RESEARCH NOTES AND STATISTICS

Moving Out of Cotton: Notes from a Longitudinal Survey in Two Vidarbha Villages

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Cotton farmers in the black soil regions of the Deccan Plateau were among those most adversely affected by the agrarian distress in rural India after the mid-1990s. One important way in which these farmers tried to adapt to conditions of distress was by changing cropping patterns. This note discusses how cotton farmers in two villages in the Vidarbha region of Maharashtra State shifted to soybean and maize during the period of agrarian distress. The two villages – located in Akola and Buldhana districts of Maharashtra – were first surveyed in 2006–7 and 2009–10 respectively, when cotton was the predominant crop. In 2012–13 and 2013–14, the villages were surveyed again in order to understand the extent of and the reasons for the shift in the cropping pattern. The note uses secondary data to contextualise the discussion, and primary data from the two surveys to analyse shifts in cropping pattern at the village level.

Shifts in Cropping Pattern, Maharashtra

Cropping pattern in Maharashtra is diversified, with farmers in the State growing foodgrain, oilseeds, cotton, sugarcane, and other crops. About 50 per cent of the gross cropped area in Maharashtra was under foodgrain cultivation in 2013–14 (Table 1). Cotton and oilseeds were grown on 18 per cent and 17.9 per cent, respectively, of the gross cropped area. Sugarcane was grown on only 4.8 per cent of the gross cropped area.

Cropping pattern in the State diversified over the years. Table 1 provides data on cropping patterns for the ten-year period between 2003–4 and 2013–14. In brief, there was a moderate reduction in the share of area under foodgrain during this

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Table 1 *Share of area under major crops in gross cropped area, Maharashtra, 2003–4 to 2013–14* in per cent

Crops	Share in gross cropped area										
	2003–4	2004–5	2005–6	2006–7	2007–8	2008–9	2009–10	2010–11	2011–12	2012–13	2013–14
Rice	6.9	6.7	6.7	6.8	7.0	6.8	6.5	6.6	6.7	6.7	7.0
Wheat	3.0	3.4	4.1	5.5	5.4	4.6	4.8	5.7	3.8	3.4	4.7
Sorghum	19.8	21.3	21.0	20.5	18.3	18.1	18.6	17.7	14.0	14.2	13.2
Pearl millet	5.9	6.8	6.4	6.4	5.7	3.9	4.6	4.5	3.6	3.4	3.3
Other cereals	2.7	3.0	3.0	3.5	3.9	3.8	4.3	4.6	4.7	4.4	5.1
All cereals	38.3	41.2	41.3	42.6	40.4	37.1	38.9	38.9	32.7	32.2	33.3
Pigeon pea	4.7	4.8	4.9	5.0	5.1	4.5	4.9	5.6	5.3	5.3	4.9
Gram	3.6	3.7	4.5	5.8	6.0	3.4	5.0	6.2	4.7	4.9	7.9
Green gram	3.1	2.9	2.4	2.5	2.9	1.9	1.9	2.4	1.9	1.9	1.9
Black gram	2.7	2.4	2.1	2.2	2.5	1.4	1.6	2.1	1.6	1.6	1.4
Other pulses	1.3	1.3	1.4	1.5	1.4	0.8	0.9	1.1	0.8	0.8	1.0
All pulses	15.3	15.1	15.2	17.0	17.9	13.8	15.0	17.5	14.3	14.4	17.1
Foodgrain	53.6	56.3	56.5	59.6	58.3	50.8	53.9	56.4	47.0	46.6	50.4
Groundnut	1.7	1.9	2.0	2.0	1.8	1.4	1.4	1.7	1.4	1.3	1.4
Soybean	7.1	9.4	10.4	11.2	11.8	13.6	13.4	11.8	13.0	13.3	15.2
Safflower	1.1	1.1	1.2	1.2	1.0	0.8	0.8	0.7	0.6	0.5	0.5
Other oilseeds	2.4	2.5	2.7	2.7	2.3	1.8	1.5	1.4	1.0	0.9	0.9
All oilseeds	12.3	14.9	16.2	17.1	16.9	17.7	17.3	15.7	16.0	16.0	17.9
Sugarcane	2.0	1.5	2.2	3.8	4.8	3.4	3.4	4.5	5.1	4.6	4.8
Cotton	12.3	12.7	12.8	13.8	14.1	14.0	15.1	17.1	18.0	18.1	18.0
Gross cropped area	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: *Handbook of Basic Statistics of Maharashtra State*, Directorate of Economics and Statistics, Government of Maharashtra, 2003–4 to 2013–14.

period. On the other hand, there was a rise in the share of area under both cotton and oilseeds. The share of area under cotton rose from 12.3 per cent in 2003–4 to 18 per cent in 2013–14; and among oilseeds, it was the share of area under soybean cultivation that recorded the highest rise, from 7.1 per cent in 2003–4 to 15.2 per cent in 2013–14.

Given that Maharashtra's agro-climatic regions are distinct, a regional analysis of changes in cropping pattern is necessary. Table 2 provides data on area under cotton and soybean cultivation across different divisions of the State. One conclusion that may be generalised across all the divisions is, clearly, the rise in area under soybean. In all the divisions, the area under soybean cultivation was larger in 2013–14 than in 2003–4. The area under cotton cultivation also rose during this period in all the divisions, with the exception of Amaravati. In all divisions other than Amaravati, the increase in area under soybean appears to have been due to its spread to plots of land previously under foodgrain, particularly coarse cereals. Amaravati appears to be the only division where cultivation of soybean spread to plots where previously, among other crops, cotton was grown as well. Between 2003–4 and 2013–14, the area under cotton in Amaravati division fell by 106,000 hectares, while that under soybean rose by 954,000 hectares.

Figure 1 gives the shares of area under cotton and soybean cultivation in Amaravati division between 2003–4 and 2013–14. While the share of area under cotton in gross cropped area fell from 28 per cent in 2003–4 to 24.7 per cent in 2013–14, that of soybean rose from 12.1 per cent to 35.1 per cent in the same period. In other words, soybean displaced many crops, including, uniquely for Amaravati division, cotton.

It is the unique nature of the shift in cropping pattern in Amaravati that is the subject of this note. Why did the farmers of Amaravati division exit cotton in favour of soybean cultivation? To understand this shift better, we examined longitudinal household data for two villages – Dongargaon and Savali – in Amaravati. Dongargaon is located in Akola district and Savali is located in Buldhana district. In both the villages, the substitution of cotton with soybean was apparent during our fieldwork, and particularly so after 2011.

The Site and the Method

Dongargaon is a village in Akola tehsil, Akola district, Maharashtra (see Figure 3). The village is located at a distance of about 13 km from the town of Akola along National Highway (NH) 6, which connects Akola with Amaravati and Nagpur. The inhabited part (*gaothan*) of the village lies less than a kilometer off NH6 towards the south. The market town of Murtizapur is about 32 km east of the village. Dongargaon is surrounded by the villages of Sisa, Masa, Kumbhari, and Babulgaon.

Table 2 *Area under cotton and soybean, by division, Maharashtra, 2003–4 to 2013–14* in thousand ha

Year	Pune		Aurangabad		Amaravati		Nagpur		Nasik	
	Cotton	Soybean	Cotton	Soybean	Cotton	Soybean	Cotton	Soybean	Cotton	Soybean
2003—4	2	125	900	399	1119	485	238	540	504	33
2004—5	3	188	1000	475	1076	720	225	608	536	70
2005—6	9	177	1080	646	1049	807	202	633	535	84
2006—7	7	151	1150	649	1156	922	198	679	593	120
2007—8	6	150	1248	662	1090	1032	194	682	657	138
2008—9	3	149	1327	719	963	1289	163	752	690	155
2009—10	5	154	1371	806	1019	1216	264	660	724	182
2010—11	7	154	1550	825	1165	1033	367	543	850	176
2011—12	5	163	1693	960	1157	1137	384	574	921	176
2012—13	3	161	1729	994	1139	1177	374	568	940	164
2013—14	4	191	1777	1144	1013	1439	382	573	985	173
Change, 2003—4 to 2013—14	2	66	877	745	—106	954	144	33	481	140

Source: *Handbook of Basic Statistics of Maharashtra State*, Directorate of Economics and Statistics, Government of Maharashtra, 2003–4 to 2013–14.

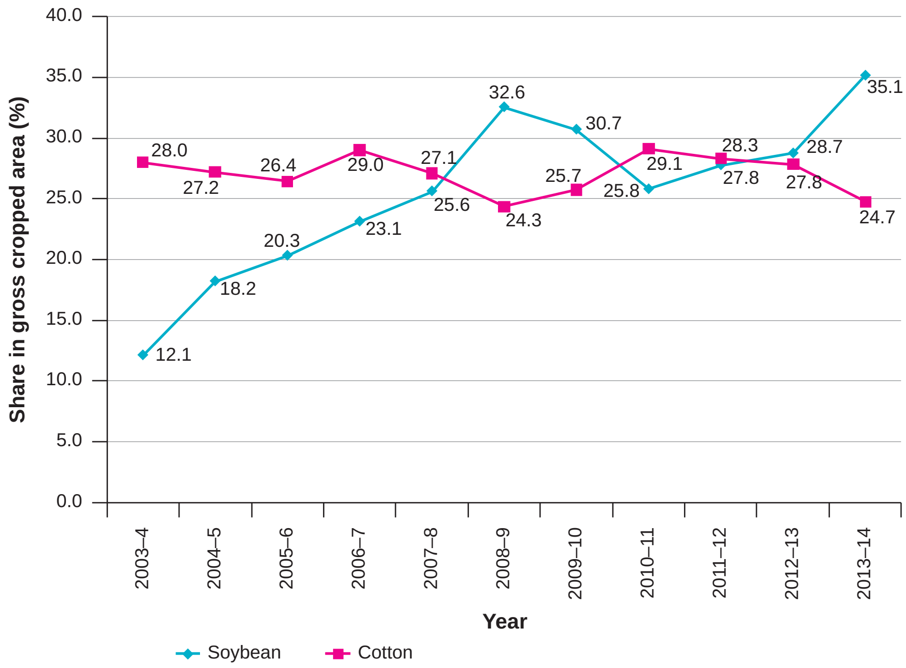

Figure 1 *Share of area under soybean and cotton in gross cropped area, Amaravati division, 2003–4 to 2013–14,* in per cent
Source: Handbook of Basic Statistics of Maharashtra State, Directorate of Economics and Statistics, Government of Maharashtra, 2003–4 to 2013–14.

Dongargaon was first surveyed by our team of investigators in the summer of 2007, with the agricultural year of 2006–7 as reference year. There were 357 households in the village, and we conducted a census-type socio-economic survey of all the households, using detailed questionnaires. The survey began in the last week of April 2007 and was completed by the third week of May 2007.

Savali is a village in Buldhana tehsil, Buldhana district, Maharashtra. The district is situated on the westernmost border of the Vidarbha region. The village is located around 35 km from the district-town of Buldhana and 3 km off the Buldhana–Aurangabad highway. The nearest marketplace is Dhad, at a distance of 5 km from the village. Savali is surrounded by the villages of Karadi, Mhasala, and Ruikhed.

Savali village was first surveyed by our team in the summer of 2010, with the agricultural year of 2009–10 as reference year. There were 279 households in the village at the time. The population was 1,325. As in Dongargon, in Savali too a census-type socio-economic survey using detailed questionnaires was conducted in May 2010, between the first and third weeks of the month.

In the winter of 2013, our team of investigators visited Dongargaon and Savali again, and conducted a resurvey of all the households in the two villages *that had owned or operated land in the earlier surveys of 2007 and 2010.* Only households that owned or operated land in the earlier surveys were resurveyed in 2013 as our objective was primarily to understand shifts in the cropping pattern. Indeed, this implied the exclusion of two sets of households: those who had attained ownership of land between the two surveys, and those who had begun to lease or mortgage land between the two surveys. During the resurvey, we asked the households questions on land ownership and cropping pattern for two agricultural years: 2012–13 and 2013–14. We also asked the households the reasons for shifts in the cropping pattern, if any. Thus we had access to longitudinal data on the cropping pattern of all landholding households in the two villages for three agricultural years each: 2006–7, 2012–13, and 2013–14 for Dongargaon, and 2009–10, 2012–13, and 2013–14 for Savali.

In addition, we have used data on costs of cultivation collected from the census survey of households in Dongargaon for 2006–7 and Savali for 2009–10. For 2012–13, we conducted selected case studies of households from different land size-classes, as well as irrigated and unirrigated plots, to understand the ways in which costs of cultivation had changed between the two surveys. These case studies were in the form of intensive interviews with the heads of households, which were further corroborated in equally intensive group discussions with cultivators in each village.

Shifts in Cropping Pattern

Dongargaon Village, Akola District

In 2007, when we first surveyed Dongargaon, the village was hardly the dry *kharif* village it was in the 1960s. Of the 534 acres of *land owned* by the village residents, 179 acres (or 33.5 per cent) were irrigated by different means. If we considered only the *cultivated area* (i.e. excluding land left fallow), the share of area irrigated increased to 40.5 per cent. Though 61 per cent of the owned area was still unirrigated in 2007, the expansion of irrigation had led to important shifts in the production environment of agriculture between the 1960s and 2000s. Of these, the most important shift was in the cropping pattern.

In 2006–7, the major crops grown in Dongargaon were sorghum and cotton in the first season, and wheat and vegetables in the second season. A feature of the cropping pattern of the village was the wide variety of crop combinations used in intercropping. There were about 45 different combinations of crops (monocrops and intercrops together) that we noticed during our survey. A summary of the areas under different crop combinations in Dongargaon is given in Table 3. In 2006–7, monocropping of traditional cotton and Bt cotton accounted for the single largest share of land under cotton cultivation in the gross cropped area: 32.2 per cent. An additional 9.1 per cent of the gross cropped area was under cotton as an intercrop, with pigeon pea, sorghum, soybean, and black gram. Thus, in about 41 per cent of the gross cropped area, cotton was cultivated either as a monocrop or an intercrop. Sorghum was the second most important monocrop, cultivated in 21.7 per cent of the gross cropped area. Sorghum was also cultivated as an intercrop, with cotton, pigeon pea, black gram, and green gram. Thus, in about 27 per cent of the gross cropped area, sorghum was cultivated either as a monocrop or an intercrop. Wheat in the second season and soybean in the first season, in that order, were the third and fourth most important monocrops. Soybean was a relatively new crop in Dongargaon in 2006–7, cultivated in the first season.

In 2006–7, the area under Bt cotton was on the rise in Dongargaon. In Maharashtra, Bt cotton seeds were introduced for commercial cultivation after 2002. Secondary data show that in 2001–2, the average yield of cotton in the State was 195 kg per hectare or 78 kg per acre. The average yield was reported at 330 kg per hectare or 132 kg per acre in 2006–7, and 356 kg per hectare or 142 kg per acre in 2013–14. Higher productivity of cotton was a major reason for farmers in Dongargaon to shift to cotton from other crops such as sorghum. Indeed, the sharp rise in irrigated area in the village contributed to the growth in productivity of cotton, which in turn contributed to its preferred cultivation vis-à-vis sorghum.

In 2012–13 and 2013–14, when we resurveyed Dongargaon, the cropping pattern was completely different. First, the area under cotton had declined considerably. The total monocropped area under cotton and Bt cotton in the village fell from 32.2 per cent in 2006–7 to 16.6 per cent in 2012–13, and just 6 per cent in 2013–14. Cotton continued to be cultivated as an intercrop, but the intercropped area under cotton had also decreased. As already mentioned, cotton had been cultivated either as a monocrop or an intercrop in 41 per cent of the gross cropped area in 2006–7. However, the corresponding shares fell to 22.3 per cent in 2012–13 and just 6.9 per cent in 2013–14.

Secondly, if cotton was the most important crop in the village in 2006–7, soybean was the most important crop in 2012–13 and 2013–14. About 24 per cent of the gross cropped area in 2012–13 and 38.5 per cent of the gross cropped area in 2013–14 were under cultivation of soybean as a monocrop. Soybean was also intercropped with pigeon pea in an additional 15 per cent of the gross cropped area in 2012–13 and 2013–14. In sum, soybean was cultivated either as a monocrop or an intercrop in about 40 per cent of the gross cropped area in 2012–13 and 53 per cent of the gross cropped area in 2013–14.

Thirdly, the area cultivated with sorghum also fell sharply in Dongargaon between 2006–7 and 2013–14. If sorghum was monocropped in 21.7 per cent of the gross cropped area in 2006–7, the corresponding share declined to 6.9 per cent in 2012–13 and 4 per cent in 2013–14.

Table 3 *Cropping pattern in Dongargaon, by crop, 2006–7, 2012–13, and 2013–14* in acres and per cent

Crop combinations	2006–7		2012–13		2013–14	
	GCA (acres)	Share in total (per cent)	GCA (acres)	Share in total (per cent)	GCA (acres)	Share in total (per cent)
Soybean	39	5.8	195	24.0	345	38.5
Gram	–	–	100	12.3	137	15.2
Soybean + Pigeon pea	12	1.7	123	15.1	131	14.5
Wheat	104	15.5	82	10.1	96	10.7
Sorghum	145	21.7	57	6.9	36	4.0
Vegetable	–	–	27	3.3	30	3.3
Bt cotton	29	4.3	78	9.6	29	3.2
Cotton	187	27.9	57	7.0	25	2.8
Cabbage	3	0.5	16	1.9	22	2.4
Onion	–	–	10	1.2	12	1.3
Pigeon pea	25	3.7	1	0.1	8	0.8
Brinjal	–	–	2	0.2	5	0.6
Bt cotton + Pigeon pea	12	1.8	8	0.9	4	0.4
Sorghum + Pigeon pea	11	1.6	–	–	4	0.4
Cabbage + Spinach	–	–	–	–	3	0.3
Cotton + Pigeon pea	25	3.7	31	3.8	3	0.3
Cucumber	–	–	3	0.3	2	0.2
Lemon orchid	–	–	1	0.1	2	0.2
Maize	–	–	–	–	2	0.2
Bt cotton + Vegetable	–	–	–	–	1	0.1
Cabbage + Lemon orchid	–	–	2	0.2	1	0.1
Cauliflower	–	–	1	0.1	1	0.1
Spinach	–	–	1	0.1	1	0.1
Green gram	4	0.6	6	0.7	1	0.1
Black gram	8	1.1	2	0.2	1	0.1
Brinjal + Cabbage	–	–	5	0.6	–	–
Brinjal + Onion	–	–	1	0.1	–	–
Bt cotton + Soybean	–	–	6	0.7	–	–
Bt cotton + Sorghum + Pigeon pea	4	0.6	–	–	–	–
Cotton + Sorghum	4	0.6	–	–	–	–
Cotton + Sorghum + Pigeon pea	9	1.3	1	0.1	–	–
Cotton + Soybean + Pigeon pea	4	0.5	–	–	–	–
Cotton + Black gram	3	0.4	–	–	–	–
Fodder crops	–	–	1	0.1	–	–
Sorghum + Green gram + Black gram	7	1.1	–	–	–	–
Green gram + Pigeon pea + Black gram	4	0.6	–	–	–	–
Others, including vegetables	32	4.8	–	–	–	–
All crops	668	100.0	811	100.0	898	100.0

Note: Cotton refers to the traditional variety of cotton.
Source: Survey data, 2007, 2013.

Table 4 *Irrigated and unirrigated area, Dongargaon, 2006–7 and 2013–14*, in acres

Type of land	Area of each type of land owned (acres)	
	Dongargaon, 2006—7	Dongargaon, 2013—14
Unirrigated land	446	323
Irrigated land	179	311
Fallow land	5	1
Total	630	635

Source: Survey data, 2007 and 2013.

Fourthly, the richness of multiple crop combinations that existed in the village in 2006–7 was not to be found in 2012–13 and 2013–14. Most of the intercropping arrangements of cotton-based crops had been replaced by monocropping, especially of soybean.

Fifthly, as Table 3 shows, a major change that occurred in the village between 2006–7 on the one hand, and 2012–13 and 2013–14 on the other, was a rise in the multiple cropping index. The gross cropped area owned by residents of the village rose from 668 acres in 2006–7 to 811 acres in 2012–13 and 898 acres in 2013–14. This rise in gross cropped area was primarily a result of a further spread of irrigation, in particular of irrigation through groundwater sources such as wells, tube wells, and borewells. Table 4 shows data on irrigated and unirrigated land in Dongargaon; the area irrigated rose from 179 acres in 2006–7 to 311 acres in 2012–13. Due to the spread of irrigation, as Table 3 shows, many vegetables newly found a place in the cropping pattern of Dongargaon in our second and third surveys.

Savali Village, Buldhana District

Savali was first surveyed by us in 2009–10. Compared to Dongargaon in 2006–7, Savali had a higher share of irrigated area in its gross cropped area in that year. About 425 acres out of 855 acres (roughly 50 per cent) of the area owned by resident households of the village were irrigated in 2009–10. As in Dongargaon, the presence and spread of irrigation defined the cropping pattern of the village in multiple ways.

In 2009–10, Savali's cropping pattern was dominated by soybean (Table 5). Monocrops of soybean occupied 41 per cent of the gross cropped area. Maize was the second most important monocrop, occupying about 12 per cent of the gross cropped area. Together, cotton and Bt cotton occupied 10.1 per cent of the gross cropped area as monocrops. Sorghum, safflower, and wheat were the other important crops that were cultivated in the village.

Compared to 2009–10, Savali's cropping pattern was different in both 2012–13 and 2013–14. In 2012–13, while the share of monocropped area under soybean remained

Table 5 *Cropping pattern in Savali, by crop, 2009–10, 2012–13, and 2013–14*, in acres and per cent

Crop combinations	2009–10		2012–13		2013–14	
	GCA (acres)	Share in total (per cent)	GCA (acres)	Share in total (per cent)	GCA (acres)	Share in total (per cent)
Soybean	494	41.0	548	41.5	503	32.3
Maize	141	11.7	134	10.1	383	24.6
Gram	230	19.1	369	27.9	300	19.3
Soybean + Pigeon pea	–	–	91	6.9	155	9.9
Wheat	44	3.6	30	2.2	122	7.8
Bt cotton	103	8.6	29	2.2	25	1.6
Chilli	10	0.9	15	1.1	14	0.9
Cotton	18	1.5	43	3.3	14	0.9
Sorghum	53	4.4	26	2.0	13	0.8
Safflower	69	5.8	9	0.6	10	0.6
Bt cotton + Pigeon pea	3	0.2	2	0.2	4	0.2
Green gram + Black gram	3	0.2	2	0.2	4	0.2
Sunflower	5	0.4	–	–	3	0.2
Brinjal	4	0.3	–	–	2	0.1
Chilli + Pigeon pea	–	–	–	–	1	0.1
Maize + Pigeon pea	–	–	–	–	1	0.1
Pigeon pea	3	0.2	1	0.1	1	0.1
Tomato	–	–	–	–	1	0.1
Vegetable	–	–	0	0.0	1	0.1
Gram + Wheat	–	–	–	–	1	0.0
Ladies finger	–	–	–	–	1	0.0
Groundnut	3	0.2	1	0.1	0	0.0
Black gram	6	0.5	0	0.0	0	0.0
Pearl millet	1	0.0	–	–	–	–
Beans	–	–	0	0.0	–	–
Beans+Groundnut+Green gram+ Pigeon pea+Black gram	1	0.1	–	–	–	–
Bt cotton + Soybean	1	0.1	1	0.1	–	–
Cotton + Green gram + Black gram	1	0.1	–	–	–	–
Cotton + Soybean	–	–	5	0.4	–	–
Cotton+Pigeon pea	1	0.0	13	1.0	–	–
Cotton + Black gram + Pigeon pea	–	–	1	0.1	–	–
Gram + Sorghum	3	0.2	–	–	–	–
Groundnut+Green gram+Black gram	–	–	2	0.2	–	–
Sorghum + Soybean	1	0.0	–	–	–	–
Sorghum + Safflower	3	0.2	–	–	–	–
Green gram	3	0.2	–	–	–	–
Green gram + Pigeon pea + Black gram	2	0.1	–	–	–	–
Pigeon pea + Chilli	–	–	1	0.1	–	–
All crops	1204	100.0	1323	100.0	1555	100.0

Note: Cotton refers to the traditional variety of cotton.
Source: Survey data, 2010, 2013.

similar, soybean was also cultivated as an intercrop with pigeon pea in 6.9 per cent of the gross cropped area, which further rose to 9.9 per cent in 2013–14. Thus, if we consider all the plots where soybean was cultivated either as a monocrop or as an intercrop, the share in gross cropped area amounted to 48.9 per cent in 2012–13 and 42.2 per cent in 2013–14.This represented a rise in the area under soybean between the first survey, and the second and third surveys.

The reason for the reduction in area under soybean between the two consecutive years of 2012–13 and 2013–14 was a rise in the area under maize. The share of area under maize in gross cropped area rose from 10.1 per cent in 2012–13 to 24.6 per cent in 2013–14. Maize substituted soybean in part, but also cotton, sorghum, and safflower. The share of area under cotton in gross cropped area in Savali fell precipitously between 2009–10, and 2012–13 and 2013–14. In fact, cotton was cultivated in just about 2.5 per cent of the gross cropped area in 2013–14; the corresponding share for 2009–10 was 10.4 per cent. Our qualitative interviews showed that Savali was a totally cotton-dominated village till the late-2000s.

The spread of soybean and maize, and the decline of cotton and sorghum in Savali happened alongside a rapid growth in irrigated area in the village. Between 2009–10 and 2012–13, the irrigated area increased from 425 acres to 616 acres, while the unirrigated area decreased from 428 acres to 265 acres (Table 6). Thus, as Table 5 shows, the gross cropped area owned by village residents rose from 1,204 acres in 2009–10 to 1,323 acres in 2012–13 and 1,555 acres in 2013–14. In other words, just as in Dongargaon, there was a sharp rise in cropping intensity in Savali also. This led to the introduction, into Savali's cropping pattern, of a large number of vegetable crops that were absent in 2009–10.

Reasons for Cropping Pattern Shifts

During our second and third village surveys in 2012–13 and 2013–14, we asked each household why it had changed its cropping pattern as compared to the time of the first survey. While multiple reasons were cited, the most frequent response was "high cost of cultivation" for the earlier crop. In Dongargaon, most landowning

Table 6 *Irigated and unirrigated area, Savali, 2009–10 and 2013–14*, in acres

Type of land	Area of each type of land owned (acres)	
	Savali, 2009—10	Savali, 2013—14
Unirrigated land	428	265
Irrigated land	425	616
Fallow land	2	2
Total	855	883

Source: Survey data, 2010 and 2013.

households replied that it was the higher cost of cultivation for Bt cotton that influenced their decision to shift to soybean. In Savali, most landowning households told us that they had shifted out of cotton to soybean some time in the late 2000s itself due to the high cost of cultivation for Bt cotton. Again, they cited higher cost of cultivation as the reason for shifting out of soybean to maize between 2012–13 and 2013–14. Our question was an open question, and the answers were not coded prior to the survey. As a result, a number of households did not directly mention higher cost of cultivation as the reason for the change in cropping pattern. Instead, they spoke of higher labour costs in the cultivation of the earlier crop, lower output price received for the earlier crop, and unaffordable input costs in the cultivation of the earlier crop. We included all such responses under the broad reason of "high cost of cultivation," as all of them ultimately pointed to low profitability.

Our argument in this paper builds on the responses that we received from the farmers on the reasons for the shift in cropping pattern. We repeatedly sat with groups of cultivator households and elicited answers on our questions regarding their crop choices. We also generated estimates of the costs of cultivation for each major crop to understand if it was indeed a cost-advantage that prompted a shift in the choice of crops. We could then compare the costs of cultivation during the second and third survey periods with our estimates of costs of cultivation from the first survey.

We argue here that while higher costs of cultivation may act as a trigger for cropping pattern shifts, their impact on the decision-making of farm households is not fully or solely based on absolute differences in costs across crops. Farmers also base their decisions regarding choice of crops on a careful analysis of risks in cultivation. In both Dongargaon and Savali, we found that when farmers were faced with the question of choosing one crop over others, they did not simply compare the expected profitability rates of cotton, soybean, and maize; they also considered (a) the initial current expenditures required for each crop in the context of capital market imperfections; and (b) the probability of these initial costs getting sunk in the event of an expected yield-shock, which in turn was derived from their own subjective experiences of rainfall variations in previous years.

By 2013–14, the economics of crop cultivation in Dongargaon and Savali had changed fundamentally as compared to the first survey year. Most inputs, such as seeds, fertilizers, pesticides, and labour, recorded a very sharp rise in prices in this intervening period. Other than in the case of labour costs, there is clear evidence that the increases in input prices were policy-driven and conscious (Ramakumar 2014). While input costs rose sharply, output prices did not rise commensurately. The support prices declared for cotton, for instance, rose at a rate far slower than the rise in input prices. There were three implications of this. First, the sharp rise in input prices necessitated that the farmer incur a large sum of money as initial current expenditure regardless of the actual level or price of output. Given the imperfections in the capital market, which manifested in the form of a lack of enthusiasm on the part of formal financial institutions to advance timely and adequate credit, the real costs of these initial current expenditures were perceived by the cultivators as extremely burdensome.[1] Secondly, in the context of higher current expenditures, any yield-shock resulting from an abnormal or seasonal variation in rainfall may exacerbate the financial burdens imposed by higher input prices and capital market failures. Thirdly, the lower-than-expected level at which support prices were declared meant that higher costs of cultivation, adjusted for the risks of yield-shock, depressed the rates of profitability.

In such circumstances, farmers' decisions regarding crop choices were determined within a larger risk-management strategy, whereby the expected burden of incurring a high current expenditure was weighed against the expected loss in the face of a probable yield-shock (or crop failure). When farmers, in the short run, record experiences of frequent yield-shocks, they are very likely to fall back on a "play-it-safe" strategy of risk minimisation; in other words, farmers end up choosing a crop with lower requirements of current expenditure that can minimise burdens in the case of a yield-shock, rather than opting for a relatively risky strategy of incurring heavy current expenditures under more optimistic expectations of a good harvest. More specifically, over one season, farmers in Dongargaon and Savali appeared to prefer a "low-input and low-output" crop over a "high-input and high-output" crop.[2] This risk-minimising strategy was employed in strategic combination with an income-maximising strategy, where crops were so chosen as to diversify into more sowings over the full year.

In our view, as capital market failures and insurance market failures become more widespread, farmers are even more likely to fall back on such a strategy. This may be the case even if the profitability ratio of the less favoured crop is, on average, higher than that of the more favoured crop.

In what follows, we shall try to further explain our arguments with data from the two villages.

Cotton to Soybean, Dongargaon Village

Costs and Returns in Bt Cotton Cultivation

In 2006–7, when we first surveyed Dongargaon, the dominance of cotton in the cropping pattern was premised on two factors. First, the average profitability ratio of Bt cotton was the highest among all crops in the village, at 2.5, which was a major reason why it was rapidly substituting non-Bt cotton and sorghum (see Table 7).

[1] For an elaboration, see Ramakumar and Chavan (2014).
[2] These terms are borrowed from Acharya (1997).

Table 7 *Indicators of cost of cultivation and profitability, cotton and Bt cotton, Dongargaon, 2006–7,* in Rs per acre

Item of cost	Cotton (Rs per acre)	Bt cotton (Rs per acre)	Soybean (Rs per acre)
Seeds: home-produced	–	–	–
Seeds: purchased	431	815	641
Manure: home-produced	239	332	55
Manure: purchased	226	913	107
Fertilizers	618	815	743
Pesticides	71	407	93
Total hired labour costs	2219	2420	1524
Other costs	90	90	80
Cost A2	3894	5791	3243
Imputed value of family labour	677	957	411
Cost A2 + FL	4571	6748	3655
Farm business income (A2)	1413	8532	1820
Profitability ratio (A2)	1.6	2.5	1.6
Farm business income (A2+FL)	736	7575	1408
Profitability ratio (A2+FL)	1.3	2.1	1.4

Source: Survey data, 2007.

Secondly, even though soybean had a higher profitability ratio (1.4) than non-Bt cotton (1.3), the costs of cultivation and farm business incomes of the two crops were largely comparable. As a result, while soybean did make a debut in the village by the mid-2000s, it did not substitute non-Bt cotton on a large scale. As Table 7 shows, the cost of cultivation per acre (A2 + imputed family labour costs, FL), at 2006–7 prices, was estimated at Rs 4,571 for non-Bt cotton, Rs 6,748 for Bt cotton, and Rs 3,655 for soybean. The farm business incomes per acre were Rs 736 for non-Bt cotton, Rs 7,575 for Bt cotton, and Rs 1,408 for soybean.

The situation in 2013–14 was, however, fundamentally different, as compared to 2006–7. Our data for 2013–14 showed, first, that the costs of cultivation of Bt cotton had risen significantly between 2006–7 and 2013–14. Detailed cost estimates provided in Table 8 show that the total cost of cultivation per acre (A2 + imputed family labour costs) for Bt cotton had risen from Rs 6,748 in 2006–7 to Rs 21,050 in 2013–14. Costs of inputs had risen in almost all departments: seeds, fertilizers, pesticides, and labour. The rise in costs of inputs was due both to a rise in the quantities applied and a rise in the per unit cost of inputs.

Secondly, yields per acre of Bt cotton had risen between 2006–7 and 2013–14. We had noted in our earlier report that "if traditional cotton yielded, on average, 2 to 3 quintals per acre, Bt cotton yielded, on an average, 6 to 7 quintals per acre" (Ramakumar, Raut, and Kumar 2009). In 2013–14, the average yield for Bt cotton in the village was even

Table 8 *Indicators of cost of cultivation and profitability, Bt cotton, Dongargaon, 2013–14,* in Rs per acre

Item of cost/Operation	Cost (Rs/acre)	Remarks
Deep ploughing	600	Rent for tractor with labour
Shallow ploughing	300	Rent for tractor with labour
Making rows for sowing	500	Rent for tractor with labour
Seed prices	1200	1.5 bags per acre; Rs 800 per bag (1.5 × 800 = 1200)
Sowing	600	By hand; 3 women for 1 day at Rs 100 per day (3 × 100 = 300); 2 men for 1 day for watering at Rs 150 per day (2 × 150 = 300)
Irrigation	600	2 rounds; 2 days per round; at Rs 300 per round (2 × 300 = 600)
Animal weeding	900	6 rounds at Rs 150 per round (6 × 150 = 900)
Hand weeding	2700	3 rounds; 7 women for 1 round at Rs 100 per day (7 × 100 × 3 = 2100); 1 man per round at Rs 200 per day (1 × 200 × 3 = 600)
Fertilizer: DAP	2400	2 bags at Rs 1200 per bag (1200 × 2 = 2400)
Fertilizer: Urea	350	1 bag at Rs 350 per bag (1 × 350 = 350)
Fertilizer: Magnesium	300	1 bag at Rs 300 per bag (1 × 300 = 300)
Fertilizer: MoP	450	1 bag at Rs 450 per bag (1 × 450 = 450)
Labour in fertilizer application	500	5 women at Rs 100 per day (5 × 100 = 500)
Pesticides	3800	–
Labour in pesticide application	600	4 men at Rs 150 per day (4 × 150 = 600)
Harvesting	5000	Yield: 10 quintals/acre; Rs 5 per kg picking charges; for 1,000 kg (5 × 1000 = 5000)
Transport	250	Rs 25 per quintal (25 × 10 = 250)
Cost A2 + FL	21050	–
Output price (in Rs per quintal)	4000	–
Gross revenue	40000	Given yield per acre of 10 quintals (10 × 4000 = 40000)
Farm business income (A2+FL)	18950	–

Source: Case studies of cultivators, 2014.

higher, at around 10 quintals per acre. As a result, the gross revenue in Bt cotton in 2013–14 was as high as around Rs 40,000 per acre, leaving a farm business income of roughly Rs 18,950 per acre. Notably, the farm business income for Bt cotton in 2013–14 was more than twice the farm business income for Bt cotton in 2006–7. In other words, higher yields of Bt cotton more than compensated for the rise in input costs on a per acre basis.

Reasons for Higher Input Costs in Bt Cotton Hybrids

In the cultivation of Bt cotton, hybrid seeds issued by private firms were used on a large scale. As field surveys in rural India have shown, contrary to a widely held belief, Bt cotton hybrids in India have been marked by a rise in pesticide costs per acre over non-Bt cotton varieties and hybrids. Data collected by us from Dongargaon in 2006–7, reported in Table 7, show that while 1 acre of non-Bt cotton required Rs 71 as pesticide costs, 1 acre of Bt cotton required Rs 407 as pesticide costs (see Ramakumar, Raut, and Kumar 2009). Data from Warwat Khanderao village in Buldhana district of Maharashtra, analysed by Swaminathan and Rawal (2001), also showed that while pesticide costs in 1 acre of non-Bt cotton varieties was recorded at Rs 277, the corresponding figure for 1 acre of Bt cotton hybrids was recorded at Rs 1,014. In fact, in the case of most inputs like seeds, fertilizers and labour, the costs per acre in the case of Bt cotton hybrids were higher than for non-Bt cotton varieties and hybrids.

Over the years, two specific shifts took place. On the one hand, due to changes in the policies on farm subsidy under the austere fiscal regimes of successive governments, the cost of inputs in agriculture rose (see Ramakumar 2014). On the other hand, the per acre input requirements in the cultivation of Bt cotton hybrids also rose. Agricultural scientists are in agreement with the assessment of higher input costs for Bt cotton hybrids as compared to non-Bt cotton varieties in the dry rural areas of central India. In his work on Bt cotton hybrids, Kranthi (2012) has argued that:

> The general cost of cotton cultivation has increased over the past 5 years. This increase may not necessarily be related to Bt cotton, but could be a result of [the] input-intensive nature of the hybrids . . . Hybrids are inherently responsive to high levels of inputs and are profitable in high-input intensive systems . . .
>
> Hybrids are highly input-intensive and more susceptible to pests and diseases and thus require more fertilizers and pesticides for optimum production. The cost of hybrid seed is [also] much higher . . . Additionally, many hybrids are susceptible to sap-sucking insects, leaf-curl virus and leaf reddening, adding to input costs . . .

The argument here is not related to yield per acre of Bt cotton hybrids. The average yield per acre for Bt cotton hybrids in 2013–14 remained higher than for non-Bt cotton varieties.

Costs and Returns for Soybean

As compared to Bt cotton, the cultivation of soybean was considerably less input-intensive. Soybean seeds were available at cheaper prices than Bt cotton seeds. The number of rounds of weeding in soybean cultivation was lower than in Bt cotton. The quantity of fertilizers and pesticides applied was also lesser in soybean than in Bt cotton, which in turn meant that a smaller number of wage labourers needed to be hired. Whereas human labour had to be employed for picking cotton during

Table 9 *Indicators of cost of cultivation and profitability, soybean, Dongargaon, 2013–14,* in Rs per acre

Item of cost/Operation	Cost (Rs/acre)	Remarks
Deep ploughing	600	Rent for tractor with labour
Shallow ploughing	300	Rent for tractor with labour
Sowing and fertilizer application	500	Rent for tractor with labour
Spraying of weedicides	250	Rs 150 for weedicides and Rs 100 for labour
Animal weeding	300	Cost for one round only
Spraying of pesticides	250	Rs 150 for pesticides and Rs 100 for labour
Harvesting	1200	Rent for harvester
Transport	20	—
Cost A2 + FL	3420	Yield: 8 quintals per acre
Output price (Rs per quintal)	3000	—
Gross revenue	24000	Revenue per acre: Rs 3,000 × 8 quintals = Rs 24,000
Farm business income (A2 + FL)	20580	—

Source: Case studies of cultivators, 2014.

harvesting, mechanical harvesters could be rented for the harvesting of soybean. As a result, our data for 2013–14 show that the total per acre cost for soybean cultivation was only Rs 3,420 (see Table 9). Considering the average yield of soybean, of 8 quintals per acre, the farm business income per acre in Dongargaon was estimated at Rs 20,580 in 2013–14.

For the farmers of Dongargaon, the differences between Bt cotton and soybean cultivation were striking. As Table 8 shows, the initial expenditure required in Bt cotton cultivation was Rs 21,050 per acre and the farm business income per acre was Rs 18,950 per acre. In contrast, while incurring a significantly lower amount, Rs 3,420 per acre, as initial expenditure in soybean cultivation, a comparable farm business income of Rs 20,580 per acre could be attained. Given the difficulties in obtaining finance from formal financial institutions and rainfall uncertainties that could result in crop failure, the substitution of Bt cotton with soybean was a "play-it-safe" strategy. In the context of risks and capital market failures, a "low-input and low-output" crop was thus preferred to a "high-input and high-output" crop.

Cotton to Soybean to Maize, Savali Village

When we surveyed Savali in 2009–10, the cropping pattern in the village was in the process of shifting out of cotton. As mentioned, soybean was already the major crop grown in the village. In 2009–10, 61 households cultivated Bt cotton and 14 households cultivated non-Bt cotton, whereas monocropped soybean was cultivated by 167 households.

While soybean was the most dominant crop in terms of area under cultivation, our data for 2009–10 clearly show that the farm business income for Bt cotton was higher than for soybean and non-Bt cotton (see Table 10). For 1 acre, the average farm business income of Bt cotton (A2+FL) was Rs 3,003, while the corresponding figures were Rs 1,590 for soybean and Rs 680 for non-Bt cotton.

However, as we have already discussed in the case of Dongargaon, the higher farm business income of Bt cotton was not a primary consideration for farmers in Savali while choosing their cropping pattern. Our interviews show that the higher initial investment required for Bt cotton cultivation – Rs 11,267 per acre – was the most proximate reason why Savali farmers had begun to move out of cotton cultivation in 2009–10. On the other hand, the costs (A2+FL) per acre for soybean – Rs 7,428 – were lower than even for non-Bt cotton cultivation – Rs 9,618.

Furthermore, the average size of landholding in Savali was lower than that in Dongargaon. If the average size of ownership holding was 4.1 acres in Dongargaon, the corresponding size was 3.6 acres in Savali. About 51 per cent (119 out of 232) of landholding households in Savali held plots of less than 2 acres, and about 70 per cent (163 out of 232) of landholding households held plots of less than 3 acres. The smaller average size of holding also contributed to the inability of farmers to make large initial investments in the cultivation of Bt cotton, even if the profitability rate for Bt cotton was higher than that for other crops. In addition, yield-shocks due to frequent failures of the monsoon and seasonal variations in rainfall rendered Bt cotton cultivation risky.

Table 10 *Indicators of cost of cultivation and profitability, non-Bt cotton, Bt cotton, and soybean, Savali, 2009–10,* in Rs per acre

Item of cost	Cotton (Rs per acre)	Bt cotton (Rs per acre)	Soybean (Rs per acre)
Seeds: home-produced	–	–	80
Seeds: purchased	896	1100	850
Manure: home-produced	300	478	259
Manure: purchased	–	12	67
Fertilizers	1590	2132	1114
Pesticides	1598	1490	969
Total hired labour costs	1769	2351	2184
Other costs	1446	1956	994
Cost A2	7599	9519	6517
Imputed value of family labour	2019	1748	911
Cost A2+FL	9618	11267	7428
Farm business income (A2)	2699	4751	2501
Farm business income (A2+FL)	680	3003	1590

Source: Survey data, 2010.

Our interviews with farmers and farmers' groups in Savali were replete with remarks made by farmers against Bt cotton. Most of them mentioned that while Bt cotton provided higher yields, 10 quintals per acre, as compared to non-Bt cotton, it was uneconomical to continue with Bt cotton due to the higher initial costs and the small size of their farms. Many of the small farmers cited the rise in wages for picking as an important factor associated with the rise in costs of cultivation of Bt cotton alongside the rise in prices of other inputs. One farmer said, "The wage for cotton picking in this village is now Rs 7 per kg. At this wage rate, we cannot continue to cultivate cotton."

Ironically, another factor associated with the decline of Bt cotton cultivation in Savali was the spread of irrigation. As discussed already, the gross cropped area in Savali increased between 2009–10 and 2013–14 as a consequence of the spread of groundwater irrigation. The availability of water in the village altered decisions related to cropping patterns.

For instance, cotton was a crop that occupied more than 6–7 months in the field (see Table 11). Once sowing was completed in June–July, the picking of cotton would begin by November, and then continue till the next January or February. If cotton was combined with pigeon pea as an intercrop, the crop cycle would be even longer: after the completion of cotton harvesting in January, the pigeon pea crop would stay in the field and be harvested only in February or March. Till the late 2000s, the extension of the first crop of cotton into the later part of the season was not unwelcome for the farmers; for, when the spread of irrigation was limited, a second crop would in any case be difficult. However, with the availability of water, a second crop became possible. The presence of cotton in the crop cycle would not allow a second crop, but only an intercrop like pigeon pea. Soybean, on the other hand, was a four-month crop. If soybean was sown as the first crop, its harvesting could be completed by October, and a second crop of wheat or maize could be sown by the end of October or the beginning of November, which in turn could be harvested by the next February or March. The substitution of Bt cotton with soybean in Savali after the late 2000s was influenced by this consideration to a large extent.

Table 11 *An illustration of the different possibilities of crop cycles, month-wise, Savali, 2013–14*

June	July	August	September	October	November	December	January	February	March	April	May
Cotton											
Cotton with Pigeon pea											
Soybean with Pigeon pea											
Soybean					Wheat or Maize						
Maize				Maize			Chilli or Vegetables				

Source: Observations and detailed interviews with cultivators, Savali, 2014.

First crop
Second crop
Third crop

Furthermore, soybean could also be intercropped with pigeon pea. Whether a farmer chose to sow a monocrop of soybean, or an intercrop of soybean and pigeon pea, was, according to many Savali farmers, guided by two considerations. First, whether the plot was irrigated or not: an intercrop would be grown in irrigated plots and a monocrop of soybean would be grown in dry plots. Secondly, according to the farmers, female members of the cultivating household always insisted on intercropping pigeon pea with either cotton or soybean. Pigeon pea was an item of consumption in the household, valued by women. The inclusion of pigeon pea in the crop cycle was partly an indication of how successful women in the household were in persuading the male decision-maker.

The Shift from Soybean to Maize

If the shift from Bt cotton to soybean was the story of 2009–10 in Savali, the striking conclusion from our survey in 2013–14 was the further shift from soybean to maize. Between 2012–13 and 2013–14, the area monocropped with soybean fell from 41.5 per cent to 32.3 per cent, while the area monocropped with maize rose from 10.1 to 24.6 per cent. Only about 2.5 per cent of the gross cropped area was monocropped with cotton in 2013–14.

After August 2012, the prices of soybean began to fall in both the international and domestic markets (see Figure 2). For the Savali farmers, this fall in prices of soybean

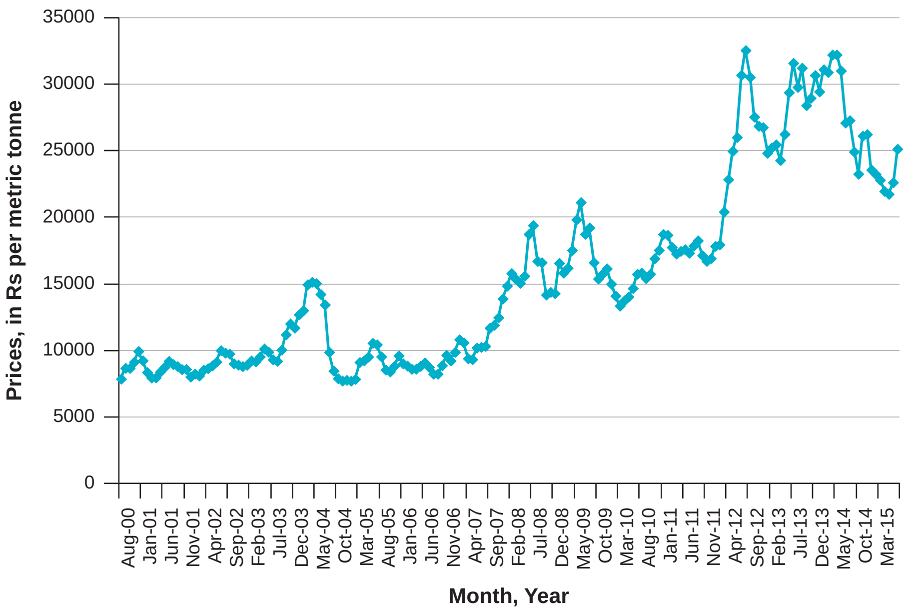

Figure 2 *Trends in the prices of soybean, Chicago soybean meal, futures (first contract forward), 2000 to 2015*, in Rs per metric tonne
Source: www.indexmundi.com

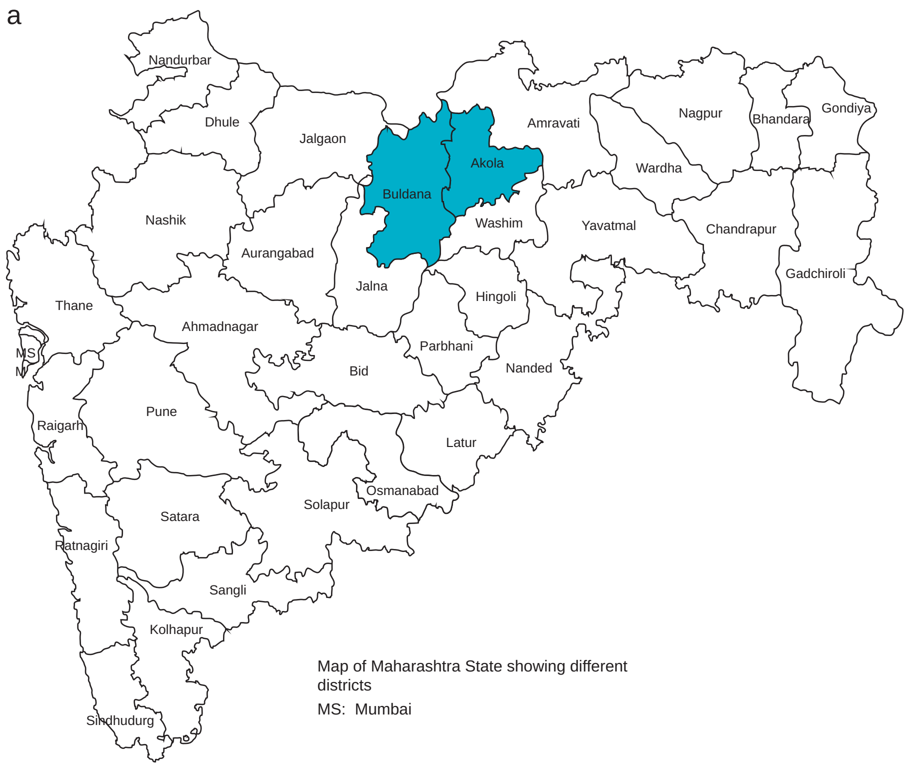

Figure 3 *(cont'd on next page)*

threatened to erase all the advantages of soybean over Bt cotton. They began to look for a more diversified income generation strategy. Maize was identified as an attractive option for several reasons.

First, maize was a short-duration crop as compared to soybean. If soybean required about four months to be harvested, maize required only about three months. Thus, a farmer could cultivate the first crop of maize and harvest it by September, cultivate a second crop of maize and harvest it by December, and, if irrigation was available, cultivate a third crop of chilli or a vegetable till March the next year (see Table 11). The presence of soybean in the crop cycle did not allow the luxury of a third crop because the first crop of soybean continued to occupy the plot till late October. The revenue gains from such a strategy were significant for the small farmers of Savali, even though maize prices were also falling alongside soybean prices.

In Tables 12 and 13, we have provided our estimates from Savali of the costs of cultivation of soybean and maize in 2013–14. As is clear from the tables, the costs incurred for cultivating soybean and maize were similar: the total costs per acre

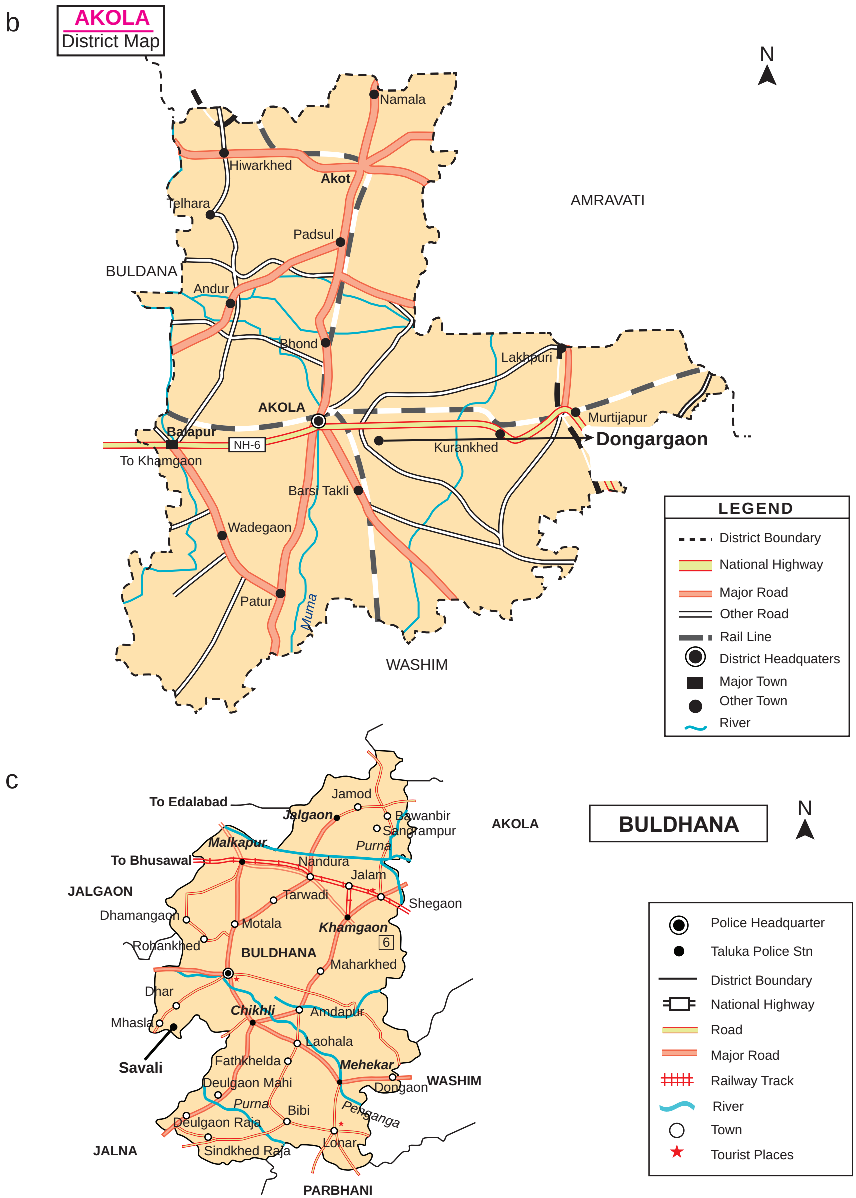

Figure 3 *Map Panel showing (a) Akola and Buldhana within Maharashtra; (b) Dongargaon village within Akola district; (c) Savali village within Buldhana district*

for soybean was Rs 13,270 while that for maize was Rs 13,465. However, the net revenue in the cultivation of maize was slightly higher: the farm business income for maize was Rs 24,035, while that for soybean was Rs 21,730. Thus, without incurring any additional expenditure prior to harvest, farmers could obtain a higher farm business income by cultivating maize, in addition to being able to

Table 12 *Indicators of cost of cultivation and profitability, soybean, Savali, 2013–14,* in Rs per acre

Operation	Cost (Rs/acre)	Remarks
Deep ploughing	800	Rent for tractor; 2 hours; Rs 400 per hour (2 × 400 = 800)
Shallow ploughing	500	Rent for tractor
Breaking clods	500	Rent for tractor
Seeds	1500	30 kg per acre at Rs 50 per kg (30 × 50 = 1500)
Labour for sowing	500	Labour charges
Fertilizers	2400	2 bags of DAP at Rs 1200 per bag (1200 × 2 = 2400), completed with sowing
Weedicides	800	Rs 3000 per litre; 250 ml applied per acre
Labour for weedicide spraying	80	2 persons at Rs 40 per acre (2 × 40 = 80)
Pesticides	2700	*Koragen*: 30 ml per acre; Rs 700 per acre; 3 rounds of *Tonic*: 60 gm per acre; Rs 600 per acre
Labour for spraying pesticides	240	2 persons per round at Rs 40 per person, 3 rounds (2 × 40 × 3 = 240)
Harvesting	2000	Piece-rated; assuming yield of 10 quintals per acre
Threshing	1000	10 quintals at Rs 100 per quintal (10 × 100 = 1000)
Transport	250	10 quintals at Rs 25 per quintal (10 × 25 = 250)
Cost A2 + FL	13270	–
Yield (quintals per acre)	10 Q	–
Output price (Rs per quintal)	3500	–
Revenue (Rs per acre)	35000	–
Farm business income (A2 + FL)	21730	–

Source: Case studies of cultivators, 2014.

earn more farm business income from a second crop of maize grown in the same plot of land.

Secondly, according to many farmers, an important advantage of maize over soybean was that maize required less application of pesticides. Thirdly, the cultivation of maize also allowed farmers to tide over the much-complained-about problem of "labour shortage" during the peak harvest season. Many farmers said that with the expansion of non-agricultural employment in nearby villages and towns, they faced major difficulties in obtaining a larger number of labourers for harvesting. On the other hand, maize could be harvested with mechanical harvesters that could be rented.

Table 13 *Indicators of cost of cultivation and profitability, maize, Savali, 2013–14,* in Rs per acre

Operation	Cost (Rs/acre)	Remarks
Deep ploughing	800	Rent for tractor; 2 rounds at Rs 400 per acre per round (2 × 400 = 800)
Shallow ploughing	400	Rent for tractor
Breaking clods	400	Rent for tractor
Row-making/Zari	400	Rent for tractor
Seed prices	1125	1.5 bags per acre; 1 bag = 3.5 kg; Rs 750 per bag (1.5 × 750 = 1125)
Labour for sowing	700	1 man and 5 women; wages at Rs 200 for men (1 × 200 = 200) and Rs 100 for women (5 × 100 = 500)
Animal weeding	500	Rs 200 for labour; Rs 300 for bullocks
Fertilizer: 20:20:20 (1)	1700	2 bags per acre; Rs 850 per bag (2 × 850 = 1700)
Fertilizer: Zinc	240	5 kg per acre; 1 bag
Fertilizer: 20:20:20 (2)	850	1 bag per acre; Rs 850 per bag
Fertilizer: Urea	300	1 bag per acre; Rs 300 per bag
Labour for fertilizer application	200	2 women; Rs 100 per day per woman; all rounds
Pesticides	375	2 rounds; 5 bags per acre; Rs 75 per bag
Labour for pesticide spraying	100	1 woman; Rs 100 per day per woman
Harvesting	3000	Piece-rated; yield: 25 quintals per acre
Threshing	1750	Rs 70 per quintal
Transport	625	Rs 25 per quintal
Cost A2 + FL	13465	–
Yield per acre	25 Q	–
Output price per quintal	1500	–
Revenue	37500	–
Farm business income (A2 + FL)	24035	–

Source: Case studies of cultivators, 2014.

CONCLUSIONS

The aim of this note is to analyse the factors associated with changes in the cropping pattern in two Vidarbha villages in Maharashtra. Our data showed that the farmers shifted out of cotton to soybean in one village, namely Dongargaon, and from cotton to soybean to maize in another village, namely Savali. Conventional economic theories focus on the decision-making of farmers based on narrow and static considerations of utility maximisation, whereas in reality farmers engage with dynamic and complex scenarios. They face multiple constraints that are economic, institutional, agroclimatic, and infrastructural in nature. This note uses an open-ended mix of quantitative and qualitative tools to better understand farmers' choices.[3]

Our analysis shows that farmers base their choice of crops not only on absolute differences in profitability, but also on their evaluation of imperfections in the capital market, and that they factor in an understanding of the risks and uncertainties involved.

In the case of Dongargaon and Savali, first, the spread of irrigation between the two surveys implied an expansion of crop-choice possibilities on the farm. This freeing of an agroclimatic constraint was an important aspect of the context in which farmers made their choices. Secondly, while Bt cotton yields remained higher than the yields of non-Bt cotton hybrids and varieties in Dongargaon and Savali, farmers were increasingly averse to the large initial investment that Bt cotton cultivation required. This was particularly so for two reasons: first, the capital market imperfections that manifested in the form of refusal of public banks to lend to farmers; and second, the highly subjective probability that farmers attached to crop failures caused by inadequate rainfall. As a result, farmers chose to settle for a low-input, low-output crop (like soybean) in favour of a high-input, high-output crop (like Bt cotton).

In Savali, the spread of irrigation allowed farmers one more option. The substitution of a four-month crop like soybean with a three-month crop like maize allowed them to sow a second and a third crop, and obtain additional income.

The decision of farmers to withdraw from Bt cotton cultivation in Vidarbha is not to be confused with the highly suspect claim of "failure" of Bt cotton. Our data show that these decisions took place within a particular policy context that led to a sharp rise in input prices and the plateauing of output prices, as well as constraints in the supply of public agricultural credit to farmers. Combined with the frequent failure

[3] A dominant view in the literature is that farmers are risk-averse. Typically, for economists, risk-aversion implies the presence of a concave utility function, while risk-proneness implies the presence of a convex utility function. A risk-averse farmer privileges an initial gain compared to a subsequent gain; as a result, farmers make choices such that even if the expected income of Choice A is lower than of Choice B, the former may be chosen if expected future variations are lower. Costs related to "risk" and "uncertainty" are also incorporated into the above framework by economists. A risk has a known probability; an uncertainty has an unknown probability. In reality, neither are probabilities of risks fully known, nor are probabilities of uncertainty fully unknown. Thus, economists assume that farmers compute a subjective probability based on the known probability, which in turn is incorporated into their utility functions prior to maximisation.
The question of whether farmers are indeed free agents, who are in complete command of their choices, has, of course, been contested. Institutional constraints (such as tenancy contracts and capital market failures), agro-ecological constraints (such as climate, topography, soil type, and irrigation) and infrastructural constraints (such as availability of markets and transport facilities) affect the choices of farmers in a basic way. A neo-classical utility framework, or even a new-institutional utility framework, is unable to comprehensively capture the complexities that underlie the choice of farmers. What cannot be modeled is often assumed as given, and hence, the dominant economic paradigm is a less useful and static framework in which to understand the choices of farmers in the presence of risks.

of rainfall in the early 2010s, these contextual factors rendered the cultivation of cotton riskier than the cultivation of other crops for Vidarbha's farmers. The shift in cropping pattern from the cultivation of cotton to soybean and maize has to be seen as a response of farmers to such risk, and should not simply (and simplistically) be dismissed as technological failure.

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