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Real-Time Contingency Planning: Conquering the Current Situation in Rainfed Agriculture

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Agriculture plays a crucial role in ensuring livelihood security for approximately two-thirds of the population. Rainfed farming accounts for 85.17 million hectares out of the total 142 million hectares of cultivated land and contributes approximately 44% to the overall food grain production. Climate change affects agriculture with events like droughts, floods, heavy rain, frost, hailstorms, heat waves, and cold waves. These events often happen during the growing seasons in many parts of the country. This affects the production of *kharif* food grains and impacts the economy, farmers' income, and price stability. Rainfed farming is no exception for these, it depends solely on monsoon for crop production. The onset, amount, and distribution of this monsoon decided rainfed farming success. There is a 40% chance that the monsoon will be unpredictable, meaning that in 4 out of 10 years, crop production could suffer. We need to create strategies to handle these situations. To face these aberrant weather condition, need real time management contingency planning. These plans are based on interaction of whether soil related technology (land, water, soil, and crops) or policy, that is used during a growing season is called a real-time Contingency Plan. This is essential to keep crops, production, and income stable in rainfed areas.

Introduction

Rainfed farming refers to agriculture that is solely dependent on rainwater and does not receive any additional water at any stage of the crop through irrigation. (Reddy and Reddy, 2019). Rainfed agriculture contributes to 55 per cent of the net sown area (139.42 M ha) and 61 per cent of India's farmer population. It accounts for approximately 44 per cent of the total food grain production, supports two-thirds of livestock, and 40 per cent of the human population. Almost 34 major crops grow annually compared to 4–5 major crops in irrigated areas. Rainfed farmers follow a diverse portfolio of economic activities, including horticulture, agroforestry, seed spices, medicinal and aromatic plants, fishery, livestock, and beekeeping However, the growing world population, water scarcity, and climate change threaten rainfed farming through increased vulnerability to droughts and other extreme weather events that reflect the country's economy and food security. (NRAA, 2022)

Weather and climate play key roles in agricultural production also soil and management factors limiting current farm yields and improved practices to close the gap (Ittersum, *et al.*, 2013). In recent years, the increased frequency of extreme climatic events has caused enormous damage to agricultural sectors, particularly in the Indian subcontinent. Farmers' foundational decisions on genetic and edaphic factors establish a crop's potential

yield at the outset, representing the immutable "past" of the growing season. However, the realization of this potential is overwhelmingly dictated by the unpredictable "current" situation, that is, in-season weather aberrations. This article argues that the significant limitations in the accuracy and hyperlocal precision of long-range weather forecasting render conventional predict-then-act models inadequate, creating a critical planning gap for farmers. As a solution, this study presents Real-Time Contingency Planning (RTCP) as a superior management paradigm. RTCP shifts the focus to a scientifically grounded observe-and-react framework, utilizing pre-planned adaptive strategies triggered by actual weather events rather than unreliable forecasts. The RTCP framework is essential for building agricultural resilience, empowering farmers to mitigate risk, stabilize production, and secure livelihoods by conquering the volatile present rather than attempting to predict it.

Agricultural productivity is determined by the interaction between static pre-season decisions and dynamic in-season environmental conditions. Foundational decisions regarding genetic factors (crop and varietal choice) and edaphic factors (soil characteristics) establish the potential yield ceiling for a given season. However, the actual yield is significantly influenced by climatic variables, particularly in rainfed systems, where the weather is the principal determinant of crop performance. The critical challenge lies in managing a system with a fixed potential in a highly variable climatic environment. When applied adaptively, agronomic management is the primary mechanism for in-season adjustments. This responsive application of agronomic practices forms the basis of Real-Time Contingency Planning (RTCP), a framework for managing climate-induced risks.

Weather Variability and Its Impacts on Agriculture

- Rainfall drives water availability and determines sowing time (rainfed crops) Temperature drives crop growth and duration
- Temperature and Relative Humidity influence pest and diseases incidence on crops
- Radiation influences photosynthetic productivity
- Wet and dry spells cause significant impact on standing crops, physiology, loss of economic products
- Extreme events (eg. high rainfall/floods/heat wave/cold wave/cyclone /hail/frost) cause enormous losses of standing crops

The Agricultural Planning Dilemma: Fixed Plans and Variable Conditions

Climate's Dominance and the Forecasting Gap

In Indian rainfed agriculture, the South-West monsoon is the most critical variable influencing the *kharif* crop production. Weather aberrations, such as droughts and floods, are the primary drivers of yield volatility. Although seasonal weather forecasts could theoretically inform planning, their utility is constrained by significant limitations. Key among these are:

- **Lack of Skill and Accuracy:** Long-range forecasts have demonstrated limited skill in predicting critical monsoon characteristics, failing to anticipate major seasonal droughts like those in 2002 and 2009.
- **Absence of Hyperlocal Precision:** Forecasts are typically issued at a district level, a resolution too coarse to be actionable for farm-level decisions, as forecast accuracy decreases with smaller geographical areas and longer lead times.

This "forecasting gap" necessitates a shift from a *predict-then-act* model to a more resilient *observe-and-react* paradigm, which is the operational principle of the RTCP.

The Vidarbha Context: A Place of Climate Vulnerability

The Vidarbha region of Maharashtra exemplifies the challenges of climate variability in rainfed agriculture, contributing to significant agrarian distress. The region experiences a range of weather aberrations, including delayed monsoons, mid-season dry spells, and high-intensity rainfall events, leading to waterlogging. Deficit rainfall occurs approximately once every four years. The impact on primary *kharif* crops, such as cotton and soybean, is severe,

with excess rainfall during critical growth stages causing significant reductions in yield and quality. Recent weather events underscore this vulnerability, as illustrated by the widespread crop damage caused by excessive monsoon showers.

The RTCP Framework: A Paradigm for Adaptive Management

The Central Research Institute for Dryland Agriculture (CRIDA) has developed a Real-Time Contingency Planning (RTCP) framework to address climate variability. RTCP is defined as any technology-related or institutional measure implemented based on real-time weather patterns during the crop season. It operates on the principle of "structured flexibility," using pre-prepared District Agricultural Contingency Plans (DACP) that are activated by specific, real-time weather triggers. Key principles include:

1. **Proactive Preparedness:** Advance preparation of action plans and ensuring the availability of inputs, such as seeds for alternative crops.
2. **Real-Time Implementation:** Interventions are deployed only when specific weather-based triggers are met.
3. **Institutional Coordination:** Requires collaboration among researchers, extension agencies, and government departments for effective implementation.

Agronomic Interventions: The Arsenal for Real-Time Response

The RTCP is operationalized through a suite of on-farm agronomic interventions. These are deployed in an integrated manner based on specific contingencies. The major categories of interventions include:

- **Soil and Moisture Conservation:** Practices like creating conservation furrows and biomass mulching to maximize rainwater capture and reduce evaporation.[5]
- **Crop and Varietal Adjustments:** This involves selecting shorter-duration varieties or alternative, drought-tolerant contingent crops (e.g., replacing cotton with pigeonpea) in response to a delayed monsoon.[16]
- **Cropping Systems Management:** Utilizing intercropping (e.g., Soybean + Pigeonpea) to mitigate risk and crop rotation to improve soil health and resilience.[5]
- **Nutrient and Plant Health Management:** Applying foliar nutrition during dry spells when soil uptake is limited and prophylactic plant protection measures during periods of excess moisture to prevent disease outbreaks.[5]

Table 1: Real-Time Contingency Planning (RTCP) for Vidarbha with Interventions

Weather situation	Major risk	RTCP interventions (observe → act)	Expected outcome
Delayed onset of monsoon (2–4 weeks)	Late sowing, shortened crop season	Short-duration crops (green gram, black gram, cowpea); seed priming; reduced plant population	Ensure crop establishment
Early-season dry spell	Poor germination, seedling mortality	Gap filling; soil mulch; foliar spray (2% KNO_3 / 1% urea)	Improve early crop survival
Mid-season drought	Flower/boll shedding	Life-saving irrigation; foliar nutrition; ridge–furrow opening	Reduce moisture stress
Excess rainfall / waterlogging	Root damage, nutrient loss	Emergency drainage; N top dressing; fungicide spray	Restore root function
Prolonged drought year	Crop & fodder scarcity	Fodder sorghum/cowpea; silage; crop residues	Livestock survival

(Source: Srinivasarao, *et al.*, 2016)

Conclusion: Building Agricultural Resilience Through Dynamic Planning

Agricultural planning in rainfed regions, such as Vidarbha, must reconcile fixed pre-season production potential with in-season climatic variability. Given the established limitations of long-range forecasting, a shift from predictive planning to adaptive management is required. Real-Time Contingency Planning (RTCP), developed by CRIDA, provides a robust framework for this shift. By using pre-planned, scientifically vetted agronomic interventions triggered by real-time weather events, the RTCP enables farmers to effectively manage climate-induced risks. The application of the DACP framework in Vidarbha offers a practical, location-specific roadmap for stabilizing production and enhancing the resilience of the region's agricultural systems. The successful mainstreaming of RTCP depends on continued institutional coordination and effective dissemination of agro-advisories to build a climate-resilient agricultural sector in India.

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