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Safflower Production in Northern Afghanistan

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An introduction to the area and practice of safflower production, and the project activities of Joint Development Associates International in introducing the crop in Northern Afghanistan since 2005.

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Summary

Thorny safflower is a traditional plant in Afghanistan which was described as a center of origin by Vavilov (Singh and Nimbkar, 2006). Spineless types were tested and introduced by JDA starting in 2006. Safflower shows good potential for areas with unpredictable and limited irrigation water and for some rainfed areas. Around 1,000 farmers have been involved in growing safflower between 2007 and 2011 mainly in Faryab, Jawzjan and Balkh provinces and the numbers are increasing each year. Training programs involving more than 9,000 farmers have increased awareness of the crop and its cultivation. Production potential for 2011/12 is thought to stand at around 150 mt in total. Farmer

to farmer exchange within on-going training programs can facilitate rapid uptake. Local traders are buying safflower from at least 4 district centers and an informal survey of Kabul market suggests the internal market for bird feed stands around 1,500 mt at 1,250 USD/t. More must be understood about the impact or risks associated with planting dates, irrigation timing, and the market to establish Safflower as a sustainable cropping choice. Little has been done to address adding value or marketing, but that will be necessary to expand and improve market conditions. Another weakness is the lack of institutional support including the formal seed system i.e. varietal or seed selection, release, marketing and distribution, all of which must be addressed to ensure a sustainable, reliable and economic source of seed in the future. This paper introduces the activities around safflower production in Northern Afghanistan by the international NGO Joint Development Associates (JDA) and highlights some of the successes and challenges.

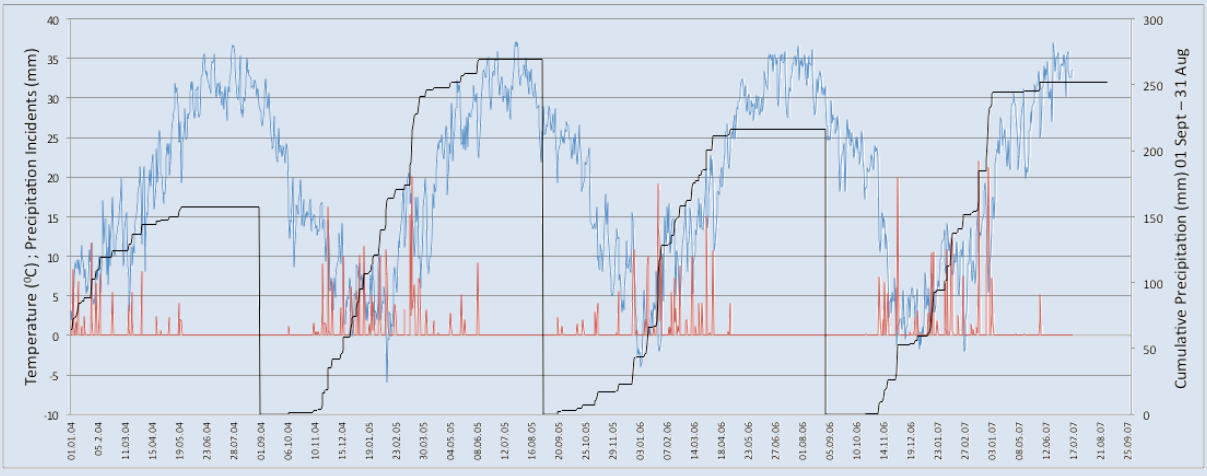
The Production Environment

a. Climate

Figure 1 indicates that daily mean temperatures rarely dip below zero, but minimum temperatures of less than -5^{0}C do occur and usually a period of 40 days is described as the 'chiller' when temperatures are low enough to prevent wheat from growing, i.e. <5^{0}C. In the three winters presented in figure 1, on average 43 days per year saw minimum temperatures of <5^{0}C; 11 days < 0^{0}C; 3 days per year <-5^{0}C; and 3 days per year <-7^{0}C. Mean daily summer temperatures reach over 35^{0}C. On average 93 days per year go over 35^{0}C; 29 days > 40^{0}C and 0.5 days > 45^{0}C.

In this 4 year period, rainfall averaged between 200 -275 mm/yr three times and once closer to 150 mm/yr. In the past years, (2010/12 data not presented) rainfall was recorded at 100 mm and low rainfall years must be considered part of the natural cycle. The majority of precipitation falls as rain in low areas and snow in high areas. Irrigation water is supplied by mountain snow melt throughout the year at locations that are able to access it.

Figure 1: Mazar Climate Data 2004-07. Daily Average Temp C; Precipitation Occurrences mm; Cumulative Annual Precipitation mm. Raw data from Mazar Agricultural Research Department.



*** Rainfall accumulated from 1st September 2003 is included in the 2003/4 rainfall data shown.**

b. Land and Irrigation

About half of Afghanistan's cultivated area is considered irrigated and half rainfed. Most of the irrigated land is surface irrigated from snow melt, but water rights and management is often problematic. The irrigated land can be further described according to water quantity, type, and certainty of availability. Land which receives one or two irrigations each year and on an uncertain basis is sometimes referred to as semi-irrigated; and land which benefits from the catching of flood water, if available, is referred to as 'sail-ab' or 'flood-water [land]'. In some cases, whole villages are able to designate just half or a third of their land each year, cultivate that area only and rest the remaining land, since there is not enough water every year for all of the land. Often land is distributed to villagers in these systems by lottery, and it is common to receive a different parcel in each rotation. These systems are communally established and can result in more fertile land because of the fallow periods. The practice is well represented in Jawzjan and some parts of Balkh province and is typical of land selected for safflower production and where no fertilizers are applied. Powerful families or individuals may of course be better represented in the development and implementation of these systems in some locations.

The semi-irrigated or flood-water lands are distinct from the higher potential irrigated land where water is assured and may be double cropped. The former types are potential areas for safflower production. But complications arise when irrigation channels are blocked rapidly during flooding, making them unusable for up to a month at a time, and a whole village may be occupied cleaning the channel. This can happen several times a year and some irrigation channels are characterized by a hill of silt running at their edges (figure 2). In the 2012 cropping year, despite good rainfall, many crops were effectively under drought because of blocked irrigation channels.

Rainfed land can be understood as two different agro-ecosystems: low lying areas of < 400m and higher elevations where summer temperatures are less extreme and the soils retain their moisture more effectively. Safflower is sometimes grown in the higher areas and also in low areas during exceptional years.

Figure 2: (l) Canal ditch for irrigation water with trees on a large man-made bank of canal silt. (R) Villagers on a silt hill which follows the bank of the irrigation canal into the distance.

c. Soils and Fertility

Soils in Northern Afghanistan are typically of pH > 7.8. P and K levels are often good, but low organic matter and soil physical characteristics, as well as high pH or poor water quality can limit availability of P, Fe, or negatively impact plant health and access to other nutrients. In some locations, including Jawzjan province, soils are saline and high water tables are a problem. Organic matter is generally very low, but soil fertility appears widely adequate for safflower production.

Fertility is managed according to the farmer's understanding of his own soils, systems, and crop responses. Farmers typically must prioritize the application of limited amount of inputs across his land because of risk and limited resource management. Since rainfed or semi-irrigated land is often not cropped each year, fertility is considered adequate for the levels of available moisture, and inputs are not used. Safflower is generally valued as a crop that does not require large amounts of chemical fertilizers.

Activities and Status

Varieties and Testing

In 2006 JDA tested 111 lines from three sources: 1) the USDA collection at Washington State University, 2) Montana State University's own material from the Moccasin Research Center, and 3) Sarpan Seeds, India.

Thirty-eight promising lines were sown in replicated trials that were carried out in Balkh and Jawzjan provinces in 2007/08, and 15 lines promoted into a third year of trials and seed production plots.

Of these varieties (table 1), nine are now counted as appropriate or pre-release material and seven are in a participatory varietal evaluation with 54 farmers from three districts experienced in safflower production. This will establish regional and farmer preference and crop performance.

Table 1: Some promising lines including those under farmer evaluation in Northern Afghanistan (2011/12)

Varieties	Origin	Source
Mocc 22	US	Central Ag Research Center, Moccasin Montana
Mocc 5	US	Central Ag Research Center, Moccasin Montana
Mocc 23	US	Central Ag Research Center, Moccasin Montana
Mocc 24	US	Central Ag Research Center, Moccasin Montana
Mocc Pop 5	US	Central Ag Research Center, Moccasin Montana
81/318/Bop	US	USDA Collection, Washington State University
BJ-986	Egypt	USDA Collection, Washington State University
BJ-799	Israel	USDA Collection, Washington State University
SS 101	India	Sarpan Agri-Horticultural. Dr Gaddagimath

Extension Activities and Status

JDA works with an integrated model of research and development in which farmers play an important role in the process. Parallel and collaborative activities between farmers, extension agents and JDA research hubs can result in rapid and relevant learning as multiple farmers across diverse environments are trying new approaches and sharing their findings with the program. Centrally, we are able to work on replicated trials and return information ideas and methodologies to farmers' specific problems. Crop demonstrations, field seminars, participatory varietal selection, and other activities create a de-centralised synergy.

Early in our work with safflower, Osiyo Hamkorlik, a sister company of JDA, offered farmers contracts for safflower seed which Osiyo Hamkorlik planned to press for oil. This link removed market uncertainty and reduce risk in the first year. Multiple farmers grew the crop across diverse environments and JDA was able to assess the potential of the crop. In this typically entrepreneurial culture, farmers looked for alternative competitive prices before following through with their contracts. Many found better prices with local traders, which was an important step in establishing a sustainable cropping option.

The buy-back program encouraged more than 400 farmers to grow safflower in 2008/09(see figure 2),and stimulated trading activity that has continued in two important Jawzjan districts; Balkh district and Mazar I Sharif(the capital of Balkh province).

While resources would not have allowed a repeat of the contract, it was also appropriate to withdraw from it, establishing that farmers would be growing at their own risk in 2009/10. It meant letting the open market and farmers decide on the viability of growing safflower. Some stopped, others started or expanded their growing, and in 2011 there was a growing sense amongst farmers that there was a good market for safflower which was confirmed by discussions we have had with traders in Kabul.

Seed uptake pathways

In withdrawing from the contracting approach, JDA has continued to train farmers and increase awareness among traders and oil presses. It is noteworthy that Faryab was introduced to safflower for the first time through JDA's training program in 2010/11. It was a low rainfall year, but the crop did well and in four training locations farmers bought more than 155 kg of seed from the land owner. It is expected that 18 new safflower producers will sow with a potential of up to 10 ha. This development highlights the potential for rapid uptake of attractive technologies when properly extended in a program such as this.

Similarly, a recent survey of farmers involved in 2008/09 when contracts were given, indicates that an initial 12 farmers interviewed had passed on seed to 68 other farmers at the end of their first growing year. After the second year, seed had been passed to an additional 64 farmers.. Farmers generally gave out more seed in their first year of growing but not to farmers beyond their own field, thus quickly saturating the local area. Wider spread distribution occurred by other mechanisms, such as through traders in regional markets as well as in Mazar-e Sharif and Kabul, who reported selling safflower seed to farmers.

Table 2: summary of JDA activities for safflower promotion in Northern Afghanistan, 2007-2011

2007/8 - Distribution of seed with fert on credit, no buyback.

Location	Seed Given kg	People	Area ha	Yield	Villages
Sar I Pul Centre	14	8	1.6		1
Jawzjan: Faizabad	149	12	8.3		6
Total	***163***	***20***	***9.9***		***7***

Poor rainfall resulted in crop failure - even barley was not harvested this year.

2008/9 - Contract Farming of Safflower

Location	Seed Given kg	People	Area ha	Yield kg / ha	Villages	Sold Back kg
Balkh: Kholm	96	48	9.6		14	
Balkh: Kaldar	82	20	2	1600	1	3427
Jawzjan: Fisabad	340	170	34	544	6	3565
Jawzjan: Acha	360	180	36		6	574
Balkh: Dawlatabad	34	17	3.4		1	
Balkh: Nari Shari	12	1	0.6	762.5	1	394.5
Total	***924***	***436***	***85.6***	***969***	***29***	***7960***

Minimal harvest was sold back but the fact that farmers were accessing a local market was an important step for work with Safflower. Yields were mixed but showed promise and progress was made in identifying areas of high potential.

2009/10 - Seed Sales Without Contract & Extension Program

1) 200 kg of seed sold to 50 farmers in Faizabad district, Jawzjan.
2) New extension program included safflower growing in 19 districts, 4 provinces for 1,900 farmers.

Farmers from previous activates were planting safflower in areas where there was confidence the extension program increased awareness of the new crop and enabled farmers assess it.

2010/11 - Phase II of basic agronomy training program

1) 35 training locations in 24 districts of 5 provinces included safflower in a basic agronomy training program for around 3,500 farmers.

This introduced safflower into a new and potentially important safflower growing province. Low precipitation resulted in near crop failure for many safflower producers but showed its drought tolerance in other locations, seed is spreading from farmer to farmer.

2011/12 - Phase III of basic agronomy training program, pvs and sample distributions

1) 37 training locations in around 25 districts of 5 provinces included safflower in a basic agronomy training program for around 3,200 farmers.
2) 175 samples of 3kg seed each were given to farmers who specifically requested safflower seed following last years training program.
3) Participatory Variety Evaluation exercise carried out with 54 farmers growing 6 new lines in multiple locations.

This is ongoing. Enthusiasm from farmers in engaging in PVS and other activities seems to be coming from a growing awareness of a local market for safflower and its potential to diversify cropping.

Area Under Production

Production of domesticated safflower was minimal before JDA's work started in 2005. A spiny wild-type was being grown, particularly in Kabul province but much less so in the north. It was used as a barrier for animals and children, and harvested for bird feed, but not as a main crop. One farmer in Jawzjan described bringing a handful of seeds in from Iran in 2002, believing them to be saffron. Not knowing the saffron crop he did not realize his mistake for several years until JDA arrived with the spineless variety and extension programs. Until this point, he had been increasing his seed and feeding the crop to his animals. He had not been able to find a buyer for it and it had not caught on as a crop. This farmer still has his Iranian variety which is somewhat thorny and very heterogeneous. He is now a leading grower of spineless varieties and works in partnership with JDA in evaluating varieties, and enjoying the cash markets fostered by the larger scale of production. When JDA's work with safflower started, it was so unfamiliar that even with training, a number of farmers harvested the flowers rather than waiting for the seed in their first year of cultivation. Since safflower was promoted at the same time investments in saffron were made, a certain amount of confusion has occurred. Table 3, shows estimated production/areas for the past few years.

Table 3: Estimated safflower production statistics, Northern Afghanistan 2007-11

Year	# Farmers	# Districts	Land (ha)	Total Pdtn (mt)
2007/8	20	3	10	0
2008/9	436	6	87	122
2009/10	287	19	57	69
2010/11	1000	24	200	56
2011/12	-	-	-	-

Safflower production for the 2011/12 year is expected to be in the range of 100 t. Early precipitation and onset of cold weather this year has both delayed wheat planting, and may leave farmers wanting to diversify from their wheat crops in expectation of a good yield. Some farmers are reporting plans to extend their safflower growing significantly and Faryab province may be an important new production area. Farmers are increasingly confident that local traders will buy the crop at acceptable prices. However, seed availability may be a constraint. If market prices are maintained, production is expected to exceed 200 t in 2012/13.

Agronomy and Productivity

This section reports broadly on farming practices and findings in Northern Afghanistan's key locations for safflower production; with some commentary on areas for improvement.

Timing of sowing

Farmers are able to plant safflower from late October through mid-March. Optimal times depend on location, irrigation or moisture availability, and weed burden. Fall-sown safflower has occasionally been damaged by cold weather. Balkh province farmers, in the

Kholm area for example, tend to plant during the coldest period and find satisfactory results. They describe the water at this time of year as "sweet" compared to spring water which they call "sour". In Jawzjan, farmers prefer to sow in the fall but have sometimes had reduced stands due to frost damage. Other farmers in Jawzjan wait until the cold weather has passed and plant in the spring when soils are warmer. Timing of sowing remains an open question, particularly with regards to heavy weed burden. Because safflower ripens a little later than wheat and shortens the second season, it is not grown in areas where second crops can be grown. Spring planting therefore offers improved weed control, faster establishment, and no risk of frost damage. These advantages are offset by the possibility that water will not be available later in the season, and so spring roots will not penetrate the ground as well as fall established crops. Presently, 40% of safflower is sown in late fall; 10% winter and 40% early spring.

Land preparation, seed rates and sowing

Safflower is being grown with seed rates between 10 and 25kg/ha, depending on conditions, particularly moisture availability. Land is typically prepared by oxen (70%) then seed broadcast and covered, or broadcast before harrowed in with a tractor (20%). Increasingly farmers are gaining access to two wheel tractors which either rotivate once and then rotivate in broadcast seed (10%), or can seed in 50 cm rows at a lower seed rate and with DAP in line. Patchy stands can be a problem particularly when cultivating with oxen since seed depths are too great, or when irrigating and in areas where water stands. After one or two years of cultivation and with better understanding of crop physiology, farmers adjust their seed rates–usually seed rates are too high in the first instance. Instances of intercropping with chickpea have been seen but not yet evaluated.

Fertility

Where the land has been left fallow, as is sometimes the case on the rainfed or semi-irrigated land, often no fertilizer is added for safflower. If land fertility is less than 75-125kg/ha, DAP is broadcast, or 50 kg/ha if sown by line. Nitrogen is not usually applied, but in spring for fall crops, up to 125kg/ha can be broadcast as a top dressing after irrigation or rainfall. Safflower can perform well under these low input conditions and this is an important feature of the crop.

Irrigation

Safflower is grown in semi-irrigated land and only occasionally irrigated or higher altitude rainfed land. Nevertheless, farmers like to be able to give a pre-sowing irrigation. If available, watering will take place in the spring as the crop begins to elongate, before flowering and as the seed fills. Practice varies, however, with some farmers' finding the crop being negatively impacted particularly by late irrigation and others finding it necessary. Since flood systems are being used standing water can be a problem and the problems caused by irrigations probably reflect soil drainage and field levelness. Efficient approaches to bed formation and planting could offer much improvement on the current system for irrigated stands.

Weed control

Fall sown and late fall crops can be susceptible to weeds and in most systems safflower is broadcast. Grass-type herbicides have been used for grass weed control in spring safflower but this is not common farmer practice. Farmers understand the weed control benefits of spring planting and in heavy weed areas prefer this, otherwise they aim to weed once or twice by hand while the crop establishes. JDA is promoting line sowing and improved hand tools for economic weeding operations.

Harvesting and threshing

Safflower is hand harvested hence the importance of spineless varieties for these systems. Some farmers have complained about threshing, but allowing the heads to dry thoroughly and either treading, beating, or driving over them with a two wheel tractor or other proves straightforward and viable.

Yields

Performance of safflower has been found to be somewhat erratic. Average yields in reasonable moisture years of 2008/9 and 2009/10 were 1.4t/ha and 1.2t/ha respectively. Some farmers report yields in excess of 2t/ha and we have seen this in our own fields. On the other hand, yields of 0.8t/ha are also common. But development of line and bed sowing, and better understanding of irrigation, particularly during flowering and grain filling, is expected to stabilize yields.

Markets and Trade

Trade and markets for safflower are developing. In the second year of safflower production, a JDA project offered contracts to around 400 farmers. In that year, local traders offered higher prices and bought some seed from farmers. Since then the price has been rising, and farmers in several locations have more confidence that safflower has a good market. Traders will now buy safflower from district markets in Faizlabad, Aqcha, and Kholm, and it is in demand in Mazar-e Sharif, Balkh's capital, as well as in Kabul. Farmers will be growing safflower in Faryab for the first time this year and in quantities large enough that a regional trader should buy the crop. Larger farmers or government extension agents have also sometimes taken a personnel interest in trading safflower from the communities in which they work, establishing an important link between farmers and traders (even regional) as well as raising confidence to farmers that there will be a market at the end of the year. Interviews with Mazar traders in 2010 indicated that they traded in the order of 42 t. Meetings with Kabul traders suggest that they bought a total of about double this from Northern Afghanistan. Most of the safflower traded in Kabul comes from Pakistan, Iran, and China. Early estimates of the quantity vary from 3,000-15,000 t.

Prices and Utilization

Presently the safflower price in regional markets fluctuates below and above the price of sesame, but generally higher than flax at around 912 USD/t; Kabul traders suggest that they pay much more for imported safflower with prices of more than 1,300 USD/t depending on exchange rates so prices to farmers have the potential to improve.

Seed is sold in small quantities from regional and Mazar markets to homes for bird seed, and in larger quantities to Kabul where the bird seed market dominates.

Local presses as well as JDA have experimented with pressing safflower oil. One farmer in Kholm plans to establish a press for safflower and market it as particularly healthy oil. The oil compares favourably to sesame which is the favoured oil by Afghans. However, low oil extraction of between 15-17% is a problem and the limited marketing that has accompanied the product has not made safflower oil economic yet.

Oil presses and processing has been limited to animal power and crude operations with no quality processing locally. This is changing and one oil press in Mazar is now also blowing bottles and bottling edible oils. Bulk oil could also be possible but requires high prices to offset current values of seed for bird seed and low oil percent. The recent

introduction of a number of higher quality pressing units with filtering or processing capability could be an important part of developing the required high value markets for safflower even if sold in bulk.

Building a premium for safflower remains an open issue as it requires bottling and improved marketing oil products, but there is little evidence of the capacity for these components developing at the moment.

Safflower straw is recognized as a good quality feed stuff and valuable for burning. This is a tradable product.

Challenges and Future Work

Priorities include:

- Understanding the market, its size and sustainability, the need for adding value, improving oil percentage.
- Establishing sustainable mechanisms for production and supply of improved seed.
- Agronomic research or timing of sowing; appropriate mechanization particularly for bed forming and sowing; irrigation timing for different types of soil.
- Sun pest, cut worm, and Oxythyrea spp., aphids, Meloid spp., are potential pest problems for safflower.

Conclusions

JDA's work since 2005 has established that safflower has the agronomic potential to be an important crop for Northern Afghanistan particularly in moisture limited environments. It offers diversification from the wheat-dominated environment, and so improves crop rotation, resilience in an environment with uncertain moisture availability, drought resistance, and diversified revenue source. Additionally, distribution of safflower from farmer to farmer and increasing trade of safflower seed is a promising indicator of its value. However, if safflower is to become a sustainable cropping option more work needs to be done and on-going institutional support is required. For example, little is known about the market size which is currently limited to bird seed because current pressing options, varieties and cropping systems, result in low oil yields thus income obtained from the processed oil does not cover the cost of oil production. Seed supply is not yet reliable and basic agronomic questions remain about how to reduce yield variability across locations and years. In addition, pests which have contributed to a reduction in safflowers production in India are starting to be present in Afghanistan, and will require management techniques. If this work can be supported, the possibility of answering these questions, developing the necessary linkages and institutional support will be greater, and safflower may establish itself as an important cropping choice in Northern Afghanistan.