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Stagnating Crop Yields - A Challenge To Future

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Introduction

With the ever increasing population and rise in our energy demands, feeding the hungry planet and sustaining the current environment is no less than a struggle for the coming generations. Problems increase manifold with some sporadic reports of stagnation in yield of major crops around the globe. For the current key crops -rice ,wheat ,maize and soybean, which provide ~64% of agricultural calorie production, there is significant evidence for staggering crop grain yields and this situation will in turn adversely disturb the world food system.

Crop grain yield stagnation implies the situation where the yield once improved and then staggered or collapsed, or it was not improved in the first place. Although there is not sufficient data of spatial distribution for global crop yields but from the current records of the United States it is clearly evident that at ~36% of the American wheat harvested areas the yield is not improving. These results underscore the growing challenges of coping with the increasing agricultural demands globally. It is also found that across 24–39% of maize, rice, wheat and soybean-growing areas, yields has never improved, stagnated or collapsed. While a all-round analysis depicts that historically there were noticeable improvement in yield around the world with the percentage of world that never experienced any yield improvement in the four crops (rice, wheat, maize, soybean) to be less than 1 percent.

At the world level the uneven trends in yield are witnessed due to both biophysical and socioeconomic factors. Erratic rainfalls due to climate change, higher night time temperatures, declining soil fertility and quality, scarcity of water resources ,resistance build up among major pests and diseases, lack of financial support and the conditions of current cultivars reaching their yield potential are some of the key factors in building up the problem in the first place.

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Table 1 | Yield status globally and for the top 10 producers.

Maize				Rice				Wheat				Soybean			
		m. ha	%			m. ha	%			m. ha	%			m. ha	%
	NI	43.7	29.9		NI	57.4	37.5		NI	82.8	38.8		NI	20.1	24.3
	a	0.9	0.6		a	1.6	1.0		a	2.8	1.3		a	0.8	1.0
Global	b	38.2	26.1	Global	b	53.7	35.1	Global	b	78.4	36.8	Global	b	19.0	23.0
	c	4.7	3.2		c	2.1	1.4		c	1.6	0.8		c	0.2	0.2
	IM	102.7	70.1		IM	95.6	62.5		IM	130.4	61.2		IM	62.6	75.7
USA	NI	2.4	7.6	China	NI	22.7	78.7	China	NI	12.8	55.5	USA	NI	2.6	9.0
	IM	28.8	92.4		IM	6.1	21.3		IM	10.3	44.5		IM	26.3	91.0
China	NI	14.6	52.2	India	NI	16.0	37.1	India	NI	18.9	69.9	Brazil	NI	2.1	14.1
	IM	13.3	47.8		IM	27.1	62.9		IM	8.1	30.1		IM	12.5	85.9
Brazil	NI	1.8	18.8	Indonesia	NI	9.8	81.4	USA	NI	7.4	35.9	Argentina	NI	1.7	12.4
	IM	7.8	81.2		IM	2.2	18.6		IM	13.2	64.1		IM	12.2	87.6
Mexico	NI	2.2	31.0	Bangladesh*	NI	0.0	0.0	Russian Federation*	NI	-	-	China	NI	5.4	58.1
	IM	4.8	69.0		IM	10.6	100		IM	24.0	100		IM	3.9	41.9
Argentina	NI	0.1	5.2	Vietnam	NI	0.2	2.1	France	NI	4.2	79.2	India	NI	3.8	51.4
	IM	2.6	94.8		IM	7.2	97.9		IM	1.1	20.8		IM	3.6	48.6
France	NI	0.2	10.5	Thailand	NI	0.3	2.6	Canada	NI	0.08	0.8	Paraguay	NI	2.2	98.4
	IM	1.5	89.5		IM	10.0	97.4		IM	9.3	99.2		IM	0.04	1.6
India	NI	2.9	37.1	Myanmar*	NI	0.0	0	Germany	NI	1.5	80.4	Canada	NI	0.0	0.0
	IM	4.9	62.9		IM	7.6	100		IM	0.4	19.6		IM	0.9	100
Indonesia	NI	0.07	1.9	Philippines	NI	0.5	11.9	Pakistan	NI	1.1	13.4	Bolivia	NI	0.9	99.8
	IM	3.5	98.1		IM	3.7	88.1		IM	7.3	86.6		IM	0.0	0.2
Italy	NI	0.7	59.2	Brazil	NI	0.5	21.2	Australia	NI	7.7	60.2	Indonesia	NI	0.3	59.2
	IM	0.5	40.8		IM	1.8	78.8		IM	5.1	39.8		IM	0.2	40.8
South Africa	NI	0.0	0.0	Japan	NI	0.3	19.3	Turkey	NI	5.4	63.6	Italy	NI	0.1	99.9
	IM	2.8	100		IM	1.4	80.7		IM	3.1	36.4		IM	0.0	0.1

Abbreviations: NI, yields not improving; IM, yields improving.
Global breakup into the three NI yield trend types also provided ((a) Yields never improved + (b) Yields stagnating + (c) Yields collapsed). Percentages may not add up to 100% because of rounding.
See Supplementary Data 1 for details of all countries analysed.
*Only national analysis. Top ten producers based on average production for the decade ending 2008 as reported by FAO. Areas are based on the average harvested area for 2004–2008.

(Table reference: Deepak K. Ray, Navin Ramankutty, Nathaniel D. Mueller, Paul C. West & Jonathan A. Foley. (2012) Recent patterns of crop yield growth and stagnation. *Nature communication* 3, Article number: 1293)

Although, the intensified cropping systems helped in increasing the farmer's income but have resulted in crop failures and increased yield variability in a limited resource environment. This might have been helpful in increased total factor productivity (output produces per unit of input), but was ineffective to support the crop-wise production. Another ray of hope comes from improved crop management practices that may help in closing the yield gaps to some extent, but miracles don't happen. In addition to that, long decades of biochemical and physiological research depict the difficulties in translating basic research into crop yield improvement in fields.

So it is evident that notable efforts are needed in the agriculture sector in coming years to meet these growing challenges of fulfilling the food requirement and sustaining a livable environment. As there is no single factor contributing to the current stagnation of crop yield, so each issue should be addressed separately and a overall synergistic approach should

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be followed integrating techniques from different domains of agriculture including soil science ,plant protection and plant science.

Some promising paths lead us to non-traditional ways of breaking the barriers listing, molecular crop transformation and site specific management (SSM) of crops as two prominent techniques suitable to bereave the current scenarios. Genetic engineering of crops will help us to develop crops with higher efficiency towards limited inputs while SSM will help in providing inputs according to the inherent spatial and temporal needs of a plant.

Conclusion

Keeping in mind the insufficiency of recent crop production trends, additional efforts are required in low performing areas and sustainable conservation practices for the currently performing geographical units.