Participatory climate risk assessment with dryland farmers

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Abstract
Farmers in predominantly rainfed farming systems face significant production risks associated with variable climate. The impact of climate risks are further exemplified for many subsistence farmers whose capacity to cope with production losses is limited. Assessing the risk is a first step towards managing or minimising climate related production risks. The objective of this study is to quantify the climate risk perceptions of farmers in a dry land agriculture setting as an input into discussions on climate risk management. This study is set in the Telangana region of Andhra Pradesh, India. Farmers' production risk assessment has been captured via administering a semi-structured questionnaire. As farmers relate to crop calendars and climate variability, the methodology focuses on using crop calendars (crop phenology) as an entry point to link different climate variables to different stages of crop development. Farmers' knowledge on how different climatic variables impact cropping at different stages (such as early or late onset of monsoon, excess rains/dry spell at critical stages of crop development, extreme events such as hailstorms etc) has been captured. As an example, results from paddy rice farmers are presented. Farmers ranked in a decreasing order: late rains at transplanting, excess rain at tillering, flowering and harvest, and excess temperature at panicle extension, as climatic events adversely impacting the yield. The analysis and results from this study are expected to provide useful inputs to the seasonal climate forecasters on the priorities of the farming community, used in discussion on adaptation options in the context of variable and changing climate.

Key Words
Climate variability, crop calendars, production risk, climate risk management

Introduction
Understanding the risks posed by the current season-to-season variability of rainfall and its multiple impacts and having clearly defined risk management frameworks to cope with it are critical to minimise production losses as a result of climate risks (Aggarwal et al, 2010; Meinke, 2006). A number of opportunities to facilitate management of climate risks in agriculture exist today, including agro-advisories and early warning systems. Traditionally these approaches tend to take a top down approach for climate risk assessments, agromet-advisories and extension services. We argue that a participatory approach involving the farming communities to quantitatively assess risks related to climate on their crop production could provide relevant bottom-up feedback so the risk assessment and management strategies could be more effective and tailored. The focus of this work is on farmers' understanding of climate variability and strategies to manage the risk associated with the variability which forms an important input to discussions on adaptation.This has been achieved using a risk based approach to quantify climate influenced production risks for two major crops viz., paddy rice and cotton for the kharif season (June to October). The results are expected to provide critical bottom-up inputs for agronomists and agro-meteorology service providers to support farming communities in their effort to minimise the climate related production risks. The study region is set in Andhra Pradesh state in India and comprises three villages viz, Gorita (low rainfall), Nemmani and Bairanpalli (high rainfall). The work presented in this paper is part of a larger ACIAR-CSIRO project on developing multi-scale adaptation options in the context of climate variability and climate change in Laos, Cambodia, Bangladesh and India. The work presented here is a brief version and more detailed version of the paper will appear as a separate publication.

Figure 1 Study region

Method
Climate change can be an 'abstract' term for many farmers. They are more familiar with the climate variability. It is well understood that climate risk is an

inherent part of discussions on climate variability. Therefore, climate risk management is a sensible basis to discuss behaviour change required for adapting to climate change. As farmers relate to crop calendars and climate variability, the methodology focuses on using crop calendars (crop phenology) as an entry point to link different climate variables to different stages of crop development. Farmers' knowledge on how different climatic variables impact cropping at different stages (such as early or late onset of monsoon, rains at critical stages of crop development, extreme events such as hailstorms etc) will be captured via a participatory approach using a semi-structured questionnaire.

Climate risk has been defined by a number of authors (Jones and Boer, 2003; Gommes, 1998; Sivakumar and Motha 2007) as a function of probability (chance of occurrence) of an event and the impact, in this case a negative impact on production or crop yield.

Risk = Probability X Impact -----Eq1

In terms of the agricultural production risk, this equation can be expressed as

Average loss / annum = Average number of events / annum * Average loss / Event (Gommes, 1998) -----Eq 2

We have taken this approach to quantify the production risk as a result of adverse climatic events as experienced by the farmers in the study locations.

Participatory Climate Risk Assessment

Participatory climate risk assessment was carried out in the three villages initially during November-December 2010 and subsequently in September and December 2011. Ten farmers in each village were selected and administered a semi-structured questionnaire. Surveys were conducted during 2010-11 with farmers who have been farming at least for the last ten years and whose income is predominantly from agriculture. Farmers shared their experience about the impact of climate on their crop production during the last 10 years. The climate risk assessment was used to identify farmers' experience of the key climate variables that impact on crop production (for different crops / trees – different geographic areas). The relative ranking of the variables highlighted farmers' priorities. Two crops were selected for discussions viz., paddy and cotton. For each of the crop stages farmers were asked to identify climatic events that had an adverse impact on their crop yield. For example, for cotton, farmers were asked to identify climatic events (such as dry spells, excess wetness) at different stages of the crop (such as sowing, square bud, blossom, boll and harvest) and the number of times that such climatic events occurred in the last 10 years (chance of occurrence)and their assessment on the impact on yield (impact). For paddy, different stages of crop development such as transplanting, tillering, panicle extension, flowering and harvesting stages were discussed. Some farmers kept records of the farm operations for a number of years and could refer to the data from their document. Risk was calculated as a product of chance of occurrence (of a climatic event) and impact (on crop yield).

Farmers provided information on their experience of the last 10 years about a particular year being good or poor from the growing seasonal rainfall point of view. These data were plotted against the crop yields reported by farmers and are presented in Figure 2.

Results

Farmers perceptions of good and poor seasons

Farmers identified rainfall as a significant factor among the reasons for a year being indicated as good or poor impacting crop yield. Most of the farmers have identified a good and a poor year which stood in their memory over the period of the last 10 years. Rating of a year as a good or a poor one varied across the three study villages and among farmers in the same village as well. For example, 2004 was a poor year for farmers in all the villages except two, one in Barinapalli and one in Gorita. As a contrast year 2005 was rated as poor by farmers in Gorita due to excess rainfall and good by farmers in Nemmani. Comparing this with the cumulative rainfall figures, it is evident that for Gorita the season tracked 90^{th} percentile from start to finish of the season while in Nemmani the season had a median start and a higher than median finish. Year 2009 also provides useful insights into farmers' experience with seasonal rainfall, for example, for some farmers in Bairanpalli and Gorita 2009 was good year while for some it was a poor year (2009 tracked decile 1) . In further discussions farmers mentioned that the year was good for those farmers who had access to well irrigation and those benefitted by higher market value for their produce due to demand and supply conditions (many farmers crops were lost hence less produce in the markets).Market prices, ability of farmers to adapt to prevailing climatic conditions (by switching to alternate crops or vegetables, for example) are some of the factors that influenced the categorisation of 2009 as a good year for some farmers. The results from this analysis should caution against applying a universal good or a poor year classification across the region and highlights the heterogeneity of climatic impact on agricultural productivity as experienced by the farmers.

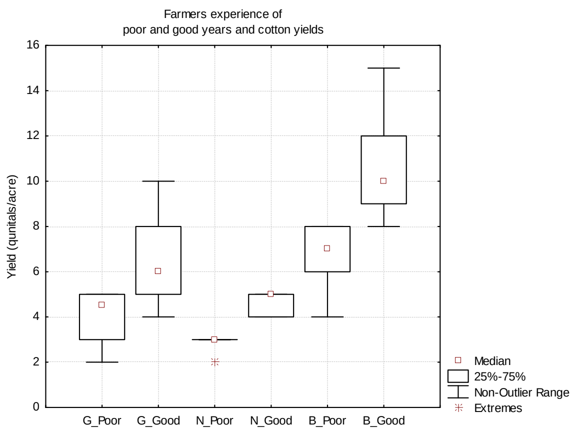

Figure 2. Cotton yields in 'poor' and 'good' years as reported by farmers
Locations: G-Gorita; N-Nemmani; B-Bairanpalli

Yields reported by farmers were plotted during the last ten years (Figure 1) across both what farmers perceived as poor and good years. For cotton, the box plot clearly demonstrates the comparison in yields during the years which farmers experienced as poor or good. In Bairanpalli and Nemmani, the yield difference for cotton in poor and good years is clear differentiated. This is consistent with the observation of Cooper et al (2008) that in a system reliant on rainfall as the sole source of moisture for crop growth, seasonal rainfall variability is inevitably mirrored in both highly variable production levels.

Participatory climate risk assessment

Farmers, from their experience, indicated approximate impact on the crop yield (in terms of percent loss compared to their 'normal' yields) as a result of the adverse climatic events (Tables 1 & 2). For example, in the case of paddy, farmers in Gorita ranked in a decreasing order, late rains at transplanting, excess rain at tillering, flowering and harvest and excess temperature at panicle extension as climatic events adversely impacting the yield (Table 1). In Bairanpalli, later rains at transplanting was ranked 1 by farmers as adversely impacting yield, followed by excess rains at harvest, tillering, flowering and panicle extension (Table 2).

Table 1 Climate risk assement by farmers and link to crop claendars and climate records for Paddy in Gorita

Farmer data						**Link to crop calendar and climate record**	
Crop Stage	**Climatic events**	**Chance of occurrence**	**Impact**	**Risk**	**Rank**	**Crop calendar**	**Year (from weekly rainfall data)**
Transplanting	late rains	0.5	0.45	0.225	1	Jul 3-4 wk	2001, 2002, 2004, 2007, 2009
Tillering	excess rains	0.7	0.15	0.105	2	Jul 4 wk-Aug 1wk	2001, 2002, 2004, 2005, 2007. 2008
Flowering	excess rain	0.5	0.15	0.075	3	Sep 3 wk-Oct 1 wk	2001, 2002, 2004,2007, 2009
Harvest	excess rain	0.3	0.1	0.03	4	Oct 4 wk-Nov 1 wk	2001, 2006, 2007

Table 2 Climate risk assement by farmers and link to crop claendars and climate records for Paddy in Bairanpalli

Farmer data						**Link to crop calendar and climate record**	
Crop Stage	**Climatic events**	**Chance of occurrence**	**Impact**	**Risk**	**Rank**	**Crop calendar**	**Year (from weekly rainfall data)**
Transplanting	late rains	0.5	0.5	0.25	1	Jul 3-4 wk	2001, 2006, 2009
Tillering	dry spell	0.6	0.2	0.12	2	Jul 4 wk-Aug 1wk	2003, 2004, 2006, 2007. 2009
Harvest	excess rains	0.5	0.2	0.1	3	Oct 4 wk – Nov 1 wk	2003, 2006, 2007, 2010
Panicle extension	excess rains	0.2	0.15	0.03	4	Sep 1-3 wk	2001, 2006, 2007
Flowering	excess rains	0.2	0.15	0.03	4	Sep 3 wk – Oct 1 wk	2001, 2007

We then compared farmers' experience of climatic events to the climatic record. We illustrate this process with an example from Gorita (paddy) (Table 1). For the transplanting stage farmers indicated that late rains affected their yields 5 times out of 10 in the last 10 years. We looked up the crop calendar for the location to identify the period in which this activity took place, which was typically during Jul 3-4 week. From the weekly rainfall records for the locations we listed the years in which 'late rains' occurred in the location, this was for 5 years viz., 2001, 2002, 2004, 2007 and 2009, which corresponded well with farmers' experience (5 out 10 being 'late rains'). Likewise for other crop stages there seems to be generally a good match between farmers' experience and climate record. This good correspondence lends credence to the study's use of farmer recollection of the key climate events of the past 10 years that have adversely impacted their crop yields.

Conclusion

The results of the study show the importance of integrating farmers' knowledge and experience to provide an important bottom-up feed back to the agro- meteorology advisories on climate risk assessment and management. The surprising but important finding is the heterogeneity of the farmers' experience of a year being good or poor. This provides useful information for targeting advice and support from extension and agro-advisory service providers. The analysis also provides relevant inputs to seasonal climate forecasters on the priorities for the farming communities regarding the climate variable and timing of the forecast that is most useful. The approach of using crop calendars as a link between farmers' perceptions of the impact of climatic events at various crop stages and climate record has provided a way to integrate farmer knowledge and climate records. The differences in climate risk assessment across the low and high rainfall villages provides an opportunity for agro-meteorology services to use the two ends of the spectrum (low and high rainfall locations) in their discussion for services in the region.

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