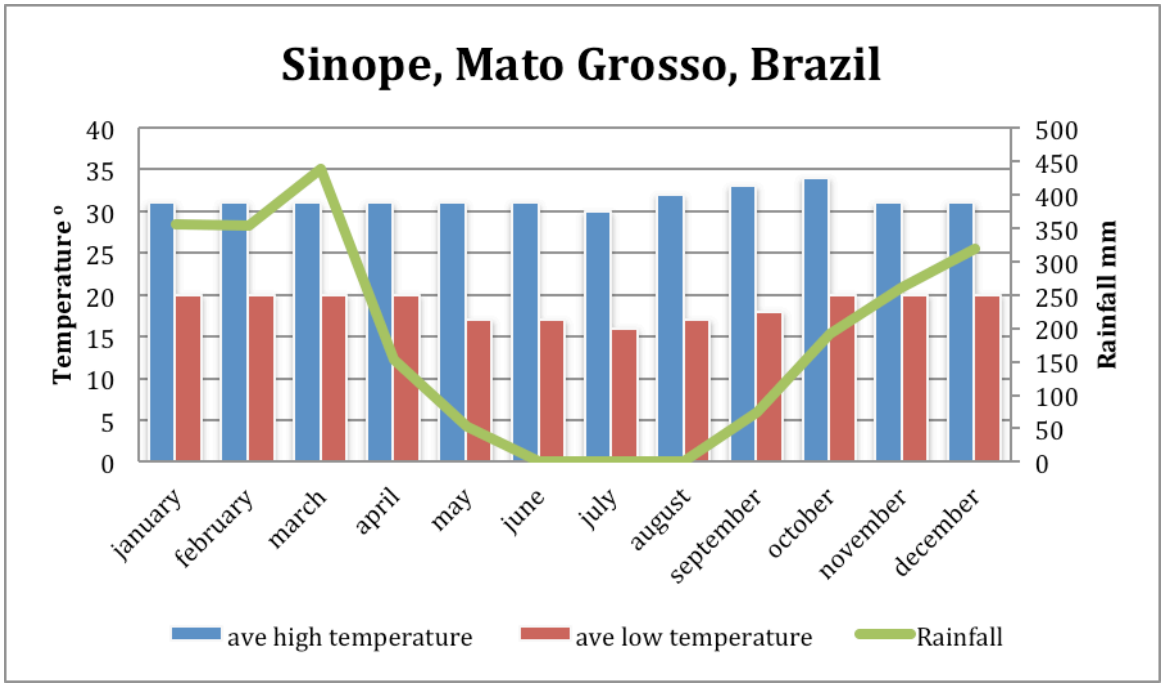
The wet season is the time of the year when most of the precipitation occurs and can last for months. There are many places where excess rainfall during the wet season is stored in one form or another (typically in below ground aquifers or above ground dams) and then applied as irrigation to subsequent crops during the drier months.

Although generalisations are made about the climate across the tropics, variability certainly exists. The wet seasons usually correspond to the summer months of the respective hemisphere but rainfall distribution can still be quite different and require different

management to work with. The following graphs, figures 2 through 5, illustrate four distinct areas. Although the temperatures correspond quite well with each other, there are two things that really stand out:

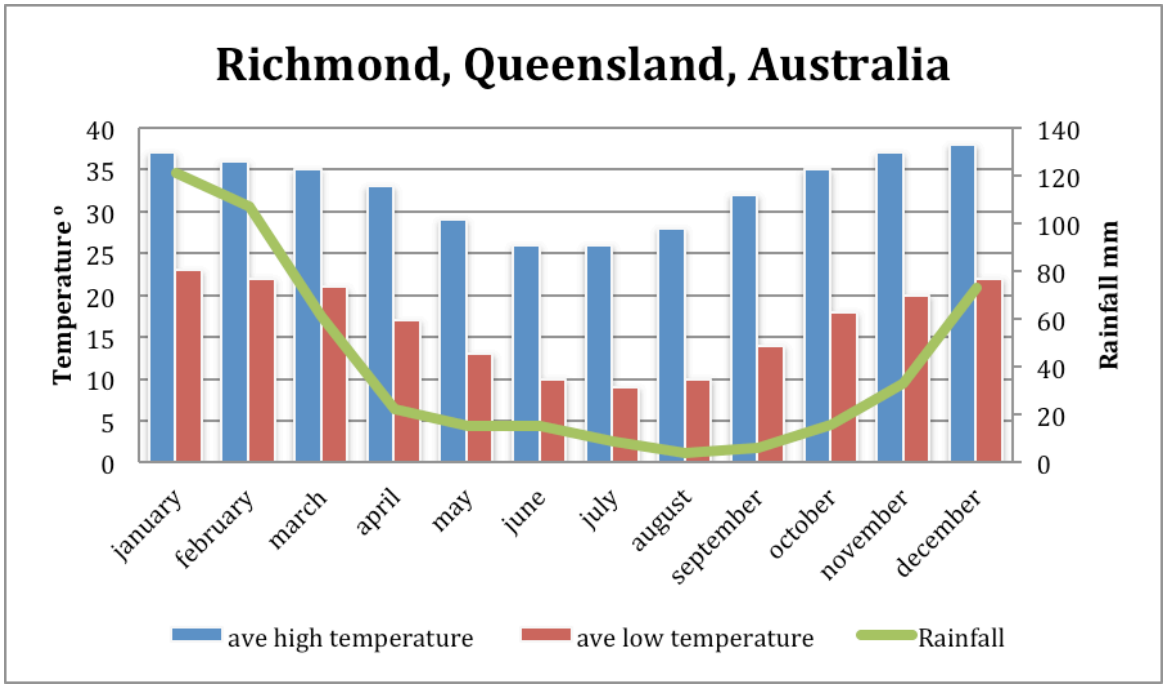
1. The extremes in monthly precipitation totals of the Mato Grosso, deep in the Brazilian interior, range from very intense summer rain to virtually completely dry in winter months.
2. How dry Richmond, Queensland is in comparison to those selected localities. Still situated very much in the tropics, Richmond has an almost arid climate that makes cropping a challenge. The enterprises that operate in this area rely on storing water from the summer for later use.

Figure 2



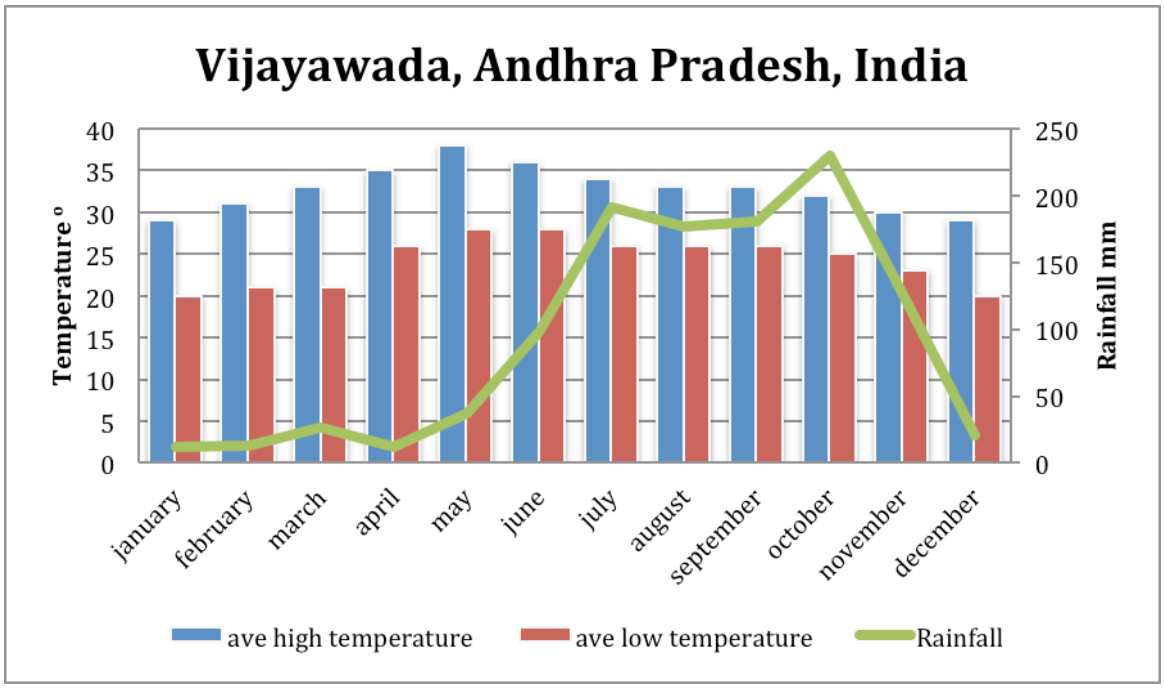
data extracted from www.worldweatheronline.com 2012

Figure 3



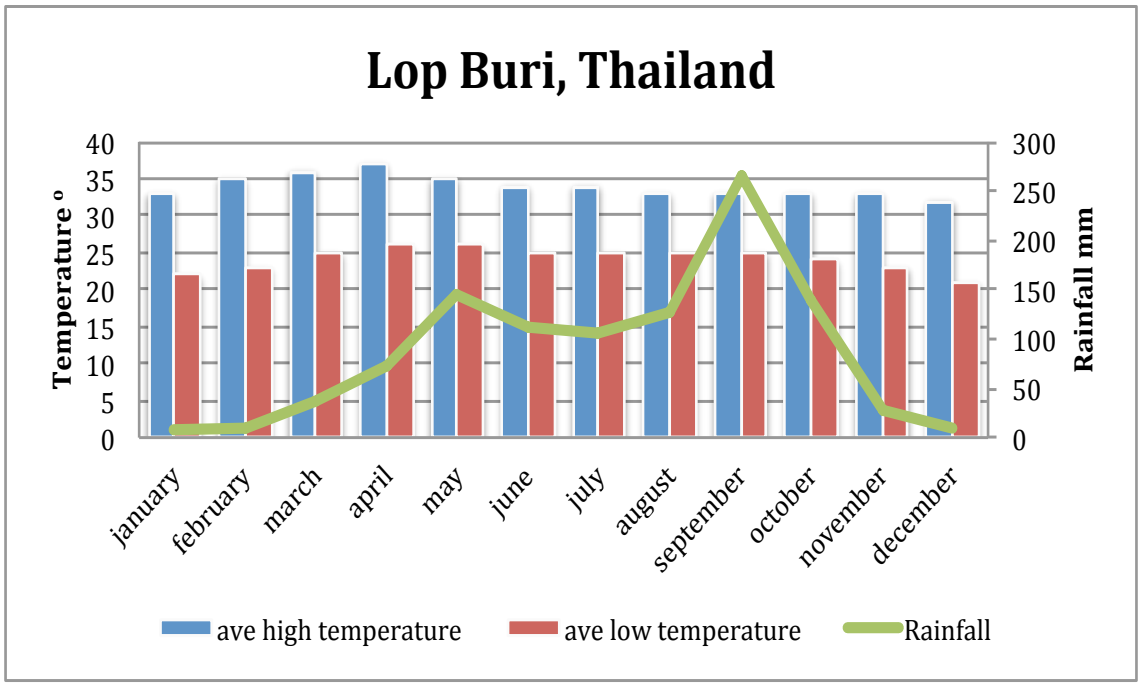
data extracted from www.worldweatheronline.com 2012

Figure 4



data extracted from www.worldweatheronline.com 2012

Figure 5



data extracted from www.worldweatheronline.com 2012

Soil

Soil types and characteristics are literally the building blocks of any farming system and probably have more effect on how operations are carried out than any other component in that system. The soil is a complex living ecosystem with chemical, physical and biological systems interacting to enable our crops to grow. Water is held and nutrients are metabolized for future use by plants but the soil performs many other functions as well, not in the least acting as a support medium. Agricultural soils vary greatly around the world and can range from low water holding capacity progressing through the loams to heavy dark clay based soils which can hold enough plant available water to grow an entire crop.

Because of high evaporation rates in the warmer parts of the world, a high proportion of clay is a desirable trait due to the ability for those soils to hold moisture and nutrients for future use when rainfall is limited. In a country such as Australia, dark clay soils can be considered some of the best when asked to grow rain fed or irrigated crops, as the number of dry days far outnumber the wet. However, one of the limitations of heavy (high clay content) soils, when matched with mechanized farming, is the trafficability of those soils when wet. Over the past two decades, the developed world has experienced farm machinery growing in size. The sole reason for change was to accommodate more efficient farm operations in a generation that has experienced tighter economics and a shrinking labour supply. It is a frequent occurrence for tractors to effectively sit idle for months throughout Queensland's rainy seasons as the wet soils do not possess the capability to successfully hold the tractors weight. On the other hand, Indian farmers who use oxen as their farming tool of choice do not face this problem. The size of the tractor undoubtedly has a bearing on exactly how well the machine will perform on wet ground. For instance, a common tractor across India and Thailand is a John Deere 5410 model rated at 81 horsepower and having an operating weight of approximately 2700 kg (tractordata.com). Contrast this with a common row crop tractor used in Australia such as a John Deere 8430. This tractor has a horsepower rating of 330 horsepower and an operating weight of over 13 000 kg. The larger tractor has the capacity to get a large amount of work done in a day but will be at a severe disadvantage in a wet field, especially if the soil has a high water holding capacity. Farmers in these areas did not feel that tractors' getting bogged

was a major issue (Nandigama, 2011). The reason for this is the farmers do not feel as if the weight of the tractor would be an overbearing issue in their region.

Almost as an exception to the rule are Brazil's vast areas of free-draining red sandy loams. Combined with generous rainfall, these soils enable the development of a farming system that can utilize large machinery as machine traffic can be supported quite quickly after rainfall. For example, a clay type soil receiving 25 mm of rain in an afternoon storm on successive days might not dry out enough to drive on until there are five or more days of no rain, while on the sandy loams farm operations can quite often continue the next morning (Blair, 2011). Soils of this type have allowed Brazil to develop a farming system that simultaneously allows harvesting of one crop whilst a second one is being established in the middle of their wet season.

Agronomics

The agronomic aspect of a farming system is often the area where the farmer can have the most input in regards to the day to day business of producing the crop. Key activities include preparation of the seed bed, planting of the seed, and nurturing of the crop through to harvest.

Written records detailing agronomic practices were almost impossible to obtain in some locations where information is passed on verbally from farmer to farmer and generation to generation (Kumar, 2011). As a result of this, information was gathered through observing farm practices, communicating with the farmer and documenting useful recollections. This is a huge contrast to our modern computerized record-keeping systems informing daily practice.

Asia is truly blessed with some beautiful soil - deep, dark, soft fertile soils exist in many areas. Tillage involving deep ploughing followed by multiple passes of lighter disc machines is very common prior to planting on farms where mechanization has taken over. This, combined with burning of some residue is regularly undertaken to allow planting machinery to operate unhindered. Most agricultural machinery is locally manufactured. Significant parts of the areas in Asia heavily rely on human and animal labour.

Cultivating cotton, India **Photo: Aaron Sanderson 2011**

The above picture illustrates a farmer inter-row cultivating 200 mm high cotton with a pair of Brahmans attached to the front of a steel and timber single row cultivator in India. The accuracy and quality of the job performed by the farmer is not to be underestimated. The animal – which was obviously accustomed to its job - had the ability to walk in a straight line throughout the entirety of the process. The Indian farmers were curious as to how many farmers in Australia still farm with an ox. It would be hard to find one.

Brazil is almost the other end of the spectrum as far as machinery and soil preparation goes. In the broadacre areas it was apparent that large current generation machinery was being utilized in a largely no till farming system. This is very similar to what is found on Australian farms. Soybeans get planted as the rainy season begins in October and as it is harvested in January and February, corn or cotton is no till planted immediately behind the header to take advantage of the rest of the wet season (Bruch, 2011). That corn stubble cover is then retained and soybean planted straight into it later in the year. However, some rolling or mulching of

corn stubble does occur. The exception to the rule is cotton residue that is mulched and offset-disced twice (Carroll, 2011).

Planting seed populations do not seem to vary much in size. For example, a corn population of roughly 62 000 plants per hectare seems to be the desired planting rate in most areas visited, including Australia. It was surprising to find that hybrid seeds from multinational seed companies were so extensively used. There is no doubt that seed genetics is truly a global industry. Around the countryside there were signs placed against paddocks of crops showing off new varieties; this is as common in other parts of the world as it is in Australia.

Another interesting finding is that even in these developing countries, agricultural chemicals are in widespread use. The same products are available around the world, with their presence seen regularly on our shelves and a widespread use within the industry. India's weed control program looks very similar to the program in Brazil, Thailand and other locations where a similar crop rotation is used. What does vary greatly however, is application technology. While the Brazilians are using current generation self-propelled sprayers, similar to what we see here, application in most of Asia is rudimentary. Knapsack sprayers are by far the most common apparatus for field spraying, although modifications to enhance performance were common. A sprayer in the Philippines consisted of two operators with a knapsack sprayer each but connected together with nozzles spaced along a piece of Poly Vinyl Chloride (PVC) pipe, carried between the two operators to create a 'boom' sprayer (Vial, 2011). Another operator in India had a back-mounted, motor powered mister that he carried along as he walked up and down the rows of cotton, and in this particular instance in a cloud of mist with no protective equipment. Communication with the farmers revealed that he was a contractor and was utilizing the latest technology.

Crop Nutrition

An expectation that mixed farming (crops and animals) would be the norm across many of the areas that were visited was not realized. Integrating animals into a cropping system through the use of grazing stubbles and/or pasture crops is a way of cycling nutrients to enhance soil fertility for subsequent crops. Nutrient removal through the harvesting of crops means that eventually those nutrients will have to be returned through one system or another or significant fertility decline will occur. Subsistence farming is the most graphic illustration of this. A piece of land is cleared and cropped until the production declines and then a new piece of land is brought into production while the last piece is let to revert back to its former state to allow nature to regenerate it (Ninnes, 2011). This is a very slow and drawn out process.

A lot of areas visited have been farmed for many generations and the fact that the ground is still producing suggests that there have been farming systems in place over time that has enabled nutrient cycling and fertility regeneration to occur sufficiently to maintain productivity. From observation, the reliance on manufactured fertiliser is currently almost universal, although it cannot have always been this way as manufactured fertiliser products have not been around forever. Farmers in all areas visited were investing heavily in fertiliser, of the same composition, right across the world. These same farmers state that fertiliser is becoming too expensive and rates need to continually increase to maintain production levels. Urea appeared to be the most common fertiliser as well as large amounts of solid products supplying phosphorus. Rates of product used also appeared, with possibly the exception of Brazil, to be quite universal and in line with what growers in Australia would reasonably expect to use. Approximately 20 kg per hectare of nitrogen per tonne of expected yield of maize seemed to be used in most places. In Brazil, the double crop of soybeans in the rotation allows them to use rates in the order of 15 kg/ha/tonne of yield (Ferracuti, 2011).

In the United States of America (US), Europe and more recently in Australia, fertilisers in liquid forms have become popular as growers fine tune their crop nutritional needs and question the efficiency of their applied nutrients. Systems and machinery have also evolved to allow application of these products. In contrast, there appeared to be little evidence of the use of these more advanced products in the areas visited. Most fertiliser products seemed to be basic products in granular form. However, there was quite a bit of promotion of granular blended products in Brazil (Ferracuti, 2011).

Case study

Carroll Farms, Rhoda Velha, Western Bahia, Brazil.

Western Bahia is located in the central eastern part of Brazil, approximately 900 km west of Salvador on the east coast. The farmed area is a plateau that rises two hundred metres up a sharp escarpment running hundreds of kilometres north/south. This topography creates an uplift which increases precipitation as the weather fronts cross the area, causing rainfall totals on the western edge of the plateau of around 1 500 mm and then slowly tapering off in an easterly direction. Carroll Farms is a US-based operation situated on the escarpment about 120 km south of the main business centre called Luis Eduardo Magalhaels (LEM). The farm crops approximately 12 000 hectares (ha) each year on soils that are a red sandy loam of volcanic origin. They are very free-draining and can be trafficked within hours of rainfall events. Last year 10 000 ha of cotton was grown with the balance in a soybeans followed by corn double crop situation. Neighbouring farms either had a cotton focus, similar to Australia, or a largely no-till soybean /corn rotation (Bruch, 2011). The soybeans are planted with the first rains of the season starting late October and then the cotton takes a few weeks to plant, starting in mid-November. The soybeans are generally harvested during the middle of the wet season in January and then corn no-till planted as quickly as possible so that the crop is maturing before the wet season finishes (Carroll, 2011). The ability to traffic soils so quickly after rain is one of the major advantages that Brazil has over areas that farm on clay-based soils such as in Northern Australia.

Fertiliser is all spread, some prior to planting and the balance in-crop. Approximately 140 total units of nitrogen is applied as well as MAP (mono-ammonium phosphate) and 0.5 tonnes/hectare (t/ha) of gypsum. New ground needs 6 t/ha of lime in the beginning to neutralize the naturally acidic soils in the region and raise pH. This process takes 3 to 4 years before soybeans, corn and cotton can be produced. Following that, a maintenance application every 3 to 4 years of 1 to 2 t/ha is required. Dry land rice is grown in those early years because of its ability to tolerate the growing environment (Maronezzi, 2011). Yields of these crops currently average about 3 bales/ha for cotton, 10.5 t/ha for corn and 3 t/ha for soybeans (Carroll, 2011).

Cotton field in Western Bahia, Brazil **Photo: Aaron Sanderson 2011**

Cotton picking commences in June and runs until September. The total crop is picked using only seven pickers, configured to pick six rows on metre spacing. Boll buggies and module builders are still currently used but evaluation of the newer round bale technology is being evaluated. Once the rain stops in March, there is a totally dry period which enables this harvesting operation to proceed virtually unhindered. While soybean and corn crop residue has been embraced to provide ground cover benefits in a no till farming system, the cotton system still relies on cultivation to manage stubble. Cotton stalks are mulched and then disced twice behind the pickers. Erosion by both wind and water is an issue on these light soils so this cultivation practice is not considered ideal, despite government regulation that dictates that no regrowth is allowed on cotton stalks after the end of September (Carroll, 2011). This is to make sure there is no green bridge for carry-over of insect pests to the following crop. However, there is also legislation to ensure the same for soybeans, to minimize transmission of soybean rust to the next season.

Carroll Farms operate their own four-stand cotton gin on site and cotton bales are branded with their own insignia. Marketing and other farm administration, including large amounts of regulatory compliance, are conducted from an office in LEM.

High numbers of farm workers are still a feature on this farm, although, as wages continue to increase, labour costs are becoming a higher priority. Regulations governing hours worked and housing and catering standards have increased markedly in recent years. For example, workers work an eight hour day shift but only work for seven out of the eight hours for the night shift. A meal trailer and portable ablutions need to be provided. Approximately 60 people are employed year round with the numbers increasing to around 130 during the picking months. This operation is largely self reliant for skills, having everyone from machinery operators up to agronomists and area managers (Weihs, 2011).

Imported machinery costs are high due to import tariffs although the more expensive items such as tractors, pickers and headers are largely all imported. Secondary machinery is mostly produced domestically, although the sight of large row crop planters from the US is becoming more common (Hoppe, 2011). As well as three self propelled crop sprayers Carroll Farms also have their own aircraft and pilot for spraying.

Labour

The most popular conversation topic that came up amongst farmers right across the world is the discussion about labour. The supply of people to do the manual tasks often required in agriculture seems to be a problem not limited to any particular country or demographic. The other interesting thing is there is this idea that unskilled labour can be better sourced from countries other than your own. For example, the US has a large reliance on labour from Mexico, Western Europe from Eastern Europe, Thailand from Myanmar, India from Pakistan and Australia from Asia. The shift away from agriculture to urban areas for better employment is not a new concept but as you look at countries with different levels of economic status, a common denominator is that agriculture is often at the less desirable end of favoured jobs. These jobs are often outdoors in the elements where operating conditions can be hot or cold, or dirty and dusty and for an ever-increasing urban community around the world, these sorts of jobs are falling out of favour in preference to other forms of employment. For example, in India and China especially, the growth of manufacturing and electronic industries are creating an enormous drain on labour for traditional industries such as agriculture. It is hard to imagine that in these countries with very high population levels, and in comparison to Australia, a very decentralized demographic, that there could be a labour shortage but the emergence of businesses in rural areas manufacturing consumer goods or electronic parts or a range of other products has put a large strain on human resources available for food production. A labourer in Thailand can now make the choice of working on a farm and harvesting corn by hand, dragging a large hessian sack through a three metre high corn crop in 35 degree heat and 95% humidity or worse, or assembling electronic circuit boards in a clean air-conditioned building. It is often a simple choice, regardless of remuneration (Pongpanich, 2011).

For some activities, without a major change in the farming system that is possibly beyond the scope of the grower to understand and implement, these activities will continue to be carried out in much the same way that it has been done for a very long time.

Planting rice, India **Photo: Aaron Sanderson 2011**

To change an activity such as this photo of women transplanting rice seedlings in India, to something consuming less labour units, would require changes to many aspects of the farming system. Mechanising a transplant system for rice has proved elusive so far even for the most developed parts of the world, so direct seeded systems have prevailed, so that conventional seeding equipment can be used (Reddy C S, 2011). However, direct seeding is being trialled in these areas as a way forward through increasing labour availability issues but that is not the only consideration. Currently rice seed is germinated in a nursery, and because of its size, is easy to manage and protect until the crop is established. The crop is then transplanted into the paddy fields after approximately a month in the nursery but if a direct seed approach is taken, those paddy fields need water applied much sooner and far more seed is required. Managing water on and off some of these fields to allow germination and then subsequent crop growth can also be difficult due to a lack of machinery to create levees and gates (Kumar, 2011).

Social issues

In many parts of the tropical world, even ignoring country boundaries, the social fabric of society is the determining factor on how agriculture operates, especially where producing food for yourself, family and immediate neighbours is the number one objective. The land tenure systems are wide and varied as well, but there is much more involvement of the greater community in what happens on the piece of land that you are farming than we in the western world are used to (Gonzales, 2011). It is not necessarily government regulation, although there is always a degree of that, but more practical and hands on issues that have the greatest effects. Dr Ken Sayre from the Global Conservation Agriculture Program based in Mexico at CIMMYT, says that in his travels around the third world trying to promote conservation agriculture as a farming system, these social issues can be some of the most problematic. For example, one of the easiest ways to enhance water use efficiency in a cropping situation is to retain and utilize crop residues from the previous crop to act as a mulch layer on the surface of the soil (Sayre, 2011). This is something that Australian farmers have embraced particularly well over the past 20 years. Traditionally these crop residues would be burnt to enable the machinery to operate effectively while preparing the ground and planting the next crop, but by designing planting machinery to handle these residue loads and still completing the planting task, sometimes the difference is the ability to grow a second crop for the year or not. In a lot of cases, this can mean the farmer would be able to produce a crop to cover his direct food needs as well as having crop to sell to generate income, all the while only using the resources of soil water that were available all along. To get back to the original point that Ken was making, you as a farmer could be keen to embrace such techniques to enhance your cropping program, but it becomes very difficult when the accepted practice is for the guy down the road to utilize your crop stubbles to feed his goats until there was nothing left. Without your stubble, he would not be able to run his goats and by definition be out of business. Another example is when the crop residue left behind in your cotton field is gathered up by the local villagers to provide fuel for their cooking fires and other domestic uses (Gallegos, 2011).

Case study

Thailand Pacific Seeds Thailand

This company operates a seed genetics company based near Lop Buri a couple of hours drive north of Bangkok. They also provide agronomic support for local growers in the production of corn and sorghum crops, very similar to the operation of their partner company here in Australia. This is mostly a dry land production area although there are areas of irrigation interspersed throughout. The wet season runs from May through to October and delivers approximately 1200 mm throughout the year. Typically, on the break of the season farmers would start to plant corn. Farms are quite mechanized, most seemingly having small tractors in the 50 hp size, although 2 wheel tractors were also pretty common. Cultivation with a light disc for weed control would occur prior to planting on mostly dark self mulching soils that make your mouth water. Planters are often locally made and only a couple of rows wide using plate distribution systems like those that were common here in Australia 30 years ago with tyne delivery to the ground. Seeding rates of around 66 000 seeds/ha and 100 to 125 units of nitrogen applied by spreader with some Phosphorus but little Potassium used. A blanket application of 3 litres/ha of Dual and 3Kg/ha of Atrazine is applied behind the planter for a once pass weed control that appears to be quite effective, although some interrow cultivation is carried out. Yields on corn average around 4 t/ha although 10 is occasionally achieved (Pornwirat, 2011).

Harvesting corn, Thailand **Photo: Aaron Sanderson 2011**

Harvest is undertaken either with predominately Thai built harvesters which mostly seem to run on tracks and are also used for rice, or the crop is picked by hand. The harvest is mostly done by contract and the price is roughly the same for each option, the equivalent of around $A 60/ha (Pornwirat, 2011). Machines are becoming more popular as the availability of labour becomes more scarce and growers find that extra enticements are required to get farm labour such as meals and accommodation. Grain is harvested at high moisture and then dried, either spreading out on large concrete areas or by using newer commercial dryers. The hand harvested material is placed in hessian bags and taken to a location where a contract sheller is working and the corn is then separated from the cob and dried. These operations are often owned by the local seed dealer.

Northern Australia

There is currently another wave of interest in further development of the perceived large areas of arable land and abundant water supplies that exist across an area encompassing the northern areas of Western Australia, the Northern Territory and Queensland. Over recent years visits to the Ord River Irrigation Area and time spent looking at country around Katherine in the Northern Territory as well as a trip across Queensland to the Gulf of Carpentaria and back to the east coast earlier this year, have provided an insight into farming in this remote part of the world. Before even getting into the issues faced with operating farm businesses in those areas, the underlying feature is remoteness. They are simply a long way from major business centres that support field crop style agriculture. This means that to get a drum of chemical, bags of seed or fertiliser or to ship produce out, logistically it becomes a large and costly organizational issue.

However, those issues aside, the methodology required to physically produce a crop in the North is not greatly different to that of more southern or temperate localities. Farmers operate in a highly mechanised environment in this country, and farm operators in Northern Australia will not be going back to animal power or manual human labour on any scale again so they must look at other ways to address issues. Actually, the machinery requirements are similar to other areas of Australia. Seeding rates do not need to vary greatly and fertiliser application can be accomplished using existing technology. The difference now becomes management. Sure, they might use some slightly different genetics, but it can be in the resultant physiology of the plant that needs to be accounted for. Because of the growing conditions, the size and shape of the leaves on a cotton plant grown in North Queensland differs markedly to one at Moree in New South Wales for instance, and has large implications to the way the crop is managed to get it to set and retain fruit. A weed control program using residual herbicides in the tropics could still look quite similar to a southern one but there is a tendency for rates to be significantly higher to overcome more rapid breakdown of those herbicides due to heat, moisture and biological activity. It took quite a bit of trial and error to get to a point of effectiveness verses persistence with residual herbicides when starting to farm in the Burdekin. The herbicide must provide effective weed control long enough into the crops growth cycle to be worthwhile but then not persist after that crop to negatively impact on the next crop. In a lot of parts of the world, a bean crop followed by a corn crop is a pretty

common rotation in a twelve month period, often then returning to the beans. In the Burdekin, the challenge is in trying to get enough longevity out of the traditional Atrazine/Dual herbicide program to control weeds in the corn crop long enough into the season but not so long as to have those same herbicides causing growth problems to the soybeans planted only a matter of days behind the corn harvester. Also, retaining nutrients through the wet season can also be a challenge due to large amounts of rainfall, especially when it comes to highly mobile nutrients such as Nitrogen. Nitrogen typically moves in the soil water solution so if there is water movement through the soil, then Nitrogen and other nutrients will be leached out the bottom. Similarly, in a waterlogged situation which invariably occurs at some stage each summer, denitrification can occur with N being lost as a gas to the atmosphere.

Were there lessons to be learnt in other tropical areas around the world that could be used in farming across the north of this country? Possibly; there are not a lot that are directly applicable, there are some hints. A great frustration of growers farming in the northern monsoonal environment is the extended wet summer that brings modern machinery to a halt every year for many weeks at a time. But in Thailand, where small tractors were prolific, bogged tractors did not seem to be a great problem when the issue was discussed with growers, and nearly every harvester runs on tracks so that they could traverse wet ground, especially in rice fields but again, quite small machines. There can be many times the advantages of large (and heavy) modern machinery can quickly be dismissed in a northern Australian wet season.

Also hand chipping of weeds was a pretty common sight in many areas, especially across Asia. For those growers, this is still a cost effective alternative to large doses of residual herbicide. Should growers in the technologically advanced world be trying harder to utilise the technology we have to more specifically target our weeds in some other way instead of a blanket herbicide approach?

Conclusion

There are no silver bullets hiding elsewhere in the world for overcoming the operational problems in the country's northern region. Each area of the world comes up with their own methods and solutions in response to the environment in which they operate. This includes the physical environment - such as climate and weather –and is also shaped by history and culture and the availability of resources. This makes comparing farming systems, or even potential farming systems in Northern Australia, to other parts of the tropical world a virtual impossibility.

So much of the methodology of agriculture is hung on the traditions of those that have gone before. This becomes exceptionally obvious in countries that do not have well organized research and development programs to support their growers, which unfortunately covers a lot of the tropical world. As a result, the farming systems in many of these regions have not changed or had the ability to improve substantially over many years, with the methodology basically being passed from one generation to the next.

The natural resources on offer across northern Australia vary quite considerably across the different parts and are also reasonably unique in the tropical world. Except for some small coastal areas, we do not have an abundance of rainfall. Northern Australia generally receives substantially less rainfall than many other tropical areas, with most rainfall predominately arriving over a short period of time. The wet season is often very short, not the 6 to 8 months enjoyed by tropical Asia. Northern Australia does not have the vast areas of well drained arable soils that Brazil or Thailand enjoys; rather we have a patchwork of heavy soils scattered across the northern region. This makes it difficult to get critical mass together to offer infrastructure and support services to the growers operating there.

While the lack of available labour situation is an issue all over the world, it is especially difficult in Australia. Australia has a vast region across this top end that just simply does not have a large population and those population centres are often long distances away from existing or potential farming areas. In other areas, the populations of the countries are mostly much higher with a larger number of people engaged in agriculture. Even in more remote areas, there are quite high numbers of people, often in small villages, which can supply labour.

There is more common ground across the world when it comes to agronomics. Supply of field crop genetics by large multinational companies is almost universal, as is supply of farm chemicals and fertilisers. The rate of use of these is also similar across the board. Yields of crops generally reflect the ability of the growers to supply inputs to those crops which is no different anywhere in the world.

The big issues in the north of this country continue to be the same as they have been for many years. It is simply a very large place and logistics and its associated costs continue to be the overriding factor. As a result, farming systems issues continue to take a back seat to other problems. Support and infrastructure, proximity to markets, and the availability of skills and labour will continue to be the debated topics for this part of the world.

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Plain English Compendium Summary

Project Title:	Farming Systems in the Tropical Areas of the World:
Nuffield Australia Project No.:	1112
Scholar:	Aaron Sanderson PO Box 254 Ayr Qld 4807
Phone:	0428186497
Fax:	
Email:	atsando@bigpond.com
Objectives	To gain an understanding of the field crop farming systems of the tropical regions of the world.
Background	Producing field crops in the tropical regions of the world present some unique challenges. After farming in tropical North Queensland for a number of years I was interested to see how other parts of the world handled the same issues and challenges that I was dealing with.
Research	Research was conducted primarily by talking to growers on their farms, in their fields, and seeing first hand their operations. I visited growers in China, the Philippines, India, Thailand, Northern Australia, Brazil, and Mexico.
Outcomes	Farming systems have developed in response to many influencing factors and as a result are very complex and site specific. Wholesale adoption of a system to another area is not practical but visiting different areas and seeing the system at work provides some basis on which to improve Australian systems.
Implications	
Publications	Nil