Cool Season Pulse Crops Suitable for Rotation with Rice

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Abbreviations List

ACIAR	Australian Centre for International Agricultural Research
CAP	Common Agriculture Policy
CSPC	Cool Season Pulse Crops
GRDC	Grains Research and Development Corporation
IARI	Indian Agricultural Research Institute
ICARDA	International Centre for Agricultural Research in Dry Areas
ICRISAT	International Crops Research Institute for the Semi Arid Tropics
IIPR	Indian Institute of Pulses Research
NAFTA	North American Free Trade Agreement
PAU	Punjab Agricultural University
PGRO	Processors and Growers Research Organisation
RIRDC	Rural Industries Research and Development Corporation

Executive Summary

Following the completion of six weeks overseas joint Nuffield study of general agriculture issues, I visited a number of countries to study cool season pulse crop (CSPC) options which may be suitable for rotation with rice.

Growing cool season pulses provides a number of positive benefits including no requirement for nitrogen fertilizer, increased yields for the next cereal, no issues with stubble residue and an irrigation requirement which is supplementary to normal rainfall. Despite the positive features of growing pulses, the need for continuing disease resistance and markets will restrict irrigators to producing the main pulses supported by the Australian breeding programmes.

Canada has embraced pulses with increasing enthusiasm since the mid eighties and is the world's largest pulse exporter. Their preference where climate allows is to grow dry beans but distribution is limited to areas which have at least 110 frost free days. CSPC are grown over large areas of Alberta and Saskatchewan however, irrigation of these crops is limited to only small areas in these provinces and the dominant irrigation type is sprinkler. The biggest impact on production of CSPC was the introduction and use of granular inoculants to inoculate the soil rather than seed dressings or liquid even in soils with previous inoculant history. We need to trial and release granular inoculants in Australia.

In Syria and NW India, with climate similar to southern Australia, large gains have been made incorporating disease resistance from wild strains of CSPC. Of particular interest to southern irrigators is Ascochyta in chick peas and chocolate spot in faba beans. In Syria there has also been a successful breeding programme to lower the toxicity of Lathyrus, which would be a very useful rotational crop for rice growers who also run livestock as it can be grown without the need for raised beds. We have to continue to encourage Grains Research and Development Corporation (GRDC) investment in pulse development and breeding including linkages with ICARDA and ICRISAT.

England is placing an increasing importance on faba bean exports which will see increasing competition in the key Egyptian market if they can continue to increase quality. On farm, growers are moving to lower plant populations to improve yields.

We have to remain mindful that other countries are looking to increase pulse production and the pressure will remain to use irrigation to produce high yields, of high quality, at least cost with opportunities to value add also fully explored. It is essential that we liaise with breeders for selection of high yield under irrigation as the priority around the world is more toward increasing yield under drought stress. This is not always conducive to achieving maximum yield when moisture stress can be alleviated with irrigation.

Acknowledgements

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Aim

To explore cool season pulse crop options suitable for rotation with rice which would provide further break crop additions for the wheat/barley sequence which is used extensively in rice based farming systems in southern Australia.

Figure 1 Dr. Malhotra Senior Chick Pea Breeder ICARDA Syria discusses trial results with the author

Introduction

My wife and I run an irrigated farming business in the Riverina region of southern NSW. The climate is Mediterranean temperate with the annual average rainfall of 400mm distributed fairly evenly over the year. The soils are heavy red clay and clay loams with rice, a summer growing crop, the principal enterprise. It is rotated with a number of winter crops including canola, wheat, barley, seed oats and faba beans. Rice is flood irrigated by ponding water behind levees erected along contour lines. The second crop of rice is followed immediately by a winter cereal crop to extract any remaining moisture. This type of irrigation layout restricts the availability of rotation crops to those which can tolerate some waterlogging as the surface is inundated during irrigations and held till the irrigation bay is completely wetted. To overcome this constraint and to lift yields with crops that have some tolerance to waterlogging, earthworks are carried out to change the irrigation layout to 1.8 metre beds which are irrigated by capillary action from dividing furrows sloping down the contour. Water is supplied to each furrow via a 50mm plastic syphon pipe.

High wheat and barley yields can be achieved with irrigation however to maintain them a break crop is required. Canola has been excellent in the past but is increasingly becoming more variable in yield with an overall declining yield trend. Fluctuations in world prices impact on its profitability so that irrigators are looking for more choices to fit the rotation.

What are cool season pulse crops?

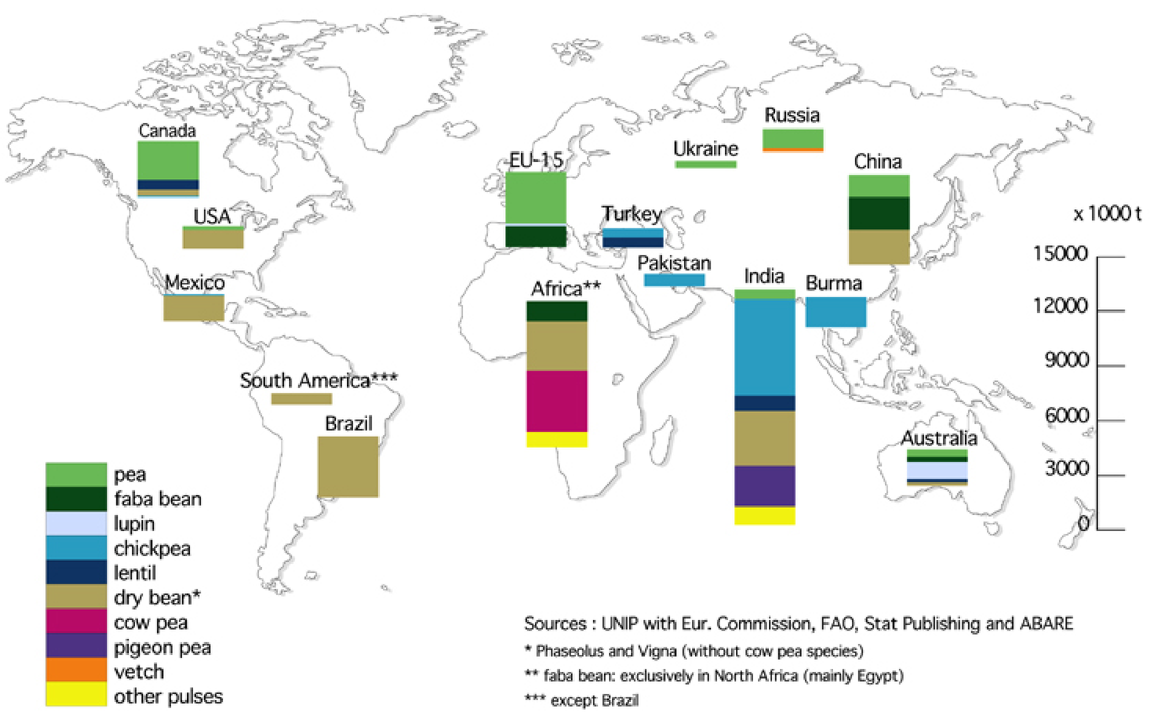
Pulses are the edible seeds of legume crops and the major cool season groups grown in Australia include field peas, chickpeas, faba beans, lentils, lupins and vetch. With the exception of lupins they have a hypogeal type of germination meaning the seed leaves remain below ground. Warm season pulses such as soy beans and dry beans are characterised by an epigeal type of germination which means the seed leaves emerge from the soil. The cool season pulse crops are more frost–tolerant, grow vegetatively during the cool season and flower as day length becomes longer. Soy beans and dry beans have much higher gross margins than the cool season pulse crops but as summer crops they are in competition with rice which has an even higher gross margin.

Why have cool season pulses in the rice rotation?

- Irrigation water requirement for cool season pulse crops is not high and water use timing is more in line with the natural flow of the rivers in southern Australia.
- Pulse crops are considered environmentally friendly because of their ability to source most of their N requirement from the atmosphere rather than fossil fuels.
- They have low crop residue and low carbon-to-nitrogen ratios which allow easier transition to the next crop in the rotation without burning.
- Wheat crops following pulses require less nitrogen, less pesticide and have increased yield.
- Developments in irrigation layout (principally beds in bays and high speed watering) will reduce the impact of waterlogging and allow a wider range of pulses to be grown in the rotation without the current cost of removing levees and installing new beds at the completion of rice cropping.
- More choice is needed in the winter crop rotation with cereals.

World Pulse Production

Main Grain Legume Producing Countries in 2003



Source: *http://www.grainlegumes.com*

Pulse crops are an important food crop in many parts of the world but production and trade in grain is small in comparison to the world's main grains.

FAO 2003	**Rice**	**Wheat**	**Maize**	**Soy**	**Canola**	**Pulses**
Production (million tonnes)	583	560	641	189	37	57
Export Trade (million tonnes)	28	110	91	65	7	8
Area (million hectares)	148	207	144	83	23	69

Source: Food and Agricultural Organisation of the United Nations

Canada

Canada is the world's largest exporter of pulses and has achieved that status with phenomenal growth in production of twenty percent per year over twenty years. Changes began with the removal of the freight subsidy for grain and farmers moved to lower yielding higher value crops such as canola and pulses. Canadian farmers admit that canola and pulses have re-payed their mortgages while wheat is a gap filler; where as the converse situation applies in Australia. Similar to the rest of the world, production is dry land based with only small areas of the cool season pulses irrigated.

Canadian irrigation development is primarily located in the province of Alberta where approximately 600,000ha is irrigated. Most is within the 13 irrigation districts centred on the light glacial soils in the dry south. The majority of water diverted is supplied by spring precipitation and mountains snow/glacier melt. Global warming is an issue as the snow melt is happening earlier in the season when flows cannot be utilized. Flood irrigation is now less than sixteen percent with the majority of water applied through centre pivot irrigators. The high elevation between storage and field is used to generate electricity and in some cases used to drive the centre pivot irrigators with water. The main crops irrigated are forages and cereals. Dry beans are the main irrigated pulse crop with only a small area of cool season pulses irrigated. As in most other countries the cool season pulses are relegated to rain fed areas. The area of dry beans and potatoes is increasing under irrigation. Potatoes require good soil and a contract with a processor. They cannot be grown as a monoculture so other crops are included in the rotation.

The table below shows the variation in profitability between the crops irrigated in Saskatchewan Province.

Irrigation Economics Saskatchewan 2004

Gross Margins at High Yield (CA$/ha)

Potato (seed)	**3 861**	**Faba bean**	**215**
Potato (table)	**1 507**	**Soft wheat**	**205**
Dry bean	**857**	**Durum wheat**	**188**
Canola	**405**	**Canary seed**	**163**
Lentils	**385**	**Hard wheat**	**156**
Sunflower	**361**	**Flax**	**106**
Oriental mustard	**313**	**Pea**	**96**
Kabuli chick pea	**279**	**Barley**	**64**
Yellow mustard	**217**	**Desi chickpea**	**32**

Source: Irrigation Crop Diversification Corporation. Irrigation Economics and Agronomics Saskatchewan 2004

Alberta has reached the maximum allowable for water allocations, however there is an option to increase allocation in some areas if efficiency can be increased. Half the annual flow of water has to be supplied to the neighbouring province Saskatchewan, which is only utilizing four percent of their allowance. Money and the cost of energy appear to be hindering its development. As in Alberta forage and cereals are the main stay crops for irrigators.

Canada has invested a lot of resources into development of pulse crops. The recent appointment of a new pulse breeder aims to capitalize on the changes which are part of the North American Free Trade Agreement (NAFTA). After 2008 there will be no tariffs on beans exported to Mexico and I met with Dr Parthiba Balasubramanian at Morden Research Station where he is looking to breed new bean varieties to suit the Mexican market. The Canadians have also discovered and obtained new bean genetic material from Mexico which can handle -6 degrees C. The plan is to infuse the new material into current and new varieties which would greatly extend the production area of dry beans in Canada.

Some of the most significant research which lifted pea yields across Canada was with inoculants. Research at a number of sites including Indian Head and Swift Current clearly demonstrated that a granular form of rhizobium inoculant has a greater influence on plant growth and seed yield than seed inoculation. We need to encourage the continuing development of granular inoculants in Australia. Inoculating the soil rather than the seed resulted in better Rhizobium survival and higher yields even in soils with a previous history of Rhizobium application.

India

India has the second largest population in the world. They also have the second largest area of arable land (170 mill ha) and second largest irrigated area (45.8 mill ha). The main religion is Hindu so the majority of the population are also vegetarian. To fulfil their protein needs they consume a large quantity of pulses. In 2004 they produced 14.5 mill tonnes of pulses from 24 million hectares, as well as being the world's leading import market for food pulses.

The pulses in order of importance to India are chick pea (desi and kabuli), pigeon pea, mung bean, field pea, black gram, cow pea, lentil and moth bean. 40% of farmers have less than 1 hectare and grow wheat/rice for family consumption. Production of pulses is secondary to the major crops supported by the government which include wheat and rice. Higher government guaranteed purchase price for these crops has led to the stagnation of legume production for the past 30 years. Larger farmers have a rice/wheat cropping system when irrigation is available and pulses are relegated to the poorer drier areas of the country. Legumes and oilseeds are the major crops of dry land farming. There are concerns in India about increasing grain legume imports and creating poverty and unemployment, as agriculture provides the livelihood security for over sixty percent of the population. The government increased the import duty on all pulse crops from five to ten percent in 2002 and in 2003 support prices for pulse and oilseed prices were raised by nearly ten percent.

Government support, in particular for rice, has consequences for the future. The majority is produced in the "bread basket" of India – the Punjab region. It is being produced with underground water at a high intensity level with estimates of only 20 years production left at current decline rate of the aquifer. Another issue for production is the cost and poor supply of electricity involved in pumping water from the aquifer. High level discussions are now taking place to consider converting production from rice to hybrid maize as a more sustainable alternative.

The visit to India included the Indian Agricultural Research Institute at New Dehli, Punjab Agriculture University at Ludhiana, the Indian Institute of Pulses Research at Kanpur and the International Crops Research Institute for the Semi-Arid Tropics located near Hyderabad.

Indian Agricultural Research Institute (IARI)

The IARI is the country's premier national Institute for agricultural research, education and extension. The complex is spread over an area of about 500 hectares. The climate is sub-temperate and semi-arid with annual rainfall of 563 mm. Total number of staff is over four thousand.

The visit coincided with the IRIA centenary year scientific convention. The discussion on "world food security" was of interest as it has ramifications on trade. The three parts to food security include production, absorption of food in the body and economic access. The third issue is now considered to be much more important which is the purchasing power and ability to buy. Market access and the need to increase incomes to increase the purchasing power of the poor was a strong message. The discussion also centred on mono culture and "chemicalisation" of farming leading to increased pest and diseases with declines in soil health. There was also much discussion on a future push to hybrids and particularly maize.

Chickpea breeder Dr. Yadav hosted a tour of all the pulse field plots at the institute. The crops involved were chick peas (desi and kabuli), field peas and lentils. It was pleasing to note Dr. Yadav has good interaction with Australian pulse breeders. The climate here is similar to most of India with it being too dry for Ascochyta Blight. Southern New South Wales, Victoria and South Australia have more in common with the climate of north west India (Punjab region) and Syria which experience seasons of long duration combined with low temperatures and rainfall during the cropping period. Dr Yadav has been a breeder for thirty five years and takes 10 years to develop a new variety completing 200 crosses per annum.

The main pulse problems in India are soil borne diseases (Fusarium Wilt and Root rot), Pod Borer (Helicoverpa armigera) and moisture stress.

The four breeding criteria at IARI are resistance to soil borne diseases, drought tolerance, early maturity and wide adaptation. The quality characteristic goals are Desi, Chick peas, 100 seed weight 20 – 25 grams and seed size 5-6mm. Kabuli 100 seed weight 40 – 50 gram and seed size 10 – 12mm. There was one irrigation trial for maturity. Two irrigation applications delayed maturity significantly.

Punjab Agricultural University (PAU)

Punjab is known as the development state. It has one and a half percent of both the population and area of India however it produces fifty to fifty five percent of India's rice (2.6 million hectares) and forty to fifty percent of India's wheat (3.2 million hectares). Productivity is 4 – 5t/ha of wheat and 5 – 6t/ha of rice each year. Wheat and rice are double cropped and cropping intensity is 187%. Almost all (96%) of Punjab is irrigated with small farms averaging 2 – 3 ha. It uses 20 – 30 % of all of India's chemicals and fertilizers. In 1960 there were 800,000 ha of pulses whereas the current area of lentils, chick peas and peas is 18,000 ha. The introduction of semi dwarf wheat and rice together with government support policies created the swing away from pulses. Wheat and rice had easier agronomy, fewer losses, was all mechanised and easy to sell.

Pulses are considered the crop of the future as water availability declines. Rice uses the most water and wheat requires 5-6 irrigations. Rice on beds is using more water as there is no 'puddling' to seal the soil. The decline in the water table below annual monsoon recharge is 300 – 600mm/year and up to 1500mm. Another significant problem is pollution. All the paddy stubble is burnt over a 2 – 3 week period. After harvest it is cut with a shredder, burnt 2 – 3 days later, then irrigated and wheat sown with a seed drill. Farmers are increasing mung bean and chick pea cultivation after rice.

The PAU covers an area of 600 hectares plus district farms. It has five colleges on campus but agriculture is the largest. There are approximately 500 students and 1100 scientists. I was hosted by the senior pulse breeder Dr. Sandhu. Varieties here are more relevant to southern Australia as this is the only region in India where Ascochyta is an issue. Late varieties are also not suitable for Punjab as flowers are dropped at high temperatures. PAU has a lentil and chick pea breeding program, a small program for peas and a new crop program. Faba beans are part of the new crop program, however are not popular as a dried bean and are being evaluated for suitability as a green vegetable. Faba beans do not always set pods well due to cold at flowering. 70% of the chick peas in India are grown under rain fed conditions. In the Punjab 94% are irrigated. Crops are only irrigated twice – a pre irrigation and once two months after emergence. Vegetable peas are a significant area but marketing is still an issue.

The season opens with peas selling at 20 rupees/kg fresh and finishes on 5 rupees/kg. Peas have two irrigations also as there is only 50 – 100mm of rainfall during the growing season.

As mentioned earlier, pulses are normally the crop of second choice to wheat which has better economics. They are grown where soil is not suitable for wheat and where there is less water. Small areas are grown for personal consumption.

At the PAU pulse disease plot, material is screened for the following five diseases-Ascochyta Blight (the most important), Botrytis grey mould (no control available), Wilt, Footrot and Dry root rot. Testing of seedlings is carried out in both the glass house and the field. Material is screened from both ICRISAT and ICARDA. They carry out 60 – 70 crosses/year of chick peas and 50 of lentils. IIPR coordinates both the research and funds.

Dr. Yadvinder hosted an inspection of the wheat/rice on beds project. There was 20% water saving with wheat but none with rice. The incorporated stubble plots have higher levels of phosphorus and requirements have halved. He also hosted a visit with a local farmer whose biggest problems were an uncertain electricity supply (6-8hrs in summer), marketing rice at harvest (2 days sitting in the market place) and labour shortage for transplanting. On farm gross margins for wheat are 10,000 rupees/acre ($716Aust/ha), rice 8,000 rupees/acre ($573/ha) and chick peas 6000 rupees/acre ($430/ha)

Indian Institute of Pulses Research (IIPR)

IIPR provide research backup for the whole country. They have sixteen hectares at the main centre plus 415 hectares for seed production approximately ten kilometres away. India is working on 8 pulses. (three summer and five winter). My visit was hosted by Dr. Basu. Dr. Basu is a physiologist working on an ACIAR project. 70 varieties are being tested in collaboration with Australia (none are being tested under irrigation). Dr. Basu reiterated the pulse problems of lack of government procurement for pulses (marketers dictate terms and storage of pulses is difficult with a maximum of three months), highly prone to diseases and seed of improved varieties not available (replacement rate by farmers is less than 5%).

IIPR also has a significant bio tech program.

International Crops Research Institute for the Semi Arid Tropics (ICRISAT)

ICRISAT is the international centre for desi chick pea but is working on kabuli type also as the Syrian types (ICARDA) are too long season for the semi arid tropics (India and central and western Africa). ICRISAT is working mainly with root diseases while the disease focus at ICARDA is foliar diseases, a function of their differing climates.

India has the largest chick pea breeding program in the world with forty to fifty breeders. They have a program for high input chick peas at Hisar in Haryna state but as in most of the world the breeding emphasis is for performance under drought, not irrigation.

Dryland selections under high input often have excessive growth and lodge after irrigation.

Syria

Production of pulses in Syria is over 240,000 tonnes which is enough to meet the country's needs and generate an exportable surplus. Eighty percent of the 300,000 hectares grown is rain fed with a temperate Mediterranean climate similar to southern Australia. Annual rainfall requirements for the three pulses grown in Syria are:

Lentils	250 - 350 mm
Chick Peas	350 - 450 mm
Faba Beans	450 - 800mm

In 1977 the International Centre for Agricultural Research in Dry Areas (ICARDA) was established at Tel Hadya in northern Syria. The 948 ha site incorporates three villages which supply much of the labour. It has 500 staff which includes 46 principal scientists and is located in the heart of the area known as the birth place of agriculture. Many of the crops we now grow were domesticated there 10,000 years ago.

ICARDA is one of sixteen international agriculture research centres and is the international centre responsible for barley, durum and bread wheats, pasture and forage legumes as well as the pulses lentil, faba beans and kabuli chick pea. Germ plasm for all these crops is stored and released world wide. Opportunities are opening in southern Australia for more disease resistant pulses thanks to the close interaction between ICARDA and the Australian pulse breeders.

Dr. Malhotra the senior chick pea breeder gave a detailed tour of their whole program. The breeding program is focussed on four areas of stress – Ascochyta blight, Fusarium wilt, cold and drought. They are attempting to break the correlation between leaf size and disease. Larger leaf and seed size results in a larger Ascochyta risk. As well as the standard breeding crosses there is innovative research with radiation treated lines, mutated wild lines and testing with carcinogenic chemicals to double the chromosome number to cross and evaluate. Approximately 500 markers have been established for chick peas and lentils but no work has been done on Faba Beans to date.

The emergence of Aschochyta resistant lines could lead to an increase in world production as countries such as Italy re visit chick pea production.

The other area of interest to rice growers at ICARDA is the lowering of neuro toxins in grass pea which could open opportunities for green manuring and stock feed with the seed able to withstand waterlogging which can occur during winter in the standard rice lay out. It is hardy enough to be sown into rice before harvest to germinate on the remaining moisture.

Jordan

Sunrice is a large company owned by rice growers in southern Australia. It exports eighty five percent of Australia's rice production to approximately seventy two countries and has a very well recognised international brand. The acceptance of the brand in the Middle East is strong and *Sunwhite* billboards are ubiquitous. The Middle East head office for Sunrice is located in Amman.

While staying in Amman I visited a number of new supermarkets which appear to be an increasing method of retail as opposed to the open markets. The branded colourful *Sunwhite* packs are being copied by different companies to sell a number of different products to bounce off the high esteem in which Sunrice is held in the Middle East. The option may exist in the future to use Sunrice infrastructure when under utilized in drought years to market pulses in conjunction with rice, given their control and ownership from paddock to packet in the supermarket. It is also within their resources to examine value adding of pulses as they do so effectively with rice products.

Jordan is a net importer of pulses and the neighbouring Saudi Arabia is a large importer of pulses. Saudia Arabia is also a very significant market for Sunrice.

England

Our initial six week Nuffield group study tour did not include England as we spent a week in Ireland instead. I visited England as part of my later study to visit a number of Nuffield scholars and attend the annual Pulse Processors and Growers Research Organisation (PGRO) annual field day. The PGRO is the United Kingdom centre for applied research on temperate peas and beans. It was formed in 1944 and is funded by voluntary crop levies. As well as the inspection of field trials, there was also an opportunity to taste a variety of snack foods made from value added faba beans.

The pulse industry in the UK is dominated by winter beans, spring beans and spring peas. The winter and spring beans are faba beans and the spring peas include marrow fat, blue peas and white peas. The faba beans are used for stockfeed and export to Eygpt for human consumption. They are harvested moving into winter and quality can be an issue with weather damage. Insect damage from Bruchid beetles is also a major issue. Some exporters use electronic colour sorters during the cleaning process to ensure quality.

The changes to EU agricultural policies will assist the production of non traditional break crops. The single farm payment is now based on farmers meeting a number of environmental criteria rather than relating to production of a particular crop type. Under the 2005 CAP however a protein support payment has become available for the legume crops. As is happening in other countries around the world, incorporated disease resistance has seen production shifting to chick peas and 2004 saw the first commercial trial of chick peas grown in England.

Beans are a valuable break crop but treated roughly with the seed often broadcast then ploughed in deeply. Depth of sowing for winter beans was a surprising twenty centimetres. The normal plant density of 25 plants per square metre is being reduced with good results.

Two examples of Gross Margins provided by a Nuffield scholar farming in southern England show the relative profitability of pulses to the mainstream crops. (A $ per hectare)

	2003	2004
Spring Barley	1673	1430
Winter Barley	1627	1265
Winter Wheat	2102	1662
Winter Rape	1667	1285
Winter Beans	1477	1350
Spring Beans	1358	1160
Set-a-side		540

Conclusion

Many countries around the world are looking to pulses as a crop with potential. While pulse crops have many positive attributes, their susceptibility to disease is an issue which requires constant attention. The infusion of disease resistance from wild races which has been achieved in Syria and India will continue and is generating optimism around the world. It will create new opportunities for irrigators in southern Australia. The challenge now is to be able to extract yields with supplementary irrigation which return gross margins that can compete with the rest of the crops grown in the rice rotation. A high level of management will be required with an emphasis on maintaining the disease resistance by not pressuring the system and adhering to the guidelines on disease management.

The big challenge is profitability. Rice is the chief grain consumed by the world's poor. Pulses are the chief protein source for the world's poor. The Australian rice industry is profitable because it grows the highest yields in the world and sells value added product into quality markets. We need to be doing the same for pulses. Food prices in India and many developing countries are greater than half what they are in Australia. How do you make a profit exporting to these countries? The product has to be packaged and aimed at the middle class and above.

The other conundrum is the change in diet which occurs as income and living standards rise. As incomes rise the diet changes with an increase in meat consumption at the expense of rice, cereals and pulses. This limits world market growth for pulses roughly to population increase. In 1963 India had a population of 473 million and they consumed 9 million tonnes of pulses at 20 kg per head. In 2001 the population was 1,033 million and they consumed 11 million tonnes of pulses at 11 kg per head. In 1963 Japanese rice consumption was 167 kg per head but in 2002 rice consumption was 86 kg / head. Meat consumption over the same period rose from 10 kg per head to 44kg per head. Opportunities may become available in stockfeed with the growing trend in meat consumption, however the best margins are still available in the human consumption market tailoring the product for the middle class and above.

Recommendations

Given that irrigation represents less than 1% of the land cropped in Australia it is easy to forget when the research levy funds are being allocated. It is pleasing to see this beginning to change with GRDC funding increasing in this sector. Irrigation produces half the profit in Australian agriculture and has a large potential to increase productivity. The liability has been the lack of irrigation crop varieties which have been specifically developed for irrigation. It is critical that irrigation is included in the national variety trials so that irrigators can compare performance under irrigation. The follow on is to select varieties which perform better under irrigation and look toward to breeding specifically for irrigation. The use of dryland varieties and then irrigating is not the formula for high production given that many varieties are being bred for drought tolerance.

The pulse industry also needs continued funding and the formation of the national pulse breeding program has been a positive initiative. The pulse Australia crop support program has also been successful and needs to be continued into the future. Continued collaboration with ICARDA and ICRISAT is a critical component for future sustainability for the pulse industry.

The new faba bean variety (Nura) is a product of this international cooperation. The new variety performed well with one fungicide application compared to the seven or eight applications used on the current recommended varieties to keep chocolate spot under control. The new variety was released at the end of 2005 and has the potential to reduce costs significantly. Also progressing through seed increase is a variety of chick pea which is resistant to Ascochyta and Phytophera root rot. Similarly this variety completed the 2005 season in southern Australia with one fungicide application. Aschochyta resistance to this level has not previously been available to irrigators in southern Australia and the disease has prevented success with chick peas in the past. Flood irrigation provides a less favourable environment for disease than sprinkler irrigation but it is critical to grow chick peas on raised beds and irrigate quickly. Field peas are another option for irrigators now that good resistance to lodging is available with the variety Kaspa. For rice farmers who still maintain livestock, grass pea is a new opportunity for forage or green manure having good tolerance to water logging and very low neurotoxin levels which has constrained the use of grass pea previously. The new variety Cerora will be available after seed build-up during the 2006 season.

Cool season pulses demand a higher level of management than the winter cereals and it is important to get the basics right. In Canada, granular inoculants contributed to productivity increases and they are currently being developed in Australia. There is also the requirement of higher soil pH and sulphur levels than those which are common with the dominant red irrigation soils in southern NSW.

References

Upadhyaya, D (Ed) 1999 *Technology for Increasing Pulses Production in India*
Army Printing Press: Lucknow

Johansen, Duxbury, Virmani, Gowda, Pande and Joshi (Ed) 2000 *Legumes in Rice and Wheat Cropping Systems of the Indo-Gangetic Plain-Constraints and Opportunities*
Cornell University: New York

Thomas, C (Ed) *2004 Annual Report 2003-2004*
Indian Agricultural Research Institute: New Delhi

Irrigation Crop Diversification Corporation 2004
Irrigation Economics and Agronomics Saskatchewan

Food and Agricultural Organisation of the United Nations
[http://faostat.fao.org] accessed 10th September 2005

[http://www.grainlegumes.com] accessed 10th September 2005