8. AGRONOMIC DATA

Enumerators were asked to mark out five small sample plots in each sample field in order to measure plant characteristics, pest attack and damage, take soil and groundwater samples, and harvest by hand. The agronomic measurements generated considerable data that are impossible to comprehensively summarise in this report. This section provides only an indication of the material available in the database.

To summarise the data on cotton, farms were allocated to one of five zones as follows:

Table 8.1 Zoning of Farms for Summary of Cotton Data

Zone	Farm Nos.	Location (1)	Altitude (1)	Other details	Av. Yield (t/ha) (2)
1	17, 18, 21, 22	South (37.4N:64.6E)	Middle (315m)		3.0
2	25, 26, 27	North West (41.8N:60.1E)	Low (87m)		2.6
3	3, 4, 23, 24, 35, 36	Central (40.1N:67.1E)	Middle (256m)		2.5
4	14, 37	South East (40.2N:70.3E)	Middle (363m)	Poor soil	1.6
5	9, 10	East(40.4N:72.9E)	High (914m)		2.6

Notes: (1) Coordinates and altitude are means for farms in zone.
(2) Yield based on hand harvesting of sample plots.

This simple zoning takes account of major climatic variations in that the summer is shortest in zones 2 and 5 and longest in zone 1. To a small degree it corresponds with some of the main soil variations in that saline soils are most common in zones 1, 2 and 3 and absent in zone 5, and soils in zone 4 are coarse-textured colluvium compared with the alluvium/aolian deposits of the other zones. However, there is considerable variation in soil characteristics within these zones, variation in groundwater depth, and variation in the agronomic practices applied to the crops.

8.1 Plant Population in Cotton

Plants were counted in sample plots in March, June and October and values recorded as plants per metre for row crops, or per square metre for broadcast or narrow-drilled crops. March was the main count for winter wheat, and June and October the main counts for summer crops. The averages by zone for cotton are given in Table 8.2.

Table 8.2 Average Plant Population in Cotton ('000/ha)

Year	Zone	June	October
1996	1	105424	77847
	2	142917	139926
	3	132542	121596
	4	155000	148000
	5	103463	100126
1997	1	110840	110567
	2	152185	146251
	3	126101	120259
	4	117654	92444
	5	111282	108889
1998	1	105026	94121
	2	204167	175278
	3	146806	140573
	4	103403	95000
	5	114489	104222

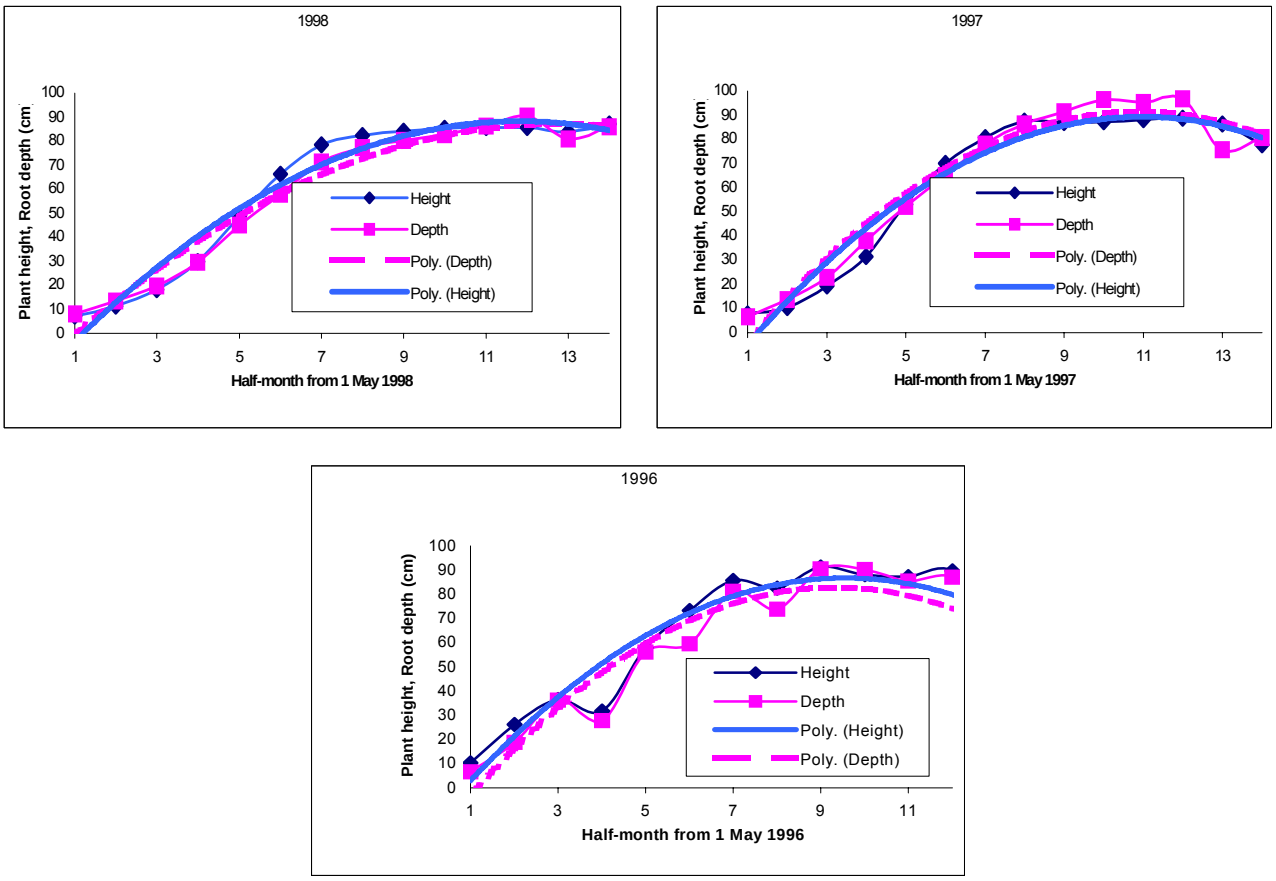
Plant population counts by zones have shown that as a rule the highest plant population by June is observed in the second zone (142,000, 152,000 and 204,000 plants/ha in 1996, 1997 and 1998 respectively) and the least is in the first zone (105 - 110,000 plants/ha). By October this difference is leveled to some extent due to thinning, manual weeding and mechanized cultivation, however,

the above trend is retained till the end of vegetation. In general plant population by all zones is close to the recommended for the region (110 – 130,000 plants/ha).

8.2 Plant Height and Rooting Depth in Cotton

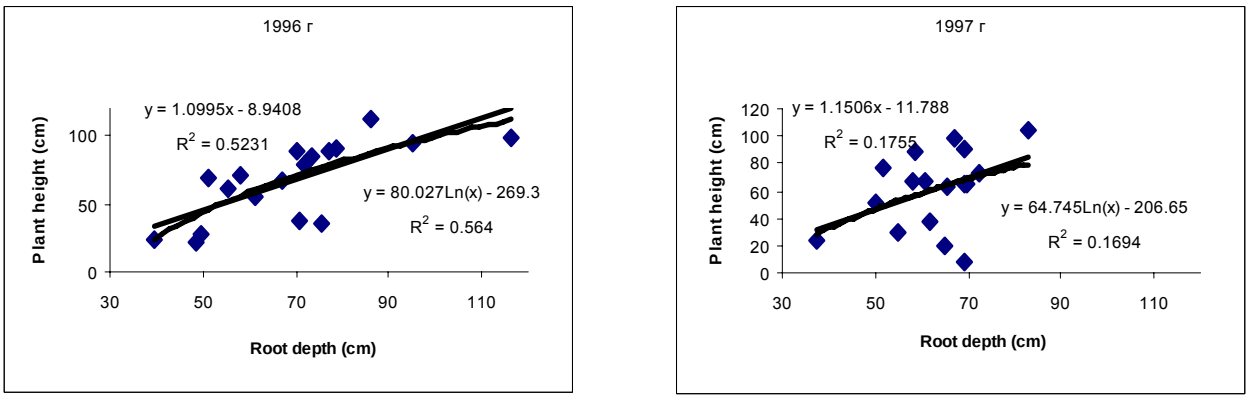
The extension of roots mirrors the above-ground plant growth as shown in Figure 8.1.

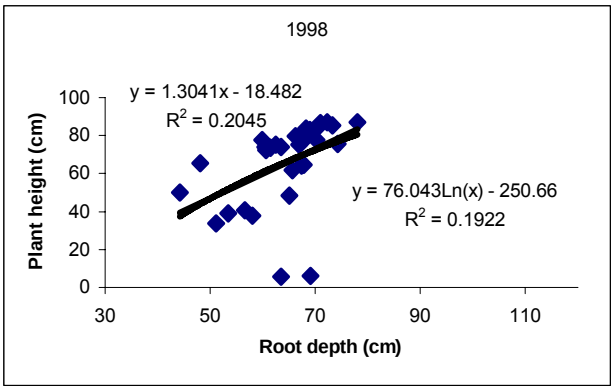
Figure 8.1 Average Maximum Root Depth and Height of Cotton



In early season, there is a lag in root extension, by early July roots are as deep as the plant is tall and by September, roots are still extending as stem growth has stopped. This reflects in a slight polynomial relationship between plant height and root depth, illustrated in Figure 8.2.

Figure 8.2 Cotton Root Depth and Height in Zones 1, 2, 3, 5





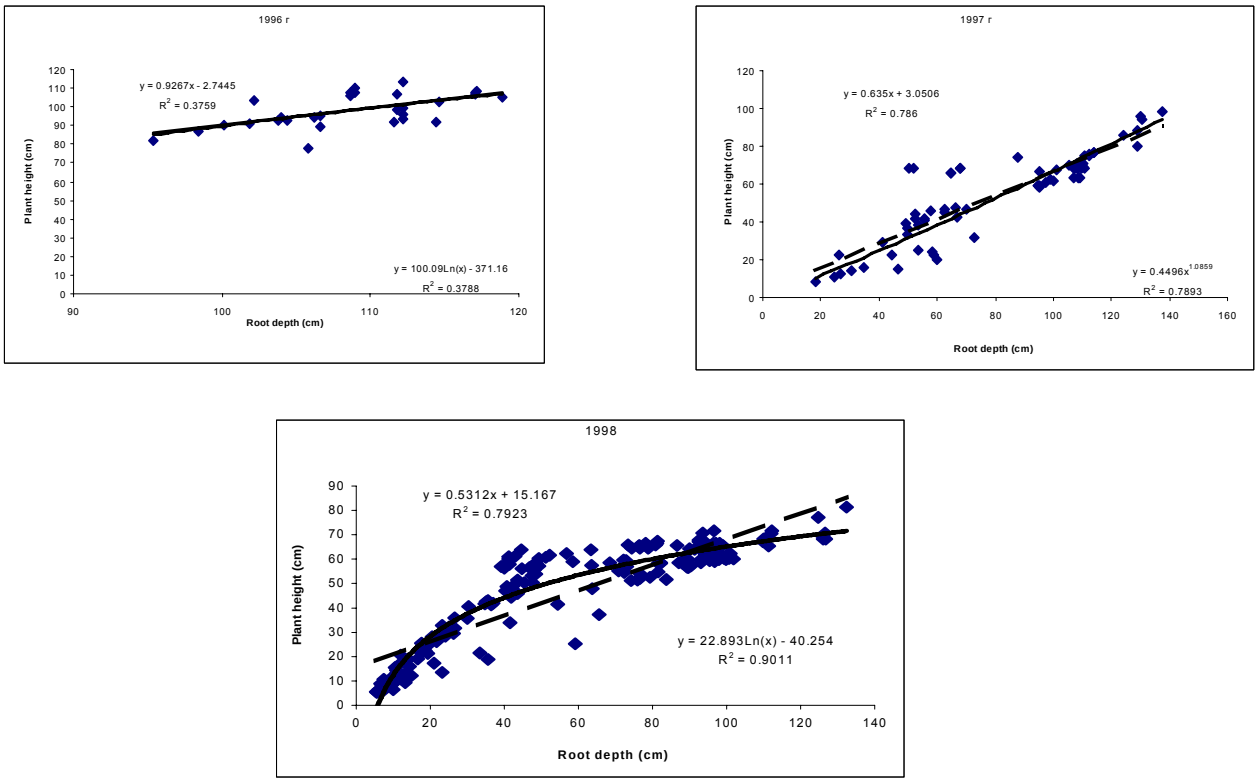
However, the cubic polynomial r^2 value of 0.52 is only marginally better than the r^2 of the linear fit, so that the simple linear relationship appears to be adequate. Furthermore, for the farms in all zones except zone 4, the linear coefficient is effectively 1.0 so that plant height provides a reasonable measure of root depth. This is practically important for two reasons. Firstly, ideal irrigation schedules are more sensitive to the assumption of root depth than other factors, such as daily variation in rate of evapotranspiration, and the AWC of the soil. Secondly, regular monitoring of root depth in the field is difficult and time consuming compared with measuring crop height.

There are some important qualifications to this generalisation of data:

- it may possibly be affected by the climatic peculiarities of any particular season
- root extension is markedly affected by an indurated horizon in the soil such as a ploughpan or a gypsic horizon (see Section 14)
- the irrigation system affects root depth, well-managed drip irrigation for example, limiting root extension to the percolation depth of water, which may be only 30cm
- roots in coarse textured soil with low AWC will range deeply for water.

This last point is illustrated in Figure 8.3 based on data from the farms in Tadjikistan, located on the colluvial slopes of the mountains flanking the Ferghana Valley.

Figure 8.3 Root Depth and Cotton Height in Zone 4

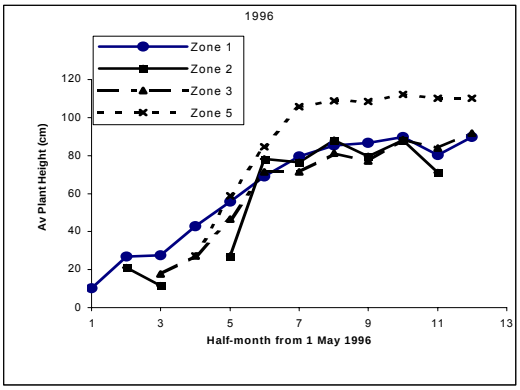


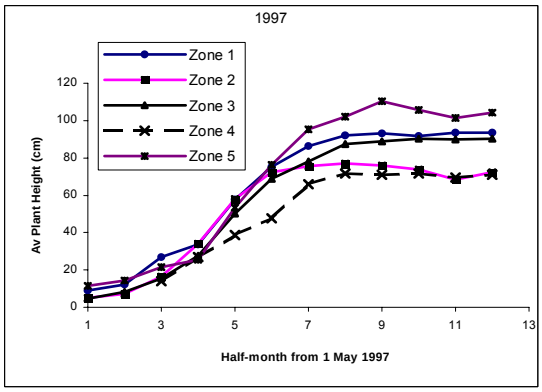
The extent of zonal variation in growth characteristics of cotton plants is illustrated by their averages, shown in Figures 8.4 and 5.

The handicap of the infertile soil and inadequate irrigation regime is shown by the development curve for plant height for zone 4. The benefit of warmer temperatures in zone 1 is seen in the more rapid growth in June and July, and conversely the slower development in zone 5 is the consequence of cooler temperatures. The effect of the short season in the most northerly areas is seen in the end to growth extension in July, but it is not clear if this is due to cooling temperatures or problems with the irrigation system in the lower reaches of the river systems. Particularly interesting, is the continued growth well into September of the high altitude cotton in zone 5, that suggests the problem in zone 2 may not be the consequence of falling temperature.

On account of the close relationship between crop height and root depth, the zonal variation in rooting follows a similar pattern to above-ground extension as shown in Figure 8.5. Probably, the main difference is the rapid growth of roots in the coarse-textured soils of zone 4 during June and August because of irrigation deficit.

Figure 8.4 Cotton Height Growth by Zones





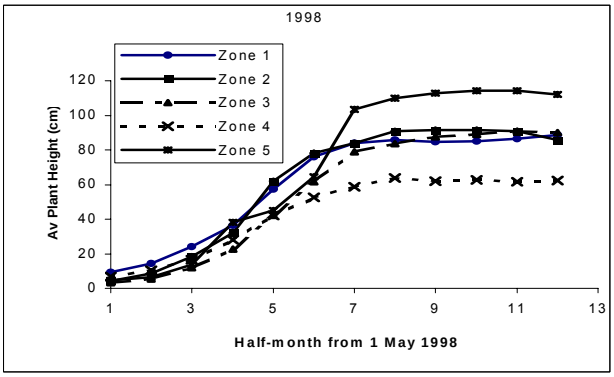
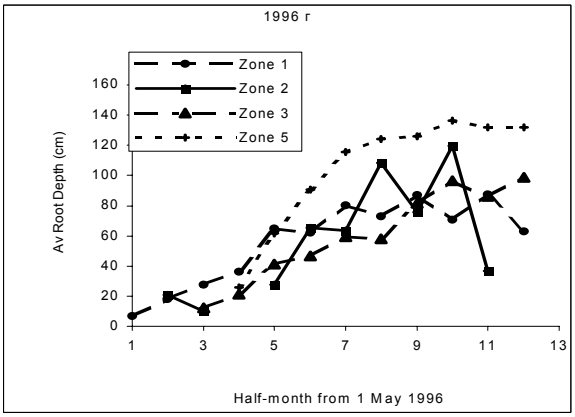
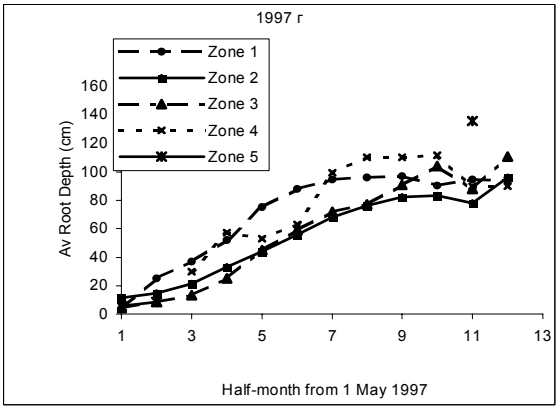
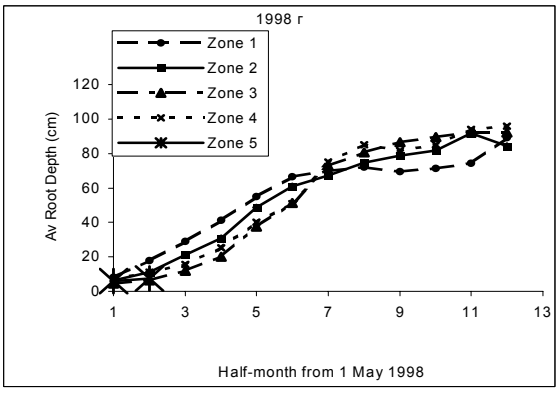


Figure 8.5 Cotton Root Depth by Zones



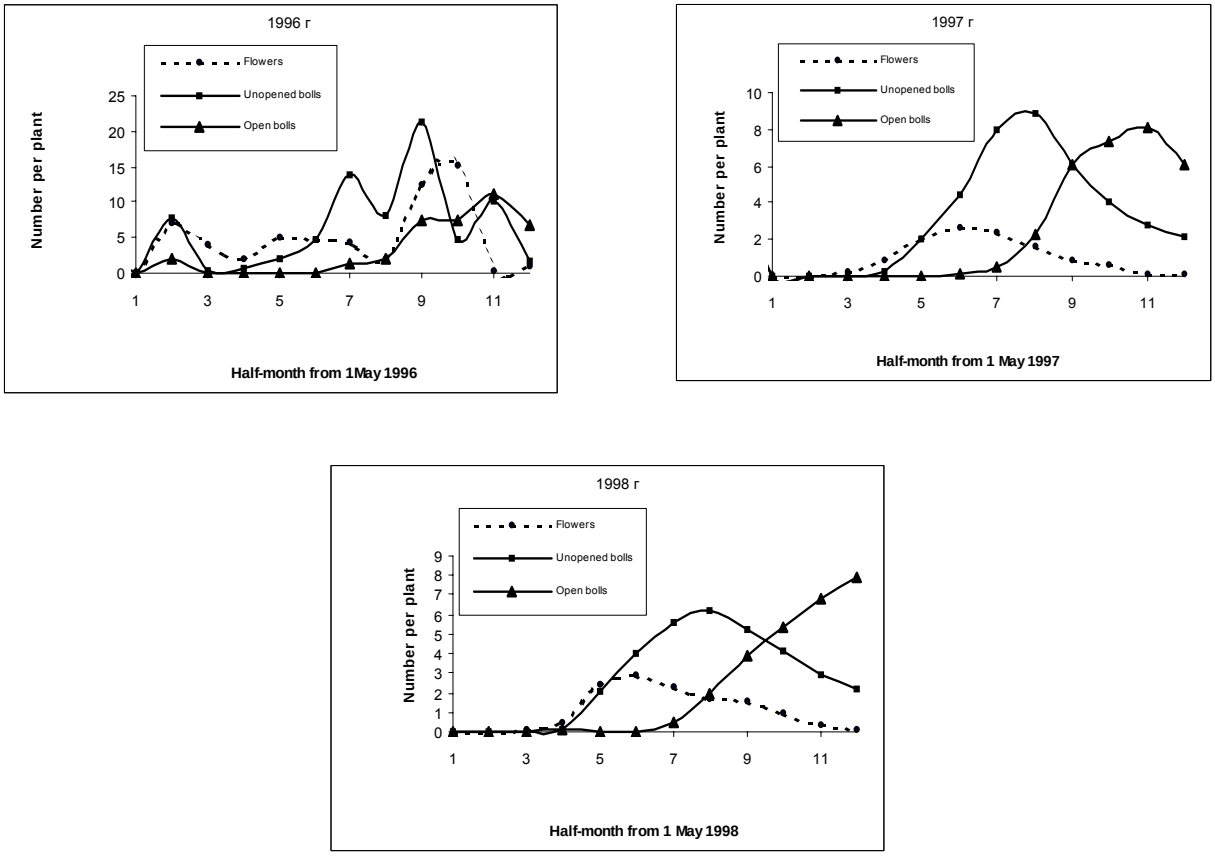




8.3 Flowering and Boll Development in Cotton

Using data from all sample farms, the average data on flowering and boll formation are shown in Figure 8.6. In the warmer and early-planted areas, cotton flowering begins in early June, but most generally in late June. By early July, there was an average of one flower per plant per day and this rose to nearly three by the end of July. From August onwards there is a steady decline in flower production as bolls are set, but even in September there was about one flower per plant daily.

Figure 8.6 Average Flowering, Boll Set and Boll Split in Cotton



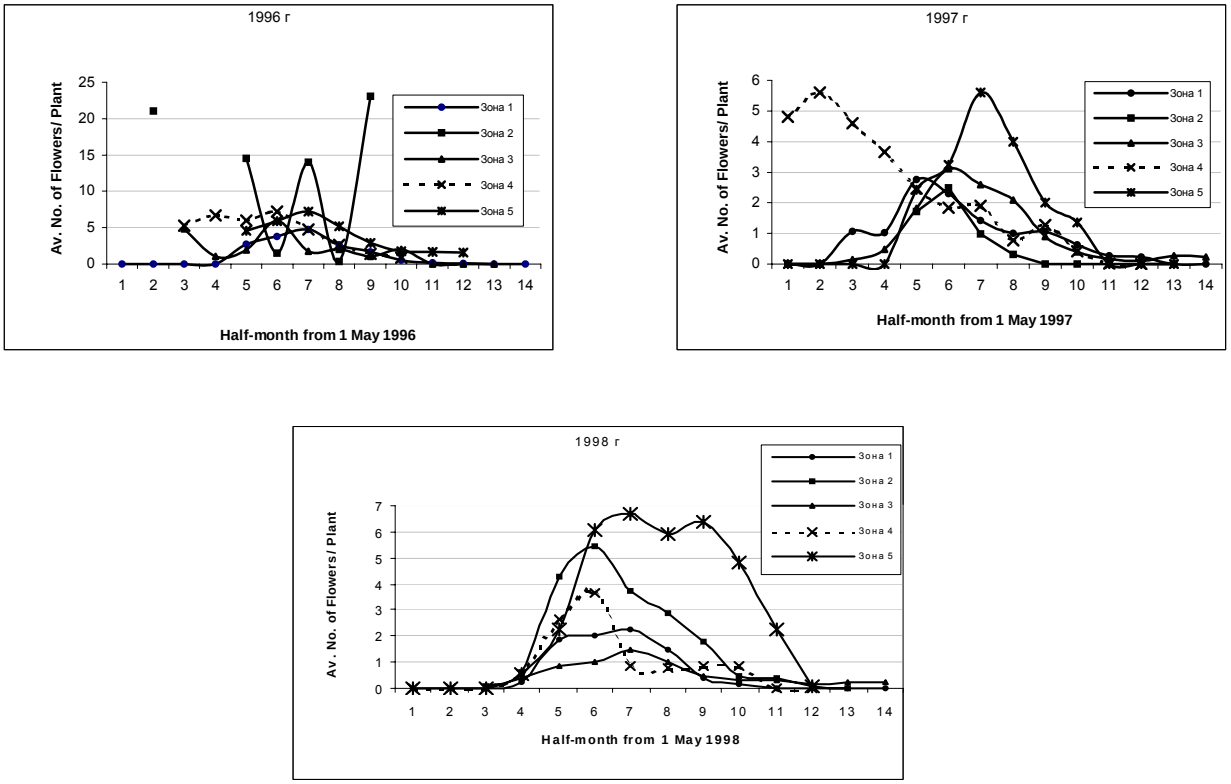
Setting of the first flowers and development of these first bolls is vital to heavy yield of good quality cotton, especially in this region of exceptionally short season for cotton. Later bolls are smaller, their fiber is immature and the quality is adversely affected by dews and early rains as they split during autumn. Furthermore, due to shortage of labour for harvesting and the reluctance of pickers to harvest sparse bolls in inclement wether, the late balls often remain unharvested.

Figure 8.6 shows that the number of unopened bolls peaks during August with an average of more than eight bolls per plant. As bolls split, the number declines thereafter and the number of open bolls increased accordingly. Boll split begins in late July and increases rapidly during August and September, sharply declining in October. During October, there were approximately seven open capsules per plant, representing those that were harvested or could be harvested.

The integrals of the flowering and boll formation curves in Figure 8.6 shows that many more flowers and bolls are produced than reach maturity. The dehiscence of flowers and bolls is a normal feature and the result of physiological imbalance between the net assimilation rate of the canopy and conflicting demand of respiration, vegetative growth and boll development. Net assimilation rate is a function of the leaf area index, stress caused by weed competition, pest attack, salinity and water logging, atmospheric conditions, and the supply of nutrients and water from the soil. Unfavourable levels of any of these factors will cause shedding of flowers and immature bolls.

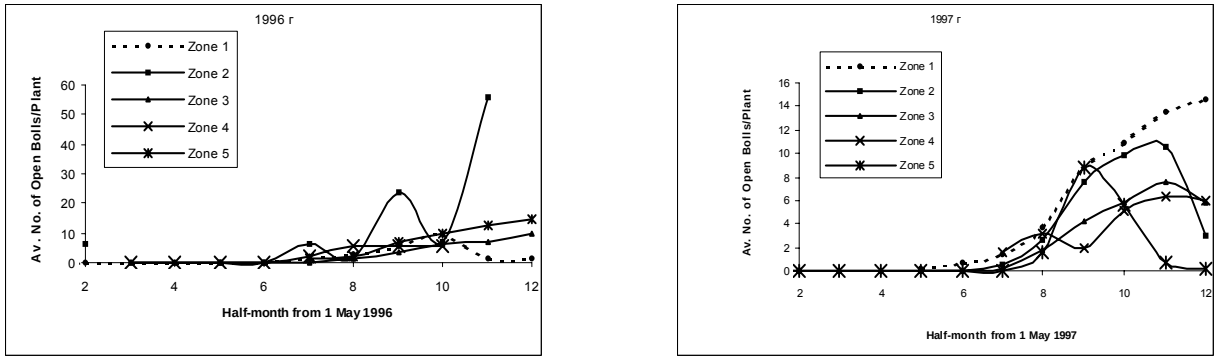
Patterns of flower production are quite similar in zones 1, 2 and 3 as shown in Figure 8.7 except that flowering in the southern zone is earlier and more prolific, and later and less prolific in the northern zone. Interesting observations are the very early and prolific flowering in the crops on the poor soils of zone 4, and the mid-season spurt in flowering in the cotton at high altitude.

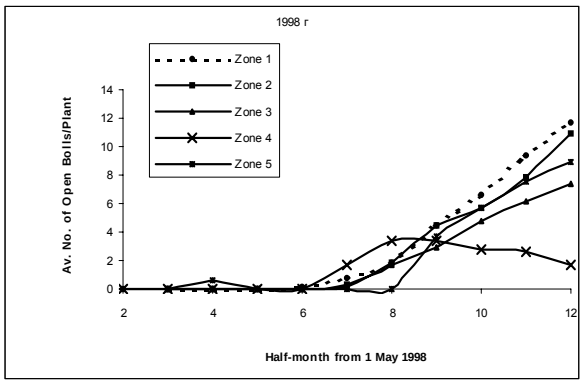
Figure 8.7 Flowering in Cotton by Zones



Zonal variation in boll splitting is illustrated in Figure 8.8. Open capsules are not shed by the plant so that it is technically impossible for the counts to decrease between September and October as shown for zones 2 and 5. This reflects perhaps an element of random error in counting and processing data, or more likely misunderstanding by the enumerators that they should count all the capsules whether or not they still contained fibre. It is likely therefore that the overall average number of split bolls should be greater than seven per plant, as discussed above.

Figure 8.8 Cotton Boll Splitting by Zones





Boll splitting in crops in the southern zone was marginally ahead of other areas with the exception of zone 4 where it seems that water stress may have hastened the process. Boll counts in September ranked the zones in the same order as the recorded final yields.

8.4 Weed Competition

As a rule weeds emerge prior to cotton germination and develop more rapidly consuming a lot of nutrients and soil moisture. Without proper control weed competition causes yield losses and increase of pest population. Very often up to 40 percent of total labour is used for weeding and due to a high weed population yield losses of cotton are around 20 percent.

Enumerators were counted number of weeds in the sample plots during vegetation period. Weed population in cotton are summarised by the zones described above, as shown in Table 8.3. These data to a great extent reflect the use of different measures for weed control.

In 1996 the biggest weed population at the end of vegetation period was recorded in zone 2 (17,5 per metre of row) that of in 1997 1998 was up to 10.4 per metre of row in zone 1 (October) and zone 2 (June). This is the evidence of poor interrow cultivation and ineffective manual weeding.

Table 8.3 Weed Population in Cotton
(Number/Meter of Row)

Year	Zone	June	October
1996	1	2,25	1,08
	2	7,72	17,51
	3	1,22	3,23
	4	5,62	
1997	1	2,53	10,44
	2	5,85	6,05
	3	1,65	3,36
	4	9,13	5,20
	5	1,08	0,00
1998	1	6,09	8,02
	2	16,45	8,18
	3	2,47	3,82
	4	2,73	1,76
	5	0,96	0,00

8.5 Pests and Diseases

Enumerators were asked to record the date of the first siting of pests and diseases in the sample fields, to record the name of the organism, and to assess the damage to the crop on a score from 0 (nil) to 4 (severe). Enumerators were mostly trained as engineers and none were entomologists or

pathologists, but were asked to seek the help of the farm specialists. Most failed to do so and records are very far from complete.

8.5.1 Cotton Pests and Diseases

All the data about pests and diseases for 1996 – 1998 are summarised in Table 8.4

Table 8.4 Pests and Diseases of Cotton

Year	Common name	Date of first report of			Damage score (0 - nil, 4 - severe)					No. of reports
		eggs	larvae/ nymphs	adults/ fungus/ bacterium	May	June	July	August	Sep	
1996	Cutworm	15 June		18 June	0	3,6	1,0	0	0	13
	Spider mite	10 June	07 Feb	07 Feb	0	1,9	3,2	3,1	0	38
	American bollworm	03 June	07 Apr	12 June	0	0,8	1,4	1,4	0	56
	Armyworm	10 July	20 May	10 July	1	1,5	2,8	0	0	10
	Aphid	10 July	10 July	05 June	0	0	0,9	0	0	18
	Wilt			03 August	0	0	0	0	0	4
	Nematodes	09 July			0	0	0	0	0	1
	Thrips tabaci			05 June	0	1,5	0	0	0	6
1997	Cutworm	21 June	20 May	20 May	0	1,2	1	0	0	12
	Lucerne beetle	21 June	21 June		0	1,0	0	0	0	1
	Spider mite	21 June	25 May	25 May	0	1,6	1,8	0,9	0	51
	American bollworm	18 July	23 May	23 May	0	1,1	1,5	1,4	1	62
	Armyworm		05 May	20 May	0,8	2,0	1	1	1	29
	Aphid	20 May	20 May	20 May	0,5	1,8	1	1	1	37
	Wilt		01 July	01 July	0	0	1	1	1	4
	Sucking bug		01 July	01 July	0	0	1	0	0	2
	Thrips white		21 July	21 May	0	0	0	0	0	1
	Big cotton aphid		16 May	16 May	1	1	1	1	1	11
	Leaf beetle			20 May	0	0	0	0	0	4
	Cutworm		20 May	20 May	0,3	1	1	0	0	9
	Chloridea dipsacea L.		20 may	20 May	0	1	1	0	0	15
	Root rot		22 May	03 May	1,8	0	0	0	0	16
	Thielaviopsis basicola Ferr			01 July	0	0	2	0	0	2
1998	Cutworm	10 April	09 April		0,1	1	0	0	0	13
	Spider mite	01 June	04 May	01 June	0	1	0,7	1	0,8	54
	American bollworm	10 May	10 May	10 May	0	0,2	0,7	1,4	2,1	191
	Armyworm	01 June	01 June	01 June	0	1	1,2	1,2	1,2	33
	Aphid	20 May	20 May	20 May	0	0,6	1	1,4	0	32
	Thrips tabaci	25 April	25 April	25 April	1	1,1	1	1	1	58
	Bug		15 June	15 June	0	1	1	1	0	3
	Trips white	10 May	30 April	12 May	0	0,3	0	0	0	30
	Big cotton aphid	25 April	25 April	25 April	1	1	1,1	1	1	66
	Root rot			01 May	1,9	0	0	0	0	9
	Aphis laburni Kalt.	01 June	01 June	01 June	0	0	1	1	1	19
	Oria musculosa		01 July	01 July	0	0	1	1	1	5
	Phytomera gamma L.		01 July	01 July	0	0	1	0	0	1
	Stem rot			30 May	1	0	0	0	0	1
	Cotton mite		07 June		0	0	0	0	0	1
	Whitefly			01 August	0	0	0	0,9	1,6	28

In all, some 14 pests and three diseases were noted. Of these, American bollworm, spider mites, aphids, leaf-eating caterpillars and cutworms were the most common. Root rot caused (most likely) by *Fusarium* and *Rhizoctonia spp* was also the most common disease.

The first recorded pests were armyworms in early May, followed shortly by cutworms and aphids. The damage caused by aphids and armyworms was quite serious in some fields but crops quickly recovered after application of chemicals. Larvae and adults of American bollworm were first noted in late May and their eggs rather later. No damage was reported in May from American bollworm but by June, some damage was being reported, rising to a low-moderate level in June to August. In only three out of 40 fields where this pest was reported, did damage reach a serious level. Mostly the damage scores were very modest. Spider mites were reported in 38-54 fields and in some quite early. However, damage peaked in June and July to generally low-moderate levels and became serious in only three fields. Aphids were recorded in 18-98 fields from mid-May and

although the damage caused never became serious, there was a visible level presented throughout the season with a peak in June. Cutworm damage was widespread with peak score 3.6 (June 1996). In 13 fields damage was serious.

Root rot was noted in May but later on with rising of temperatures it disappeared. Every one of the records of root rot was in a different field and most commonly the damage was scored at level 2. This is relatively serious level of loss of seedlings may not be typical for the region but may have been caused by the exceptionally wet and sometimes cold spring during germination (1997) and the use of untreated seeds.

From the analysis of data in Table 8.4 it should be noted the general trend towards increase the number of cotton fields affected by aphids (almost twice as much in 1998 as compared with 1996) and American bollworm and armyworm (almost by threefold in 1998 as compared with 1996).

8.5.2 Wheat Pests and Diseases

Table 8.5 Pests and Diseases of Winter Wheat

Year	Common name	Date of first report of			Damage score (0 - nil, 4 - severe)					No. of reports
		eggs	larvae/ nymphs	adults/ fungus/ bacterium	Feb	Mar	Apr	May	June	
1996	Cutworm		21 June		0	0	0	0	3,0	1
	Smut			05 June	0	0	0	0	4,0	1
	Thrips tabaci			10 June	0	0	0	0	0,5	4
1997	Aphids	20 March	20 March	20 March	0	1,0	1,3	1,4	0	9
	Smut			03 May	0	0	0	0,8	0	5
	Thrips tabaci			05 March	0	0	1,0	0	0	1
	Bug	11 March		05 March	0	1,0	1,5	0	0	5
	Semi-thrips		05 March	05 March	0	0,5	1,5	3,2	0	10
	Swedish wheat fly		01 April	01 April	0	0	0,3	1,0	0	5
	Swedish oats fly			04 April	0	0	0	1,0	0	1
	Stem rust (brown)			10 March	0	1,0	1,0	1,0	0	8
	Glume rust	20 March		20 March	0	0	0	2,0	0	3
	Locust		01 April	05 April	0	0	1,0	0	0	2
	Locust Moroccan			01 April	0	0	1,0	0	0	5
	Thrips white			25 March	0	1,0	0	0	0	1
	Weevil			01 April	0	0	1,0	0	0	2
	Mildew			05 March	0	0	0,8	1,3	0	12
	Big cotton aphid		27 March		0	2,0	0	0	0	1
	Stem rust			01 April	0	0	1,0	3,0	0	2
	Leaf beetle		05 March	05 March	0	0	1,8	2,0	0	8
	Grain beetle		05 April	05 April	0	0	1,0	1,0	0	2
	Capsid bug			10 March	0	0	0,5	1,0	0	4
	Hessian fly		01 April	01 April	0	0	1,0	2,0	0	4
	Stem rust (black)			15 April	0	0	0	2,0	0	1
	Ant (black)	03 May		03 May	0	0	0	1,5	0	2
	Cutworm		03 May	03 May	0	0	0	0,5	0	2
	Stripped mosaic virus			15 April	0	1,0	1,0	0	0	2
	Ant (red)	03 May		03 May	0	0	0	1,0	0	1
1998	Bug			10 April	0	0	1,0	0	1,0	10
	Semi-thrips	20 March	01 June	20 March	0	1,0	0	0	1,0	3
	Swedish wheat fly				0	0	0	0	0	6
	Swedish oats fly			20 March	0	0	0	0	0	5
	Sucking bug	20 March		10 March	0	0	0	0	0,4	10
	Mildew			25 March	0	1,0	1,0	0	1,7	12
	Big cotton aphid		15 April		0	0	1,0	0	0	4
	Leaf beetle		15 April	15 April	0	0	0	0	0	3
	Grain beetle	21 March	15 March	31 April	0	0,2	0	0	1,0	11
	Capsid bug			01 March	0	0	0	0	0	7
	Hessian fly			20 March	0	0	0	0	0	5
	Ant black		10 March	10 March	0	0,3	0	0	0	3
	Aphid (lucerne)		20 March		0	1,0	0,8	0	0	7
	Clover red bug		15 April		0	0	0	0	0	2
	Lucerne midge			10 March	0	0,5	0	0	0	2
	Lygus oblireatus			21 March	0	0	0	0	0	1
	Бурая пятнистость			03 June	0	0	0	0	1,0	2

No pests or diseases were recorded in the months after planting until March. The first to appear were aphids, stem rust, some sucking bugs and a single case of stripped mosaic virus, all causing some slight damage. As crops booted with the warmth of April, seral other pests appeared together with mildew. By May, several insects were causing moderate damage, mildew intensified somewhat and glume rust appeared on the inflorescences causing moderate damage. As the crops matured in June, aphids maintained their presence as they had done all spring.

It should be noted that the number of cases of different pests has increased in 1998 as compared with 1996 (e.g. number of fields with bug was doubled, number of cases of grain beetle in 1998 was 5 times more than in 1997 – 11 cases against 2).

8.5.3 Pests and Diseases of Lucerne

No diseases but 21 insect species were recorded during survey period in the lucerne sample fields, as shown in Table 8.6.

The most important pests were lucerne beetles, aphids, sucking bugs and armyworms, in how common they were and the level of damage they caused. Lucerne beetles and armyworms appeared in February, causing moderately serious damage throughout the spring months. Aphids and sucking bugs appeared a month later, quickly causing moderate damage during spring. All these pests were presented throughout the summer until September. Most of the other recorded pests appeared during the summer or autumn and caused only slight damage.

There was a sudden appearance of the American bollworm in August causing moderate damage, demonstrating the wide host spectrum of this pest and that control measures for cotton would need to take account of larvae feeding on lucerne.

Data in Table 8.6 show difference in the appearance of pests during the survey period. So, number of cases of aphids and lucerne beetles was doubled as compared with 1996, that of thrips was fivefold in 1997-1998, and much more number of cases of armyworms and cutworms was noted in 1997-1998.

Table 8.6 Pests and Diseases of Lucerne

Year	Common name	Date of first report of			Damage score (0 - nil, 4 - severe)									No. of reports
		eggs	larvae/ nymphs	adults/ fungus/ bacterium	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	
1996	Lucerne beetle	10 July	10 May	10 April	0	0	0	1,0	3,2	2,6	0	0	0	14
	Aphid		05 June	01 June	0	0	0	0	2,6	0	0	0	0	5
	Thrips tabaci			02 June	0	0	0	0	1,0	0	0	0	0	1
1997	Cutworm		03 May	03 May	0	0	0	0	0	1,0	0	0	0	2
	Lucerne beetle	10 Feb	10 Feb	10 Feb	3,0	3,0	1,8	2,3	1,0	1,0	1,0	1,0	0	22
	American bollworm		01 Feb		0	0	0	0	0	0	2,0	0	0	2
	Shira disease	21 June	21 June	21June	0	0	0	0	1,0	0	0	0	0	1
	Armyworm	21 June	20 Feb	01 April	2,0	2,5	1,0	0	1,0	2,0	1,0	1,0	0	10
	Aphid		10 March	01 April	0	1,5	2,0	1,5	2,0	1,0	1,0	1,0	0	12
	Thrips tabaci			10 March	0	0	0	0	1,0	1,0	1,0	1,0	0	5
	Sucking bug		10 March	10 March	0	1,0	0	1,5	1,0	1,0	1,0	1,0	1,0	13
	Locust			05 April	0	0	0	0	0	0	0	0	0	1
	Locust Moroccan		01 July	01 July	0	0	0	0	0	1,0	0	0	0	1
	Weevil			03 May	0	0	0	2,0	0	0	0	0	0	1
	Big cotton aphid		01 April		0	0	1,0	0	0	0	0	0	0	1
	Cutworm		03 May	03 May	0	0	0	1,0	1,0	0	0	0	0	2
	Cutworm		01 July	01 July	0	0	0	0	0	1,0	1,0	1,0	1,0	4
	Aphid (lucerne)		10 March	01 April	0	0	0	0	1,0	0	1,0	0	1,0	3
	Lucerne midge			01 August	0	0	0	0	0	0	0	1,0	1,0	2
	Meadow moth		01 Sep		0	0	0	0	0	0	0	1,0	1,0	2
	Cutworm (gamma)		01 Sep		0	0	0	0	0	0	0	1,0	1,0	2
	Bruchophagus roddi Guss		01 August	01 August	0	0	0	0	0	0	0	1,0	1,0	2
	Lygus oblireatus		10 March	10 March	0	1,0	1,0	0	0	0	0	0	0	2
1998	Lucerne beetle	10 March	10 March	15 April	0	1,0	2,0	1,0	1,0	1,0	0	1,0	0	13
	Armyworm	30 April	25 March	25 March	0	1,0	0	1,0	1,0	1,0	1,0	1,0	0	9
	Aphid				0	0	0	0	0	0	0	1,0	0	5
	Thrips tabaci		20 April	20 April	0	0	0	0	1,0	1,0	1,0	1,0	0	5
	Bug				0	0	0	0	0	1,0	0	0	0	1
	Swedish oats fly			20 March	0	0	0	0	0	0	0	0	0	1
	Sucking bug	10 March	10 March	10 March	0	0,5	0	1,0	1,0	1,0	1,0	1,0	1,0	19
	Locust			15 April	0	0	0	0	0	1,0	0	1,0	0	4
	Thrips white			06 June	0	0	0	0	1,0	1,0	0	1,0	0	5
	Grain beetle		15 March	01 June	0	0	0	0	0	1,0	0	0	0	2
	Hessian fly			15 April	0	0	0	0	1,0	1,0	0	0	0	3
	Cutworm		01 June	01 June	0	0	0	0	0	1,0	0	0	0	1
	Aphid (lucerne)	15 March	15 March	15 March	0	1,5	0	0	1,0	1,0	0	0	0	4
	Clover red bug	25 April	25 April	25 April	0	0	0	0	1,0	1,0	1,0	1,0	0	9
	Meadow moth	25 April	25 April	25 April	0	0	1,0	0	1,0	1,0	1,0	1,0	0	6
	Locust			15 April	0	0	0	0	0	0	0	0	0	1
	Whitefly				0	0	0	0	0	0	0	2,0	0	2
	Joint-worm				0	0	0	0	0	0	0	1,0	0	1