Efficient water management: way forward to climate smart grain legumes production

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15 July 2014

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Abstract

The most important way to increase the grain yield of food legumes per unit area under stress environment should be consist of proper technological backup with infrastructure, timely availability of quality inputs along with policy support. Efficient water management is one of the critical inputs as in general perception is that legumes need no supplementary water, whereas research finding revealed that need based watering at critical stages are capable to improved production by 15-25 % depending up how much stress has already being faced by the standing crop till now.

Keywords: climate change, legumes, water management, food security

1. Introduction

Legumes are the basic ingredient in the diets of a vast majority of the Indian population, as they provide a perfect mix of vegetarian protein component of high biological value when supplemented with cereals (Andrews and Hodge, 2010 ; Ali and Gupta, 2012). Grain legumes are not only important sources of proteins but also offer vitamins and minerals, popularly known as "Poor man's meat" and "rich men vegetable". For an active normal body grain legume requirement is about 40 g per day or 14.6 kg per person per year (Narasinga Rao, 2010). Data clearly indicated that availability and intake decrease with the period of time, which was 60.5 g/day during 1950-51 and 31.6 g during 2010-11 (GoI, 2012). Since republic (1950) productivity of legume has been increased by 0.56 times respectively. Area production and productivity were registers incremental growth with the time at all India levels, though fluctuations were noticed in case of all the parameters. At All Indian levels remarkable, 30 per cent, growth in area under grain legume (26.28 Mha) was notice during 2010-11.

1.1 Important grain legume crops of India

As rainfed crops, legumes are mostly mixed or intercropped with cereals or long-season and widely-spaced crops. Cropping systems research has identified - compatible crops for intercropping and the optimum proportions and spatial arrangements that yield maximum intercropping advantage.

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Chickpea or gram (*Cicer arietinum* L.) and pigeonpea or "tur" (*Cajanus cajan*) which together account for 61 per cent of the total pulse production, are the principal grain legumes; chickpeas are grown in the post-rainy season (Oct.—March) and pigeonpeas are planted in the rainy season (June-Oct.). Other legumes grown exclusively in the post-rainy season are lentil (*Lens culinaris* Medic), "khesari" or grasspea (*Lathyrus sativus* L.) and peas (*Pisum sativum* L.). Mungbean or green gram (*Vigna radiata*) "urd" or black gram (*Vigna mungo*) and cowpea (*Vigna sinensis*) are grown in both seasons but the post-rainy season crop is possible only in the warmer parts of the country. Where irrigation is available these can also be grown in the summer. Other grain legumes grown in the rainy season with limited regional importance are field beans (Lablab purpureus L.) Sweet moth bean (*Vigna acantifolia*), cluster beans (*Cyamopsis tetragonolobus*) and soybean (*Glycine max*). Groundnut (*Arachis hypogaea*) is the major oil seed legume grown in both seasons but in the post-rainy season the crop is mostly confined to the irrigated areas of peninsular India.

1.2 Agricultural productivity

Irrigated area produce 2.5 to 3.5 t/ ha, whereas in case of rainfed it is still ranged in between 0.8 to 1.0 /ha. Is it not a self-explanatory to focus on the important of efficient water management in agriculture production? Foregone narration is enough to indicate the priorities and possibilities for water management in legumes.

1.3 Importance of climate and legume options

Only a limited number of crops are adapted to the climatic conditions and the farmer must sow the crop best suited to the moisture conditions encountered at that time. Success with rigid or complex sequences is difficult in the face of widely varying rainfall. To achieve the optimum production potential under different abiotic and biotic stress condition, selecting crops and theirs varieties based on criteria described in this presentation would certainly boost crop production efficiently in India (Singh and Kumar, 2009). Studies on climate change have underscored two points; first that atmospheric commons, namely the earth's carbon absorbing capacity, is finite and depletable and that growth of GHG emissions, even at their present level pose a threat to humankind (Singh et al., 2013). Carbon pollution is causing the world's climate to change not only on the magnitude of the change but also on the potential for irreversibility, resulting in extreme weather, higher temperatures and more droughts. Our earth is undoubtedly warming. This warming is largely the result of emissions of carbon dioxide and other Greenhouse Gases (GHG's) from human activities including industrial processes, fossil fuel combustion, and changes in land use, such as deforestation etc. Day by day the cycle of climate on earth is changing. Global warming has led to season shifting, changing landscapes, rising sea levels, increased risk of drought and floods, stronger storms, increase in heat related illness and diseases all over the world. This has resulted due to emissions of Green House Gases (GHG's) from various anthropogenic activities (IPCC, 2007). An increase of temperature by 1°C it would be equivalent to a 150 km Northward shift of isotherms (lines joining places with similar temperature) or about 150 m lower altitude. There is a 5 per cent decrease in rice yield of every °C rise in temperature above 32 °C (IPCC, 2007 and Salih and Hardallou. 1986). According to recent report by Inter Governmental Panel on Climate Change (IPCC) by 2100 AD, due to global warming the average global surface temperature is projected to increase by 1.1 to 4.0 °C above 1990 levels for low emission scenario of greenhouse gas (GHG). The furthermost upsetting portion of the forecast is the estimated increase in winter time and summertime temperatures by 3.2°C and 2.2°C respectively, by 2050 (Wani et al.,2 003). Such uncharacteristic rises drives surely have an adverse impact on pulse production in the form of a reduction in total crop-cycle duration. Grain legumes like mung bean and urd bean are short-duration crops (65-75 days). Further reduction in crop duration will amount to a lower yield per unit area (Singh et al., 2012a). However inclusion of summer pulse/legumes particularly short duration mung bean under irrigated condition (Singh et al., 2012a). Inclusion of grain legume in cropping system as intercrop particularly crop with wide space like sorghum, maize sugarcane etc. will certainly instruments stability in respect to oilseeds and especially grain legume production and will bound to prosperity in this region (Singh and Kumar, 2009).

2. Why water management is so important in grain legume production?

Poor soil and agro-climatic conditions not only compel late sowing of winter legumes, which leads to reduced length of growing period but also necessitate to sustain cold injuries at early vegetative phase which freeze all biological activities for prolonged period. A sudden rises in temperature after that, not only induces forced maturity but simultaneously invites several biotic stress viz., diseases and insects pests (Ali *et al.,* 2012; Reddy, 2009 and Singh and Singh, 2008). Traditionally winter legumes sowing is delayed up to last week of November and some time under extreme circumstances it goes up to the first fortnight of December, obviously due to reasons already explained. However, optimum sowing time of winter legumes is first fortnight of October (Singh *et al.*, 2013 and Ramakrishna *et al.,* 2000). Consequent upon delayed planting, early encounter with severe cold, growth and development of winter legumes crop gets hampered for a considerable period. Subsequently plants get comparatively less time to complete their lifecycle which, by and large forces maturity (Ramakrishna *et al.,* 2000). In Indian IGP, normal sown winter legumes is a medium duration (130-150 days) crop, while under late sown conditions it is forced to complete its life cycle in 105±5 days (Joshi, 1998; Ramakrishna *et al.,* 2000; Reddy, 2009; Singh and Singh, 2008 and Singh *et al.*, 2012). Typically, a late sown winter legume undergoes three distinct phases and considerable degrees of phenological modifications are bound to happen. Eventually, winter legumes crop during its early seedling phase grows slowly due to its energy invested in the initial establishment (Singh *et al.*, 2002 and Singh *et al.*, 2012). However, in mid-phase, insignificant growth and development is observed. This poses serious threat to realization of full yield potential due to cold injuries. This phase is very important for creating source of channelizing the energy at later stage. In the last and most important phase winter legumes faces heat injury, resulting in early onset of reproductive phase, causing imbalance in resources and inputs, biotic stress and forced maturity (Joshi, 1998; Dixit *et al*. 2009; Reid *et al.*, 2011 and Singh *et al.*, 2012). To improve the winter legumes production under late sown conditions of Indian IGP, critical examination of situation revealed that, interventions to boost vegetative growth during early and mid-phase of life, to create base / source is the basic necessity that can be achieved by accelerated vegetative growth, and finally unilateral translocation of photosynthate to sink during reproductive stage(Guilfoyle and Hagen, 2001and Pandey and Gautam, 2009) are therefore essential.

3. Crops and cropping pattern

Moisture is basic necessity for existence of any farm of life including agriculture. Crops and cropping patter is interdependence and interchangeable largely influenced by growing period of particular region which is again an outcome of soil and climatical considerations. An attempt has been made to quantify the agricultural / cropping activities based on length of growing period basically depends on availability of water/ moisture to support successful crop production (Table 1).

Table 1: Choice of cropping pattern for different growing periods

Length of growing period	Efficient cropping system
<75 days	Perennial vegetation
	Monocropping of short duration pulses
75-140 days	Monocropping
140-180 days	Intercropping
> 180 days	Double cropping

4. Criteria for selecting crop for water scanty situation

Selection of crop /species based on their tolerance to dry spell/condition, temperature salinity etc. Fallowing crops mentioned in table 2 may be selected as per their tolerance power (degree of tolerance) to environmental abiotic stress and off course requirement. Crop succeeds under series of event, interaction with surrounding environment particularly with soil, water and weather conditions upon which biotic stress is buildup (Andrew and Hodge, 2010). One should select crops for their agroclimatic situation based on consideration mentioned elsewhere in this article. Survival of fittest and adoption to the extreme condition is two widely accepted theories in this modern biological system but in real situation both are seen in combination because nature is great leveler in one or other respects for coexistence of above said theories partially in agricultural production system some crops requires more water where as some need comparatively less than others (Loss, 1997). Economic plants which are more concern in agricultural systems are annual, biennial or some perennial herbs, based on agro-ecological conditions and availability of water crops are simply divided in to two category water loving plants (hydrophytes, cryophytes etc.) and some of them having less affinity to water are (sandophytes). Based on experience gained due to experimentations and evolves from centuries lists of crop are given in the table 3 which needs less water than others. Crops are also categorized based on their relative degree of tolerance to the limited water. Generally grasses and beans are hardy in nature and considered more tolerant than others.

Table 2: Legume crops for limited water supply

Scientific Name	Common Name	Degree of Tolerance*
Leucaena leucacephala	Leucaena	2.0
Phaseolus vulgaris	Common Bean	1
Vigna unguiculata	Cowpea	1.5
Cajanus cajan	Pigeon Pea	2.0
Dolichos lablab	Lablab Bean	2.5
Vigna radiata	Mung Bean	2.0
Phaseolus acutifolius	Tepary Bean	2.5
Vigna aconitifolius	Mat Bean	2.5
Tylosema esculentum	Marama Bean	3.0

Rated from 0 (no tolerance) to 3 (high tolerance)

5.1 Growing season and rainfall requirements:

Under limited irrigation condition, duration of crops and their total water requirement and breakup of requirement is very much essential. According to availability of scanty water one should select crops as per in table 3 and 4. List may be endless but some of most widely grown and used only are listed with respect to days taken to complete vegetative phase and post vegetative(reproductive) phase for long duration (late maturing) and se well as short duration (early maturing) genotypes.

5.2 Soil Consideration:

Before selecting particular crops and their specific variety we must considered the type of soil, depth of soil, fertility status, salt tolerant capacity, pH of the soil and minimum depth of ground water along with the capacity of tolerance to short periods of water logging and moisture stress. According to above consideration, requirements for different principle crops are laid down in table 4.

Table 3: Growing season and total water requirements for selected drought tolerant crops

Crops Name	Number of Days				Rainfall after Sowing				Rainfall in Month of Flowering		
	From sowing to 50% flowering		From sowing to harvest		Early Maturing		Late Maturing				
	Early Maturing	Late Maturing	Early Maturing	Late Maturing	(Sand) No moisture storage	(Clay) Maximum Moisture Storage	(Sand) No moisture storage	(Clay) Maximum Moisture Storage	(Sand) No moisture storage	(Sand) No moisture storage	Rainfall at Harvest
Ground Nut	60	90	95-110	110-140	300 mm/ 3 months	125 mm/ 3 months	500 mm/ 4 months	300 mm/ 4 months	60 mm/ 10 days	60 mm/ 10 days	30 mm/ 10 days
Chick Pea	---	----	120	180	200-300 mm/ 3 months	0 mm/ 3 months	300-400 mm/ month	100 mm/ 4 months	25 mm/ 10 days	25 mm/ 10 days	25 mm/ month
Pigeon Pea	100	210-300	150-180	270-360	500-1000 mm/ 6 months	300 mm/ 6 months	700-1300 mm/ 12 months	700-1300 mm/ 12 months	40 mm/ 10	40 mm/	50 mm/ mon

Table 4: Soil requirements for selected drought tolerant crops

Soil Characteristics		Legumes			
		Ground Nut	Pea	Gram	Cowpea
Texture	Heavy			√	
	Medium	√	√	√	√
	Light	√	√		√
Minimum rooting Depth (cm)	Deep (90+)				
	Med. (60-90)	√	√	√	√
	Shallow (30-60)				
Fertility	High				
	Medium	√	√	√	√
Salt Tolerance	Good				
	Moderate				
	Poor	√		√	√
pH Range		6.0-8.0	5.5-7.5	5.5-7.5	5.5-7.5
Tolerance to short periods of water logging		Low	Medium to Low	Medium to Low	Medium to Low
Minimum depth of ground water (cm)		60	30-50	30-50	40

6. Water management in grain legumes

It is well known fact that three basic resources, viz. climate, soil and water, determine the nature of crops that can be grown successfully in a particular region (Singh and Kumar 2009).An efficient utilization of these resources is essential for optimum production of food for human consumption. Under a given set of environmental conditions production of crop is limited by the availability of nutrition and water. Soil provides anchorage for the plants and also serves as a reservoir of water and nutrients required by them. While chemical fertilizers supplement the low nutrient supplying capacity of the soil, there is no substitute of water for production of crops. Efficient management of water, a limited resource as it is, is of utmost importance for sustaining and increasing the production. Water, crucial to life and existence, is an important aspect in the cultivation (Singh, 2012). Drought stress has become the major limiting factor on plant growth and yield. Water deficit during the reproductive growth is considered to have the most adverse effect on crop productivity.

6.1 Water use efficiency in grain legumes

Water use efficiency (Y/ET) is the outcome of an entire suite of plant and environmental processes operating over the life of a crop to determine both Y and ET. Consequently, biomass production per unit ET, has been used extensively as an interim measure of water use efficiency. ET comprises non-productive evaporation (E) of water from the soil surface and productive transpiration (T) of soil-stored water by the plant. Evaporation of free water from leaf surfaces adds to non-productive evaporation (interception evaporation) (Ali, 2008). Crop grown in a sunny and hot climate needs more water per day than the same crop grown in a cloudy and cooler climate. There are, however, apart from sunshine and temperature, other climatic factors which influence the crop water need. These factors are humidity and wind speed. When it is dry, the crop water needs are higher than when it is humid. In windy climates, the crops will use more water than in calm climates. The highest crop water needs are thus found in areas which are hot, dry, windy and sunny. The lowest values are found when it is cool, humid and cloudy with little or no wind. From the above, it is clear that the crop grown in different climatic zones will have different water needs and thus water use efficiency also varies accordingly (Ali, et al 2012). It was noticed by several researcher that dicot plants are more efficient than monocots, similarly C3 plan are performed better than C4 plants (Keller et al., 2000).

6.2 Irrigation Requirement:

The crop requires total 4 -5 irrigations i.e. two irrigation at an interval of 7 days and three irrigations at an interval of 15 days. Legume plants with relatively high water requirements are very sensitive to soil drought as lesser rainfall during the vegetation season is one of the most important environmental factors limiting the crop yield. Irrigation is not recommended about 2 weeks after planting. Excess water at seeding slows growth and may increase root rots. During the rest of the season, moisture levels in the topsoil should be kept at or above 50% of available water. Critical stages at which water stress should be avoided to the crop are two critical times during bloom and pod set. Soil type does not affect the amount of total water needed, but affect frequency of water application. Growth and development of legume crops in general is very sensitive to water stress. That sensitivity is a result of its maximum depth of rooting is relatively shallow, approximately 0.9 m (Hebblethwaite, 1977). An experiment conducted in Eastern Sudan reported more economic yields were when the crop was irrigated at 21-day intervals up to flowering and at 7-day intervals after the onset of flowering. The highest grain and total biological yields were obtained when irrigation was at intervals of 14/7 days (Farah et al., 1990). In a field experiment at loamy-sand soil in Saudi Arabia, it is reported that considerable grain yield of most of legumes seed can be achieved if irrigated at 15% soil moisture depletion from field capacity, which was not significantly different from the yield at field capacity (Naeem, 2008).

6.3 Critical growth stage for grain legumes

Drought of different intensity is experienced in rainfed areas at various growth stages of legumes. Response to limited irrigation has been observed in most of the grain legumes. Among various crops, common bean *(Phaseolus vulgaris L.; French bean*) was found to be more responsive to irrigation followed by pea. The success of mung bean as a catch crop (during summer months) in the rice-wheat system is solely dependent upon adequate supply of irrigation plants (Keller et al., 2003). Latesown chickpea in sequence with rice also needs irrigation compared to the normal sown crop, probably due to restricted root growth with late sowing. Pre flowering or flower initiation and post podding has been found to be the most critical stage in most of the legumes. However, the initial soil profile moisture and soil types largely determine the requirement of subsequent irrigation. Similarly, excess moisture or water logging reduces oxygen concentration in the rhizosphere and thus affects BNF activity and nutrient availability with consequent yield reduction. Therefore, it is imperative to provide good drainage, especially in low-lying areas

7. Grain legume performance in response to water management

Most of legumes is best adapted to the more moist agriculture areas and does best under relatively cool growing conditions. Hot, dry spells result in wilting of the plants and may reduce seed set. The crop should be grown with caution in the brown soil zones and on droughty, light-textured soils unless irrigation is available, as most of legumes respond very well to irrigation. Agronomy of irrigated most of legumes is similar to dry land production. Yields can be much higher than dry land production; however, special attention must be paid to prevent losses due to diseases, such as *botrytis* and *ascochyta*.

7.1 Grain yield

Since, there is a certain correlation between dry matter production and grain yield in most of legumes crop; it appears that the maintenance of adequate levels of water throughout the vegetative growth of most of legumes is essential for high yields (Golezani et al., 2009). The most of legumes is regarded as a drought-sensitive crop and the major factor restricting its cultivation is the high year-to-year yield variability usually due to drought stress. Water stress decreases the final leaf area, net photosynthesis, light use efficiency, pod retention and filling by reducing the availability of assimilates and distorting hormonal balance. Water limitations considerably reduces grain yield of cultivars, due to large reductions in growth, grain filling duration, grain weight and grains per plant. Superiority of well-watered (I1:70 mm evaporation from Class A pan) plants in growth and grain filling duration resulted in production of comparatively more and larger grains and consequently higher grain yield per unit area (Table 5).

Table 5: Comparison of means of maximum grain weight, grain filling rate, grain filling duration, grains per plant and grain yield of three faba bean cultivars under different irrigation conditions.

	Treatment	Grain filling rate (mg d-1)	Grain filling duration (day)	Maximum grain weight (mg)	Grains per plant	Grain yield (gm-2)
Irrigation	I1	38.45a	43.16a	1400.0a	9.156a	493.4a
	I2	33.45a	38.69a	1214.5b	5.378b	264.4b
	I3	35.34a	30.00b	1116.9c	3.267c	157.0c
Cultivar	Aquodolce	35.46a	37.72a	1233.0b	5.322b	266.9b
	Barakat	35.41a	40.42a	1356.2a	7.411a	412.5a
	Saraziri	34.26a	33.88b	1141.7c	5.067b	235.4b

Source: Goelezani *et al*. 2009

Note: different letters in each column indicating significant difference at P<0.05. I1, I2 and I3 denotes irrigation after 70,100 and 130 mm evaporation from Class A pan respectively Therefore, sufficient water supply during plant growth and development is necessary to ensure a satisfactory supply of assimilate to the grains via an extensive and long-lived foliage. Water shortage exerted a large adverse influence on dry matter accumulation, crop growth rate and relative growth rate of most of legumes cultivars (Golezani et al., 2009). Ageeb et al. (1989) reported that irrigation to most of legumes at 7-day interval increased seed yield and the number of plants/m2, while the number of pods/plant and 100-seed weight were decreased. Many studies have reported very substantial increases in seed yields as a result of proper irrigation; including studies in regions where rainfall is abundant throughout the growing season Water requirements have not been determined, however, when growing most of legumes as a cover crop. Proper irrigation scheduling is expected to differ when the crop is grown as a cover crop compared with when it is grown for seed production. Stock and El-Naggar (1980) concluded that the optimum soil water content during flowering was at 40–60% of the available water and that either higher or lower water content resulted in sub optimal seed yields. Shuaibani, 2009 reported that water stress leads to significant decrease in number of days to flowering and maturity (Table 6). The highest reduction in seed yield was detected in T1 and T2 treatments (Table 7) which may be due to unfavorable conditions of plant growth as a result of lower water supply.

Table 6: Influence of water deficit on some growth parameters of faba bean two growing seasons, (combined analyses of two seasons)

Treatments	Parameters					
	Plant height (cm)	No. of leaves/plant	Leaf area per plant (cm2)	Plant weight (g)	No. of days to 50% flowering	No. of days to 50% of maturing
T1-Total applied water 2000m3	49.11	54.67	1222.67	978.3	44.63	123.25
T2-Total applied water 3000m3	51.75	44.33	1205.67	1132.3	46.13	124.38
T3-Total applied water 4000m3	62.58	105.33	2336.67	1325.3	46.38	125.13
T4-Total applied water 6000m3	76.10	112.67	2493.33	2176.10	45.50	130.38
T5-Total applied water 7000m3	82.16	112.98	2542.22	2706.9	45.25	137.5
T6-Total applied water 7500m3	85.25	111.67	2431.56	281.3	45.88	140.63
LSD at 0.05	7.00	5.42	44.53	343.35	0.98	2.25

Source: AL-Suhaibani N.A., 2009.

Table 7: Influence of water deficit on some yield parameters of faba bean in two growing seasons, (combined analyses of two seasons)

Treatments	Parameters				
	No. of tillers/plant	No. of pods/plant	Seed weight per plant (g)	100-seed weight (g)	Biological yield (t/ha)
T1-Total applied water 2000m3	5.11	9.41	508.3	72.66	3.23
T2-Total applied water 3000m3	5.94	8.95	553.3	82.99	3.74
T3-Total applied water 4000m3	6.05	11.79	612.1	87.44	4.37
T4-Total applied water 6000m3	6.61	13.60	902.5	86.10	7.18
T5-Total applied water 7000m3	7.19	15.29	1285.5	88.63	8.93
T6-Total applied water 7500m3	7.03	17.14	1210.1	93.21	8.52
LSD at 0.05	0.98	2.43	139.4	2.96	1.13

Source: AL-Suhaibani N.A., 2009.

Husain et al. (1988b) found that irrigation had little effect on faba bean growth in New Zealand when precipitation was adequate early in the growing season. Study indicated that farmers can reduce the need for irrigation by planting the crop later in the year when temperatures are cooler and winter rains are more reliable. In fact, with sufficient soil moisture available at the beginning of the season, it appears that the water requirements for growing faba bean can be adequately met by winter precipitation in central California, particularly when rainfall is above normal. Ouda et al. (2010) found that irrigating most of legumes with 80% of full fresh or drainage water could reduce yield by 7%. However, reschedule irrigation and applying 3156 and 3366 m3/ha of fresh and drainage water, respectively reduced yield losses to less than 1%. These findings implied that avoiding sensitive growth stages to water stress in faba bean could help in saving an ample amount of irrigation water.

7.2 Biochemical composition

Grain legumes are in general susceptible to water logging. Laser leveled bays are suitable if well drained. If drainage is not good, then beds should be considered. Irrigation times should be kept as short as possible as water logging will cause temporary growth reductions and will affect yield. Drainage is a combination of surface and internal drainage. Surface drainage can be improved with large capacity drains with good outfall, laser-levelled and smoothed bays and beds or spinner cuts. Internal drainage is related to soil structure and can be improved with gypsum where appropriate, and with pasture rotations. Minimizing cultivation, particularly of dry soil, can help to preserve soil structure and internal drainage. If drainage is less than ideal, rains following irrigation can lead to prolonged water logging and subsequently reduce yield. Pre-irrigation and sowing into moisture is a strategy successfully employed on many farms. The alternative is to rely on rainfall. Dry sowing can be successful by ensuring that the earliest rain is used to germinate the crop. The irrigation during flowering should not be too late as this may hasten the end of flowering and severely affect yield. If water is available it should be planned in such a way that plant remains free from water stress (Tewati and Virk 1996).

8. Water productivity:

The term water productivity is used to denote the amount of value of product over volume or value of water depleted or diverted or used. The value of product may be expressed in terms of biomass, grain or money. Crop water productivity may be computed during crop period considering the production or value of production from crops and water used during the period (either on the basis of irrigation water or total water used including rainfall). At the field level agronomists evaluate the productivity of water through water use efficiency, the ratio of yield to water consumed (kg/m3) by the crop through evapotranspiration (Doorenbos and Kassam 1979; Kinje et al., 2003) or as the yield per unit depth of water per area kg/ha/mm (Gregory 1989). Loss et al., reported that under Mediterranean-type environments, WUE for dry matter production and seed yield from early sown most of legumes (up to 36 and 14 kg ha−1 mm −1, respectively) were equivalent to cereals and greater than those for other grain legumes. Irrigation water-use efficiency was highest when plants were irrigated at 50% Etc as observed by Bryla et al. (2003) in subsurface drip irrigated most of legumes in California. Under deficit irrigation in Egypt, water productivity value was 1.14 and 1.21 kg/m3 under the application of

3156 and 3366 m3/ha of fresh and drainage water, respectively as reported by Ouda et al., 2010. WUE generally increased with supplemental irrigation (SI), up to the 2/3 SI level, and then decreased (except for early sowing) beyond that. Under rainfed conditions, early sowing resulted in the highest water use efficiency as reported from Syria by Oweis et al., 2005.The normal sowing date (Mid December) resulted in the maximum water productivity. Late sowing steadily resulted in the lowest water use efficiency under all levels of water availability.

9. Summary and Conclusion

We have achieved impressive economical and agricultural growth, but still incidences of hunger, malnutrition and poverty are unacceptably high, thanks our policy planner to implementation of The National Food Security Bill (NFSB) though by ordinance to provide food to poor's. Expectations of impending climates specify immense modifications in temperature, rainfall pattern, humidity and soil moisture regimes. Changes in climate not only influence the entire cropping system but also affect the performance of cultivars of different field crops including legumes. There is pressure on food legume to maintain or even to be higher yielding under the expected climate changes. Apart from other technologies and inputs like improved genotype with respect to improved resistance to multiple biotic stresses, water management will certainly going to be very crucial due multiple abiotic stresses.

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