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Adoption of Flexible Conservation Cropping Packages in Northern Iraq and Syria

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Abstract

The agro-ecologies of recent cropping systems in the dryland areas of the Middle East have many similarities to those which prevailed prior to the 1970s in southern Australia. Over the past 50 years Australian farmers have eliminated fallow phases, introduced new crops (eg. grain legumes, canola), and most importantly, adopted reduced or zero-tillage (ZT) technology which enables earlier sowing, and allows retention of residues from previous crops on the soil surface. During 2005-2012, as part of an ACIAR-AusAID-funded project developing conservation cropping for Iraq, more than 40 adaptive research experiments investigated the suitability of elements of the Australian cropping system to northern Syria and Iraq. It quickly became evident that ZT seeding without prior ploughing produced similar or better crop growth and grain yields than the conventional tillage (CT) system requiring two or three cultivations before sowing. The elimination of ploughing also enabled earlier sowing which resulted in improved water use efficiency and significant yield increases in cereals and legumes in most years. More accurate seed placement and metering with ZT seeders meant seed rates could be reduced. Most imported ZT seeders are heavy, expensive, and complicated to use and maintain, so a number of simple, effective and affordable seeders suitable for small farmers were manufactured in Syria, while in northern Iraq, the focus was on conversion of existing conventional seeders to ZT using parts made locally. Participatory extension groups were established in Iraq and Syria whereby farmers were able to borrow a ZT seeder to test on their farm without making or receiving any payment. In the vast majority of cases, farmers yields were as good, if not better with the ZT and early sowing system than fields sown conventionally, and farmers benefited from savings in fuel and labour costs because of the elimination of tillage operations and reduced seed costs. Since 2006/07, the area under ZT has grown from zero to about 30,000ha in Syria in 2011/12 (last reliable figures) and 15,000ha in northern Iraq in 2013/14. Future challenges for conservation agriculture (CA) in this region include the promotion of soil cover and diverse rotations.

Keywords: Tillage, rotation, residue, stubble, extension, cropping systems

Introduction

The agro-ecologies of recent cropping systems in the dryland areas of the Middle East have many similarities to those which prevailed prior to the 1970s in southern Australia. Both regions experience a Mediterranean-type environment with hot dry summers and cool wet winters. Crop rotations were dominated by wheat and barley (although in Australia these were often in rotation with pastures based on subterranean clover) and in low rainfall areas fallow was utilized to conserve soil moisture for the following winter (Burvill, 1979). Soils in both regions were typically infertile with poor structure and low amounts of organic matter. Crop residues were overgrazed by small ruminants especially in dry seasons, leading to frequent dust storms and soil erosion. Two or three cultivations were often employed to control weeds and this typically resulted in a three to four week delay after the first autumn rains before sowing commenced. The average grain yields of cereals were around 1.0 t/ha in both systems.

Over the past 50 years Australian farmers have eliminated fallow phases, introduced new crops (eg. grain legumes, canola), and adopted the widespread use of herbicides which enabled them to plant crops before of soon after the first autumn rains. During the last two or three decades there has also been a dramatic shift towards the adoption of ZT technology with the retention of the crop residues on the soil surface. The adoption of ZT in Australia was driven by the high cost of fuel and labour, a desire to minimize the risk of soil erosion, and also the ability to conserve soil moisture and enable early crop establishment particularly when autumn rains were marginal. The adoption of ZT practices is now widespread across Australia, and in many regions more than 85% of all agricultural land is not cultivated (Llewellyn et al., 2012). Australia is now held up as an example of where the principles of CA (i.e. ZT, soil cover, and diverse rotations) has been a success (Kassam et al., 2012).

The similarities of environments and crops, and divergence in cropping technologies in these two regions led researchers to question whether CA practices, especially ZT, could have a role to play in increasing crop productivity and improving farmer livelihoods in West Asia. This paper describes some of the adaptive research, development and extension undertaken by a project funded by the Australian Center for International Agricultural Research (ACIAR) and AusAID. The project had three phases (2005-2008, 2008-2012, and 2012-2015) with the overall aim of promoting conservation cropping technologies in northern Iraq. Most of the research experiments were conducted at ICARDA near Aleppo, and this resulted in significant spill-over adoption within Syria, even though this was not the main target of the project.

Adoption in Iraq and Syria

Civil unrest in Iraq (and later in Syria) made it difficult to undertake research and conduct extension activities, and many farmers and some researchers were skeptical whether crops could be grown in the region without ploughing. Nonetheless, awareness and interest commenced with innovative farmers examining the first field experiments. To the best of our knowledge no farmers were using ZT in Iraq or Syria when the project started in 2005, but since then the area and number of farmers adopting ZT has increased steadily, undoubtedly as a result of the project. Estimates of adoption in 2011/12 were around 30 000 ha by more than 500 farmers in Syria – these were the last reliable figures from Syria. In Iraq in 2013/14 the area of adoption was about 15 000 ha by around 100 farmers, mainly in the Ninevah governorate (Figure 1). Recent shortages and high prices of fuel as a result of the conflict in Syria have helped drive adoption, partly out of necessity.

The success of the project can be attributed to three critical strategies: 1) adaptive research to verify and fine-tune the technology for the region, 2) development of small, simple, and low cost ZT seeders, and 3) participatory extension campaigns that enabled farmers to test ZT seeders and the CA packages on their own farms.

Adaptive Research

During 2005-2012 more than 40 adaptive research experiments investigated the suitability of elements of the CA system to northern Syria and Ninevah. It quickly became evident that seeding without ploughing resulted in similar or better crop growth and grain yields than the conventional tillage system which required two or three cultivations before sowing. Direct seeding into undisturbed soils enabled early sowing which improved water use efficiency and produced significant yield increases in cereals and legumes particularly when the growing season rainfall was below average (Piggin et al., 2011).

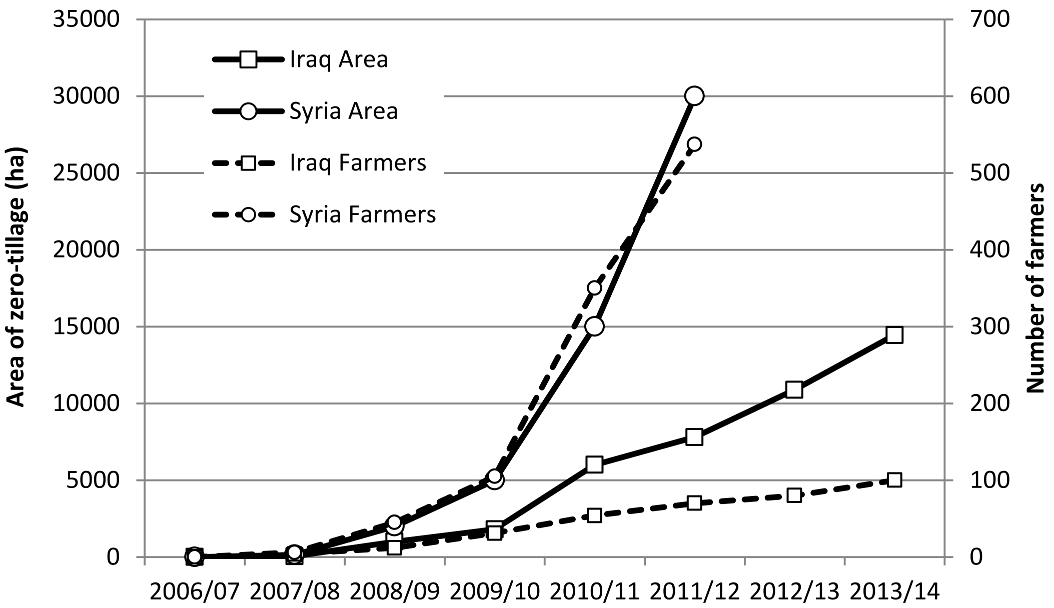

Figure 1: Area and numbers of farmers that adopted ZT in northern Iraq and Syria between 2006 and 2012

More accurate seed placement and metering with ZT seeders also meant seed rates could be reduced. Basic farmer sowing practices (eg. modified disc plough seeders with little control over seed placement) and poor quality seed, meant farmers had to use seed rates as high as 250-300 kg/ha. In contrast field experiments showed seed rates of 70-100 kg/ha produced the most profitable results over range of seasons when sown with accurate seeders and good quality seed. A reason sometimes used to justify ploughing and removal of crop residue is to avoid the build-up of diseases. However, surveys of nematode and fungal diseases in a number of crops within the long term trials at Aleppo showed no effect of tillage and crop residue, apart from Ascochyta Blight in chickpea which was more widespread but not more severe under ZT (Seid et al., 2012).

Zero-Tillage Seeders

Most imported ZT seeders are heavy, expensive, and complicated to use, maintain and repair, and therefore are unsuitable for small farmers. Hence, the availability of small, simple, and affordable ZT seeders were considered essential if permanent and widespread adoption was to occur. Tined seeders with knife points were favoured over disc machines because of their simplicity and suitability to wide range of soil-types. Local seeder manufacturing capacity was assessed and enhanced with expertise from Australian agricultural engineers, and a number of suitable ZT seeders were manufactured in Syria. In northern Iraq, manufacturing capacity and availability of materials were weakened by on-going conflict and isolation, and the focus of innovative farmers was on converting existing conventional seeders to ZT using knife points made locally and increasing row spacing to 22-30 cm (Jalili et al., 2011). John Shearer seeders introduced in earlier Australian projects and Rama seeders made in Jordan are popular in Iraq and proved cheap and easy to convert to ZT. In fields with supplementary irrigation there were some difficulties with heavy crop residues causing clumping and blockages of seed and fertilizer, but these were solved by redistributing tines on three rather than two tool bars, and lifting the seed and fertilizer box to allow free flow of seed and fertilizer down the tubes to the furthest tines.

There are currently seven manufacturers of ZT seeders in Syria, and over 70 seeders have been purchased by farmers. Improvements in materials, design, and construction are ongoing. In Iraq about 40 seeders have been converted to ZT and Iraqi farmer-manufacturer groups are involved in on-going development of locally-made seeders, tines and press wheels. In late 2012 the first Iraqi manufactured ZT seeder prototype was completed and eight more prototypes were made in 2013/14 using parts made in Turkey.

Participatory Extension

Once the CA agronomic package was developed and simple and affordable ZT seeders were available, participatory extension groups were established in Iraq and Syria. These groups involved local government, private and NGO researchers and extension officers, manufacturers, and farmers. In most cases a ZT seeder was allocated to a village or group of farmers who were able to borrow it to test on their farm without giving or receiving payment. Each user was encouraged to share experiences and supply information on crop performance from their ZT and conventional fields back to the group. In the vast majority of cases, yields were as good if not better with ZT and early sowing compared to fields sown conventionally, and farmers benefited from savings in fuel and labour costs and time because of the elimination of tillage operations as well as reduced seed costs from lower seed rates. Loss et al. (2014) compared farmer yields in ZT with nearby conventional fields for a number of crops recorded in 2008/09, 2009/10 and 2010/11 in Syria. On average over all three years the grain yield increases with ZT compared to CT were 0.26 t/ha (15%) for barley (n=278), 0.33 t/ha (19%) for wheat (n=264) and 0.23t/ha (21%) for lentil (n=88). The extension campaign also demonstrated that the package was widely applicable to all soils and seasons, and it was rare for a farmer to try a ZT seeder and not expand their ZT plantings in subsequent years, either by borrowing a seeder or purchasing their own.

The participatory aspect of this campaign was critical to its success and it gave farmers ownership of the ZT demonstrations and direct experience with ZT, early planting and low seed rates in their own fields. The fact that there were no payments, and the participating farmers were investing the majority of the cost (seed, fertilizer, fuel) was not queried nor a constraint for farmers who could see the potential of the technology to increase production, reduce costs, and improve their soils. Many farmers took much pride in presenting and discussing their results at field days and meetings. In an encouraging development in both Iraq and Syria, some farmer groups proud of their achievements and keen to spread the benefits of ZT technology have independently organized and funded their own field days. Other projects where development and extension organizations conducted all operations of the farmer demonstration from start to finish, provided all the inputs, and in some cases paid farmers for use of their land, have been less successful in generating real adoption of new technologies, probably because farmers had less ownership of the activity. As has been experienced in Australia and other parts of the world where CA has been successful (Kassam et al., 2012), farmers and farmer organizations are taking a lead in developing and promoting ZT technology in Syria and Iraq in collaboration with researchers and extension organizations. An important development was the formation of the "Mosul Society of Conservative Agriculture", a group of farmers and scientists who encourage and support CA development in Ninevah.

Preliminary socio-economic studies have investigated the impact of the participatory extension campaigns in Ninevah and Syria. In 2011 a survey was conducted of 338 wheat farmers in Ninevah, 35 who used the conservation cropping package (Abdulradh et al., 2012). The average yield of wheat was increased significantly by adopting ZT and the mean level of technical efficiency between farming systems was 87 percent for ZT farms compared to 75 percent for those using CT. The cost of ZT seeder purchase or conversion was highlighted as an obstacle for adoption, especially by small poor farmers. It was suggested that adoption of CA would be enhanced further if government subsidies for inputs such as seed, fertilizer and fuel which tend to promote their overuse were redirected towards reducing the cost of ZT seeders.

An analysis of a large survey conducted in 2011 of 820 Syrian households in 28 villages is reported by Yigezu et al. (2014) who found the average farmer was able to reduce their production inefficiency by 86% by adopting ZT, or produce the same levels of outputs as CT but with 22% less inputs. By adopting ZT, the typical Syrian farmer was getting about 465 kg/ha (31%) more yield than using CT, and net farm income increased by US$194/ha. Based on the Syrian poverty line of US$1.25 per capita per day, the adoption of ZT helped 57% of farmers lift themselves out of poverty. The survey results also highlighted the effectiveness of field days and farmer testing to promote ZT.

Future Challenges

The CA package extended in Syria and Iraq deliberately focused on eliminating tillage, adoption of ZT seeders and sowing early with reduced rates of seed. These changes reduced costs (fuel, labour and seed) and provided the greatest immediate increase in yields, and hence were the most attractive to farmers. However, little progress has been made in regard to the other two main objectives of CA, namely maintaining soil cover with crop residues and diversifying crop rotations. This strategy was intentional because promoting the whole CA package including residue retention and diverse rotations to small farmers, many of whom are poor and illiterate, would have been too great a change in one step and the added complexity would have increased the likelihood that something would go wrong with the system. Instead adoption of CA was seen as a process, whereby farmers could take a step at a time when they felt ready.

Crop residues are highly valued in the integrated crop and livestock production systems common throughout Central and West Asia and North Africa (Magnan et al., 2012). In dry years, the straw of crops can be more valuable as a stock feed than the grain. In any case, the amount of crop residue produced in these dryland systems is often low and the benefits of crop residues may be relatively small. In an analysis of a long term trial in 2009/10 on a self-mulching clay soils near Aleppo Syria and crop modeling over 30 years of weather data, Sommer et al. (2012) suggest there is little benefit in retaining standing stubble in terms of soil water retention and yield.

If farmers want to retain crop residues to benefit soil fertility and moisture retention, fields need to be fenced because many shepherds do not recognize land ownership once the crop has been harvested. One farmer in Ninevah has started a fencing program to effectively manage crop residues. If alternative feed sources were developed and adopted and grazing better controlled, then it is much more likely that crop residues would be retained on the soil surface. Many forage legumes or dual purpose cereal crops have potential, especially for farmers that produce both crops and livestock. The use of palatable perennial species to form permanent alleys in combination with CA cropping in between the alleys could also provide a solution, but again grazing would need to be carefully managed to maintain soil cover. The role and benefits of residues and alternative feed sources need more detailed study in the region, especially where rainfall is low and/or highly variable.

Cropping systems in Central Asia, West Asia and North Africa continue to be dominated by cereals, especially in dry, risky environments. Development and promotion of productive and profitable alternative crop options to diversify rotations would be beneficial to the productivity and sustainability of the whole system. Grain legume crops such as lentil and chickpea should be re-examined more closely, in addition to other crops such as canola which is grown in medium to low rainfall areas of Australia. Government policy has a role to play in regard to alternative crops. Part of the dominance of wheat in some countries can be attributed to governments subsidizing wheat prices in an attempt at enhancing food security, in addition to low productivity and/or poorly developed markets for alternative crops.

On the back on the success of this project, other projects have been recently funded to promote the adoption of CA in Morocco, Algeria, Tunisia, Egypt, Jordan, Lebanon, Turkey and Tajikistan, and there is also much interest from Iran and Sudan. These and other CA projects will benefit from the lessons learnt and the successful strategies used in Iraq and Syria.

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