

Appendix

I. Bore-well yield data chart

Bore-well yield data chart			
Discharge (in inches)	Liters per second	Litres per hour	Gallons per hour
1.18	0.21	756	168
1.57	0.45	1620	360
1.96	0.80	2880	640
2.36	1.20	4320	960
2.75	1.80	6480	1440
3.14	2.50	9000	2000
3.54	3.40	12240	2720
3.93	4.50	16200	3600
4.33	5.70	20520	4560
4.72	7.10	25560	5680
5.11	8.60	30460	6880
5.51	10.60	38160	8480
5.90	12.30	44280	9840

Source: Indo-American Company, Amminabhavi

II. Amount of ha irrigated per crop in Rainy season and Winter/Summer season

Amount of hectares irrigated or non-irrigated in Rainy-season

		groundnut	onion	cotton	chili	Jowar	wheat	potato	Bengalgram	Greengram	blackgram	Sugarcane	Tomato	maize	paddy	
small landowners	irrigated	17	2,4	3,4	7,7	3,4	0	2	0	5,3	0	0	2	8,2	0	52
	rainfed	15	1,4	2,4	5	3,8	1	4	0	9,9	1	0	0	4,5	0	48
medium landowners	irrigated	6,7	5,3	2,1	3,4	1,6	0	0	0	1,6	0	0	1	3,4	0	25
	rainfed	15	0,5	5,1	4,3	8,9	0	2	0	9,7	1	0	2	6,1	1	54
large landowners	irrigating	31	4,5	3,6	19	2,4	0	2	0	5,9	1	4	1	22	1	97
	rainfed	75	24	14	20	39	24	7	32	66	3	10	0	3,6	0	320
Total		159	38	31	59	60	25	17	33	99	6	14	6	48	2	596

Amount of hectares irrigated or non-irrigated in Winter/Summer season

		groundnut	onion	cotton	chili	Jowar	wheat	potato	Bengalgram	Greengram	blackgram	Sugarcane	Tomato	maize	paddy	
small landowners	irrigated	5	0,8	2,4	3	12	13	0	6,7	0	0	0	2	6	0	51
	rainfed	2	0	0	0	8,5	11	0	9,9	0	0	0	0	0	0	31
medium landowners	irrigated	5	0	2	0	2,4	11	0	0,8	0	0	0	0	1	0	23
	rainfed	2	0	2	0,4	20	8,1	0	8,1	1	0	0	0	0	0	41
large landowners	irrigated	2	8,1	4	5,3	8,5	14	0	7,1	1	0	2	1	7	0	60
	rainfed	4	12	49	23	47	28	0	30	0	0	0	0	0	0	192
Total		19	21	59	32	99	85	0	62	2	0	2	2	14	0	398

III. Amount of landowners irrigating per crop

Amount of landowners irrigating of non-irrigating in Rainy-season

		groundnut	onion	cotton	chili	Jowar	wheat	potato	Bengalgram	Greengram	blackgram	Sugarcane	Tomato	maize	paddy	
small landowners	Irrigated	13	5	5	11	6	0	3	0	6	0	0	7	13	0	69
	rainfed	13	2	4	5	5	2	4	1	9	2	0	1	5	0	53
medium landowners	irrigated	5	3	2	4	1	0	0	0	1	0	0	2	2	0	20
	rainfed	7	1	4	4	8	0	1	0	8	1	0	3	4	2	43
large landowners	irrigated	7	2	2	6	1	0	1	0	3	1	3	3	2	1	32
	rainfed	11	6	3	3	5	1	2	1	11	2	1	0	1	0	47
Total		56	19	20	33	26	3	11	2	38	6	4	16	27	3	264

Amount of landowners irrigated or non-irrigated in Winter/Summer season

		groundnut	onion	cotton	chili	Jowar	wheat	potato	Bengalgram	Greengram	blackgram	Sugarcane	Tomato	maize	paddy	
small landowners	irrigated	6	2	4	8	9	13	0	7	1	0	0	7	9	0	66
	rainfed	1	0	0	0	7	8	0	9	0	0	0	0	0	0	25
medium landowners	irrigated	2	0	2	0	2	6	0	1	0	0	0	0	1	0	14
	rainfed	1	0	1	1	10	6	0	4	1	0	0	0	0	0	24
large landowners	irrigated	2	1	1	3	3	5	0	2	1	0	2	1	2	0	23
	rainfed	1	1	6	3	11	8	0	8	0	0	0	0	0	0	38
Total		13	4	14	15	42	46	0	31	3	0	2	8	12	0	190

IV. Main crops description

Rice

The major food grain crop of India is *rice*. But the crop is almost negligible for the research population in the urban fringe area of Dharwad-Hubli during the research period, due to its relatively high water requirement and instable yield. The water requirement of the large number of rice varieties vary with the season and varieties. The existence of many rice varieties is due to the Green Revolution. Rice is a typical grain cereal which is genetically modified to achieve higher yields, but it requires also many water. On average, the water requirement is about 63 cm or 0.67 cm/day in Rainy season and 103 cm or 1.02 cm/day in Summer season. Due to shorter duration and lower evapotranspirative demand of the atmosphere, there is a lower water requirement during the Rainy season. Moisture is the primary factor responsible for yield. The yield stability of rice is the least among the stability order of these crops; jowar > groundnut > maize > rice (Lenka, 1991).

Rice is the staple food of the people of the eastern and southern parts of India. The countries production increased from 53.6 million tons in 1980 to 74.6 million tons in 1990, a 39 percent increase over a decade. By 1992, rice production had reached 111 million tons, second in the world only to China with its 182 million tons. Since 1950 the increase has been more than 350 percent. Most of this increase was the result of an increase in yields; the number of hectares increased only 40 percent during this period. Yields increased from 1,336 kg/ha in 1980 to 1,751 kilograms per hectare in 1990. The per-hectare yield increased more than 262 percent between 1950 and 1992 (http://www.indianchild.com/indian_crops.htm, 13/12/2004).

On the scale of Karnataka the productivity in kg/ha increased with fluctuations in the nineties. From the year 1990-91 with a productivity of 2059 kg/ha (based on 25th Edition Indian Agriculture in Brief of the Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India (1994) and the Fertilizer Statistics of the Fertilizer Association of India, New Delhi), the productivity increased to an average of 2512 kg/ha in 1999-2000 with the years 1993-94 and 1996-97 as set back years (<http://www.ppi-ppic.org/far/farguide.nsf>, 21/12/2004). In general field paddy should be harvested when the moisture contents of the grain is about 20 to 25%. The direct drying under the sun leads to an increased breakage of the grains during milling. Yield of rice is 4 to 5 tons/ha (<http://indiaagronet.com/indiaagronet/crop%20info/wheat.htm#harvest>, 21/12/2004).

Sugarcane

Sugarcane is a highly irrigated crop. About 70 percent of the sugarcane area in India is irrigated. The commercial crop is most of the time irrigated during the pre-monsoon and post monsoon period. The duration of the crop depends on the variety and varies between 1 – 1.5 year for harvest. During the maturation phase of the crop, the crop ripens and the sucrose content in the cane increases. Shortage of the soil moisture and pre-monsoon stress reduces the sucrose contents and hardens the cane. Sugarcane needs 2 irrigations during the post-monsoon period in Southern India. Water requirement varies with climate and soils, and is by approach 220-240 cm in Karnataka.

The maturity of sugarcane is generally recognized by leaving fewer green leaves at the top. A sliced ripe cane shows a slight sparkling in its flesh in contrast to the more watery cut surface of an unripe cane. The Cooperative generally begins the sugarcane harvest about the first of November and continues for an average of 150 days. At present the harvesting and supply of sugarcane is done by farmers after receiving the cutting orders from the factory authorities, which is a coordinated undertaking to allow for maximum utilization of the mill's capacity. The cutting orders are issued depending upon the date

of planting based on an agreement between the farmers and factory. This system will not hold good as uniform maturity of the cane crop can't be controlled. In a typical harvesting unit, three or four harvesters operate in tandem with tractors and strings of wagons. The huge machines contain rotating knives, which cut the sugarcane at the base of the stalk. The cane tops are also cut off by rotating knives. As the sugarcane passes through the harvester, it is cut into 12-inch lengths called billets and then put into in-field wagons. The sugarcane is then hauled to near-by transfer stations and loaded into semi-trailers for delivery.

Sugarcane is a typical irrigated crop and needs good irrigation facilities. The yields of sugarcane differ over the different varieties. The general yields given by the Agriculture Resource Centre are for a 11 to 12 month-old plant crop under commercial cultivation 100 t/ha in case of Suru, 170 t/ha for Adsali and 120 t/ha in case of pre-seasonal sugarcane (<http://indiaagronet.com/indiaagronet/crop%20info/wheat.htm#harvest>).

The average yield in 1980-81 for Karnataka was about 85 t/ha. (<http://wgbis.ces.iisc.ernet.in/energy/agriculture/table18.html>, 21/12/2004).

The more recent average Karnataka yields of sugarcane for the nineties are based on the Indian Agriculture in Brief, 25th Edition, and the Fertilizer Statistics. These statistics show a fluctuating increase in productivity from 1990 to 2000. The Karnataka 1990-91 yield was 76989 kg/ha, and 101122 kg/ha in 1999-2000 the highest in this period. In the early nineties there was a growth to 96209 kg/ha in 1994-95 followed by a setback period 1995-96 with a yield of 79559 kg/ha.

When we take a look at the research population of Dharwad-Hubli only 2.4% of the farmers are cropping about 1 ha sugarcane. Only large landowners with good irrigation systems (2 bore-wells or more) with more than average capacity can contract these factories. Based on the experiences of these farmers they had a recent average yield of 136 t/ha.

Potato

Potato is an underground modified stem. The root system develops from buds as branched secondary systems. At maturity potato roots penetrate to a depth below 60 cm. Duration varies between 75 to 110 days this time period is short for intelligible manipulation of the water regime. Severe moisture stress results in vegetative and tuber yield depression. Irrigation alleviates the stress and induces rapid cell enlargement compensating the depressed growth. This sometimes causes malformation of tubers but frequent small irrigation will reduce this malformation. For good yields it is necessary to maintain a uniform soil water level from the tuber growth till maturity. For land preparation about 4-5 cm water is requested. And for a good yield 5-7 irrigations are required and will give a yield of 165 quintal/ ha.

Potato is mostly grown in Winter season during October to December but there are no cases in the research population in Dharwad-Hubli cropping in this season. Only 13% of the farmers cropped potato, in Rainy season.

Potato needs irrigation at frequent intervals, depending upon the soil and climatic conditions. Pre-sowing irrigation followed by 5-6 light irrigations are sufficient.

Potato is harvested from the time of its sufficient size until the vines are fully ripe. The harvesting of the early crop depends largely on the price prospects in the market. The crop should be attained maturity because of its solid content with less skin and to avoid injuries during the harvest. In general, the average yield varies from 20 to 30 t/ha. The best method storing potato is in cold stores at 2.2 °C to 3.3 °C and at 75 to 80% relative humidity (<http://indiaagronet.com/indiaagronet/crop%20info/wheat.htm#harvest>, 21/12/2004). As we see potato needs relative much water, this is one of the reasons why it's cropped in Rainy season, expecting some rain, during the drought in Dharwad-Hubli.

And the relative low amount of farmers cropping potato in the research period depends on the predictions of the market prices these were very low at that moment compared to 2001. Of the potato cropping farmers in Rainy season still 36% is irrigating. The potato irrigating small landowners were cropping potato on average on one ha. The small landowners who were dependent on rainfall were also cropping an average of one hectare and the medium landowners were cropping two hectares of rainfed potato and no irrigated hectares. The large landowners were cropping on average two hectares of irrigated potato and four hectares of rainfed potato in Rainy season. The total average potato yields based on the recent experiences of the farmers are for the irrigated crops 20.7 t/ha and for rainfed crops 18.3 t/ha.

Tomato

Tomato is an important Winter season vegetable in India and is grown extensively. Irrigation treatments increased the fruit yield significantly. In Rainy season the maximum yield was obtained with irrigation during vegetative and reproductive phase. Irrigation requirements are 40-80 cm in Rainy, Winter and Summer season planted crops.

Tomatoes are annually grown on nearly 80,000 hectares in India which is almost 1.5 per cent of the world area. The average yields in India are about 10 t/ha this is a relative poor yield comparing to a world average of 17.4 t/ha (FAO Production Year Book, 1982). The most important processing areas in India are the states of Karnataka, Maharashtra, Uttar Pradesh, Haryana and the Union Territory of Delhi. Karnataka accounts for almost 25 percent of total production of processed tomatoes. Presently, only an estimated 2 per cent of the total production in India is used for processing into various tomato products (http://www.actahort.org/books/200/200_5.htm, 21/12/2004).

In Dharwad-Hubli 19% of the farmers is cropping tomato in Rainy season against almost ten percent in Winter season. Irrigating small landowners are cropping on average 0.8 ha, medium landowners 0.9 ha and large landowners 0.8 ha in Rainy season. Rainfed tomato is only cropped by small and medium landowners, on 0.8 and 1.3 ha respectively. In Winter season only irrigated tomato is cropped. Small landowners are cropping 0.6 ha and large landowners 1.5 ha in Winter season. The seasonal yields for tomato are difficult to indicate because of the daily and weekly market harvests of the ripe fruits.

Onion

Onion is an important vegetable crop in India. It has relatively limited root systems and high demands for water. Based on cultivator practices, 5-6 irrigations are required for June planted crop, 12-15 for October and 15-20 for Summer planted crop.

Dry onion crop is ready for harvesting after 5 months. The green onion mostly used for marketing becomes ready for harvesting in three months after transplanting from the drysets where it is raised. Onion is sensitive for rotting effects. The Winter season onion should be pulled out by hand and immediately shifted to shade for curing. The harvested bulbs should never be left in main field where the heat may affect the crop and which in turn increases rotting in storage. The harvested Rainy season crop should be left in the field for few days for drying of leaves. But when the season is mild, the bulbs after harvesting should be left in the field for curing which makes it firm and dry. Generally, it takes 6-8 days for curing (http://www.ikisan.com/links/knt_onionVarieties.shtml, 29/12/2004). In general the harvested onion bulbs should be avoided from rains and direct sunlight. Injured, rotten, diseased and thick necked bulbs should be sorted out thoroughly at the time of curing before storage. The yields for onion are dependent on the different varieties but by approach the average yield for onion over India is about 25

to 30 t/ha (<http://indiaagronet.com/indiaagronet/crop%20info/wheat.htm#harvest,21/12/2004>).

In Dharwad-Hubli 24% of the farmers are cropping in Rainy season and 5% are cropping in Winter season. In Rainy season 50% of the farmers are irrigating and in Winter season 75% of the farmers who are cropping onion. In Rainy season the irrigating small landowner are cropping 0.5 ha, the medium landowners 1.8 ha and large landowners 2.2 ha. The rainfed onion is cropped by small landowners also on 0.5 ha, by the medium landowners on 0.5 ha, and by large landowners on 4 ha. In Rainy season the average yields of the rainfed and irrigated crops are almost equal around 4.9-5.0 t/ha. These yields are based on the experience of farmers in the research period and can be biased. It would appear very low, compared to the Indian average but it can be possible as result of the recent drought.

V. Questionnaire

Landownership - Large landowners > 10 ha. Area :
 Medium landowners 5-10 ha. Soiltype:
 Small landowners < 5 ha.

1. How many members are in your family?

- nuclear family
 joint family

amount of familymembers:

	Name		Age	Economic Activity	Education level
	Male	Female			
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

		<u>owner</u>		<u>renter</u>		<u>combination</u>	
* How many acres do you have?							
How many acres do you crop/cultivate?							
* How many acres, (of land) 4 years back?							
How many acres did you crop/cultivate 4 years back?							
		Yes	No	Yes	No	Yes	No
Do you hire agricultural laborers	Temp. workman (days per year)						
	Regular workman						
Do you work on the land?	Temp. (days per year)						
	Regular workman						

2. Since when do you hire in agricultural laborers?

3. How much is one laborer a day?

Man :
Women:

4.You use irrigation

	Crop 1 Name/ acres	Crop 2	Crop 3	Crop 4	Crop 5	Crop 6	Crop 7	Crop 8
Which crops do you have	Name/acre							
- Rainy-season	Name/acre							
- Summer-season	Name/acre							
- Winter-season	Name/acre							
# Which Crops are you irrigating ?								
# How many acres irrigate in total?								
Cash/commercial crop or food crop?								
Since when irrigating?								
# How many acres irrigating in 1 day?								
# How many hours irrigating a day?								
How many days irrigating in 1 week?								
How many cycles in a year?								
How many months irrigating, - Summerseason								
How many months irrigating, - Winterseason								
How many months - Rainy-season								
Yields after harvest (how many bags)								
Price per bag (on the market)								

Which crops did you have before 4 years back ?	*Name/acre								
- Rainy-Season									
- Summer-Season	*								
- Winter-Season	*								
Which of them were irrigated?									
Cash/commercial crops or food crop									
How many hours irrigating a day, 4 years back									
How many days irrigating a week, 4 years back									
How many months irrigating, 4 y back - Summerseason									
How many months irrigating, 4 y back - Winterseason									
How many months4 years back - Rainy-season									

5. How are fields irrigated?

Drainage	Sprinkler	Drip	canal	well	Pipeline	other	Costs

6. Where does irrigation water come from? groundwater, rainwater

Where is the water come from?

1. canals tank piped bore-well dug-well Motor Yes No

- How many well(s) in your land?

- Age of this well(s)?

1. Motor: Diesel Electricity
horsepower:

amount of acres irrigating a day:

costs of the motor:

costs a year (electricity bill or diesel):

For how much exchange?

10. Do you use Strategies?

- No, I don't need it

- Yes,
 - * Changed tasks of the members of the household
 - Migration of members
 - Sponsoring
 - Contracting
 - Selling land
 - Getting access to organisations/institutions
 - Other:

11. *Changes in land, *changes of tasks of the member within the household, cause of drought?