Reducing risk of crop failure by building system-level resilience through science-based natural resource management interventions: A case for rationalising crop insurance premia

Policy Brief 44
July 2022

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1. Background

Drylands are facing several challenges such as water scarcity, land degradation, and poor agricultural and livestock productivity. These areas are also hotspots of chronic poverty and malnutrition posing a serious threat to economic development. Agriculture and allied sectors play an important role in providing livelihoods to more than 55% of the population in this ecosystem. This sector is going to face heightened distress due to risks associated with changing climatic conditions. Likelihood of diverse biotic (pest/disease) and abiotic (drought, dry spells, floods, hailstorm, etc.) stresses is increasing, and therefore, farmers are often suffering from crop losses either partially or fully. With this realization, the Government of India and several state governments have designed many social protection programs to alleviate distress among farmers due to crop loss.

To harness low hanging fruits during the **Green Revolution** period (1960-70), considerable focus was put on major irrigation projects, which contributed immensely to the expansion of surface irrigated areas – from 13 million hectares during 1970 to 18 million ha by 2000 (Green et al. 2020). However, such emphasis and investments, were ignored in the dryland systems, which actually hold vast untapped potential. To unlock this potential, successive governments have invested substantially in the development of drylands through the introduction of many initiatives for soil and water conservation measures on watershed scale since the 1970s (Bhan 2013). But such measures focused largely on mid-lands where second- or third-order stream networks originate, while neglecting uppermost part of the watershed/catchment or ridge area, which is largely owned by resource poor farmers (Anantha et al. 2021). Over-grazing and deforestation exacerbated land degradation over time resulting in the reduced moisture retention ability of these landscapes. This led to increased risk of crop failure even during favourable rainfall years. All these circumstances have trapped resource poor farmers of the drylands within the low-productivity high-risk cycle, thereby condemning them to inescapable poverty.

The Government of India, from time to time, has launched or modified existing policy measures to alleviate risk in crop production through instruments such as crop insurance (Pradhan Mantri Fasal Bima Yojana [PMFBY]). Farmers are encouraged to opt for the crop insurance scheme by paying a small part (up to 25%) of the premium (institutional credit linked) to cover the risks arising due to biotic, abiotic stresses as well as extreme climatic events. A large portion of these premiums (nearly 75%) is covered by the government (both centre and state) for a notified crop insurance scheme as a subsidy. Insurance companies, on the other hand, undertake risk evaluation for a target geography largely based on crop cutting experiments (CCEs) or weather indices. Premium is fixed for major/notified crops based on historical crop yield risk assessment for a target district. However, the current methods of assessing crop losses is not robust due to high spatial and temporal variability and a high degree of human involvement leading to corresponding errors. Furthermore, this method of crop risk assessment does not fully account for i) resource availability; ii) risk carrying capacity; and iii) management factors that normally determine crop productivity. Crop loss, therefore, varies spatially and temporally which needs to be captured dynamically in a shorter period of time (15-20 days) for quicker indemnity payments so as to protect farmers' livelihoods.

The Government of India has also been investing jointly with public and private agencies in taking various other measures to reduce the risk of crop failure in drylands. One of the most significant measures has been investing in improving the capacity of landscapes to support crop and livestock productivity through watershed management. It has been amply demonstrated that watershed development measures on degraded landscapes improve moisture availability both *in situ* and *ex situ*, thus contributing to reduced risk of crop failure across the treated landscapes (Singh et al. 2021). Moisture being the most critical factor in determining the success or failure of crop production, its availability/non-availability must be accounted for in risk assessment.

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This policy brief attempts to argue in support of rationalizing investments in the crop insurance premium in areas where the government/other agencies have substantially invested in landscapes resulting in enhanced water/moisture availability leading to lower chances of crop failure. In doing so, this brief considers two seminal aspects for reducing the government's fiscal burden of paying its share of insurance premium towards crop insurance viz., i) integrating landscape resource management into it for imparting resilience at farm level; and ii) proposing a rationale for factoring in government investments on landscapes for prudent management of rainwater leading to reduction in crop failure arising from lack of moisture for agriculture, or from drought. The policy brief presents a case study from the Bundelkhand region – one of the most fragile dryland agro-ecologies of India – in support of its arguments.

2. Building systems resilience through water conservation interventions - Case studies

2.1 KISAN MITrA Initiative in Lalitpur, Bundelkhand, Uttar Pradesh[1]

Drylands, especially uplands in the topo-sequence suffer from severe water scarcity, land degradation and poor agricultural productivity though they receive moderate to good rainfall. Due to excessive erosion and poor moisture retention ability of soils, most of the rainfall received on such landscapes is not captured in soils. To address these issues, Government of Uttar Pradesh launched an ambitious initiative in 2018, which was implemented by ICRISAT-led consortium across all seven districts of Bundelkhand region of the state. The project was implemented in pilot sites covering about 5000 ha area in each district.

2.1.1 Impact on crop vegetation and livelihoods

One such cluster dominated by tribal population exists in Poora Bridha village of Talbehat block of Lalitpur district, Uttar Pradesh, India. This cluster was suffering from acute water scarcity over the years and productive farming remained a daydream. This led to large-scale migration of the tribal families and the cluster of villages turned desolate. Landscape resource conservation along with climate resilient agriculture technologies were implemented at the project locations. Five large-scale *haveli* structures were renovated with masonry core wall. Larger fields were divided into smaller plots through earthen field bunding with masonry support surplusing arrangements to dispose-off excess runoff. Further, runoff generated from hillocks was guided through diversion drain and field drainage channels to the newly constructed *haveli* system. In addition, three-kilometre-long drainage network was widened and deepened with nala-plugs at suitable intervals. Different tree species were planted all along the drainage lines and field bunds following different agroforestry models. About 50,000 timber and fruit trees were planted in about 500 farmers' fields. Altogether, 98000 cubic meter storage capacity was created in Poora Birdha village which is able to harvest about 4 to 5 lakh cubic meter of freshwater per year. As a result, the water levels in shallow dug wells have increased by 6-8 m compared to baseline (Table 1). This cluster has now transformed into a prosperous landscape with adequate water availability (Figure 1). With the availability of surface and groundwater in sufficient quantity for human, livestock and agricultural use, over fifty tribal families that had migrated to nearby cities have come back and resumed cultivation of crops. They have realized that adequate water is available now for cultivating two crops a year resulting in sufficient availability of crop residues that can be used as fodder for livestock. Before the project interventions, only four ha land was partially cultivated with a total net return of about Rs. 1.8 Lakhs per annum. After the project interventions (2021), about 100 ha of agricultural land which remained fallow has been brought back to productive cultivation with a total net return of about Rs. 80 Lakh per year. This has very significantly reduced the risk of crop failure and the out migration of the small and marginal farmers of this cluster of villages.

Figure 1: Change in land-use: from degraded to productive landscape in Birdha village, Lalitpur district, Bundelkhand UP.

[1] See more success stories @ http://idc.icrisat.org/idc/wp-content/uploads/2021/09/04_Success-stories.pdf

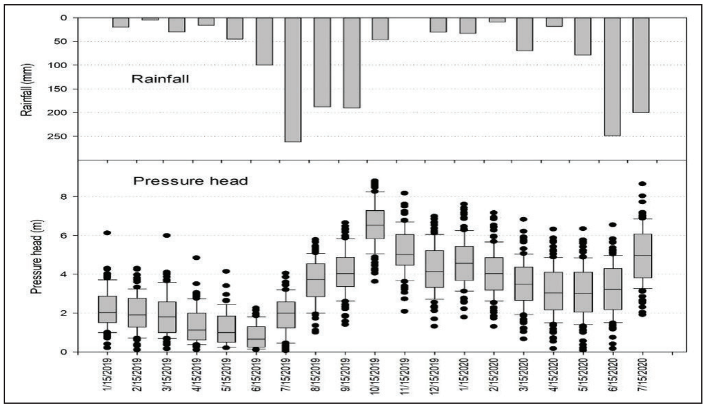

Figure 2. Temporal change in groundwater table in Rauli-Kalyanpur village since Jan 2019.

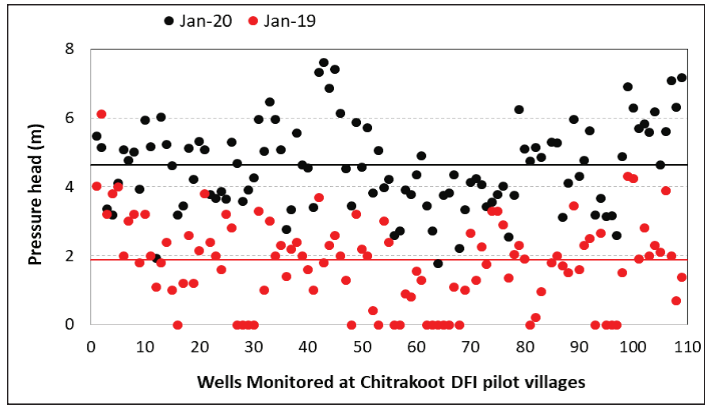

Figure 3: Comparison of groundwater table before (Jan 2019) and after (Jan 2020) project interventions in 110 dug wells in Rauli-Kalyanpur village.

Table 1: Change in resource availability, cropped area and income after the implementation of landscape rejuvenation initiative under KISAN MITrA in Lalitpur district, Uttar Pradesh.

Resource availability status	2019	2020	2021
Investment made (₹ in Lakh)	-	32	38
Storage capacity created (m3)	-	52000	98800
Groundwater level (bgl: m)	10	4	2
Well recovery period (hours)	120	20	10
In-migration (No of families)	-	15	50
Area cultivated (ha)	4	35	100
Net income: kharif (₹ in lakh)	0.6	6.3	18.8
Net income: rabi (₹ in lakh)	1.2	21	60
Net income/year (₹ in lakh)	1.8	27.3	78.8

2.1.2 Building resilience through groundwater recharge

In the case of another pilot site at Rauli-Kalyanpur village, Chitrakoot district, the defunct *haveli* system was renovated in May-June 2019. Further, field bunding, deepening of drainage network were also undertaken in about 500 ha of the landscape. To capture the impact of various rainwater harvesting measures, groundwater levels were monitored on a monthly timescale in about 110 dug wells that are located in a radius of two km using water level indicator. Figure 2 shows hydraulic head in different dug wells, its variation, maximum to minimum range along with its average (as shown by box plot) since January 2019. The average pressure head in Jan 2019 was 2.0 m and it significantly increased during the monsoon season. However, the average pressure head in Jan 2020 was 4.5 m which indicates a net gain of about 2.5 m.

Figure 3 further describes the variability of hydraulic head in the month of January (before and after project status). Data indicates that average gain in hydraulic head was 2.5 m but the benefits of recharge was as high as 4-5 m in nearly 20-30% of the wells monitored. This also indicates that about 50-80 mm of additional water was available during the post monsoon season that helped farmers to harvest a successful crop.

2.1.3 Enhanced water availability

Water balance analysis showed that the total storage capacity created through various *ex-situ* rainwater harvesting interventions was about 2.0 million cubic meters. Considering that these structures fill up at least twice a year, it is estimated that a minimum of 4 million cubic meters of water was harvested which also facilitated groundwater recharge. Enhanced groundwater and soil moisture availability have brought significant changes in land use, especially by converting the fallow lands into cultivated lands thereby improving water-use efficiency. It is estimated that about 800 acres of fallow land (seasonal or permanent fallow) has been brought into productivity cultivation in this cluster of villages. Available soil moisture in fallow lands, which used to lost earlier (as non-productive evaporation), is now utilized for crop cultivation with the availability of supplemental irrigation. This was critical l for crop production during post-rainy season. It is estimated that about 1.5 million cubic meters of such green water (soil moisture) has been utilized

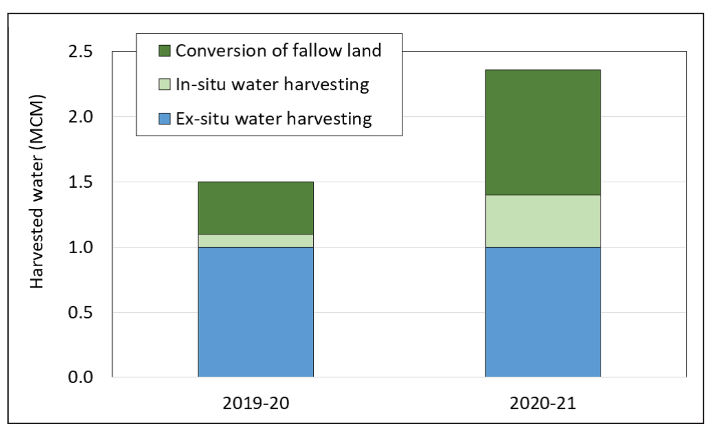

Figure 4: Impact of various RWH interventions on water resource availability.

for productive crop cultivation in an indirect method of water-saving/conservation. Thus, about seven million cubic meters of freshwater was additionally brought into productive cultivation in the pilot villages/sites, which has led to over 5000 farming families being benefitted during 2019 and 2020 (Figure 4).

2.1.4 Impact on crop productivity

The crop cutting experiment (CCEs) results were summarized on four treatments to isolate the impact of various interventions. They are: (i) improved cultivar + micronutrient application; (ii) only improved cultivar; (iii) only micronutrient application; and (iv) farmer practice (control). In general, grain yield per ha from treated fields was higher than that of control plots. The highest productivity gain was noticed in the case of chickpea followed by field peas and mustard. This impact on productivity was observed with a combination of both improved cultivar and application of recommended micronutrients while other external factors (such as irrigation) showed significant influence on productivity in the case of wheat (Figure 5). This shows the effect of resource conservation measures in reducing the risk of crop failures across the landscape.

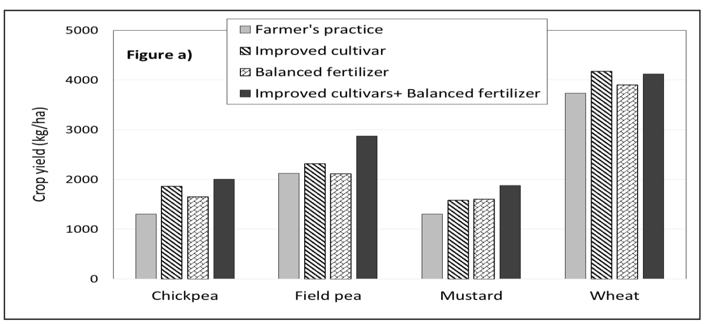

Figure 5: Impact of improved cultivars and crop management practices with increased moisture availability.

2.2 Parasai-Sindh watershed, Jhansi, Uttar Pradesh

Parasai-Sindh watershed is located in Babina block of Jhansi district, Uttar Pradesh, covering 1250 ha (12.5 sq km) of geographical area. It embraces three villages, namely Parasai, Chhatpur and Bachauni, located between 25°23’56’’ to 25°27’9’’ N and 78°19’45” to 78°22’42’’E (Figure 6). Soils of the watershed are categorized as Alfisols, which has poor water retention capacity (available water 100-120 mm/m). Farmers in Parasai-Sindh watershed are mostly dependent on agriculture and livestock-based activities. Before 2011, about 75% of the total area was under cultivation; 20% was left fallow, and 5% was under other uses (Garg et al. 2020). This landscape has low to moderate slope of 1-3% and all the farmers follow flood irrigation method. Black gram/green gram was cultivated under rainfed condition, and

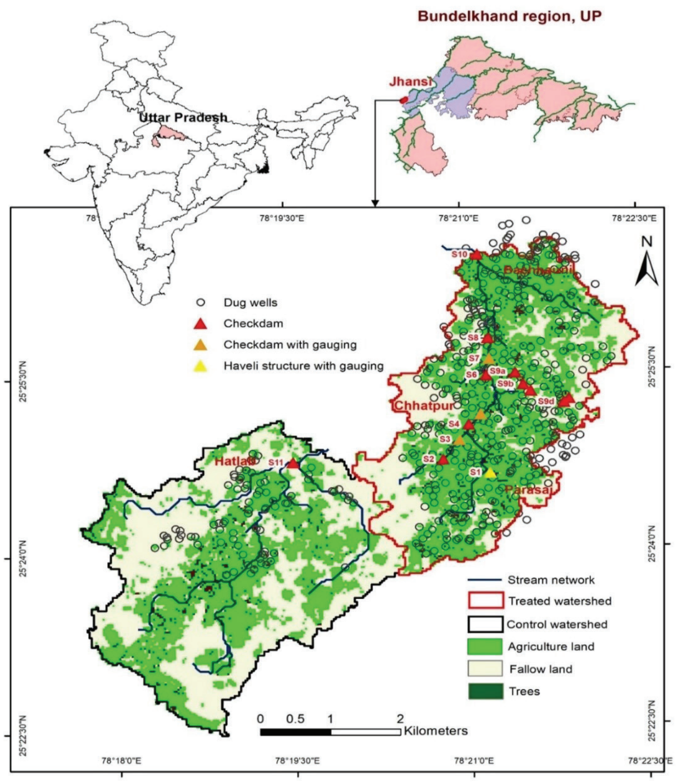

Figure 6: Location of Parasai-Sindh watershed in Jhansi, Bundelkhand region of Central India; Figure also shows stream networks, dug wells along with major land use classes in treated (Parasai-Sindh) and control watershed (Hatlab).

groundnut with supplemental irrigation during kharif season. Wheat, chickpea and barley were dominant crops during the rabi season which was cultivated with the support of supplemental irrigation. A total of 388 dug wells were the source of irrigation for rabi cropping which depended on the South-West monsoon for recharge. Prior to implementation of the project, Parasai-Sindh watershed was habitually suffering from severe water scarcity. Available groundwater was not sufficient to meet domestic and agricultural demands before 2011. To address water scarcity, a range of *in situ* and *ex situ* soil and rainwater conservation measures were implemented following a ridge-to-valley approach between 2012 and 2016 (Garg et al. 2020; Singh et al. 2021). This watershed was intensively monitored for measuring water availability, agriculture production and crop intensification before and after project interventions.

2.2.1 Enhanced water resource availability

Figure 7 describes the functioning status of dug wells along with rainfall distribution between 2011 and 2016. The dug wells’ functioning status is categorised into five groups: dry, poor (<1 m pressure head), medium (1-3 m pressure head), good (3-5 m pressure head), and very good (>5 m pressure head). During the project period, years 2011 and 2013 were the wet years, which received

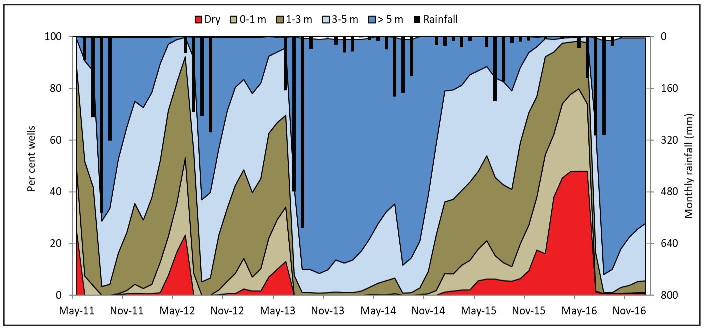

Figure 7: Functioning status of dug wells in Parasai-Sindh watershed in relation to rainfall on monthly scale between 2011 and 2016; data collected from 388 dug wells monitored at monthly intervals.

1189 mm, and 1276 mm rainfall; 2012 and 2016 were normal years that received 825 mm and 768 mm rainfall, whereas 2014 and 2015 were dry and very dry years, with 520 mm and 404 mm rainfall, respectively. Years 2011 and 2012 were considered as the pre-development phase, whereas by 2013 over 70% of the rainwater harvesting structures were completed.

A comparison of status of functioning dug wells in wet years before (2011) and after implementing watershed development interventions (2013) revealed that despite receiving similar amount of rainfall, only about 60% (July) and 25% (December) of dug wells were functioning with very good water status in July and December 2011. However, in 2013, number of wells functioning with very good status was 90% in August and 85% in December 2013. Once the groundwater recharged to its full potential in 2013, its availability was prolonged until two consecutive dry years occurred (i.e., up to December 2015). The wells started drying only after December 2015 as it was one of the driest years. Further, a comparison of the two normal years (before 2012 and after 2016) also witnessed with similar results. For example, by the end of December 2012, the functioning status of wells showing very good, good, and medium was recorded as 19%, 38% and 34%, and the remaining 9% was under the poor/dry category. However, the functioning status of wells in December 2016 was recorded as 74%, 20%, 4% and 2%, respectively. This clearly indicates that the groundwater availability has immensely improved across the watershed villages during, and post-project interventions.

2.2.2 Crop intensification

Normalized Difference Vegetation Index (NDVI) of treated watershed during February months for 2010-11 (before interventions) and 2013-14 and 2014-15 (after interventions) is shown in Figure 8. Rainfall received during 2010-11 was 1170 mm. However, about 30% of area at upland was left fallow during rabi season – before project interventions – despite having wet year in 2010-11 upland of the landscape because it was water scarce in the post-monsoon season and farmers were reluctant to cultivate. The only farming was found in fields close to the peripheral stream network. However, after project interventions, almost 95% area was brought under cultivation in 2013-14 as indicated by the NDVI map. February is peak vegetative crop growth stage of wheat crop in this area. It must further be noted that despite 2014-15 being one of the dry years it had relatively better

Table 2: Cultivated area under different crops before and after project interventions in Parasai-Sindh watershed.

Crop	Area cultivated before intervention (ha)	Area cultivated after intervention (ha)	Difference (ha)
***Monsoon season* (Jun-Oct)**			
Groundnut	702 (63%)	903 (82%)	201
Blackgram	125 (11%)	75 (7%)	-50
Sesame	126 (11%)	56 (5%)	-70
Fodder/vegetables	15 (1%)	23 (2%)	8
Fallow	138 (12%)	49 (4%)	-89
***Post-monsoon season* (Nov-Mar)**			
Wheat	563 (51%)	967 (87%)	404
Mustard	126 (11%)	33 (3%)	-93
Chickpea	75 (7%)	22 (2%)	-53
Lentils	23 (2%)	0 (-)	-23
Barley	10 (1%)	61 (6%)	51
Fallow	309 (28%)	23 (2%)	-286
***Summer* (Apr-May)**			
Fodder/vegetables	5 (0.5%)	50 (4.5%)	45
Fallow	1101 (99.5%)	1056 (95.5%)	-45
Note: Parenthesis indicates per cent of total cultivable land			

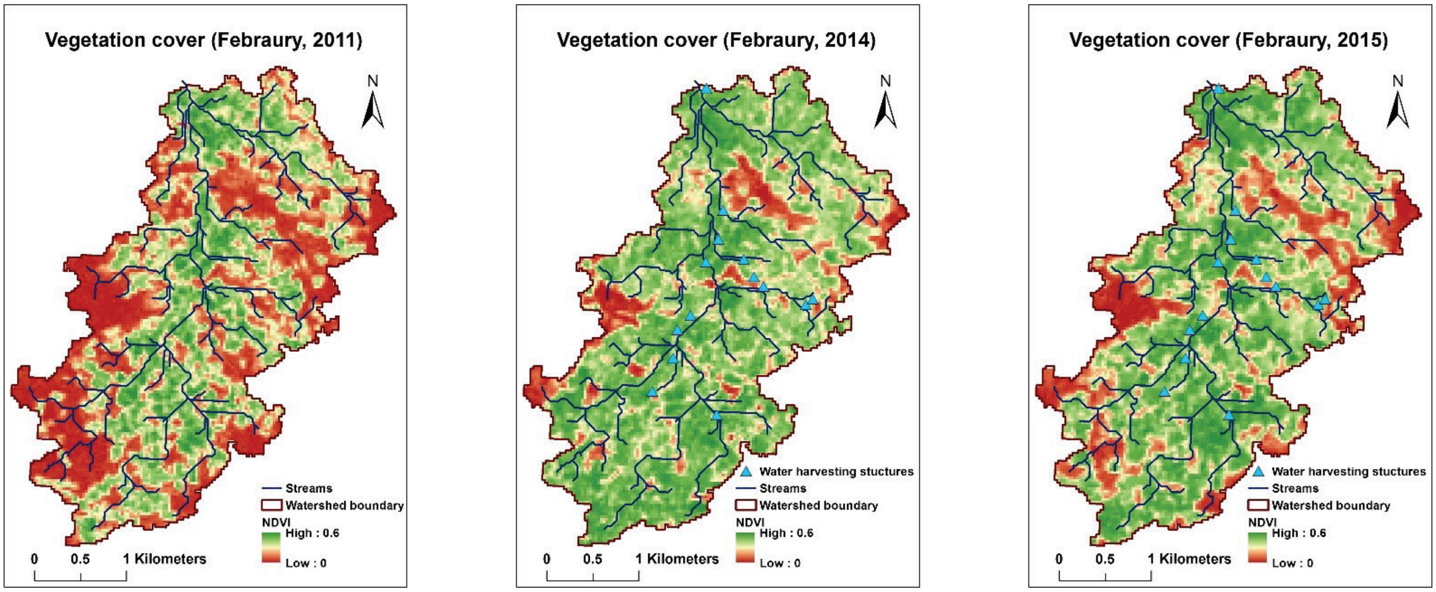

Figure 8: NDVI mapping from remote sensing during February represents rabi crop area at Parasai-Sindh watershed before (2011) and after (2014 and 2015) the watershed interventions; Rainfall = 2010-11: 1190 mm; 2013-14: 1270 mm; 2014-15: 520 mm.

crop acreage as compared to 2010-11. This has been possible due to enhanced groundwater availability, which was supported from the previous year. Despite having negligible groundwater recharge in 2014-15, the land was able to support the cultivation of a second season crop with previously available groundwater reserves.

Table 2 shows the cultivated area under different crops (monsoon and post-monsoon) before and after project interventions in Parasai-Sindh watershed. Out of a total cultivable area of 1106 ha, 63% was under groundnut, 24% under pulses, and 12% of area was left fallow in monsoon – before project interventions. After project interventions, farmers preferred to increase area under groundnut, which increased to 82%, whereas area under pulses reduced to 14% and about 4% was left fallow in the monsoon season. On the other hand, during post-monsoon season, before project interventions, 51% of area was under wheat, 11% under mustard, and 10% under other crops such as chickpea, lentils, and 28% was left fallow. After the project interventions, a remarkable change took place in that 87% of total cultivated land was converted into wheat and 10% for other crops, and only 2% area was left fallow. The area under fodder and vegetable crops increased from 5 ha to 50 ha during the summer period with increased water availability.

2.2.3 Increased crop productivity and household income

Figure 9 compares the yield of major crops before and after project interventions. Yield for monsoon season crops (sesame, blackgram, groundnut) increased marginally, whereas significant difference was found in crop yield obtained in post-monsoon season crops. Wheat yield, which was 1700 kg/ha has increased to 2750 kg/ha. Similarly, barley yield also increased from 1800 kg/ha to 2600 kg/ha after project interventions.

Table 3 indicates the change in average household income before and after project interventions. Out of 417 households, the total net income from agriculture before watershed interventions was estimated to be USD 0.26 million which increased to USD 0.73 million (i.e., 180% increase). But the annual income increase from livestock was estimated to be USD 0.21 million (increased from USD 0.19 million to USD 0.40 million). This income was mainly generated through increase in the buffalo population – from 950 (before) to 1300 (after) – and therefore increased milk yield from 6 L/day/animal to 8.5 L/day/animal (with lactation period of 180 days). Overall, the average household income increased from USD 1075/year (before) to USD 2725/year (after), thus marking a significant improvement in their livelihood within the short period of project interventions.

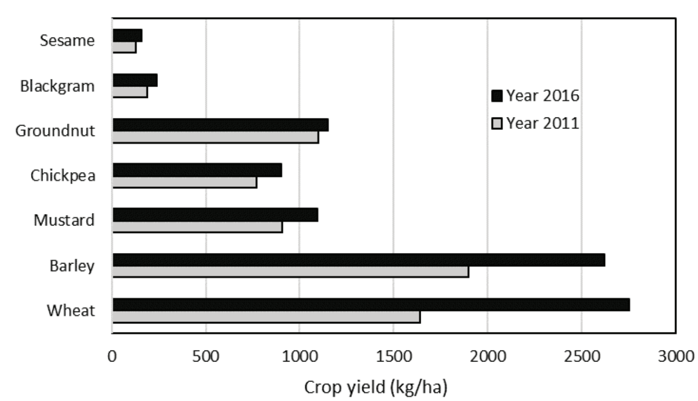

Figure 9: Comparison of crop yield before (2011) and after (2016) project interventions.

Table 3: Project impact on average household income before and after interventions			
No.	**Description**	**Before**	**After**
A	**Agriculture**		
	Kharif area under cultivation (ha)	968	1057
	Net income generated in kharif (in USD million)	0.26	0.38
	Rabi area under cultivation (ha)	797	1083
	Net income generated in rabi (in USD million)	0.0	0.35
	Total net income from agriculture (in USD million)	0.26	0.73
B	**Livestock**		
	Buffalo population	950	1300
	Average milk yield (L/day/animal)	6	8.5
	Annual income from livestock (in USD million)	0.19	0.40
A+B	**Total net income (in USD million/year)**	**0.45**	**1.14**
	Number of households	417	417
	Average household income (USD/year)	1075	2725
Note: Net income is derived by deducting cost of cultivation from gross income. Cost of cultivation includes input costs as well as family and hired labor charges.			

2.2.4 Reduced risk and yield variability

Figure 10 highlights the impact of rainwater conservation measures (before and after) on reducing the risk of crop failure as well as on minimising the cost of production. It is evident that *ex situ* and *in situ* rainwater conservation measures enhanced moisture availability in the soil, thereby reducing the risk of crop failure during the rainy as well as post-rainy seasons. The impact is more vivid in the case of post-rainy season (wheat crop) when compared with rainy season (groundnut crop). There is a significant improvement in wheat crop productivity (from 2689 kg/ha to 3325 kg/ha) as well as reduction in crop failure risk (coefficient of variation declined from 32% to 21%) (yield variability per ha) during the study period. The enhanced resource-use-efficiency, including improved management practices advocated by the watershed program, resulted in reduction in input usage. This translated into reduced cost of production per quintal of wheat (from ₹ 12.3 to ₹ 7 per quintal) as well as decreased cost of cultivation per ha (from ₹ 33138 to ₹ 23,200) Table 4.

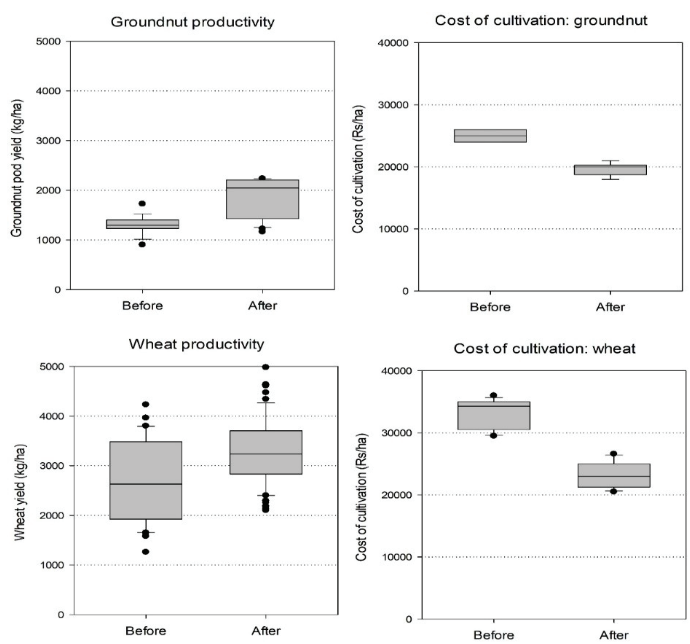

Figure 10: Comparing crop productivity and cost of cultivation of groundnut (kharif) and wheat (rabi) crops in Rajapur village of Babina block, Jhansi district.

Table 4: Comparative analysis of crop productivity and cost of production of groundnut (kharif) and wheat (rabi) crops before and after project interventions				
	Groundnut (Kharif)		**Wheat (Rabi)**	
Parameter	**Before**	**After**	**Before**	**After**
Average productivity (kg/ha)	1298 (203)*	1816 (392)	2689 (867)	3325 (712)
Coefficient of Variation (CV) (%)	16	22	32	21
Cost of cultivation (₹/ha)	25000 (1000)	19600 (1140)	33138 (2554)	23200 (2241)
Cost of production (₹/kg)	19.3	10.8	12.3	7.0
*Figures in parenthesis show standard deviation from the mean.				

Similar analysis was also carried out for capturing the benefits derived from watershed interventions in rainy season groundnut crop in the watershed area. The impact was not so apparent in rainy season crop when compared to post-rainy season crop. However, there was a significant improvement in the mean productivity level (1298 kg/ha to 1816 kg/ha) of groundnut. With notable deviations in total rainfall received and its distribution in the watershed area from year to year, significant yield variation was observed in the case of groundnut crop. Further, enhanced resource-use-efficiency and adoption of better crop management practices resulted in reduced cost of production (₹ 19.3 to ₹ 10.8) per quintal of groundnut (Table 4).

3. Building system resilience to reduce chances of crop failure: Case for rationalizing crop insurance premium

Section 2 of this policy brief clearly showcases how we can build system resilience in the dryland ecosystem by investing in building resilience at the landscape level through watershed management practices. The indicators of system resilience were estimated before and after the watershed intervention period. Both *in situ* and *ex situ* rainwater conservation measures enhanced soil moisture availability leading to increased crop productivity levels per hectare. There was a marked reduction in the crop yield variability among different micro-ecologies. This was commensurate with enhanced farm income per annum. Improved rainwater management through the watershed approach led to availability of water for supplemental irrigation during both rainy and post-rainy seasons. Thus, the inherent risk involved in crop production before and after project interventions were minimized. This also led to decline in unit costs of production. Effects of extreme climatic events, such as drought and excessive rainfall, were mitigated through effective rainwater management practices in the study area. Similarly, biotic and abiotic stresses, if any, were managed through integrated scientific management practices. The cumulative effect of all these approaches led to the building of system resilience in the drylands thereby leading to a considerable reduction in the chances of crop failure.

This situation prompts rationalization of investment by governments (both central and state) towards subsidizing the crop insurance scheme in the form of paying a major share of crop insurance premium. In the backdrop of growing climate variability, the risk of crop failure has increased in dryland ecologies. Therefore, governments are exploring alternate ways to minimize the burden by gradually weaning themselves from paying their share of crop insurance premium. The case discussed in the policy brief indicates the possibility for governments to reduce their fiscal burden towards crop insurance subsidy by asking the insurance service providers to rationalize premium in those geographies where the government has invested substantially in rainwater management (watershed development) and demonstrated lowered risk of crop failures. Governments can further invest the funds thus saved on enhancing the resilience of other vulnerable areas. In other words, it provides room for governments to save on the recurring expenditure on crop insurance premium and invest it on natural resource management (NRM), which in turn helps build the resilience of landscapes in view of climate change. Striking a balance between these two investments (premia vs NRM) over time will lead to risk proofing of vulnerable ecologies in a viable manner. The lessons learnt from this approach can then be scaled-up over large geographies (at district level) so as to build system resilience.

4. Anticipated flow of sustained savings to public sector agencies

Hypothetically, any reduction in production risks must translate into reduction in insurance premium. This holds good for crop insurance as well, especially in those geographies where crop production risk is minimised by improving inherent resilience in the production system. This policy brief illustrates a classic example of wheat cultivation in post-rainy season where mean productivity levels have increased after government intervention with reduction in crop yield variability (% coefficient of variation). Investment in watershed management – promoting resource-use efficiency – led to reduced unit cost of production of wheat. The current level of risk assessed in wheat production in Jhansi district requires both the government and farmer to jointly pay an insurance premium of about ₹ 7100 per ha per season. Building systems resilience through watershed interventions has significantly contributed to enhanced water availability, expansion of irrigation coverage, increased productivity yields and reduced crop variability, etc. All these visible indicators have showed significant improvement in wheat productivity. However, the impact is marginally lower in the case of rainy season crop groundnut. Crop production during rainy season (kharif) therefore, is still fraught with a higher degree of risk owing to deviations in total quantity of rainfall and its distribution.

The present study assumes that sustained decline in crop production risks could be translated into at least a 10% decline in wheat insurance premium (₹ 710 per ha) *ceteris paribus*. Savings thus accruing to public sector agencies could be invested in quality implementation of watershed or NRM interventions. Enhanced moisture availability encouraged the expansion of wheat cultivation in the watershed area – from 563 ha to 967 ha. If we computed the savings in crop insurance premium for the total wheat cropped area in the watershed, it amounts to a saving of ₹ 6.86 lakhs to the government exchequer. Similarly, if the computation logic is extended to the total area under wheat cultivation at the district, Jhansi district alone could save an estimated ₹ 14.20 crores to the public exchequer due to reduced risk and the commensurate reduction in crop insurance premium of wheat. And with these savings, landscape rejuvenation through watershed development approach can be funded in many other vulnerable areas in the adjoining districts. The amount of savings could be manifold, if other aspects were to be considered as well.

Building systems resilience through NRM interventions will risk proof fragile agroecosystems that are reeling under high risk-low productivity poverty cycle. Gradual expansion of risk proofing of vulnerable areas will generate significant savings on crop insurance premium, which will in turn help bring more and more of vulnerable areas under the ambit of risk proofing. Thus, it will be a self-supporting/self-funding initiative that will have many collateral benefits for improving ecosystem services, building soil carbon, and promoting local adaptations to climate change.

5. Risk reduction vs. risk sharing

Many studies have amply demonstrated that watershed interventions based on good science and quality interventions have successfully enhanced water availability, brought fallows under productive cultivation, and large areas under protective irrigation leading to increased crop productivity and cropping intensity apart from raising household income. The studies have also revealed how investments in watershed development have substantially reduced crop production risks. Minimizing the crop production risks through NRM interventions is sustainable and a good long-term measure to protect the livelihoods of farmers in dryland ecologies. Moreover, as discussed earlier there are additional benefits from such an investment to the ecology. The public sector has been investing substantial amounts through this approach. However, there are a few challenges that limit its impact on the ground. They are: 1) lack of consistent investments over a period; 2) a target-oriented approach that seldom takes guidance from good science; 3) time lag in attaining visible impacts on the ground; and 4) due importance not given to quality and institution building.

The public sector has also been investing substantially in the crop insurance program as a social protection measure against risks. The Government of India has launched PMFBY to address some of the inconsistencies and issues associated with the previous crop insurance schemes. Through PMFBY it has also visualised enhancing coverage by encouraging greater farmer participation. Although participation in the crop insurance program gives relief by compensating for the losses farmers suffer, the sector does not take away the risk altogether. It only transfers the risk from one sector to another. The fundamental risk, which indeed is lodged in the production system, needs to be addressed by working at the very basic level that enhances the system resilience. This can be achieved only by prudent natural resource management by using the watershed development tool.

This policy brief, therefore, argues for a case of rationalizing crop insurance premium in geographies where substantial investment has been made for building system resilience, and suggests a hybrid approach (a mix of risk-reduction and risk-sharing approaches) for risk mitigation/alleviation in dryland ecologies. A proper blend of these two approaches amplifies the protection offered to farmers' livelihoods from negative income deviation when exposed to such risks or natural calamities. Striking a balance between these approaches not only provides a risk shield to farmers but also strengthens the fundamentals of dryland production systems.

6. Conclusions and policy implications

Climate change is predicted to severely affect the ability of dryland production systems to support livelihoods of millions of farmers. Drylands are already bearing the brunt of frequent droughts and high intensity rainfall events. Both pose extreme threat to the already stressed resources – soil and water – in this ecosystem. Given that nearly half of the agricultural lands in dryland ecologies are under cultivation, it is all the more urgent to address the issues of soil degradation and depletion of water resources in the drylands.

Crop insurance is an extremely useful instrument to help compensate farmers for losses arising from weather aberrations and its harmful effects on crop production. It also helps farmers to continue doing what they do best at a time when many would like to move away from the agriculture sector to other domains in search of livelihoods. However, it does not address the basic issue of enabling the dryland ecologies to face the ill-effects of climate change and providing lasting solutions to the challenges being faced. This must be tackled more at a fundamental level by building the resilience of the production system and the communities that depend on the system for their livelihoods.

In this backdrop, the policy brief attempts to build a case for investing in improving the resilience of dry landscapes for addressing inherent production risks. In the process, it offers a mechanism to fund this activity through savings in the crop insurance premium because of risk reduction due to reduced probability of crop failures. Thus, it will be a self-supporting initiative that many governments can adopt by negotiating with insurance companies (for bringing down premium in risk-proofed geographies).

This policy brief has attempted to compute the possible savings in risk premium at a modest 10% for wheat crop in Jhansi district following the results obtained from the interventions taken up in the Doubling Farmers Income (DFI) project in selected village clusters in Bundelkhand, although the data suggests much lower probability of risk even during drought years. However, this analysis may need an approach followed by actuarial science to arrive at a more precise reduction in premium. The purpose of this policy brief is only to bring to light another perspective on reduction of risk in crop production rather than providing an actuarial model for assessing risk. It is for the critical stakeholders, such as governments, both at the central and state level, and the insurance companies to take this discussion forward and rationalize investments in crop insurance premium.

The evidence of risk reduction in crop production has been collected from village clusters over a 5000 hectare geographical area each across seven districts of Bundelkhand in UP, one of the most risk-prone dryland ecologies in India. It may be worthwhile to collect evidence from similar ecologies elsewhere in India and then test out the model before extending it to similar geographies at large.

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Acknowledgments

The policy brief is an output of the ReSAR (Remote Sensing for Agriculture Resilience- India Chapter) project funded by the Swiss Agency for Development and Cooperation (SDC). The funding support from the Government of Uttar Pradesh for implementing KISAN MiTRA project is also acknowledged thankfully. For further details, you may contact Dr Sreenath Dixit @ d.sreenath@cgiar.org