1634 Soil management practices of irrigated cotton farmers in the Ferhgana valley of Uzbekistan

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The Ferghana Valley of Uzbekistan is one of the most agriculturally productive regions of the world. Abundant surface irrigation water and the heavy-textured soils of the valley lead to high yields of cotton and wheat. In the Ferghana province in 2003, 105,000 ha cotton were harvested. Average yields of seedcotton in 2003 were 1.9 t ha^{-1}. LaMotte soil test kits were used to test soils sampled by farmers from 22 farms in three districts of the Ferghana province. Nitrate-N ranged from low to medium and soil P tested from medium to medium-high. Soil test K was high to very high in all soils. On-farm surveys of soil management practices were carried out in 2004-2005. Of the 32 farmers who responded, all indicated N and P fertilizer use that was about 2 X (two times) higher than needed for the cotton yields reported. Reducing fertilizer use would allow more exports of locally produced urea and superphosphate. Furrow irrigation frequency was also probably higher than needed, especially early and late in the growing seasons. Alternate furrow irrigation and use of siphons would probably reduce water use without hurting yields, and allow more river flow into the Aral Sea.

Fertile soils and irrigation water from rivers that flow from nearby snow packed mountains make the Ferghana Valley of Uzbekistan the most agriculturally productive regions of Central Asia. Irrigated cotton was harvested on 105,000 ha in Ferghana province in 2003. The source of irrigation water in the Ferghana valley is the Syr Darya River, which feeds into the Aral Sea. However, the Aral Sea crisis of the last several decades is directly linked to irrigated crop production in Uzbekistan. Since about 1960, water from the Syr Darya and Amu Darya rivers in Uzbekistan have been used for irrigated cotton production. As a result, the Aral Sea has shrunk to half its size of 1960, when it was the worlds' fourth largest lake (Libert, 1995). Additionally, salts, fertilizer and pesticide residues in the area of the Aral Sea have contributed to skin rashes, decreased birth rates and other health problems (Usmonava, 2003). Although the planners in the former USSR expanded the irrigation infrastructure for turning Uzbekistan into their source of "white gold", the same basic system is still in place today, 16 years after Uzbekistan's independence from the USSR.

Interviews with farmers revealed that for the current yield levels, the farmers may be over-seeding, over-fertilizing, and over-irrigating.

Our objective was to conduct a survey of the soil management practices of cotton and wheat farmers in the Quva, Bagdod, and Okhunboboev districts of Ferghana province, and to test soils from these farmers' fields for pH, N, P, and K.

Keywords: Fertilization, irrigation

MATERIALS AND METHODS

Interviews were conducted with 32 farmers in the springs of 2003 and 2004 in the districts of Bogdod, Quva, and Okhunboboev in the Ferghana province. In May, 2004, LaMotte soil test kits were used to test soils sampled by farmers from 22 farms in three districts of the Ferghana province. Extractable NO_3, P, and K were determined on soil samples. Additionally, nitrate, P, and K, electrical conductivity and pH were measured on irrigation water samples from these same farms.

RESULTS

Ferghana valley cotton farmers indicated an average of 3 t ha^{-1} seedcotton yield goal (Table 1). Fifty percent of the farmers reported that their yields were stable. Thirty percent noted a declining yield trend, and 20 percent indicated their yields are up some years and down in others. Average yields of seedcotton in Ferghana province in 2003 were 1.9 t ha^{-1}, on 105,000 ha harvested.

The rate of inputs surveyed (with the exception of K fertilizer) were very high for the reported irrigated cotton yields. The seeding rate was about 4 X what is used in other cotton-producing regions of the world, such as West Texas, for irrigated cotton grown in 1-m rows. The warm, semiarid climate (eg. 35 ^{o}C daytime high summer temperatures) are similar between West Texas and eastern Uzbekistan.

The 488 kg urea (225 kg N ha^{-1}) N rate is about 2 X what is recommended in the Southern High Plains of USA to obtain 3 t seedcotton ha^{-1} (Zhang et al., 1998; Chua et al., 2003) The FAO (2003) reported that N fertilizer rates for cotton in all 12 provinces of Uzbekistan and the autonomous Karakalpakstan was 260 kg N ha^{-1}. Pakistan is a relevant comparison country, as like Uzbekistan, it is a Central/Western Asian country that is a major supplier of cotton for the world market, and its cotton is furrow irrigated. The FAO reports that the N fertilizer rate used for cotton in Pakistan is 150 kg N ha^{-1} (FAO, 2004). The P fertilization rate of 84 kg P_2O_5 ha^{-1} reported in Ferghana was nearly double the 48 kg P_2O_5 ha^{-1} reported by the FAO (2003).

There were no specific questions in the survey about mode and timing of fertilization. However, we observed that urea and single superphosphate were mixed and band applied three times during the season with a ground applicator pulled by a four wheel-driven tractor.

Soil test nitrate-N ranged from low at 100 % of the farms in Quva to 66 % medium and 34 % high, respectively, in Okhunboboev (Table 2). Soil test P ranged from 100 % low in Bagdod to 34 % low, medium and high in Okhunboboev. Soil test K was high in 82 to 100 % of the farms in the three districts. The average reported K fertilization rate of only 20 kg K_2O ha^{-1}, was therefore consistent for the uniformly high soil test K levels.

Electrical conductivity (EC) of irrigation water samples was 1.8 and 2.0 mmo cm^{-1} for Bagdod and Okhunboboev districts, respectively. Only in Quva was the irrigation water EC greater than the 5.1 mmo cm^{-1} critical level established by Texas Cooperative Extension (McFarland et al., 1998)

Irrigation frequency during the cotton season averaged four times, but ranged from two to five times. Although this number of irrigations does not seem excessive, row irrigation of 3-week old cotton seedlings was observed, when the soil profile below 10 cm was moist.

Tillage was practiced an average of three times before and during the cotton cropping season. Deep, moldboard plowing was practiced by 100 % of the farmers.

RECOMMENDATIONS

Many of the inputs included in this survey of Ferghana are being over-applied for the cotton yields achieved. Farmers are over-seeding compared to other productive irrigated cotton

and wheat areas (eg. Pakistan, India, USA). Boman (2002) recommends 16 kg seed ha^{-1} for 1-m row spacing cotton in West Texas. He is assuming 9000 seeds kg^{-1}, and this planting rate would results in 160,000 plants ha^{-1}, assuming 80 % germination and emergence. Silvertooth (2001) reports that optimal range of cotton plant population for 1-m spacing is 60,000 to 120,000 plants ha^{-1}. Cotton seeding rate in the Ferghana valley could probably be reduced from the excessive 60 to 15 kg ha^{-1}. Farmers reported to us that they plant in April, which may be too early considering the relatively high latitude of 40 ^{o}N. The use of soil thermometers and planting when soil temperature at 10 cm > 15 ^{o}C should be encouraged (Boman and Lemon, 2005)

Nitrogen fertilization could probably be reduced to 120 to 150 kg N ha^{-1} (Zhang et al., 1998; Chua et al., 2003). Most of the soils are silt loams. In such heavy textured soils, it is not necessary to split-apply N fertilizer, as leaching losses are low. Phosphorus fertilization could be guided by soil tests. In high soil test P fields, no P fertilizer would be required. The timing of fertilizer applications can be simplified, specifically; P fertilizer should be applied at planting only. Nitrogen and P fertilizer rate field studies are needed in Uzbekistan. These could be carried out by extension agents and/or university soil and crop scientists. Reducing unnecessary fertilizer use would allow more exports of locally produced urea and superphosphate.

The value of moldboard tillage after harvest is questionable. Moldboard tillage is not practiced much anymore in many parts of the world, and is being replaced by "conservation or minimum" tillage. Reducing tillage would save energy, reduce costs, reduce organic matter degradation and improve soil tilth (Bronson et al., 2001; Keeling et al. 1989; Wright et al., 2005)

Water management is a critical area where extension education is needed in Uzbekistan. In the western USA, irrigation techniques such as the use of siphons, surge irrigation, and alternate row irrigation have been demonstrated to save water (Coupal and Wilson, 1990; Masud and Lacewell, 1990). It appears that irrigations start earlier and end later than necessary in the Ferghana valley. Evapotranspiration replacement, based on open pan evaporation and other weather data could be implemented. Inexpensive, surface drip irrigation is an option, but improving furrow irrigation is the first priority.

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Table 1. Survey of production practices for cotton in Ferghana valley, 2004-2005 (32 farmers)

What is your cotton variety?	2609 C (58%)
What is your cotton seeding rate in kg ha^{-1}?	60
What is your seedcotton yield goal in tons ha^{-1}?	2.9
Are your cotton yields declining, increasing or stable the last 5 years?	50 % "stable" 30 % "decreasing" 20 % "up and down"
How much total urea do you apply to your cotton crop in kg ha^{-1}?	488 (225 kg N ha^{-1})
How much total superphosphate do you apply to your cotton crop in kg ha^{-1}?	421 (84 kg P_2O_5 ha^{-1})
How much total potash do you apply to your cotton crop in kg ha^{-1}?	32 (20 kg K_2O ha^{-1})
How many times do you irrigate your cotton crop	4
How many tillage operations do you do before and during cotton?	3
Do you deep plow after cotton harvest?	Yes (100%)

Table 2. Soil test results from Quva, Bagdod, and Okhunboboev districts of Ferghana province

	Quva (11)			Bagdod (4)			Okhunboboev (6)		
	Low	Med	High	Low	Med	High	Low	Med	High
Nitrate	100%				100%			66%	34%
P	55%	45%		100%			34%	34%	34%
K		18%	82%			100%			100%
1:1 pH	7.7 (0.4)			8.1 (0.2)			8.0 (0.2)		
EC[a] (mmo cm^{-1})	6.0 (0.6)			2.0 (0.2)			1.8 (0.3)		

[a]irrigation water