

SUSTAINABLE SYSTEMS
APPROACH
TO NO-TILL FARMING IN
(WESTERN) AUSTRALIA

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EXECUTIVE SUMMARY

The idea of summer cropping (that definition changed to warm seasoned cropping, they are not really grown in summer, it is late spring) is being encouraged by the perceived sustainability benefits.

The shift in thinking was that warm seasoned crops are only part of the solution to the sustainability issues in Western Australia today. The biggest problem with the cropping system of Western Australia is the complete domination of wheat, making the system almost a monoculture.

Warm seasoned crops are a part of the solution but not the complete answer in itself. The diversity of crop rotations is a large part of the solution with warm seasoned crops contributing to that crop diversity.

The reason there is so much interest in warm seasoned crops in Western Australia at the moment is because there is belief that this will move the current farming system towards a more 'sustainable' farming system. With the monoculture (of wheat) and the predictability of the current system, any variation in the cropping rotation would be of benefit.

This has created a large amount of interest in warm seasoned cropping as it has the impression of fulfilling sustainability criteria. The theory of warm seasoned cropping has been introduced to our farming system mainly by the Western Australian No-Till Farmers Association and most certainly it would not work with full cultivation. Technology (herbicides, stubble retention, and moisture retention) has moved us closer to being able to integrate profitable warm seasoned cropping into the farming system. We at the moment have to try to integrate the warm seasoned crops into the farming system purely for long-term sustainability. We are very experienced with the growing of wheat (our speciality), but know very little on warm seasoned crops.

This also opened up the opportunity for companion cropping, with this being the growing of two crops simultaneously, although this does bring in management limitations. For companion cropping to be successful, I see one of the crops being a dominant, aggressively growing crop and the secondary crop being more of a 'weaker' crop with a secondary crop grown for a management issue (eg. weed suppression, insect deterrent). I believe notice should be taken of anecdotal evidence from biodynamic and organic farming practices that

utilise companion cropping for yield increase. The first and simplest risk management strategy of warm seasoned crops is the utilization of out of season rainfall. If a rainfall event happens in a winter crop-growing harvest, it is a complete disaster. The greater the diversity of crops grown the less the exposure to risk the farm and farmer are. Diversity of crops limit risk to both market influences (market price drop) and to production risks (bad weather events, crop pests and diseases).

Perhaps the strongest selling point for the introduction of warm seasoned crops into the Western Australian farming system is the excellent management tool it could become in countering herbicide resistance. In my studies I have learnt that herbicide resistance is generally encountered with a predictable farming system. In a way we are appeasing nature's need for biodiversity by growing more diverse crops over the whole farm.

With greater diversity in the farm cropping system, the input costs for cropping would be expected to decrease as currently a lot of the costs are on pesticides trying to 'maintain the monoculture'. Nowhere in nature is there a monoculture, if one appears, nature will put through a pestilence of the species, thin the number of plants and diversity will follow as other species appear. Currently we fight the intended monoculture with chemicals (herbicides, fungicides and insecticides). We are trying to fight nature with chemicals and we will not win; herbicide resistance is the classic point that nature will have diversity.

The classic symptoms of a cropping system with not enough intensity would be leakage. This leakage is obvious in the form of rising watertables and salinity as well as acidity, both prevalent in WA.

Our biggest challenge at the moment is to incorporate the warm seasoned crops into the system (increase the intensity) and stabilize the system verses the short term viability of the farm.

As our agronomy in warm season crops improves, the short-term profitability should improve- both through the improving profitability (agronomy and yield) of the warm seasoned crops as well as the improving profitability (agronomy and yield) of the winter crops.

Warm seasoned crops, being grown in the most difficult/ marginal time of the year, will exacerbate or magnify any production limiting factors.

The introduction of income neutral warm crops could be the perfect opportunity to grow warm seasoned cover crops. If they are grown as non-income producing circumstances i.e. As a cover crop, then the grower can learn the science of growing warm seasoned crops without any 'foregone income'. As more knowledge of warm seasoned cropping is gained, the soil moisture holding capacity will be improved furthering the opportunity of economically viable warm seasoned crops.

The sustainable farming system that will evolve from the current no-till evolution will be distinctly unique to Australia's environment and farming system. Most of the places I visited to find information on warm seasoned cropping were growing all their crops in the warm season. Their growing season was in their warm season and their barren season was their winter- our situation is the opposite in that our barren season is our warm season and we are trying to push growing crops into our barren season.

With the introduction of a wider range of crops into the rotation, the range of herbicides available for each individual crop (particularly/ especially the soil residual herbicides) will become more limited due to the sensitivity of subsequent crops to those herbicides. However, this will be offset by the lower weed burdens resulting from a more diverse, unpredictable cropping sequence.

As well as this, greater diversity of crops can be grown (a greater number of lucrative crops become economic to grow- due to greater fertility, better weed control, greater soil moisture holding capacity, etc.).

Farm economic viability is just as important as farm environmental sustainability. However, if our cropping system is not sustainable in the long term, it is certainly not economically viable in the long term.

Going to a longer rotation with a larger variety of crop types will reverse this trend. This will include warm seasoned crops as well as a greater variety of cool seasoned crops.

ACKNOWLEDGEMENTS

The first and foremost thank you that I have is to the Australian Nuffield Farming Scholars Association for the outstanding opportunity this has given me, opening my eyes and mind to the global farming situation and opportunities that this brings.

I am most grateful to the Grains Research and Development Corporation for their sponsorship of the Australian Nuffield Farming Scholars. I believe, after receiving one of these scholarships that this is a most fruitful partnership for both parties and hope that it can continue well into the future. Since my return, I have been speaking at several farmers gatherings and have been conveying the ideas and knowledge I gathered on my travels.

I must also thank QANTAS for their continued support of the Australian Nuffield Farming Scholars Association, being an Australian Scholar and doing so much travelling to the other side of the world, a sponsor that is an airline is certainly useful.

Another very grateful thank you must go to the West Wagin topcrop group (a group of local farmers that get together and monitor farming methods. During my absence through the year they monitored my crops and sprayed when required. This allowed me to fully concentrate on my task at hand and was done with no recompense and I am in their debt for this.

Finally I would like to thank my family that looked after the farm in my absence through the time I was away. The receiving of this scholarship is a huge honour and it takes a very big effort from all the above people for this all to happen and I am truly grateful.

I am also most grateful to all the people that availed themselves to me throughout my study. A lot of people took out a lot of their time for me and I appreciate that. For all the effort we put in to find the information, a lot of the time people are usually giving the information.

A special thank you must go to Dwayne Beck from South Dakota State University. He greatly assisted me in giving me a lot of relevant contacts throughout the United States. This was invaluable in that as my study topic 'evolved' from the original topic, the contacts I had received, also had their field of speciality so as the topic altered the most relevant people were still able to be found.

AIMS/ OBJECTIVES/ STUDY GOALS

The original study topic when I first left was ‘The Adoption and Agronomy of Summer Cropping in the South-West of Western Australia’. This was the study topic at the beginning but very early in the travels this evolved beyond just summer cropping. The idea of summer cropping (that definition changed to warm seasoned cropping, they are not really grown in summer, it is late spring)

It was very difficult to find anywhere that could be used as a template for me to study as there is nowhere that has the dry barren period that we have and grow a crop in that time.

The shift came after speaking to some rhizosphere ecologists from Lethbridge in Canada and was reinforced that I was on the right track once I had reached Dwayne Beck in South Dakota. He thought the tangent topic I had taken was the right one to tackle the sustainability issue, and what everyone in Western Australia thought would be overcome with warm seasoned crops.

The study topic upon my return would be best described as ‘A Sustainable Systems Approach to No-Till Farming in Australia.’ The shift in thinking was that warm seasoned crops are only part of the solution to the sustainability issues in Western Australia today. The biggest problem with the cropping system of Western Australia is the complete domination of wheat, making the system almost a monoculture.

Warm seasoned crops are a part of the solution but not the complete answer in itself. The diversity of crop rotations is a large part of the solution with warm seasoned crops contributing to that crop diversity.

INTRODUCTION

The reason there is so much interest in warm seasoned crops in Western Australia at the moment is because there is belief that this will move the current farming system towards a more 'sustainable' farming system. With the monoculture (of wheat) and the predictability of the current system, any variation in the cropping rotation would be of benefit.

CORE OF REPORT

The sustainability of the Western Australian (and Australian) farming system is under scrutiny and methods are being developed to improve its long term viability. This has created a large amount of interest in warm seasoned cropping as it has the impression of fulfilling sustainability criteria. The crop does use out of season rainfall and this seems to be one of the major events that causes sustainability difficulties.

It would be well worth noting here that it was a difficult topic to find any comparable cropping systems around the world as nowhere else, that I found, has any similar issues, in a similar environment to ours. This has been the major point that I have emphasized since my return is that we can have overseas 'experts' come and tell us their cropping systems, and how they work in their environment, but we are truly unique and we cannot be told how to do it by anybody else in the world. We need some leaders from within our farming community, in our environment, to take the lead and find the system (including warm seasoned crops) that fulfils the requirements of sustainability and viability that we are seeking.

I found that through my travelling there was nowhere that is comparable directly to our situation. We certainly have the most marginal and difficult warm seasoned cropping region of the world and when I tried to explain to the people I encountered our farming situation and what we were trying to achieve, most were a little bewildered to say the least! We can take the theory of theirs but we still have to adapt it to the individual situation. No one crop rotation will be the 'right' rotation, as the goals trying to be reached have to be set out; does the farm run stock and can the warm seasoned crop be used for grazing is a good example of how one situation may require one rotation and this may be completely unsuitable in another situation, and I believe that stock do have a fit in my farming system.

The theory of warm seasoned cropping has been introduced to our farming system mainly by the Western Australian No-Till Farmers Association and most certainly it would not work with full cultivation. Technology (herbicides, stubble retention, and moisture retention) has moved us closer to being able to integrate profitable warm seasoned cropping into the farming system. However unfortunately at this stage, I believe that we are still not at the 'profitable' stage. We at the moment have to try to integrate the warm seasoned crops into the farming system purely for long-term sustainability. We are very experienced with the growing of wheat (our speciality), but know very little on warm seasoned crops. If the crops are introduced in small areas (although I strongly believe that for the full benefit to arise from the

rotation, the whole paddock must be grown to the WSC (warm seasoned crop). Once the experience and knowledge of how we grow these crops is better developed, then the economic issue may become closer to profitable.

The difficulty of convincing farmers of the long-term benefits of this system is one of the most difficult issues we currently have with their uptake.

To counter the resistance that is encountered with convincing farmers to try WSC the following points should be emphasized to convince them to 'begin the journey'.

WSC give better utilization of subsoil and out of season soil moisture. This point can be expanded further to include issues of tackling salinity and rising watertables, (the two major issues of under-utilising the available soil moisture).

This system is getting closer to the natural ecosystem that was originally present. The natural ecosystem was in balance proved by its long-term stability. An important note here I found on my study through the Great Plains of the United States (a natural grassland ecosystem, where wheat is a very good substitute for the natural ecosystem) was that there are some varieties of sunflowers native to this area. No farmers I spoke to in that region were growing sunflowers, even though this was their native ecosystem. The reason for this was that a lot of the natural predators of the sunflowers were present, and once the sunflowers were put into a monoculture situation (a field of sunflowers and no other plant), the natural predators had the plentiful food supply and their numbers exploded.

This is another of the major points I discovered on the study, although we need to try to emulate our natural ecosystem, the monoculture of one species of any plant (even a native plant) makes management infinitely harder.

This also opened up the opportunity for companion cropping, with this being the growing of two crops simultaneously, although this does bring in management limitations. For companion cropping to be successful, I see one of the crops being a dominant, aggressively growing crop and the secondary crop being more of a 'weaker' crop with a secondary crop grown for a management issue (eg. weed suppression, insect deterrent). I do see this being a very powerful management tool if managed correctly.

The growing of warm seasoned crops, although definitely not the natural ecosystem of an evergreen tree, does move us closer to the natural ecosystem in that the trees are green moisture using plants on the soil for a much longer period of the year. To put this in the

simplest terms we took out an evergreen tree and replaced it with a 5 month (if we are lucky!) annual, no wonder our system is out of balance!!

Another issue that should be emphasized to encourage the adoption of warm seasoned crops is risk management. This can be taken in two directions here. The first and simplest risk management strategy of warm seasoned crops is the utilization of out of season rainfall. Out of season rainfall events are one of the most damaging sustainability issues we have and are known to rapidly raise the water table. If a rainfall event happens in a winter crop-growing harvest, it is a complete disaster. If there is some warm seasoned crops in, even if only a small proportion, then at least some advantage can be taken from an event out of the farmers control.

The second part of risk management that can be explained is the diversity of crops that can be grown. The greater the diversity of crops grown the less the exposure to risk the farm and farmer are. Diversity of crops limit risk to both market influences (market price drop) and to production risks (bad weather events, crop pests and diseases).

With the growing of another crop 'type' not only is risk spread, but also the workload can be spread. This is explained as in the current situation, with an opening rain, all crops are seeded within a one month (this includes all crop types grown- cereal and broadleaf). This puts strain on both the operator and the machinery as all the workload is in a very short period and is left unutilised for the rest of the year. With the opportunity for another (even if small) seeding period at another time of year farmers can get better utilization of their machinery, including the seeder, boomspray and harvester.

The workload of the farmer is also spread further through the year, spreading some of the work in the busier times of the year into somewhat quieter times.

Perhaps the strongest selling point for the introduction of warm seasoned crops into the Western Australian farming system is the excellent management tool it could become in countering herbicide resistance. (This would obviously be just as relevant anywhere else but with the high prevalence of herbicide resistance in WA, it has a very strong application here.)

In my studies I have learnt that herbicide resistance is generally encountered with a predictable farming system. The three major cropping areas of the world that have encountered herbicide resistance have been Western Australia (with a wheat, lupin, wheat lupin rotation), the Prairies of Canada (with a wheat, pea, wheat, canola rotation) and the cornbelt of the United States (that has a corn, bean, corn, bean rotation). None of these has

any similarity in crop, environment or weed gaining resistance, but they all have one thing in common- predictability. Predictability over a long period of time gives nature the opportunity to counter a particular set of circumstances.

Nowhere in nature is there a monoculture. If, for whatever reason, a monoculture does appear, nature's way of balancing and reintroducing diversity is to send in a pestilence (insect, disease, predator of some sort) to decrease the numbers of the one plant and allow the introduction of other plants for biodiversity.

So in effect, we are constantly fighting nature as we spend money on pesticides (mainly fungicides and insecticides) to maintain a monoculture while mother nature is constantly trying to break down the monoculture into more biodiversity.

With the predictability of our cropping system, nature has found the easiest way to beat the monoculture and reintroduce its biodiversity is to find ways around the management techniques that maintain the monoculture- herbicide efficacy.

Introducing an unpredictability issue into the cropping system (different time of sowing, different harvesting period) has the effect of 'confusing' nature (a good example of this would be that a selective herbicide isn't applied to the crop at the same time every year).

Another strong argument supporting the introduction of warm seasoned crops is the diversity of crops it brings onto the whole farm system. In a way we are appeasing nature's need for biodiversity by growing more diverse crops over the whole farm.

Warm seasoned cropping, at the moment should be approached from the point of view of being 'income neutral', but will at least 'stabilize the system'. We currently do not have enough intensity in the system (replaced a evergreen tree with a five month wheat plant).

The classic symptoms of a cropping system with not enough intensity would be leakage.

Leakage would be defined as unutilised resources escaping the system, and the two we have are water (salinity and rising watertables) and nutrients (acidity).

Our biggest challenge at the moment is to incorporate the warm seasoned crops into the system (increase the intensity) and stabilize the system verses the short term viability of the farm.

As our agronomy in warm season crops improves, the short-term profitability should improve- both through the improving profitability (agronomy and yield) of the warm seasoned crops as well as the improving profitability (agronomy and yield) of the winter crops.

Warm seasoned crops, being grown in the most difficult/ marginal time of the year, will exacerbate or magnify any production limiting factors. A good example of these factors would be soil fertility or deficiency. This could then be taken as a management tool for the more income productive winter crops without losing potential yield.

With our current farming system, the longer our long summer /autumn period (what, over my studies I have come to term our barren period as compared to our growing period), the more brittle our environment becomes. By this I mean it becomes more susceptible to sustainability issues; it becomes more fragile to large wind events and out of season rainfall events. With being able to 'stretch' the growing season, it will have the effect of 'shortening' the barren season and minimizing the brittle/ vulnerable season.

As much as our lack of (reliable) rainfall is the most limiting factor in the adoption of warm seasoned cropping, it could also be said that our poor, sandy soils that store very little moisture can also be attributed to the difficulty of establishing a viable warm season crops.

The only way that the soil moisture holding capacity can be improved is by the increasing of the soil organic matter. The only way this can be done is by stubble retention and cover crops. The introduction of income neutral warm crops could be the perfect opportunity to grow warm seasoned cover crops. If they are grown as non-income producing circumstances i.e. As a cover crop, then the grower can learn the science of growing warm seasoned crops without any 'foregone income'. As more knowledge of warm seasoned cropping is gained, the soil moisture holding capacity will be improved furthering the opportunity of economically viable warm seasoned crops.

Although admittedly, this is a very long-term process, it is a process that must be started.

It has taken a long time for the land to reach the state of degradation we are at now. This can be taken as both an advantage and a disadvantage, the advantage being it has taken a reasonably long time to reach the situation we are in now which has allowed us to have technology to help us address the situation. The major disadvantage of this would be that it has taken a very long time of poor sustainability farming to get to this stage and it will take a long time of sustainable management for the situation to improve. This is not a short-term fix.

It will take a long time and a lot of determination for this to work; I would estimate that at least 95% of the benefits will be 'banked' into long term benefits that will not be realized, more than likely, in that farmer's lifetime.

One of the more difficult problems that I encountered on my studies was that there was nowhere else in the world to be comparable to our situation, therefore there was nowhere to copy or build the framework for our system on. The sustainable farming system that will evolve from the current no-till evolution will be distinctly unique to Australia's environment and farming system. Most of the places I visited to find information on warm seasoned cropping were growing their crops in the warm season. Their growing season was in their warm season and their barren season was their winter- our situation is the opposite in that our barren season is our warm season and we are trying to push growing crops into our barren season.

The quick reversion back to wheat in our rotation must be reduced. It must become longer (and more erratic) before the winter cereal phase returns to a particular paddock. For the long term viability and sustainability of our farming system, this is just as important as the integration of warm season crops.

Crop rotation was a science well known previously; with the advent of large scale mechanized tillage and the adoption of monoculture wheat the 'expertise' was lost. We now have to 'rediscover' this lost science.

When the science was well known was when farmers were very self-sufficient, growing a lot of their own requirements and had very diverse rotations of crops. At this stage there was a lot of evidence of crops growing and yielding well if rotated in a particular sequence.

With the development of minimal disturbance cropping techniques and stubble retention we need to re-learn the science; although rotational studies are often neglected due to the length, scope and difficulty of the trials. We must press on and develop this science if our farming system is to become truly long term sustainable and profitable.

With the introduction of a wider range of crops into the rotation, the range of herbicides available for each individual crop (particularly/ especially the soil residual herbicides) will become more limited due to the sensitivity of subsequent crops to those herbicides.

This should not be taken as a major obstacle as regions that have taken the more diversified rotations have all experienced dramatic decreases with their weed burdens.

One of the perceived problems with the adoption of the system has been the notion that the system costs (cover crop establishment, etc.) with little chance of a return.

Evidence (from the US farmers 'further along' in their development/ evolution of this farming system) however, suggests the contrary. More lucrative crops can be grown with substantially lower input costs (both in terms of fertility and weed control). As well as this, greater diversity of crops can be grown (a greater number of lucrative crops become economic to grow- due to greater fertility, better weed control, greater soil moisture holding capacity, etc.).

Giving the whole farm system a greater chance of being both economically sustainable and environmentally sustainable, this evolution of the farming system must not be rushed into haphazardly as it is an evolution and evolution takes time. Farm economic viability is just as important as farm environmental sustainability. However, if our cropping system is not sustainable in the long term, it is certainly not economically viable in the long term.

The major factor to our current ever-increasing costs of production is our very tight rotation (our quick reversion back to very similar crop types very quickly). Going to a longer rotation with a larger variety of crop types will reverse this trend.

The variation in intensity required from year to year (i.e. dry summer to wet summer) is probably the most difficult management issue with warm seasoned crops. It will either be too intense (dry summer) or not intense enough (wet summer).

The variation of intensity required from year to year to accommodate 'barren' season variations in rainfall can be managed in this manner:

The proportion of warm seasoned cropping annuals will be regulated by the rotation each individual area is at in their own individual sequence. One uniform sequence is not going to be relevant over an entire farm, so there should be several sequences of crops growing simultaneously. Some of these sequences may be of longer duration while others could be of shorter duration, however, the most important issue of all the sequences over the entire farm is to have the right proportion of warm seasoned crops and winter crops, and cash crops and cover crops in each year.

These proportions will vary from farm to farm (this will be the fine tuning of the system to suit the individual farmer's goals, but the principle will remain the same) but the main influencing factors on these proportions will be: growing season vs. barren season average annual rainfall, moisture holding capacity of the soil, the rotation will always be dominated by

the goals of the farmer (grazing, grazing/ cropping mix, purely cropping, high input cropping/ low input cropping, weed suppression, higher fertility, etc.)

However, one important and overriding factor must be taken into consideration when designing the sequences over the whole farm program. In any one calindrical year there must be again, the right proportions of different crops (WSC, winter, cash, cover) to minimize 'bad' weather events/ seasons and yet capitalize on good seasons/ weather events.

Variations in seasonal averages (wet years and dry years) can be somewhat 'taken up' or 'compensated' for by the inclusion of perennials in the system. A good example of this would be lucerne, that can remain dormant through a particularly dry barren season (with very little or no input costs) and yet in a particularly wet summer will be active, productive, using excess soil moisture, fixing nitrogen and stabilizing the farming system. This will give flexibility to the system to allow for seasonal variations

CONCLUSION

My initial plan was to study warm season cropping for the south west of Western Australia, a very harsh and unsuitable environment for this. I ended up with the study topic evolving into sustainable rotation management.

I feel this was a better topic in that it encompassed more and went further to tackling the sustainability issues that warm seasoned crops appear to tackle. I found that there was a larger answer than just the warm seasoned crops and I tried to encompass these in my study.

I found that we are unique in our environment, and that no-one can come from another country and give us the answers to our sustainability issues we are facing. The answers to these issues are going to be tackled and found by innovative Australian farmers willing to 'think outside the box'- Nuffield has given me the opportunity to see the bigger picture and hopefully I will be able to contribute to setting up 'a sustainable systems approach to no-till farming in Australia'.