



सत्यमेव जयते  
Ministry of Agriculture &  
Farmers Welfare

# Report of the Committee on Doubling Farmers' Income

*Volume X*

**“Risk Management in Agriculture”**

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**“Agriculture requires a safety net against nature’s inclemency &  
capacity building to counter many man-made risks”**

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Document prepared by the Committee on Doubling Farmers' Income,  
Department of Agriculture, Cooperation and Farmers' Welfare,  
Ministry of Agriculture & Farmers' Welfare.

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## **Foreword**

The country has witnessed a series of concerted discussions dealing with the subject of agriculture. In 1926, the Royal Commission of Agriculture was set up to examine and report the status of India's agricultural and rural economy. The Commission made comprehensive recommendations, in its report submitted in 1928, for the improvement of agrarian economy as the basis for the welfare and prosperity of India's rural population. The urban population was about 11 per cent of the whole, and demand from towns was small in comparison. The Commission notes, that communication and physical connectivity were sparse and most villages functioned as self-contained units. The Commission encompassed review of agriculture in areas which are now part of Pakistan, Bangladesh and Myanmar. The net sown area in erstwhile British India was reported as 91.85 million hectares and cattle including buffaloes numbered 151 million. Almost 75 per cent of the cultivated area was under cereals and pulses, with rice and wheat occupying 46 per cent of the net sown area. The area under fruits and vegetables was about 2.5 per cent and that under oilseeds and non-food crops was about 20 per cent. In the ensuing years, as well known, the country underwent vast changes in its political, economic and social spheres.

Almost 40 years later, free India appointed the National Commission on Agriculture in 1970, to review the progress of agriculture in the country and make recommendations for its improvement and modernisation. This Commission released its final report in 1976. It refers to agriculture as a comprehensive term, which includes crop production together with land and water management, animal husbandry, fishery and forestry. Agriculture, in 1970 provided employment to nearly 70 per cent of the working population. The role of agriculture in the country's economic development and the principle of growth with social justice, were core to the discussions. The country was then facing a high population growth rate. After impressive increase in agricultural production in the first two Five Year Plans, a period of stagnancy set in and the country suffered a food crisis in the mid-1960s. The report in fifteen parts, suggested ample focus on increased application of science and technology to enhance production.

Thirty years hence, the National Commission for Farmers was constituted in 2004 to suggest methods for faster and more inclusive growth for farmers. The Commission made comprehensive recommendations covering land reforms, soil testing, augmenting water availability, agriculture productivity, credit and insurance, food security and farmers competitiveness. In its final report of October 2006, the Commission noted upon ten major goals which included a minimum net income to farmers, mainstreaming the human and gender dimension, attention to sustainable livelihoods, fostering youth participation in farming and post-harvest activities, and brought focus on livelihood security of farmers. The need for a single market in India to promote farmer-friendly home markets was also emphasised.

The now constituted DFI (Doubling Farmers' Income) Committee besides all these broad sectoral aspects, invites farmers' income into the core of its deliberations and incorporates it as the fulcrum of its strategy. Agriculture in India today is described by a net sown area of 141 million hectares, with field crops continuing to dominate, as exemplified by 55 per cent of the area under cereals. However, agriculture has been diversifying over the decades. Horticulture now accounts for 16 per cent of net sown area. The nation's livestock population counts at more than 512 million. However, economic indicators do not show equitable and egalitarian growth in income of the farmers. The human factor behind agriculture, the farmers, remain in

frequent distress, despite higher productivity and production. The demand for income growth from farming activity, has also translated into demand for government to procure and provide suitable returns. In a reorientation of the approach, this Committee suggests self-sustainable models empowered with improved market linkage as the basis for income growth of farmers.

India today is not only self-sufficient in respect of demand for food, but is also a net exporter of agri-products occupying seventh position globally. It is one of the top producers of cereals (wheat & rice), pulses, fruits, vegetables, milk, meat and marine fish. However, there remain some chinks in the production armoury, when evaluated against nutritional security that is so important from the perspective of harvesting the demographic dividend of the country. The country faces deficit of pulses & oilseeds. The availability of fruits & vegetables and milk & meat & fish has increased, thanks to production gains over the decades, but affordability to a vast majority, including large number of farmers too, remains a question mark.

The impressive agricultural growth and gains since 1947 stand as a tribute to the farmers' resilience to multiple challenges and to their grit & determination to serve and secure the nation's demand for food and raw material for its agro-industries.

It is an irony, that the very same farmer is now caught in the vortex of more serious challenges. The average income of an agricultural household during July 2012 to June 2013 was as low as Rs.6,426, as against its average monthly consumption expenditure of Rs.6,223. As many as 22.50 per cent of the farmers live below official poverty line. Large tracts of arable land have turned problem soils, becoming acidic, alkaline & saline physico-chemically. Another primary factor of production, namely, water is also under stress. Climate change is beginning to challenge the farmer's ability to adopt coping and adaptation measures that are warranted. Technology fatigue is manifesting in the form of yield plateaus. India's yield averages for most crops at global level do not compare favourably. The costs of cultivation are rising. The magnitude of food loss and food waste is alarming. The markets do not assure the farmer of remunerative returns on his produce. In short, sustainability of agricultural growth faces serious doubt, and agrarian challenge even in the midst of surpluses has emerged as a core concern.

Farmers own land. Land is a powerful asset. And, that such an asset owning class of citizens has remained poor is a paradox. They face the twin vulnerabilities of risks & uncertainties of production environment and unpredictability of market forces. Low and fluctuating incomes are a natural corollary of a farmer under such debilitating circumstances. While cultivation is boundarised by the land, market need not have such bounds.

Agriculture is the largest enterprise in the country. An enterprise can survive only if it can grow consistently. And, growth is incumbent upon savings & investment, both of which are a function of positive net returns from the enterprise. The net returns determine the level of income of an entrepreneur, farmer in this case.

This explains the rationale behind adopting income enhancement approach to farmers' welfare. It is hoped, that the answer to agrarian challenges and realization of the aim of farmers' welfare lies in higher and steady incomes. It is in this context, that the Hon'ble Prime Minister shared the vision of doubling farmers' income with the nation at his Bareilly address on 28<sup>th</sup> February, 2016. Further, recognising the urgent need for a quick and time-bound transformation of the

vision into reality, a time frame of six years (2016-17 to 2022-23) was delineated as the period for implementation of a new strategy.

At the basic level, agriculture when defined as an enterprise comprises two segments – production and post-production. The success of production as of now amounts to half success, and is therefore not sustainable. Recent agitations of farmers (June-July 2017) in certain parts of the country demanding higher prices on their produce following record output or scenes of farmers dumping tractor loads of tomatoes & onions onto the roads or emptying canisters of milk into drains exemplify neglect of other half segment of agriculture.

No nation can afford to compromise with its farming and farmers. And much less India, wherein the absolute number of households engaged in agriculture in 2011 (119 million) outpaced those in 1951 (70 million). Then, there are the landless agricultural labour who numbered 144.30 million in 2011 as against 27.30 million in 1951. The welfare of this elephantine size of India's population is predicated upon a robust agricultural growth strategy, that is guided by an income enhancement approach.

This Committee on Doubling Farmers' Income (DFI) draws its official members from various Ministries / Departments of Government of India, representing the panoply of the complexities that impact the agricultural system. Members drawn from the civil society with interest in agriculture and concern for the farmers were appointed by the Government as non-official members. The DFI Committee has co-opted more than 100 resource persons from across the country to help it in drafting the Report. These members hail from the world of research, academics, non-government organisations, farmers' organisations, professional associations, trade, industry, commerce, consultancy bodies, policy makers at central & state levels and many more of various domain strengths. Such a vast canvas as expected has brought in a kaleidoscope of knowledge, information, wisdom, experience, analysis and unconventionality to the treatment of the subject. The Committee over the last more than a year since its constitution vide Government O.M. No. 15-3/2016-FW dated 13<sup>th</sup> April, 2016 has held countless number of internal meetings, multiple stakeholder meetings, several conferences & workshops across the country and benefitted from many such deliberations organised by others, as also field visits. The call of the Hon'ble Prime Minister to double farmers' income has generated so much of positive buzz around the subject, that no day goes without someone calling on to make a presentation and share views on income doubling strategy. The Committee has been, therefore, lucky to be fed pro-bono service and advice. To help collate, analyse and interpret such a cornucopia of inputs, the Committee has adopted three institutes, namely, NIAP, NCAER and NCCD. The Committee recognizes the services of all these individuals, institutions & organisations and places on record their service.

Following the declaration of his vision, the Hon'ble Prime Minister also shaped it by articulating 'Seven Point Agenda', and these have offered the much needed hand holding to the DFI Committee.

The Committee has adopted a basic equation of Economics to draw up its strategy, which says that net return is a function of gross return minus the cost of production. This throws up three (3) variables, namely, productivity gains, reduction in cost of cultivation and remunerative price, on which the Committee has worked its strategy. In doing so, it has drawn lessons from the past and been influenced by the challenges of the present & the future.

In consequence, the strategy platform is built by the following four (4) concerns:

- Sustainability of production
- Monetisation of farmers' produce
- Re-strengthening of extension services
- Recognising agriculture as an enterprise and enabling it to operate as such, by addressing various structural weaknesses.

Notwithstanding the many faces of challenges, India's agriculture has demonstrated remarkable progress. It has been principally a contribution of the biological scientists, supplemented by an incentivising policy framework. This Committee recognizes their valuable service in the cause of the farmers. It is now time, and brooks no further delay, for the new breed of researchers & policy makers with expertise in post-production technology, organisation and management to take over the baton from the biological scientists, and let the pressure off them. This will free the resources, as also time for the biological scientists to focus on new science and technology, that will shift production onto a higher trajectory - one that is defined by benchmark productivities & sustainability. However, henceforth both production & marketing shall march together hand in hand, unlike in the past when their role was thought to be sequential.

This Report is structured through 14 volumes and the layout, as the readers will appreciate, is a break from the past. It prioritizes post-production interventions inclusive of agri-logistics (Vol. III) and agricultural marketing (Vol-IV), as also sustainability issues (Vol-V & VI) over production strategy (Vol. VIII). The readers will, for sure value the layout format as they study the Report with keenness and diligence. And all other volumes including the one on Extension and ICT (Vol. XI), that connect the source and sink of technology and knowledge have been positioned along a particular logic.

The Committee benefited immensely from the DFI Strategy Report of NITI Aayog. Prof. Ramesh Chand identified seven sources of growth and estimated the desired rates of growth to achieve the target by 2022-23. The DFI Committee has relied upon these recommendations in its Report.

There is so much to explain, that not even the license of prose can capture adequately, all that needs to be said about the complexity & challenges of agriculture and the nuances of an appropriate strategy for realising the vision of doubling farmers' income by the year of India's 75<sup>th</sup> Independence Day celebrations.

The Committee remains grateful to the Government for trusting it with such an onerous responsibility. The Committee has been working as per the sound advice and counsel of the Hon'ble Minister for Agriculture and Farmers' Welfare, Shri Radha Mohan Singh and Dr. S.K. Pattanayak, IAS, Secretary of the Department of Agriculture, Cooperation and Farmers' Welfare. It also hopes, that the Report will serve the purpose for which it was constituted.

12<sup>th</sup> August, 2017

**Ashok Dalwai**  
Chairman, Committee on  
Doubling Farmers' Income

## **About Volume X**

The tenth volume of the Report of the Committee on Doubling Farmers' Income (DFI) examines the various risks that the agricultural system is exposed to. The discussions in this volume range from the strategies that help build resilience to recover from challenges resulting from force majeure events, as well as to counter the risks that result from man-made actions, which could be omissions or commissions. In common parlance, these risks are those linked to monsoon and markets.

Risk is a term that typically refers to the probability of an endangering act or event. It is closely associated with damage or loss, physical or financial. Risks can be transferred through insurance. And forewarning about an inclement eventuality can minimise the impact of such events. Therefore, risk mitigation normally requires thought on both financial cover and physical actions.

The ability to take a risk, or challenge new frontiers, is highly limited in the case of farming communities. The capacity to take on risk, head-on, is circumscribed due to the fear of the unknown, structural weaknesses in the system and financial constraints of the farmers. Essentially, reforms and interventions in the agricultural value system, should be designed to impart resilience at different stages of the system. This entails actions at pre-production, production and post-production phases.

While it is not possible to allay risks and uncertainties in totality, what is however possible, is to prepare the farmer to be ready to face the probability of the occurrence of such a risk, and negotiate them appropriately with a view to minimise the negative outcomes. This necessitates sharing of information and knowledge with farmers in advance and in real terms.

Technology is emerging as a powerful tool to deploy forecast, early warnings, alerts, and the like. These tools can be gainfully deployed across agricultural sub-sectors. With the power of new generation technologies, including ICT it is now possible to collate data points from dispersed geographies and subject them to big data analytics and draw meaningful conclusions that can be shared with the farmers.

This Volume deals with risk management possibilities and suggests practical ways that will result in loss reduction and higher incomes. The following Volume-XI will discuss and deliberate in detail about the agricultural extension system, and how it needs to be strengthened in context of current day requirements.

**Ashok Dalwai**

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# Doubling Farmers' Income

*Volume X*

## “Risk Management in Agriculture”

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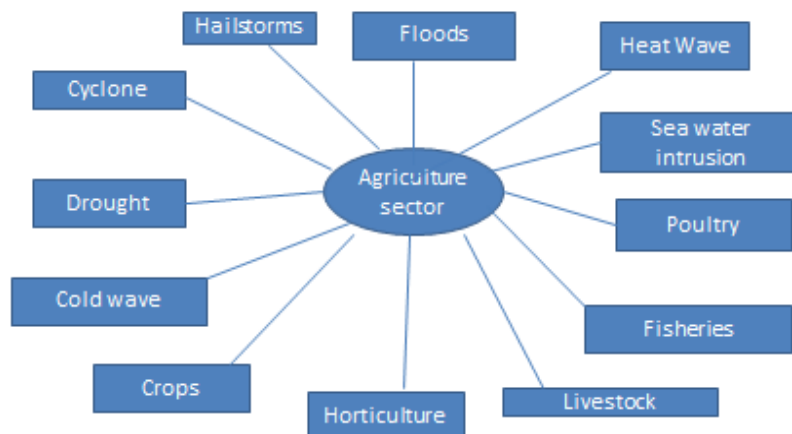
## Chapter 1

### Risks in Agriculture

*No matter how efficient the execution of plans may be, the outcome is also subject to certain random and systemic constraints. In agriculture, these constraints arise from random variations in weather, biotic interference from pests etc. and external factors like market vagaries and others. These are risks that need to be identified & addressed to realise the full potential from agriculture and associated industries. Risk management involves making a choice among alternatives that will help in allaying or minimising the negative impact and offer the farmer varying degrees of financial security.*

#### 1.1. Introduction

Agriculture is a unique sector because of its dependence on the climate and biological variables. It is also unique for its complex inter-play of both biological and market forces at different stages of its long value-chain. Therefore, in agriculture it is vital to identify and evaluate risks to be sure that decisions made on the farm and in the market will bring positive results. Scientifically, a lot of risk evaluation methods are available. However, it is not easy to see which of the methods should be used in the agricultural sector for greater effect. The agricultural sector is exposed to a variety of risks which occur with high frequency. These include climate and weather risks, natural catastrophes, pest and diseases, which cause highly variable production outcomes. Further, production risks are exacerbated by price risks, credit risks, technological risks and institutional risks. Risk management in agriculture ranges from informal mechanism like avoidance of highly risky crops, diversification across crops & sub-sectors, and across income sources to formal mechanisms like agriculture insurance, minimum support price system and futures markets etc.



#### Weather aberrations impact different sectors of agriculture

Even a cursory look at the set of agricultural activities and its business ecosystem will bring forth a sense of the unique set of uncertainty the system faces. These uncertainties are a cause of some all-pervasive risks that must be negotiated by agriculture production approach and agricultural supply chains. The production being biotic in nature, the range of factors that affect the biological processes of breeding, rearing or cultivation are a source of risk. These factors largely stem from weather and its unpredictable aspects. Since modern day development

pattern has been engendering urbanisation and can only be expected to gain further pace, they will become concentrated centres of demand for various services and commodities, including agriculture. As these centres get increasingly distant from rural areas of agricultural activity, there is pronounced spatial and time separation between production and end-uses. This, therefore, becomes an origin of another set of risks that occupy the post-production monetisation phase of agriculture. This can get aggravated because of seasonality of production and market cycles particularly in case of some produce types. Further, agriculture being closely linked with security of the society, the political economy, both domestic and international, also plays a role in the market risks that the agricultural sector has to face.

In sum, the whims of weather and the truancy about markets, are the two major causes of risks faced by the agricultural sector. Weather vagaries and force majeure events are normally beyond control of current day human intervention, besides an improved ability to predict an occurrence and act to repair or negotiate any detrimental impact. However, the market associated risks faced by farmers, can be better managed and possibly be avoided by means of intervening with technology, enabling tools and good governance.

Various volumes of this Report (both preceding and succeeding this volume no. X), logically analyse and argue on strategies to improve marketing, productivity, sustainability and resource use efficiency in agriculture and secondary activities of agriculture, besides intervention needed to address structural and governance weaknesses through reforms. However, the entire set of economic endeavours is hinged on the core undertaking of cultivating and producing useful goods that are biologically grown. One of the important aspects of risk management, is therefore, linked to the ability to forecast inclement weather situations, take steps to minimise the hazard, and insure to offset any damage that occurs.

Weather based risks include a range, which can be localised and immediate like hail damage; widespread and longer lasting like flooding; temperature linked effect resulting in yield decline or increased pestilence, resulting in debilitating both quantity & quality of output. The incidence of pests - small and large, the damage from hail, danger of drought, floods and high winds, are a few of the eventualities that manifest in different outcomes. The downside of this is, that investments made in the factors of production by a farmer are put at risk and at times are irrecoverable. Weather changes the outcome from farms and is a key factor that makes farming more a matter of chance.

Weather, when for reasons not fully understood, undergoes long term shifts in its established patterns, and is referred to as climate change. A long term, more drastic impact from climate change is a major concern of risk in the agricultural system. The data points available over the last decade demonstrate greater certainty of climate change and associated risks.

The changing climate is a major impediment in sustaining agricultural productivity, especially in case of small and marginal farming communities, where the event of loss of even a single crop can lead to starvation or malnutrition of the family. In the recent past, monsoon rainfall in

India has become increasingly erratic with intense rainfall events and reduced number of rainy days, cascading into risks of drought and flood damage to various crops including rice.

The country witnessed drought in 2002 with 19 per cent rainfall deficit. There was extreme cold wave in the winter of 2002-03 leading to frost damage of winter crops. Southern states, particularly Telangana (then part of Andhra Pradesh) faced three weeks of heat waves in May 2003. The high temperatures during March 2004 adversely affected crops like wheat, apple and potato across Northern India. The year 2005, witnessed destructive hurricanes / cyclones across the globe with some major floods in India. During 2006, the States of Rajasthan, Telangana (then part of Andhra Pradesh State) witnessed floods while, it was a drought year for North Eastern states of the country. During 2012, wide spread drought was reported in the States of Punjab, Haryana, Gujarat and Karnataka, while cyclone 'Neelam' hit the east coast of the country. The year 2014 witnessed hailstorms, early season dry spells, devastating flood in Kashmir and Hudhud cyclone in coastal Telangana. These events illustrate the high probability of risks that agriculture sector is visibly getting exposed to.

### 1.1.1. Classification of risks

As discussed above, various forms of risks that affect the agriculture sector, including both crop and non-crop sectors are broadly endogenous and exogenous to the system. They can be largely classified as follows:

**Table 1.1 Delineation of risks by type and source**

Category	Class	Source of risk	Mitigation
<b>Pre-harvest</b> (preparation & production phase)	Pre-production	Weather (rainfall, temperature), soil health, input quality (seed, fertilizer, water), etc.	Forecasting, irrigation, planning, protection, crop and animal insurance
	Production centric	Weather (rainfall, temperature, wind), pests, weeds, calamity, etc.	
<b>Post-harvest</b> (monetisation & income phase)	Agri-logistics-centric	Inability to directly communicate the output with markets of choice, quality & availability of storage & transport.	Aggregation hubs, village level logistics services
	Marketing-centric	Inefficient and ineffective market architecture, farmers not empowered to use markets as access platform, market only a transaction point.	Reorient markets as supply chain component
	Market predictability-centric	Lack or periodic demand forecasting, focus only on post-facto price information, production not linked to market demand.	Market intelligence to drive crop planning

Category	Class	Source of risk	Mitigation
Governance - centric	Universal impact	Trade policy, restrictive market rules, undeveloped inter-state trade , identification of farmers, procurement targeting only a few crops and regions, policies that are production centred and not income centred, increasing population density and decreasing per capita arable land, extractive and unsustainable production system.	Reforms - policies, (transition to sustainable production system and from production to income centric agricultural development; deregulation and liberalisation of markets, storage etc; incentivisation (e.g., exemption under I.T. Act to FPOs etc.)

The wide array of risks are both internal and external to the agriculture sector and have effect on yield, overall productivity of assets, market access and price valuation, each having financial implications for the farmer.

The preceding volumes of this Report, have addressed and recommended the necessary interventions across each category in the agricultural supply chain, to alleviate and systemically minimise the risks that arise from various inefficiencies. Further, the succeeding Volume No. XIII recommends various interventions needed for structural and governance reforms relating to agriculture and farmers' welfare. Different types of risks and risk management approaches are discussed briefly in the following sections. It would however help refer respectively to the related volumes and chapters for details.

## **1.2. Pre-harvest Risks and Negotiations**

### **1.2.1. Climate change and agriculture**

The variables of the immediate weather, and the long term climate in a zone has real and substantive effect on the entire value system of agriculture. The climate determines the weather pattern (temperature, pressure, humidity, precipitation, etc.), which in turn affect all flora and fauna in a region. The known certainty of climate change, is bringing awareness of permanent changes in weather patterns. These have already resulted in shifting of cropping and a shift in other on-farm biological activities. Besides increasing the uncertainty and the potency of weather events, climate change will disrupt weather patterns and the linked risks will shift regions.

The implication is, that traditional and standard risk mitigating practices will also need to re-adjust. Scaling up the existing risk cover to reach a larger number of beneficiaries may not be sufficient, and there may be a need to redesign the system. Traditional threats that no longer

remain prevalent in an agro-ecological zone, can be rated lower and accordingly reduce the cost of risk cover.

Climatic adversity is not predictable at regional level in the long term, though short term weather is more accurately predictable. Meteorology has advanced as a science to a level that is far more accurate than even only a few dozen years ago. Being mainly rooted in analysis of data, the large number of automatic weather recording stations and other data collection instruments, backed by data analytics are helping in making more accurate short term weather forecasts. Weather forecasting is one of the first steps in risk management. For effectiveness, however the forecast has to be shared with the farmers as an Advisory in quick time.

Weather forecast is an early warning system, allowing farmers to adjust their activity to suit the expected weather based on information/advisory shared. This is most important in case of rainfed areas, which accounts for the larger share in India's agriculture, where rainfall patterns dictate the routine of farmers. The weather also directly impacts livestock and their productivity, the fishermen and the risks they face, the flow of rivers and stress on soil. Abiotic and biotic factors, whether stressed or at ease, are all impacted by the weather and the long term climate of the respective regions.

Agriculture is defined by human intervention, in organising natural biological functions and phenomena. The practices involved have emerged over a few millennia, commencing about 10 to 12 thousand years ago, when first human settlement around domesticated animals began. The biology itself has evolved over thousands of millennia. On the other hand, the current cycle of climate change has begun disrupting the system within the recent decades and much faster than the slow process of evolution. Such short term disorders will tend to fast track natural selection and cause extinction of practices and prosecution in some more vulnerable regions, necessitating as a sequel, a new pattern of agriculture.

Even the concept of vulnerability may have to be reviewed. Typically it is correlated to areas with infrequent rainfall and from the perspective of drought. However, because of climate change, high rainfall can also become a cause for classifying a currently non-vulnerable area as vulnerable. More frequent and debilitating cyclones may require another gradation of vulnerability to natural disasters. In fact, the parameters for assessing the vulnerability of a region to climate change have been undergoing at the IPCC level.

### **1.2.2. Disruption in eco-biology**

The impact of climate change on agriculture is being reported from across the world including India. The regions that are most vulnerable are those that are more dependent on rainfall and are already facing excessive pressure on natural resources.

Climate change is throwing up new variables in weather patterns, altering weather events in periodicity and ferocity from the past set of patterns. The alterations seen are in respect of average temperatures & rainfall, and increased extreme events (e.g., heat and cold waves,

flooding), enhanced atmospheric carbon dioxide and ground-level ozone concentrations, and rise in sea level leading to inundation of coastal areas etc.

The major cause of climate change is attributed to greenhouse gas (GHG) emissions. It is also known that agriculture too contributes to GHG, as well acts as a carbon sump that alleviates the impact. A disruption in the agricultural system, will also create aberrations in GHG trends. Climate change can result in the following kinds of extreme events:

- a. Rainfall deficit or delay resulting in dry spells.
- b. Excess rainfall resulting in flooding
- c. Heat waves and hailstorms
- d. Cyclones and depressions
- e. Changes in sea currents

The impact of each event will depend on its longevity and spread. Dry spells can prolong into debilitating drought. A combination of such events lead to changes in salinity of soil, erosion, loss of bio-diversity and more. All of this cause stress to the crops and to cropping patterns.

**Table 1.2 Influence areas of climate change**

Abiotic influence	Biotic influence
Solar & UV radiation levels	Insects and nematodes (friends & foe)
Flood and drought	Avians and mammals (friends & foe)
Temperature (high & low)	Fungi and microbes (symbiotic and pathogens)
Wind force and fetch	Bacteria and Virus (pathogens)
Nutrients efficacy	Monocots and dicots (weeds)
Toxicity of chemicals	Parasites and vectors

The adverse range of environmental conditions are expected to unfortunately contain a larger potential to reduce the yields in warmer regions. However, in cooler regions too, adverse environment will affect the yield of the traditional crop varieties, and many temperate crops may not find new growing areas. India is largely a tropical and warm agro-zone and its cooler zones are along hillsides of the Himalayas. An increase in average temperature will not be offset by a northern shift as the elevation and soil conditions will not permit the same.

### **1.2.3. General nature of risks from climate variability**

The impact of climate variability and change on food and agriculture in different agro-climatic systems and the changes in risk management approaches have shaped the mitigation and the response strategies of farmers and societies over millennia. Hydro-meteorological risks such as **droughts, cyclones and floods** not only endanger human lives and property, but also have a devastating impact on food production and farmers' livelihood systems. Farm communities,

particularly small and marginal farmers who do not have inbuilt buffering mechanisms, as in the case of resource poor rain-fed regions, are disproportionately vulnerable to the severity of extreme climate events.

Climate change further compounds the problem, as it threatens to alter the frequency, severity and complexity of climate events, as also the vulnerability of high-risk regions in different parts of the country. The major cause of climate change is attributed to greenhouse gas (GHG) emissions.

**Deficit rainfall or dry spells:** Drought is a normal feature of India's climate. Droughts of varying magnitudes, intensities, duration and geographical spread have haunted India, over centuries. During the period of 1871-2002, there were 23 major drought years. Thereafter too, there have been years of severe drought. These include the years 2009, 2014 and 2015.

**Excess rainfall:** Water-logging and flooding or submergence can be a major factor that limits crop yields. The incident can be when the root and part of shoot are underwater, or when the entire plant is submerged under water. The plant can get partially or completely cut off from supply of oxygen. When plants do not get sufficient oxygen they switch over metabolism from aerobic to anaerobic mode which cannot be sustained over longer periods.

**Hailstorms:** Hail is a form of solid precipitation. It is distinct from ice pellets, though the two are often confused. It consists of balls or irregular lumps of ice, each of which is called a hailstone. Hail can cause serious damage, notably to livestock, and most commonly, the standing crops.

Many of the major crops including fruits and vegetables have been researched for developing drought resilient varieties. The adaptive traits being improved for drought tolerance are such like early vigour, osmotic adjustment, leaf senescence, etc. ICAR institutes have released many varieties suitable for cultivation under drought in cereals, sugarcane, pulses, oilseeds, fruits, vegetables, fibre and fodder crops. The same has been done for varieties suitable to cultivate in delayed monsoon.

Adverse temperature is another risk from climate change. This can manifest in extremes and cause **Heat stress**. When plants are exposed to warmer than normal temperatures for an extended period, it causes an array of morpho-anatomical and bio-chemical changes, which affect physiological growth and eventually the yield and the economics. High temperature exposure beyond a threshold level, causes irreparable and irreversible damage to the plant. This damage is called heat stress and the chance of this occurring is the risk involved. Developing crop varieties that are more tolerant to increased temperature is another area of research. Successful combination of traditional and molecular breeding techniques has resulted in the release of many heat tolerant crop varieties by ICAR institutes.

The other temperature caused stress is called **Cold stress**. Crops, livestock and especially fish,



are very sensitive to low temperature exposure over any extended duration. Fish are cold blooded and rely on a steady state temperature of the water to maintain their own temperature. Extreme cold results in wilting, chlorosis, necrosis and causes dysfunction in the plant. When air temperature drops below 5 °C (in areas where average ambient temperature is more than 10 °C) for more than 3 days, the phenomena is called a cold wave. In case of regions where the average ambient is less than 10 °C, a drop in temperature of more than 3 °C for more than 3 days is referred to as cold wave. The number of days of such exposure that results in cold stress varies, crop to crop. The ability of making a crop more tolerant to cold wave conditions and hence delay or not suffer cold stress is another research area. Many such varieties have also been developed and released. However, new challenges will always emerge demanding appropriate responsible.

**Salinity stress** is another concern raging over the environment because of climate change. Salinity level of arable soil depends on the ratio of evaporation to precipitation in land locked areas. In coastal regions, intrusion of seawater can also increase soil salinity. High salinity causes plant death from hyper-ionic and hyper-osmotic pressures. Heavily irrigated lands are becoming highly saline, while in drier areas extensive water loss also changes salinity level. Climate change can result in extended dry spells as well as extensive rainfall. Many varieties of the cereals, that can be cultivated in salinity stressed soils, have been released by various Institutes/Universities of ICAR.

**Water-logging** and flooding or submergence can be a major factor that limits crop yields. The incident can occur when the root and part of shoot are underwater, or when the entire plant is submerged under water. The plant can get partially or completely cut off from supply of oxygen. When plants do not get sufficient oxygen they switch over their metabolism from aerobic to anaerobic mode which cannot be sustained over longer periods.

**Cyclones and depressions:** In meteorology, a cyclone is a large scale air mass that rotates around a strong centre of low atmospheric pressure. Cyclones are characterised by inward spiraling winds that rotate about a zone of low pressure. The largest low-pressure systems are polar vortices and extra-tropical cyclones of the largest scale (the synoptic scale). Warm-core cyclones such as tropical cyclones and sub-tropical cyclones also lie within the synoptic scale. Meso-cyclones, tornadoes and dust devils lie within the smaller meso-scale. Upper level cyclones can exist without the presence of a surface low, and can pinch off from the base of the tropical upper tropospheric trough during the summer months in the Northern Hemisphere.

#### **1.2.4. Other pre-harvest risks and their management**

**Degradation of natural resources (land and water):** Land use change is a dynamic process in view of the socio-economic developments, market forces, and paradigm shifts at national and global levels in the wake of globalization and economic liberalization, as also the pressure to meet the requirements of the growing human and animal populations. Since over-exploitation of groundwater through indiscriminate drilling of bore wells and tube wells has reached critical levels in most districts of India, there is threat to efficiency of high water duty

crops and sustainability of yields. Hence, regulation is required to ensure that groundwater supplies are available in sustainable fashion to meet current and future requirements apart from development initiative like ground water recharge, crop alignment and efficient use of water.

**Soil-water-air pollution:** Both geo-genic and anthropogenic factors affect pollution/contamination of soil and water resources. Applications of sewage sludge water and untreated industrial effluents to agricultural soil and field crops cause accumulation of lead (Pb), cadmium (Cd) and nickel (Ni) toxicity in soil and plants. Nitrate pollution in drinking water can have serious health impact on humans, especially for babies and children. The most significant potential health effects of drinking water contaminated with nitrate are the blue-baby syndrome (methemoglobinemia) and cancer caused by over-use of fertilizers.

**Deforestation:** Diversion of forest area to non-forest activities like industries, infrastructure and human habitation, unrestricted exploitation of timber as well as other wood products for commercial purposes have been important causes of forest degradation. Risk management warrants increasing of the density of plantation and canopy cover of the notified forest areas, and promoting forestry in non-notified areas (waste-lands & cultivated lands) by promoting species that will meet the human requirements without affecting crop production. Appropriate policy framework including, liberalisation are essential and at the operational level the choice of species becomes important.

**Traditional practice of shifting cultivation:** Unsustainable traditional practice of shifting cultivation (jhum, podu etc as known in different states), along the slope in hill ecosystem has, indeed, a serious negative impact on soil, water and environmental degradation. These different practices are essentially slash and burn system of cultivation. Interventions call for new models of development that will optimally marry the apparently contradictory demands of economic development and ecological rejuvenation/sustainability.

**Inappropriate disposal of farm waste:** Waste generated by agricultural activities include farm waste, horticulture waste (fruit and vegetables), rotten seed, livestock waste, waste from markets, gardens and seedling nurseries. Unscientific dumping of these wastes in “out of place” locations not only results in land and air pollution, but also causes serious losses of nutrients through leaching and volatilization. Whereas, there exist ways of utilizing these for generating usable resources. For example, the vegetative portion of the plant can be composted and used to enrich the soil.

**Intensive tillage operation:** Continuous soil ploughing leads to development of hardpan, low input use efficiency, emission of greenhouse gases, particularly CO<sub>2</sub>. With the increasing pace of agricultural mechanization, the use has to be such as to keep soil compacting at bay. This calls for designing the farm machinery suitably.

**Faulty fertilizer management:** Conventional fertilizer management (broadcasting) leads to emission of potential greenhouse gases, particularly nitrous oxide into the atmosphere. Also,

blanket nitrogen application causes NO<sub>3</sub> pollution in the groundwater. Hence, need based fertilizer application is of utmost importance.

**Loss of bio-diversity:** Over the years, diversity (crops, microbes, animal and fish) in India has come under pressure due to massive commercialization of agriculture leading to almost extinction of traditional farming systems. Commercialization leads to mono-cropping. It is important that integrated farming system, mixed cropping etc which are more suitable to small farming practices are retained. However, technology and institutional systems will have to be developed, that will bring the advantages of modern technology and scales of economy.

**Residue burning:** Farmers in North West India have discovered burning as the cheapest and easiest way of removing large loads of residues produced by rice to establish the wheat crop rapidly after kharif harvest. This residue burning causes air pollution, soil carbon loss and environmental hazard risk. Alternate ways of residue management by capturing its value (e.g., in-situ management via composting or as feed in bio-mechanisation etc.).

**Continuous puddling and flooding practice:** Rice cultivation in puddled soil with manual transplanting requires huge amount of water, and it is estimated that India will face irrigation water scarcity in future. Also, puddling operation besides destruction of soil structure emits methane which is a potential greenhouse gas. Hence, puddling poses a great threat to climate and alternate rice cultivation practices that have by now been well demonstrated should be adopted on large scale.

**Faulty irrigation practices and secondary salinity:** Heavily irrigated lands are becoming highly saline, while in drier areas extensive water loss also changes salinity level. Climate change can result in extended dry spells as well as extensive rainfall.

**Lack of diversification in dryland region causes livelihood risk:** The livelihood and nutritional security provided by livestock rearing is enormous. Further, the net output from the unit of investment is comparatively high in livestock farming even under adverse seasonal conditions. Further, the vulnerability of livestock to weather vagaries is much lesser than that of crops. Hence, crop-livestock based production system is a risk negotiation strategy. It is worth noting, that livestock and particularly small ruminants (sheep & goat) serve as assets, which can be exchanged for money in times of distress.

**Management of manmade risk:** Volumes V and VI of the DFI Report discuss strategies for enhancing agricultural productivity and sustainability as well the associated strategies in detail and by crops. Volume VIII (inclusive of various sub-volumes) that address productivity - production issues across the crops and non-crops also provides an insight into risk management options. However, vertebrate pests also constitute an important source of risk and deserve exclusive examination. This has been met with in Chapter 2, that follows.

In nutshell the options for managing man made risks are (i) diversification of cropping systems;

(ii) promotion of carbon sequestration in agricultural practices and building resilience in soil; (iii) sustainable soil management practices and crop residue addition; (iv) popularization of aerobic rice cultivation methods and conservation agriculture ; (v) water saving technologies, water harvesting development and micro-irrigation; (vi) organic farming and integrated farming systems; (vii) afforestation and agro-forestry generation; and (viii) mixed farming and diversification of income source.

### **1.2.5. Management of natural risk**

In recent years, there has been a dramatic technological progress in the understanding of climate systems, as well as in monitoring and forecasting weather events on the scale of seasons and beyond. In addition, there also exists today the power of ICT, that can be deployed in risk management in agriculture. Some of the negotiation strategies are discussed in the following:

**Climate prediction:** Spatially and temporally differentiated weather information with a lead-time of 20-25 days, could be of value to policy planners and farmer service organizations, to provide critical agriculture input support services to farmers.

**Disseminating climate information:** India is one of the few countries possessing long term climatological records, spanning over 130 years (since 1881). This rich climate database could be utilised to draw up patterns of climate risks, that could be used in drought management and mitigation planning.

**Early warning systems for flood and cyclones:** Flood forecasting and warning systems in India, complement structural flood management measures such as embankments and channels, which aim at minimizing flood damage and also better planning of rescue/relief operations.

**Contingency crop plan:** This strategy has been evolved through research efforts since the mid 1970's, to minimize crop losses in the wake of aberrant weather conditions. ICAR-CRIDA (Central Research Institute for Dryland Agriculture) located at Hyderabad has successfully developed District Contingency Plans (DCPs) for almost all the districts in the country. They can be updated annually for greater location-specific effectiveness.

**Development of climate resilient varieties and technologies:** Enhancing resilience of farmers, through sufficient supply of stress tolerant varieties of crops, is a vital responsibility taken up by agricultural R&D community. The cost effective availability of such varieties to farmers is another concern. An important intervention necessary for bridging the gap between lab and land is affordability of cost at the farmer's end. The R&D community should always keep this in mind.

In case the stress to standing crop is in its early stage of cultivation, the damage can be re-compensated by re-sowing immediately. In such a case, there should be provision

for sufficient seed available to the farmers. To meet such an eventuality, seed banks can be developed in communities, and the inventory of seed can be rotated every next season. The concept of National Seed Reserve (NSR) will come in handy, and therefore, needs to be built up robustly.

**Crop insurance:** Crop insurance is a mechanism to protect farmers, against the uncertainties of crop production, due to natural factors, beyond farmer's control. It is also a financial mechanism, which minimizes the uncertainty of loss in crop production, by factoring in a large number of uncertainties, which impact crop yields distributing the loss burden.

**Volumes V and VI of this Report** discuss climate change and sustainability of the agricultural system as well the associated strategies in detail and by crops. The risks and the involved strategies have so far been in relation to production and pre-production phases in agriculture. It is suggested, that in the context of small and marginal farms India's agriculture structure dominated by, besides it being primarily linked to monsoons and nature, the principle of sustainable production systems is critical. Against the background, it is imperative that the production system adopts integrated farming system (IFS), conservation agriculture (CA), watershed based treatment, comprehensive rainfed farming system and the like.

### **1.3. Post-harvest Risks and Negotiation**

There exist risks associated with uncertainties after the harvest of agricultural produce, be it crop - or animal- or aqua-based. Farmers encounter a variety of risks to their economic well-being, and not all such gambles are from force majeure events. Occupational hazards for farmers also originate from unknowns arising from obstructive rules & regulations, an ineffective market architecture and their low capacity to plan for and target demand and the like. Many of these lie within the ambit of governance. Hence, it is important to recognise that the risks and uncertainties go beyond the biological (mostly production segment) and relate to the state of available agri-logistics, market structure & marketing efficiency; and policy framework of the government.

Risks unique to agricultural sector, can be negotiated by either addressing the root cause, or by insuring against their financial repercussions. In case of weather related risks, forecasting systems related to weather are a method of risk management. Weather forecasts, allow for some time to plan and take preventive measures against an eventuality. However, the unpredictability of natural events cannot always be neutralised with information and action alone. Therefore, such risks require a level of insurance, that neutralise the loss by financial compensation to varying degrees, and enable to hasten the recovery phase after the occurrence. Such insurance interventions include comprehensive crop insurance and livestock insurance schemes. These schemes could be based on different indices like area & yield, as also weather.

Forecasting of market demand holds great potential as a risk negotiator. Most of the cob-web patterns in markets result from large variations in supply (see Chapter 2 Volume IV), which

disrupt the demand-supply balance. In current situation, the periodic oversupply of produce, is a result of farmers adjusting their cropping on the basis of previous season's price information. However, if crop planning is attended to on the basis of quantum of demand, and not price realised, then distortions due to uncertain supply can be dampened to a large extent.

Market intelligence, much like advance information about the weather, is an important component in risk management for farmers. Such market intelligence will require to be applied by production departments to assist and adjust the ongoing support mechanism to guide in crop planning. Hence, the importance of an institutional system that can forecast demand and price over both short and long terms. A robust market intelligence system is in order.

The production must eventually connect with demand centres, to be monetised at optimal prices. This requires that the marketing system and the enabling logistics are brought to function as the farmers' asset base, empowering them to access market locations of choice. An integrated agri-logistics system that can shoulder a farmer-favouring agri-value system is a prerequisite to minimise food loss and transfer agri-commodities from the farm gate over space and time without compromise of quality. This will help the farmers to connect their produce with consumption centres of choice and at a time of their decision, and thereby benefit from a fair share of consumers' rupee.

Equally important is that, the primary actors in the agricultural supply chain, be identified accurately. The cultivator, a primary actor, is typically associated with land holding, which ignores the landless farmer. These even include women farmers, who may be tilling the field but do not have ready access to various benefits offered to farmers. The governance system needs to address the landless as farmer beneficiaries. For this, the requirements are building of a dynamic farmers' database, recognising lessees etc. as farmers and providing them access to credit & government schemes.

Risk management is not only about managing damage, physical or financial, resulting from a hazard. Risk management can also be distinguished to include the process and procedures that empower the individual or a group to take risks.

Success and growth of any business enterprise, also relates to the capability of the enterprise to test markets, products and innovations. The ability to take risks and to challenge the status quo, depends on the capacity to suffer financial loss. To promote such capabilities in farmers, especially to connect their output with new or untested markets, there is the need to reform the market system that can service such connectivity, cost effectively and efficiently. The recommendation to promote Primary Retail Agri-Markets (PRAMs) in Volume IV which has by now been adopted as Gramin Agri-Markets (GrAMs), to function as aggregation and logistics connectivity hubs will help from this perspective. These will serve as the first link in the marketing chain integrating thereafter with reformed & competitive domestic wholesale markets (APMCs/APLMCs) and further into export market.

The recommendation for a model Contract Farming & Services Act (Volume XIII) will also incorporate contracting of services from this perspective. The government may also consider absolving the small & marginal farmers from some of fees levied on various services to enable them to build new logistics - bridges with distant markets. The size of operation also determines the intensity of risk and its impact. The small & marginal farmer is always more vulnerable. He can be buffered to a great extent by mobilising them into farmer producer organisations (FPOs).

Income growth is not necessarily linked to growth in production. Besides building the ability to transact at markets that have a more favourable demand-supply situation, the spread in income from diversification into other crops and activities is also important. Diversification is therefore important from the perspective of hedging against various risks. The ability to sustain and rebound from a financial loss is critical in building risk taking capabilities. Such capability makes the farmers' income less vulnerable to some risks.

The government's procurement system is also not merely a market replacement system, but allows the beneficiaries of such strategic procurement, to benefit from the certainty of MSP (Minimum Support Price). From the perspective of risk management, the procurement mechanism should accordingly be designed to have a wider regional and crop-wise spread. However, it is not intended to profess a larger load on the exchequer, but that the total planned expenditure be strategically spread to various sub-sectors of agriculture, as also across crops/activities within each of them and farmers. As a risk management tool, procurement targets can be assigned to regions and crops, so as to bring the surety of market as a risk management tool, especially to those that are most vulnerable.

#### **1.4. Annotation**

In essence, the focus on income security of farmers, as propounded by the agenda of Doubling Farmers' Income, is taking agriculture into the phase of risk management with a view to neutralising or minimising the impact of risks. All development, directed to build financial independence for the farmers and their income, or minimise their costs, are directly linked to risk management in agriculture.

The risks that arise at both enterprise and at operational levels and their effective management such as better agricultural practices, market transparency, monopolies and competition, long life and short life produce, nutrient management and pest management and more, have been discussed in the preceding volumes of the Report. Exogenous risks that arise from inefficient market system and constraints thereof, are also covered in this Report.

The risks to the environment, such as from climate change and from weather based calamities, are also deliberated upon in various volumes of this Report and are of larger national concern and have long term influence on incomes of the nation's farmers. The structural and governance related issues that will help in risk management have been examined in volume XIII of the Report.

The agricultural system is risk prone, and while these need to be negotiated and managed, there is also the need to build resilience and capacity to face risks. Here governance and market support have an important role to play. The ability to take risks also allows the various actors in the agri-value system to explore and develop new markets.

While the relevant volumes and chapters may be referred to for details, this chapter paints a broad canvas of the nature and types of risks and the critical need for their resolution for securing farmers' incomes.

#### **Key Extracts**

- The uncertainties inherent in weather, yields, government policies, global markets, prices and other factors impact agriculture at various stages of its value chain, and cause wide swings in farm income. Risk management involves choosing among alternatives that reduce financial effects that can result from uncertainties.
- Flooding, drought, cold stress, heat stress, frost damage, salinity stress, and other catastrophic effect are climate-based natural risks causing decline in quantity and quality of agricultural output.
- Faulty agricultural practices like deforestation, traditional practice of shifting cultivation, inappropriate disposal of farm waste, intensive tillage operation, poor fertilizer management, residue burning, unscientific irrigation practices, continuous puddling & flooding, lack of diversification in dryland regions are anthropogenic causes of risk which lead to degradation of natural resources, soil-water-air pollution, loss of bio-diversity, etc.
- The natural risk in agriculture can be negotiated by appropriate weather prediction, disseminating early warning for flood and cyclones and developing contingency crop plans, climate resilient varieties, technologies etc. Whereas, good agricultural practices like diversified cropping systems, conservation agriculture for carbon sequestration, aerobic rice cultivation, water saving technologies and water harvesting development, organic farming and integrated farming systems, and afforestation can minimize the anthropogenic risk in agriculture.
- An efficient marketing system backed by a robust agri-logistics, price & demand forecasting and market integration are important components that not only mitigate risks but also build the ability to take certain market risks.
- Governmental support like crop & livestock insurance, weather forecast infrastructure, minimum support price and enterprise facilitative policies should be designed to minimise both the natural and anthropogenic risks in agriculture.





## **Chapter 2**

### **Vertebrate Pest Management**

*A range of direct and indirect negative interactions occur between humans and animals. With increasing density of human population and concomitant pressure on land, the context of Human-Wildlife Conflict (HWC) is building up. There are challenges in protecting crops by controlling or managing vertebrate pests, as these animal life-forms are integral and also important to ecology.*

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#### **2.1. Introduction**

Agriculture bio-diversity provides for both food security and the planet's sustainability. Terrestrial and aquatic plants as well as animals, gathering as well as cultivation, have been providing for sustenance of human and livestock population over centuries. Agriculture being biological in nature is vulnerable to several external factors. Protecting the production system against these vulnerabilities assumes importance. Effective management of vertebrate pests is also important from the perspective of realising targeted yields. Indian Council of Agricultural Research (ICAR) sponsored All India Network Project on Vertebrate Pest Management has evolved several effective and eco-friendly vertebrate pest management technologies, which need to be proactively disseminated to the farmers and other end users.

In the foresight analysis, it is becoming clear that food production has to be continuously stepped up, despite cultivable land being diverted to other economic activities and emerging challenges such as climate change, bio-diversity loss, degradation of natural resources and so on. Along with these, there are abiotic stresses such as temperature, rainfall patterns, salinity etc. and biotic stresses caused by the pathogens, parasites, insects etc. Another emerging concern in Indian agriculture is the impact being caused by the vertebrate pests and wildlife, causing drastic decrease in crop yields and consequential economic losses to the farming community. Major group of vertebrates inflicting losses in agriculture include rodents, depredatory birds and higher vertebrates. In order to mitigate this, an integrated approach is necessary. Likewise for managing the vertebrate pest problems, a multi-pronged strategy is required so that their adverse impact is minimised without harming the wildlife.

#### **2.2. Human-Wildlife Conflict (HWC)**

Human-Wildlife Conflict (HWC) is defined as any interaction between wild vertebrates and humans which causes harm, whether it is to the human or the animal or property (including the destruction of crops). Conflict arises from a range of direct and indirect negative interactions between humans and animals. These can culminate in potential harm to all involved, and lead to negative human attitudes, with a decrease in human appreciation towards wildlife and generation of detrimental effects on conservation.

Conflict generally arises from economic losses to agriculture by destruction of crops and loss of livestock through predation. In arid areas, conflict often occurs over access to water and competition for resources. A wide range of species are responsible for conflict, with the principal culprits being primates, rodents, ungulates (including antelope, wild boar, elephant,

tiger, lion, leopards etc. Conflict situations can arise anywhere, but they are frequently concentrated at the fringes of reserves where wildlife enjoys protection and land is often fertile.

### **2.2.1. Dimensions of HWC**

India is the seventh largest country in the world and second largest in Asia having 10 different bio-geographic zones, encompassing varied landscapes with rich natural resources. India also has rich diversity with approximately 45,000 species of plants, 86,874 species of animals including 390 species of mammals, 1,300 species of birds, 456 species of reptiles, 311 species of amphibians and 2,546 species of fishes. All the bio-geographic zones are facing challenges of HWC from a number of species, in varying degrees. The major species involved in the HWC are snow leopard, himalayan bear, monkeys, wild ass, *nilgai*, black buck, wild boar, elephant, leopard, sloth bear, gaur, tiger, porcupine and crocodile. In Trans Himalayas and Himalayan zones, the HWC is mainly due to snow leopard, himalayan bear and monkeys. The wild ass and *nilgai* problems are severe in regions like Thar and Kutch desert zone. The number of problematic species involved in HWC is comparatively similar in Semi-arid, Western ghats, Deccan peninsula and Gangetic plains, where the predominant species like wild boar, *nilgai*, monkeys, elephants and other antelopes cause significant problems in agriculture.

**The ways in which HWC occurs are as follows:**

- i) **Killing of humans:** Any species that attack the human being for defence purpose or for food leading to death. Species like tiger, leopard, lion, sloth bear, elephant etc. are involved.
- ii) **Killing of livestock:** Any species that preys on the livestock viz., leopard, lion, tiger and wild dog.
- iii) **Accidental injury:** Any species like, gaur, *Nilgai*, elephant, leopard, tiger, wild boar and crocodile that accidentally attacks humans or livestock for self-protection.
- iv) **Damage to agricultural crops:** Due to non-availability of preferred dietary items in the original habitat, the animals are compelled to depend on agricultural crops for food causing enormous damage to the crops. Rodents, birds, wild boar, *nilgai*, elephant, rhesus macaque and black buck are a few species in this category.
- v) **Property damage:** Species involved in damaging the households or any other structures are elephant, rhesus macaque, bonnet macaque etc.

**Reasons for HWC:** The basic requirements of space, shelter and food overlap between humans and wildlife, creating conflicts. The major reasons for such a conflict is the loss of species-specific habitats, habitat degradation and its fragmentation, intensive agricultural practices, insufficient prey base and food material, increase in human and livestock population, competitive exclusion of wild herbivores, land use transformation, developmental activities, growing interest in eco-tourism and increasing access to nature reserves.

**Legal issues:** Management of problematic species mainly depends on their status as per the

Indian Wildlife Protection Act, 1972 (IWPA) and International Union for Conservation Nature (IUCN). The species like tiger, leopard, lion, sloth bear, snow leopard, elephant, black buck, gaur and crocodile are kept under schedule–I of the Act, whereas the species like rhesus macaque, bonnet macaque and wild dog are listed under schedule–II. Likewise other species like wild boar, *nilgai* are listed under schedule–III. However as per IUCN, tigers, snow leopards, elephants and wild dogs are listed as endangered; lion, sloth bear, gaur and crocodiles are listed as vulnerable; leopard and black buck are considered near threatened and others like wild boar, *nilgai*, rhesus macaque, bonnet macaque are listed as least concerned species. The status of these species as per IWPA and IUCN is the major limitation while dealing with the species in agro-pastoral ecosystems.

Apart from these, the major constraints in vertebrate pest management are: lack of sustained efforts at local level, strong religious sentiments against killing, high cost of eliminating animals, lack of coordination with and among government departments and lengthy procedure for declaration as vermin.

### 2.3. Problems of Vertebrates in Agriculture

All the vertebrate species occurring in India are not problematic in agriculture. Among the 103 species of rodents, only over a dozen species were found to be involved in agricultural damage at different growth stages of the crop and also in storage. Similarly, of the 1364 bird species, only 63 were identified as depredatory in nature and causing damage to various agricultural and horticultural crops mostly during vulnerable stages.

**Table 2.1 Vertebrate pests in agricultural landscape**

Group	Total No. of Species	No. of species assessed to be causing crop damage
Rodent	103	14
Bird	1364	63
Antelope	6	3
Deer	9	1
Elephant	1	1
Gaur	1	1
Wild boar	1	1
Black napped hare	1	1
Primates	13	5

Among the six antelopes reported in India, three species like *nilgai*, black buck and four horned antelope were reported as crop raiders. Similarly, of the nine deer species, only spotted deer has been reported to cause crop damage on the fringes of forest blocks. Out of 13 species of primates listed, five species are involved in crop damage across different agro-ecological regions. The other species like elephant predominantly causes crop damage, property loss and injuries to humans mostly in forest fringes and also during migration across the corridors. The wild boar is the most problematic species causing significant crop damage across different

agro-climatic zones of the country.

The intensity of crop damage by these vertebrate species largely depends on their population density, cropping pattern and crop area, season and stage of the crop. Studies conducted by the All India Network Project on Vertebrate Pest Management (AINP-VPM) showed that in general the extent of damage caused by different species of rodents was to an extent of 15 per cent, followed by birds at 9 per cent. Recent studies revealed that the wild boar damage to different crops varies from 15-40 per cent, *nilgai* to the extent of 10-30 per cent, elephants 20-50 per cent, rhesus macaque 10-30 per cent, black buck 5-15 per cent and gaur 5-10 per cent.

#### **2.4. Population Estimates**

Estimating population density of animal species, more specifically the mammalian species that attract conservation interest is an important tool for their conservation and population management. However, estimating animal numbers in tropical forest habitat is difficult, because of poor visibility and relatively low density of some species resulting in inadequate sample sizes for obtaining statistically precise results. Also, except in a few locations, no systematic or scientific approaches have been followed to estimate population densities. Population numbers that are available for species such as the Asian elephant or prey species of large carnivores originate only from census programs. Although these census operations are systematic or assumed to be successful, their results are neither validated nor compared with any other long-term population studies on the species. The available population status of some of the problematic higher vertebrate species, based on secondary information reveals that the tiger population reported approximately 2,226 individuals, leopards ranging between 12,000-14,000, *nilgai* in outside protected areas numbering over five lakh individuals, elephants, over 25,000 individuals, gaur, more than 20,000 and sloth bear around 10,000 individuals.

In several countries like USA, UK, Poland, Russia and Japan, the control of problematic animals in agricultural landscape is done through hunting, caging, shooting, electrocution and translocation. In certain situations, poison baits on a large scale are widely used, as in Pakistan, for managing the wild boars. In Bhutan on the other hand, trained groups of farmers are engaged in hunting the wild boars. Italy is a country where wild boar menace is kept under check by using sodium monofluoro acetate or warfarin. While these methods are effective in managing problematic vertebrates, none of these is applicable for Indian conditions, as most of the problematic animals are listed in Schedule I to III of Wildlife Protection Act 1972. Any method resulting into either intentional or unintentional death of the animal is punishable. However, sections 11 & 12 of chapter III dealing with the Hunting of Wild Animals, permit the hunting in certain special cases. Various State governments like Gujarat, Punjab, Haryana, Himachal Pradesh, Uttarkhand, Uttar Pradesh, Karnataka, Telangana, Tamil Nadu, Andhra Pradesh and Maharashtra are providing compensation to the people affected by wildlife. In such a situation development of vertebrate management practices in India need to be strategic, logical, economical and above all, must be legally sound.

To date, there has been comparatively very little systematic research carried out to investigate

patterns of crop raiding activity by wild animals, its potential impact on farmers' food and household economic security and ways and means to manage them. Most of the research so far has focused on the issues related to crop damage by rodents. However, information on higher vertebrates such as primates and ungulates often cited as troublesome 'pests' in agricultural areas is scant and scattered.

## **2.5. Initiatives by ICAR**

Keeping in view the severity of the problem in agriculture associated wild animal species, ICAR launched an All India Network Project on Vertebrate Pest Management during 2014-15. Besides birds and rodents, management of higher vertebrates is also an important component of the Network. The Project envisages to undertake detailed studies on ecology and management of three most important wild animal species, viz., nilgai (*Boselaphus tragocamelus*); wild boar (*Sus scrofa*) and monkey (*Macaca* sp) to minimize the crop losses vis a vis farmer-animal conflict in agricultural landscape. In this regard AINP on VPM (ICAR) have developed way forward to deal with these animals taking care of loss of agricultural production, legal instruments and man-animal conflicts.

The intensive field studies on various vertebrate pests have helped to enlist key species of agricultural crops and extent of damage to various crops. Moreover, the scientists of the project have been able to generate a number of novel and field worthy technologies to minimize the damage to crops by different vertebrate pests.

## **2.6. Management Strategies**

### **2.6.1. Rodent pests**

**Why rodents are a serious problem:** Rodents are highly adaptable to a variety of habitats. Crop fields and foodgrain stores provide most conducive environments for field and commensal rodents, respectively. The gnawing habit of rodents owing to their ever-growing incisors, and their vast breeding potential make them one of the most destructive organisms. In addition, rodents possess a great feeding potential as they generally consume 5–10 per cent of their body weight on a daily basis. Agricultural fields serve as a highly productive rodent habitat and crops such as sugarcane, rice, wheat, groundnut and fodder serve as an ideal habitat for rodent pests. Similarly, threshing yards located near crop fields also act as an excellent abode for food and shelter of rodents.

**Rodent pest species:** Rodents (order: Rodentia) are one of the most successful animals on earth due to their vast breeding potential and adaptability to a variety of living conditions ranging from the snowy heights of 5,700 m to the extremes of desert. They represent a very diverse group of mammals, viz., porcupines, squirrels, voles, marmots, rats, gerbils, mice, moles, rats, etc. Of over 2,000 species reported globally, only a limited number of species (~10 per cent) are considered as serious impediments causing significant losses to food production and storage. Many species are also responsible for spreading several dreadful zoonotic diseases to man and his livestock. Rodent diversity in India is relatively low, with only 103 species

under 43 genera reported. India, being a highly diverse country, more than a dozen species are regarded as pests of agriculture. The lesser bandicoot rat, *Bandicota bengalensis*, is the most predominant rodent pest species in India and is well distributed in crop fields and residential areas all over the country, apart from the extreme hot arid regions and islands. In dryland agriculture *Tatera indica* and *Meriones hurrianae* are the predominant rodent pests. Some species like *Rattus meltada*, *Mus musculus* and *M. booduga* occur in both wet and dry lands. Species like *R. nitidus* in north-eastern hill region and *Gerbillus gleadowi* in the Indian desert are important locally. The common commensal pests are *Rattus rattus* and *M. musculus* throughout the country including the islands. *R. rattus* along with squirrels *Funambulus palmarum* and *F. tristriatus* are serious pests of plantation crops such as coconut and oil palm in the southern peninsula. *F. pennanti* is abundant in orchards and gardens in the north and central plains and sub-mountain regions. Major problematic species of rodents are listed in Table 2.2.

**Table 2.2 Major rodent pests**

Family	Common name	Scientific name
Scuridae	Northern Palm Squirrel	<i>Funambulus pennanti</i>
	Southern Palm Squirrel	<i>Funambulus palmarum</i>
	Western Ghat squirrel	<i>Funambulus tristriatus</i>
Hystricidae	Indian Crested Porcupine	<i>Hystrix indica</i>
Muridae: Murinae	Lesser Bandicoot Rat	<i>Bandicota bengalensis</i>
	Larger Bandicoot Rat	<i>Bandicota indica</i>
	Soft Furred Field Rat	<i>Millardia meltada</i>
	House/Roof/ Black Rat	<i>Rattus rattus</i>
	Wroughton's Rat	<i>Rattus rattus wroughtoni</i>
	Himalayan Rat	<i>Rattus nitidus</i>
	Indian Field Mouse	<i>Mus booduga</i>
	House Mouse	<i>Mus musculus</i>
Muridae: Gerbillinae	Short Tailed Mole Rat	<i>Nesokia indica</i>
	Indian Gerbil	<i>Tatera indica</i>
	Indian Desert Gerbil	<i>Meriones hurrianae</i>

**Rodent problem in agriculture:** The extent of rodent damage to crops largely depends upon the (i) species involved (ii) crop stage (iii) pest population (iv) availability of crop and (v) physical environment. Information on rodent damage to crops in different agro-climatic regions was generated (Table 2.3). In different years, the losses due to rodents in different crops ranged between 2-20 per cent in wheat, rice and sugarcane; 3-10 per cent in groundnut; 3-12 per cent in pearl millet and sorghum; 2.3 - 7.81 per cent in gram; 3-23 per cent in cotton and 22-8 per cent in pulses in different agro-ecosystems. Rice, wheat, sugarcane and groundnut are the most vulnerable crops for rodent depredation. Similarly, in groundnut bandicoots have been reported to hoard pods up to 320 grams/burrow.

**Table 2.3 Extent of damage and rodent species infesting field crops in India**

Crop	Stage	Damage (%) YL (yield loss Kg/ha)	Species	State/ region
Wheat ( <i>Triticum aestivum</i> )	Seedling to	5.9		Rajasthan
	Maturity	18.7-21.3	<i>Mh, Ti, Rm</i>	Rajasthan
	Pre harvest	6.3-8.2	<i>Bb, Rm</i>	Himachal Pradesh
		3.9-5.2	<i>Bb, Ti</i>	Punjab
		8.0-10.0	<i>Bb</i>	Uttar Pradesh
	3.0-21.0	<i>Bb, Ti, Mm</i>	Gujarat	
Rice ( <i>Oryza saliva</i> )	Pre harvest	1.1-17.5	<i>Bb, Rm</i>	Punjab
	Pre harvest	98-213kg/ha	<i>Bb</i>	Uttar Pradesh
	Grain formation	9-10	<i>Bb, Mm, Mb</i>	Karnataka
	Harvest stage	17.56	<i>Bb, Mb</i>	Andhra Pradesh
	Milky to maturity	4.6-16.8	<i>Bb, Rn, Mm</i>	NEH region
Pearl millet ( <i>Pennisetum typhoides</i> )	Seedling	100(crop resown)	<i>Gg</i>	Rajasthan
	Milky, Grain	Considerable	<i>Ti, Mh</i>	Rajasthan
		3.0-12.0	<i>Bb, Ti, Mm</i>	Gujarat
Maize ( <i>Zea mays</i> )	Cobs	9.8	-	Himachal Pradesh
	Cobs	9.1	<i>Rn, Bb</i>	Meghalaya
	Seedling	10.7	-	Punjab
	Seedling	50-80	<i>Bb, Ti, Mm</i>	Karnataka
	Cob formation	7.0	<i>Bb, Ti</i>	Karnataka
	Harvest	12.5	<i>Ti, Bb, Rr, Mb</i>	Karnataka
	Cobs	5.0	<i>Bb, Ti, Mm</i>	Gujarat
Bengal gram ( <i>Cicer arietinum</i> )	Pods	2.5	<i>Mm</i>	Madhya Pradesh
	Plants & pods	3.0-25.0	<i>Bb, Ti, Mm</i>	Gujarat
Soybean ( <i>Glycine max</i> )	Green pods	27.27 YL 44.76	<i>Bb, Mm, Rr</i> -do-	Madhya Pradesh
	Pod formation	0.6-3.0	<i>Mm, Ti</i>	Madhya Pradesh Karnataka
Groundnut ( <i>Arachis hypogea</i> )	Plants & Pods	3.9-19.0	<i>Ti, Rm,</i>	Punjab
	Pod setting	4.5	<i>Bb, Mb, Mm</i>	Gujarat
	Pod maturity	6.9	<i>Bb, Ti</i>	-do-
	Harvesting	7.3	<i>Mm</i>	-do-
	Peg formation	30-40	<i>Bb, Ti</i>	Karnataka
	Hoarding	2	<i>Bb, Mb</i>	Karnataka
Cotton ( <i>Gossypium sp.</i> )	Bolls	3.2-23.2	<i>Ti, Rm</i>	Gujarat
	Damaged bolls	4.0-6.0	<i>Bb, Ti, Mm</i>	Gujarat
Sugarcane ( <i>Saccharum officinarum</i> )	Partial damage to canes	2.1-21.6	<i>Bb, Ti, Rm,</i>	Punjab
	Dried canes	3.2	<i>Mm</i>	Punjab
	Without lodging	6.8	-	Uttar Pradesh
	With lodging	18.9	<i>Ti, Bb</i>	Uttar Pradesh
			<i>Ti, Bb</i>	

*Ti-Tatera indica, Mm-Millardia melitana, Bb-Bandicota bengalensis; Mh-Meriones hurrianae; Mp-Mus platythrix; Rr-Rattus rattus; Ge-Gollunda ellioti; Mb-Mus booduga; Rn-Rattus nitidus;*



In orchards *F. pennanti* is the predominant pest whereas in nurseries, a complex of *F. pennanti*, *T. indica*, *M. hurrianae* (only in arid regions) and *R. rattus* are quite commonly encountered in horticultural systems. They cause damage to the tune of 5.18-56.21 per cent in pomegranate; 8.29 per cent in pineapple and 23.5 and 11.54 per cent in apple and peach, respectively. Similarly date palm at ripening stage suffers 18-20 per cent squirrel damage. Vegetables are reported to experience 8.7-10 per cent damage by rodents in arid regions.

In plantation crops like coconut and cocoa in South India, *R. rattus wroughtoni* inhabits the coconut crown and cuts the nuts at attachment point and also the pulp. Most of the damaged nuts fall down accounting to a 10-32 per cent of damage. In case of cocoa, squirrels and rats make irregular holes in the pods (sometimes up to 50 per cent) to feed on their contents. Injured pods become unfit as black pod disease develops on such pods. In Andaman and Nicobar islands rodents inflict 5 per cent nut damage in coconut. Cardamom also suffers heavily (1.5-12 per cent in Karnataka) due to rodent depredation. Rodent problem in poly houses and drip pipes were assessed. Forestry plantations suffer two types of damage by rodents viz., (i) debarking and (ii) slicing. The debarking observed in *Albizialebbek*, *Prosopis cineraria*, *A. tortilis* and *Parkinsonia aculeatea* plantations was mainly done by *M. hurrianae*, *T. indica* and *Millardia. meltada* leading to stunted growth. Underground slicing activity by *Nesokia indica* caused loss of 4.4-10.0 per cent afforestation plantations in arid zone. Table 2.4 depicts an overview of rodent damage to these crops.

**Table 2.4 Percentage damage by rodents in horticulture and forestry plantations**

Crop	Damage (%)
Coconut	5.0-11.
Cacao	8.0-51.3
Pineapple	8.29
Pomegranate	17.8-22.4
Date palm	18.0-20.0
Apple	23.50
Peach	11.54
Vegetables	8.7-10.0
Desert forestry plantation	4.4-10.0
Grasses	1040 kg/ha

### 2.6.1.1. Management techniques of rodent pest

**(a) Cultural control:** This technique is primarily based on ecological concepts, wherein the rodents' habitat is manipulated in such a way, that it creates stress among native rodent pests. The methods are low cost treatments and involve little modification in crop husbandry

practices, like deep ploughing, removal of wild vegetation and refuge of previous crops, regular weed control and reduction in bund size etc. It helps in migration of pest rodents from crop fields. Moreover, the habitat stress created by these practices also enhances the chances of rodents falling prey to predators.

**(b) Employment of rat catchers:** Traditional rat catchers are engaged by farmers of Andhra Pradesh and Tamilnadu for physical elimination of field rodents. This practice is often done at crop maturity stage when the rodent's destruction is at its peak. However, this eco-friendly method may prove effective if performed in a planned schedule.

**(c) Mechanical control:** Mechanical removal of rodent population from any habitat is mainly done by use of different types of traps. This method is in vogue all over the world, but its success in control of field rodent is doubtful. Trapping can no doubt provide, the information on species composition and density of pest population, hence can be successfully used for survey and monitoring purpose. In indoor habitats, this method is quite effective, though in fields this method may be used as a follow up measure after bringing down the rodent pest population by poison baiting. The traps may be of single (Sherman/Snap traps) or multiple catch (Wonder traps) type. In snap traps the rodents are killed whereas others catch live rodents. Rodents use visual and olfactory cues towards traps, therefore camouflaging the traps with bushes, grasses etc. in fields enhances the trap success considerably. Indigenous *butta* or Tanjore kitty traps in South India and bamboo snap traps in *Jhoom* fields of NEH region have proved quite effective.

**(d) Biological control:** Several vertebrates, mainly birds and mammals are listed as natural predators of rodents. However, cats in domestic situation and snakes, owls, mongoose and varanids are predominant vertebrate predators of rodents. Information on stomach contents and faecal matters of predators indicated that rodents constitute over 75 per cent diet of snakes viz., Cobra and Russel viper and 61 per cent of spotted owlet and barn owls. Introduction and rehabilitation of barn owls, *Tyto alba* in oil palm plantation of Malaysia was reported to reduce the rodent damage to oil palm from 19.4 per cent to 1.4 per cent within two years. In the Cauvery Delta of Tamilnadu, studies on barn owl as potential bio control agent of bandicoots revealed a predation rate of 1-6 (Av 1.58) rodents/night. *B. bengalensis* (40 per cent) and *M. musculus* (33 per cent) constituted the major prey items of barn owls.

**(e) Chemical control:** Use of rodenticides is a most common, expedient and humane method in control of pest rodents. They have greater scope in large-scale control operations, since mixed population of several species are encountered in fields. Zinc phosphide is most widely used rodenticide in India. It is recommended at 2 per cent concentration in cereal baits. It yields around 60 per cent control success. It is highly toxic to a variety of rodent species. Major limitation in its frequent use is its high toxicity to non-target species and development of bait shyness/poison aversion in the target species after sub-lethal consumption. Bait shyness may persist for more than 2-3 months in different rodent species. Its bait can be prepared by mixing the poison (2 per cent) in oil smeared cereals viz., wheat, jowar, pearl millet etc. Because of high toxicity, zinc phosphide is recommended for field rodents only, where the rodent

infestation is very high. For controlling the residual rodents (surviving after zinc phosphide treatment), another rodenticide viz., aluminium phosphide (a fumigant) or bromadiolone (0.005 per cent), a second-generation anticoagulant rodenticide has been advocated.

Among second generation anti-coagulants only bromadiolone (0.005 per cent) is registered with Central Insecticide Board since 1988 for rodent control in fields and also in commensal situations. The second-generation anti-coagulants are effective as single dose rodenticide and have very potent antidote in vitamin K<sub>1</sub>. Moreover they are highly effective at a very small concentration in baits (0.005 per cent), thus are considered relatively safer to non-targets. They can be used for rodent management not only in fields but also in domestic situations, stores, godowns, poultry farm etc.

**Methods of bait preparation and its application in fields are described below:**

**(i) Bait preparations:** It is an important aspect of rodenticide application technique, which is often overlooked. The proportion of toxicant to bait should be maintained properly. The recommended dosage for zinc phosphide is 2.0-2.5 per cent and that of bromadiolone is 0.005 per cent in baits. The zinc phosphide is marketed in India as >80 per cent pure powder and Bromadiolone comes as bait concentrate (BC) at 0.25 per cent. Bromadiolone is available as ready to use wax block baits also at 0.005 per cent conc. Fresh poison baits of these chemicals are to be prepared by the end user himself. While too heavy dosages may repel the pest, too light dosages may dissuade the rodents from eating before consuming the lethal dose resulting into development of bait shyness, as in case of zinc phosphide. The technique developed by Coordinating Unit is very simple and has been found very effective and is widely accepted by the farming community. The technique is as follows:

**Pre-bait material (If Zinc phosphide baiting is to be done): for one kg of bait.**

- Take 960g of locally grown foodgrains (broken rice/ wheat/bajra /ragi/jowar).
- Mix 20g vegetable oil in food grain with bare hands.

**Poison bait material: for one kg bait:**

- Mix oil in foodgrains as suggested above in pre-bait preparation.
- Sprinkle 20-25 g of zinc phosphide or 20 g of bromadiolone BC and stir with wooden stick till uniform mixing is achieved. (No house hold utensil be used for this purpose).
- Use any plant leaf as applicator for bait placement inside the burrows or the baits can be placed deep in the burrows in paper packets.

**(ii) Bait placement:** Placement of bait is one of the most important aspects for an effective chemical rodent control strategy. It involves several basic principles. It should be tried to cover largest possible area in one go. The bait may be placed either in the burrows or in the bait containers/bait stations

- **Burrow baiting:** This method is advisable in field conditions where clear rodent burrows are visible. For this, all the existing burrow openings should invariably be

plugged in the evening and re-opened next morning, and active burrows be treated with pre/poison baits. The treatment of only active burrows saves the poison bait material, labour cost and time and is highly effective. For zinc phosphide treatment, pre-baiting (10-20g/burrow) for at least 1-2 day before poison baiting is essential to achieve higher kill of the pest. After pre baiting, zinc phosphide poison bait @ 10g/ burrow should be rolled deep inside the active burrows to avoid any secondary hazards. While using bromadiolone (0.005 per cent) baits no pre baiting is required and the poison baits (10-15g/ burrow) be rolled deep inside active burrows. To assess the control success, the burrows are plugged again after 3-4 days of treatment (in case of zinc phosphide baiting) and after two weeks (in case of bromadiolone baiting) and reopened burrows are examined on the next day.

- **Use of bait containers or bait stations:** In the fields, several types of indigenous bait containers have been used for placing the baits. The basic idea of selecting bait containers, is that the bait should be easily accessible to the target species and should reduce the hazard to other animals and man. This will also protect the baits from rain and other weathering. Indigenously, procured items like mud channels, hollow bamboo pieces, broken pitchers, coconut shells etc. have been effectively utilised for this purpose.

**(iii) Burrow fumigation:** Aluminium phosphide, the most common fumigant rodenticide is available in both tablet and pellet forms. Earlier tablet (3g) was recommended for burrow fumigation @ half tablet/ burrow). However, owing to its extreme toxicity to non-targets and absence of an antidote, Government of India has put this chemical under restricted ban. In recent years, a new tablet (12 g size) formulation of this toxicant (with 6 per cent a.i) has been registered for rodent burrow fumigation. For burrow fumigation, all the existing burrow openings are plugged with wet mud and aluminium phosphide tablets of 12 g size (@one tablet/ burrow) is inserted deep in the active burrows, which should also be plugged with mud to check the escape of lethal gas. All the nearby burrow openings need to be plugged invariably. The dead rodents are to be collected next day and disposed off. It is never recommended for residential premises/indoor use.

**Safety precautions in handling rodenticides:** The main hazards to persons either directly or indirectly concerned with rodents and their control are the risk of accidental poisoning. The need to maintain high standards of personal hygiene at all times should be stressed upon. Rodenticides, if handled carefully and sensibly, should present no risk to other animals or people including the operator himself. Following precautions should be followed to avoid risk.

- All poisons (pure chemicals, baits, etc.) should be clearly labeled 'POISON' and held in a locked almirah and should be away from the reach of children.
- No eating, drinking or smoking should take place when poison baits are handled. All cuts and abrasions on the hands and arms should be covered before starting the work.

- Poison baits should be prepared in well ventilated room and care should be taken not to breathe in or absorb any poison.
- The poison bait should not be touched by bare hands. Any broad leaf or spoon or gloves, if available, should be used.
- When poison baits are laid, the residents/owner of the area should be cautioned about the treatment so that children, livestock and pets can be kept away for a day to two.
- Poison bait should not be laid where the excess bait cannot be picked up in order to prevent any later danger. A record should be kept of number and location of baiting points.
- While placing the baits in the burrow, the poison baits should be rolled deep in the burrows to protect birds, livestock and other non-target species.
- Fumigation as a rule must not be in residential areas. If aluminium phosphide is being used for fumigation in the fields, the fumigant should be kept away from fire, as it is highly inflammable. Do not directly handle the tablets. Use an applicator or a long tube to insert them into the burrows.
- After poison bait preparation and field application, hands should be washed with soap properly.
- After the control operation, the left- over baits, should be picked up and dead rodents be collected and buried deep in the soil.

**Antidotes of Rodenticides:** If any poison is absorbed or illness is suspected in relation to rodent control work, medical advice be sought immediately. In case of poisoning through consumption of zinc phosphide baits, vomiting should immediately be induced by giving mustard emetic. When vomiting stops, give 6 gm of potassium permagnate dissolved in a glass of warm water. After 10 minutes, half a tea spoon full of copper sulphate dissolved in 250 ml of water should be administered. After this, any purgative can be given and Doctor called immediately for proper medical treatment. In case of accidental consumption of anticoagulants like bromadiolone, call the physician immediately. Vitamin K<sub>1</sub> administration and blood transfusion are recommended.

### **2.6.2. Depredatory birds**

Birds are known to cause considerable economic damage to variety of crops during vulnerable stages in different agro-ecological regions of the country. The extent of bird damage to any crop depends on several factors like concentration of local bird population, total area under the crop, cropping pattern habitat of the area, season and physiological status of the birds. All bird species are not harmful to agriculture. In fact there are many bird species, which are destroyers of insect pest and rodents, and hence they are beneficial to the crop and the farmers. Such beneficial birds need to be encouraged and conserved.

An investigation on both basic and applied aspects of birds as harmful and beneficial

components in agricultural ecosystems has generated valid information that has helped to evolve technologies for their management for increasing crop production.

A total of 63 species of birds belonging to 19 families have been identified as damaging several crops (Table 2.5).

**Table 2.5 Important depredatory birds and their damage status to Agricultural crops**

Family and Species	Crops	Damage Status
<b>Family: Threskiornithidae</b>		
1. Black Ibis ( <i>Pseudibis papillosa</i> )	C, OS	VL
<b>Family : Anatidae</b>		
2. Greylag Goose ( <i>Anser anser</i> )	C, V	VL
3. Bar headed Goose ( <i>A. indicus</i> )	C, V	VL
4. Lesser Whistling Teal ( <i>Dendrocygna javanica</i> )	C, V	L
5. Ruddy Shelduck ( <i>Tadorna ferruginea</i> )	C	L
6. Pintail ( <i>Anas acuta</i> )	C	VL
7. Common Teal ( <i>A. crecca</i> )	C	VL
8. Gargeny ( <i>A. querquedula</i> )	C	VL
<b>Family: Phasianidae</b>		
9. Grey Partridge ( <i>Francolinus pondicerianus</i> )	C,P,OS,W,F, V	H
10. Common Peafowl ( <i>Pavo cristatus</i> )	C,P,OS,F,V	M
<b>Family: Gruidae</b>		
11. Common Crane ( <i>Grus grus</i> )	C,P,OS,W,F, V	L
12. Sarus Crane ( <i>G. antigone</i> )	C,OS,W	VL
13. Demoiselle Crane ( <i>Anthropoides virgo</i> )	C,P,OS,W	VL
<b>Family: Rallidae</b>		
14. Purple Moorhen ( <i>Porphyrio porphyrio</i> )	C,W,V	VL
<b>Family: Charadriidae</b>		
15. Black tailed Godwit ( <i>Limosa limosa</i> )	C	VL
16. Ruff and Reeve ( <i>Philomachus pugnax</i> )	C	VL
<b>Family: Columbidae</b>		
17. Blue Rock Pigeon ( <i>Columba livia</i> )	C,P,OS,W	H

Family and Species	Crops	Damage Status
18. Ring Dove ( <i>Streptopelia decaocto</i> )	C,P,OS,W	M
19. Red Turtle Dove ( <i>S. tranquebarica</i> )	C,P,OS,W	L
20. Spotted dove ( <i>S. chinensis</i> )	C,P,OS,W	VL
21. Little Brown Dove ( <i>S. senegalensis</i> )	C,P,OS,W	VL
<b>Family: Psittacidae</b>		
22. Large Indian Parakeet ( <i>Psittacula eupatria</i> )	C,P,OS,W,F	VL
23. Rose-ringed Parakeet ( <i>P. krameri</i> )	C,P,OS,W,F, V	H
24. Blossomheaded Parakeet ( <i>P. cyanocephala</i> )	C,P,OS,F,V	VL
25. Slatyheaded Parakeet ( <i>P. himalayana</i> )	F	VL
26. Bluewinged Parakeet ( <i>P. columboides</i> )	F	VL
<b>Family: Cuculidae</b>		
27. Koel ( <i>Eudynamys scolopacea</i> )	F,V	VL
<b>Family: Capitonidae</b>		
28. Great Hill Barbet ( <i>Megalaima virens</i> )	F	VL
29. Small Green Barbet ( <i>M. viridis</i> )	F,V	VL
<b>Family: Picidae</b>		
30. Scalybellied Green Woodpecker ( <i>Picus squamatus</i> )	F	VL
31. Lesser Goldenbacked Woodpecker ( <i>Dinopium bengalensis</i> )	F	VL
<b>Family: Alaudidae</b>		
32. Short-toed Lark ( <i>Calandrella cinerea</i> )	C,W	VL
33. Skylark ( <i>Alauda arvensis</i> )	C,W	VL
<b>Family: Oriolidae</b>		
34. Golden Oriole ( <i>Oriolus oriolus</i> )	F	VL
35. Blackheaded Oriole ( <i>O. xanthornus</i> )	F	VL
<b>Family: Sturnidae</b>		
36. Starling ( <i>Sturnus vulgaris</i> )	C	VL
37. Rosy Pastor ( <i>S. roseus</i> )	C,F	M
38. Common Myna ( <i>Acridotheres tristis</i> )	C,F,V	M
39. Bank Myna ( <i>A. ginginianus</i> )	C,F	VL
<b>Family: Corvidae</b>		

Family and Species	Crops	Damage Status
40. Red billed Blue Magpie ( <i>Cissa erythrorhyncha</i> )	F	VL
41. Indian Tree pie ( <i>Dendrocitta vagabunda</i> )	F	VL
42. House Crow ( <i>Corvus splendens</i> )	C,P,OS,F,V	M
43. Jungle Crow ( <i>C. macrohynchos</i> )	C,P,OS,F,V	VL
<b>Family: Pycnonotidae</b>		
44. White cheeked Bulbul ( <i>Pycnonotus leucogenys</i> )	C,F	VL
45. Red vented Bulbul ( <i>P. cafer</i> )	C,F	VL
<b>Family : Muscicapidae</b>		
46. Common Babbler ( <i>Turdoides caudatus</i> )	C,W	VL
47. Large Grey Babbler ( <i>T. malcolmi</i> )	C,W	VL
48. Jungle Babbler ( <i>T. striatus</i> )	C,W	VL
49. Streaked Laughing thrush ( <i>Garrulax lineatus</i> )	F	VL
<b>Family : Nectainiidae</b>		
50. Purple Sunbird ( <i>Nectarinia asiatica</i> )	F	VL
<b>Family : Ploceidae</b>		
51. House Sparrow ( <i>Passer domesticus</i> )	C,W,V	H
52. Yellow throated Sparrow ( <i>Petronia xanthocollis</i> )	C,W,V	M
53. Baya ( <i>Ploceus philippinus</i> )	C,W	VL
54. Black throated Weaverbird ( <i>P. benghalensis</i> )	C,W	VL
55. Streaked Weaverbird ( <i>P. manyar</i> )	C,W	VL
56. White throated Munia ( <i>L. malabarica</i> )	C,W	VL
57. White backed Munia ( <i>L. striata</i> )	C,W	VL
58. Spotted Munia ( <i>L. punctulata</i> )	C,W	VL
59. Black headed Munia ( <i>L. malacca</i> )	C,W	VL
60. Black headed Bunting ( <i>Emberiza melanocephala</i> )	C	VL
61. Common Rose Finch ( <i>Carpodacus erythrinus</i> )	C	VL
62. Redheaded Bunting ( <i>E. bruniceps</i> )	C	VL
63. Crested Bunting ( <i>Melophus lathami</i> )	C	VL

**Crops:** C: Cereals, P: Pulses, OS: Oilseeds, V: Vegetables, F: Fruits, W: Weeds  
**Damage status:** VL: Very limited, L: Limited, M: Moderate, H: Heavy)

The number of bird species that affected various crops were: cereals - 52, pulses - 14, oilseeds - 15 and fruits - 23. Among the 46 species of beneficial birds, which devoured insects and rodent pests, all fed on insects while six of them also consumed rodents. Twenty eight species



of birds that inflicted damages to crops and fifteen of the beneficial species were omnivorous. It may be noted, that omnivorous birds have a dual role in our agro-ecosystem.

**Extent of crop damage by depredatory birds:** Crop losses due to the depredatory birds can occur either due to one species (parakeet) as in sunflower or a community of bird complex as in pearl millet, sorghum, rice, groundnut and apple. Negative impact of birds on agricultural crops varies from region to region, season to season, depending on a number of factors like number of depredatory species and their density, area under crop, ecology of the area, concentration of migrants, their food habits as well as the physiological status of birds involved.

Studies on assessment of losses due to birds in Andhra Pradesh, Gujarat, Rajasthan, Delhi, Punjab, Kerala and Himachal Pradesh have revealed that almost all cereals, pulses, oilseeds and several vegetable and fruit crops were susceptible to bird damage during sowing, seedling stage and ripening stage. The cereals were more vulnerable to bird attack especially at the dough stage. Damage to the crops of smaller grains such as pearl millet and sorghum was more serious as compared to that in case of large size grains (e.g. maize). Small cereal grains were preferred by both smaller and larger birds, whereas, maize was depredated primarily by larger species such as parakeets and crows. Isolated fields were always prone to bird damage. Similarly, early or late maturing fields were highly susceptible to bird attack. Hence for the even distribution of bird damage, synchronization of crop cultivation is advocated. Due to intensive farming, many species of birds obtain food from the agricultural fields and its vicinity throughout the year. Moreover, a few species viz., Rose ringed parakeet, House sparrow, weavers, munias and doves manage to nest in close proximity to agricultural fields. It is the congenial condition available to these species in recent times, that has led to their population build-up causing serious concerns amongst farmers and agricultural ornithologists.

Use of GPS & GIS tools in bird study revealed that the roosting sites of birds are in close proximity of the preferred food that is available, and feeding activity of birds showed a significant correlation in relation to the cropping pattern. The feeding activity ranged between 2.5 to 16.5 sq.km with an average of 8.75 sq.km. The extent of damage in different crops varied 5 to 12 per cent from roost to roost in relation to the number of birds. The incidence of damage was very high (43 per cent) within the 7.5 sq.km from the roost. The percentage distribution of the land cover of the study area comprised, 59 per cent of agricultural area that was predominantly used by birds followed by agricultural fallow land (16 per cent) wastelands (8 per cent) and others (17 per cent).

The extent of crop losses at different crop growth stages along with species composition of depredatory birds are presented in Table 2.6. The crop-wise damage is discussed below;

**(a) Field Crops**

**(i) Pearl millet:** Of the 24 depredatory species recorded in pearl millet crop from five states, Rose ringed Parakeet, Rosy Pastor, House Sparrow and Baya were the predominant species

that damaged the crop in Northwestern India. White cheeked Bulbul was reported for the first time to feed on the crop in large numbers in the arid and semi-arid zones. Estimation of bird damage varied highly in across the states. It was highest in Gujarat (0.3 to 40 per cent) followed by Andhra Pradesh (1.5 to 9 per cent), Punjab (45 per cent) and Delhi (60 per cent) during *Kharif* season. In Gujarat, bird damage to the summer crop was significantly less (0.2 to 2.1 per cent), due to the absence of migratory birds especially the Rosy Pastor, synchronization of crop cultivation also resulted in better yield compared to *Kharif* season. Bird damage to pearl millet was correlated positively at significant level with the density of the total damaging birds and the density of

Rosy Pastor *Sturnus roseus* in Saurashtra. Ruff (*Philomachus pugnax*) was observed for the first time to feed on the harvested ear-heads of pearl millet, which were kept in the field for drying, in Jamnagar, a coastal district of Gujarat.

**(ii) Sorghum & Maize:** Sorghum is one of the most preferred crops by the granivorous birds. Of the 26 species recorded feeding on sorghum, Rose ringed Parakeet, Rosy Pastor and Bank Myna were the predominant species. Bird damage to sorghum was highest in Rajasthan (2.3 to 48 per cent) followed by Gujarat (0.4 to 18.6 per cent) and Andhra Pradesh (0.5 to 16.6 per cent). In case of maize, bird damage was relatively less in Gujarat (0.3 to 2.5 per cent) as compared to Punjab (3.3 to 7.5 per cent), Andhra Pradesh (3 to 9.1 per cent) and Rajasthan (0 to 20 per cent).

Ten species of birds were recorded to feed on maize, of which the Rose ringed Parakeet was most important in all the states. In Andhra Pradesh, the bird damage in maize ranged between 10 to 40 per cent and the damage was mainly caused by Rose ringed parakeet.

**(iii) Wheat:** A complex of 13 species of birds were recorded to be damaging standing wheat crop and the extent ranged from 0.2 to 41 per cent in different parts of the country. The damage was significantly high in Rajasthan as compared to that in Gujarat and Punjab. Rose ringed Parakeet, Ring Dove and Baya were the most common species damaging the crop. In Bhal region of Gujarat, Large flocks of Demoiselle Crane, Common Crane and Short-toed Lark were reported to inflict heavy damage to wheat fields. Bird damage to germinating late sown wheat crop in fields with preceding sesame crop was recorded to the extent of 38-95 per cent at Ludhiana. In another study at village Buani (Ludhiana) under bed plantation, 78 per cent damage to sprouting and seedlings of wheat by House crow was recorded which ultimately resulted in lowest yield of 5 q/acre only. In Punjab, monitoring of bird community in selected wheat and paddy fields at 3 locations has revealed the occurrence of 23 and 25 species with maximum species richness of 15 and 12 at sowing/sprouting and tiller/ear head formation stages respectively, which can be also exploited for suppression of insect pests in these crops. In Gujarat, bird community of wheat crop agro-ecosystem is dominated by cattle egret having relative abundance of 31.72 per cent followed by Glossy Ibis, Indian Ring Dove, Little Brown Dove, Large Grey Babbler and Red wartled Lapwing. During sowing stage migratory Short – toed Lark and Calendar Larks caused heavy damage to the sown seeds to such an extent (90

per cent) that some farmers were compelled to re-sow their fields in Gujarat. In subtropical zone of Solan, Rose-ringed parakeet & Blossom headed parakeet caused 23 to 45 per cent of damage to wheat crop during milky stage.

**(iv) Rice:** Damage to rice was highest in Punjab (0.1 to 6.5 per cent), followed by Kerala (1.5 to 6 per cent), Andhra Pradesh (1.5 to 3 per cent) and Gujarat (0.1 to 1 per cent). Thirty-nine species of birds fed on the grains of standing crop in Gujarat. Baya, House Sparrow and Rose-ringed Parakeet were common and predominant depredatory birds in most parts of the state. Gargany Teal and Lesser Whistling Teal damaged paddy crop in Kole area of Kerala. The Indian Pea Fowl, Teals and Common Moorhen caused damage to the tune of 10.5 and 12 per cent respectively. The qualification for the moorhen damage is the first time in the reproductive stage of the crop. In Andhra Pradesh, the feeding guild structure of birds revealed high occurrence of insectivorous birds followed by omnivorous and carnivorous. In different agro zones of Andhra Pradesh, around 81 spp. of birds were recorded which utilize rice fields predominantly for breeding (68 per cent) activity. The feeding guild of the birds indicates high occurrence of insectivorous (53 per cent) birds followed by soil invertebrate and arthropods. The extent of damage in different growth stages showed less than 3- 5 percent.

**(v) Sunflower & Safflower:** Rose ringed Parakeet and House Crow were the predominant depredators and caused 10 to 30 per cent damage to sunflower in Andhra Pradesh; 40 to 90 per cent damage in Rajasthan; and 5.7 to 29 per cent in Punjab. On account of bird problem, the crop could not be introduced in Gujarat state. In case of safflower, Rose ringed Parakeet was the only species feeding mainly on the peripheral regions of the crop. The damage level was negligible in Andhra Pradesh and Gujarat.

**(vi) Groundnut:** During the period of sowing to sprouting stages, 3 to 33 per cent damage was caused by ten species of birds in Saurashtra region of Gujarat. The migratory Demoiselle Cranes caused damage up to 10 per cent at the time of harvesting. In Jamnagar and in Hyderabad within 5 km radius of a roost of Rose-ringed parakeet (of about 4,000 individuals) together with Rock Pigeon and Ring Dove caused about 22 per cent damage to groundnut from sowing to sprouting stage. After the harvest of groundnut, about 100 kg/ha grains remained in the fields as spillage. Several species of birds viz., Demoiselle Crane, Black Ibis, Blue Rock Pigeon, Indian Ring Dove and Rosy Pastor fed on these grains as the fields remained fallow.

**Table 2.6 Extent of damage by depredatory birds at different stages of the crops**

Crops	Stage of Crop	Extent of Damage	Depredatory Bird species
<b>Cereals</b>			
Rice	Nursery	0.6-5%	Baya, House Sparrow, White throated Munia, Spotted Munia, Black headed Munia, Black throated Weaver, Streaked Weaver, Purple Moorhen, Blue Rock Pigeon, Ring Dove, Common Myna, House Crow.
	Ripening	1.4 -	House Sparrow, Baya, Black throated Weaver,

Crops	Stage of Crop	Extent of Damage	Depredatory Bird species
		22.9%	Streaked Weaver, White throated Munia, Spotted Munia, Black headed Munia, Rose-ringed Parakeet, Large Grey Babbler, Common Babbler, Jungle Babbler, Brahminy Duck, Lesser Whistling Teal, Gargany, Common Teal, Pintail, Purple Moorhen, Sarus Crane
Wheat	Sowing and seedling	0.5-6%	House Crow, Jungle Crow, Blue Rock Pigeon, Ring Dove, Peafowl, Grey Partridge, Ruff, Black tailed Godwit, Demoiselle Crane, Common Crane, Sarus Crane, Black Ibis
	Ripening	0.6-37%	House Sparrow, Rose-ringed Parakeet, White thorated Munia, Spotted Munia, Large Grey Babbler, Jungle Babbler, Indian Peafowl, Demoiselle Crane, Common Crane, Sarus Crane, Short- toed Lark, Rufous tailed Finch Lark, Black headed Bunting, Redheaded Bunting, Ring Dove
Maize	Sowing and seedlings	10-20%	Rock Pigeon, Ring Dove, Spotted Dove, House Crow, Jungle Crow, Common Myna, Rose ringed Parakeet, Indian Peafowl, Grey Partridge.
	Ripening	6-39%	Rose-ringed Parakeet, House Crow, Large Indian Parakeet
Pearl Millet	Sowing and seedling	0.5 - 6%	Rock Pigeon, Ring Dove, spotted Dove, Red Turtle Dove, Little Brown Dove, Baya, Black throated Weaver, Streaked Weaver, House Sparrow, Grey Partridge, Jungle Babbler, Large Grey Babbler
	Ripening	0.5 - 26%	House Sparrow, Baya, Black throated Weaver, streaked Weaver, White throated Munia, Black headed Munia, Spotted Munia, White backed Munia, Red Munia, Redheaded Bunting, Black headed Bunting, Common Myna, Red vented Bulbul, White cheeked Bulbul, Large Grey Babbler, Common Babbler, Jungle Babbler, White headed Babbler, Rosy Pastor, House Crow, Rose-ringed Parakeet, Ring Dove
Sorghum	Sowing and seedling	0.5 - 8%	Blue Rock Pigeon, Ring Dove, Spotted Dove, Little Brown Dove, Red Turtle Dove, Indian Peafowl, Grey partridge, Large Grey Babbler, Jungle Babbler, Common Babbler
	Ripening	0.7 - 44%	Rose-ringed Parakeet, Blossom-headed Parakeet, House Sparrow, Baya, Black throated Weaver, Streaked Weaver, White throated Munia, Spotted Munia, White backed Munia, Black headed Munia, Rose Finch, Black headed Bunting, Redheaded Bunting, Ring Dove, Rosy Pastor, Common Myna, Bank Myna, House Crow, Jungle Crow.
<b>Pulses</b>			
Black gram	Sowing	0.2-3%	Blue Rock Pigeon, Ring Dove, House Crow, Grey

<b>Crops</b>	<b>Stage of Crop</b>	<b>Extent of Damage</b>	<b>Depredatory Bird species</b>
	and seedling		Partridge.
	Ripening	0.5-2.5%	Rose-ringed Parakeet, House Crow, Blue Rock Pigeon, Ring Dove, Grey Partridge, Peafowl.
Green gram	Sowing and seedling	0.3-3%	House Crow, Blue Rock Pigeon, Ring Dove, Grey Partridge.
	Ripening	0.5-2%	Rose-ringed Parakeet, House Crow, Blue Rock Pigeon, Ring Dove, Grey Partridge, Peafowl.
Chickpea	Sowing	0.5-3%	House Crow, Blue Rock Pigeon, Ring Dove, Grey Partridge, Peafowl, Sarus Crane, Jungle Crow.
	Ripening	0.5-2%	Blue Rock Pigeon, Ring Dove, Indian Peafowl, House Crow, Grey Partridge, Rose Ringed Parakeet.
Pigeon pea	Sowing and seedling	0.2-2%	Blue Rock Pigeon, Ring Dove, Indian Peafowl, House Crow, Jungle Crow, Grey Partridge
	Ripening	0.1-1%	Rose-ringed Parakeet, House Crow, Jungle Crow
Cowpea	Sowing and seedling	0.5-3%	Blue Rock Pigeon, Ring Dove, House Crow, Grey Partridge, Indian Peafowl
	Ripening	10-4-%	Rose-ringed Parakeet, Ring Dove, Blue Rock Pigeon, Grey Partridge, Indian Peafowl, House Crow, Small Green Barbet
<b>Oilseeds</b>			
Sunflower	Sowing and seedling	0.5-3%	House Crow
	Ripening	10-40%	Rose-ringed Parakeet
Groundnut	Sowing and seedling	0.5-36%	Blue Rock Pigeon, Ring Dove, House Crow, Rose-ringed Parakeet, Indian Peafowl, Black Ibis
	Ripening	1-15%	House Crow, Jungle Crow, Demoiselle Crane, Common Crane, Sarus Crane, Black Ibis, Indian Peafowl
Safflower	Sowing	2-15%	House Crow
	Ripening		Rose-ringed Parakeet
Mustard	Ripening		Rose-ringed Parakeet, Blue Rock Pigeon, Ring Dove, Grey Babbler
Soybean	Sowing and seedling	2-15%	Rose-ringed Parakeet, Blue Rock Pigeon, Grey Partridge
	Ripening		Rose-ringed Parakeet, Indian Peafowl, Grey Partridge, Blue Rock Pigeon
Oil Palm	Ripening	3-30%	Jungle Crow, House Crow, Indian Myna
<b>Fruit crops</b>			

Crops	Stage of Crop	Extent of Damage	Depredatory Bird species
Mango	Ripening	3 -10%	Rose-ringed Parakeet
Guava	Ripening	3-5%	Rose-ringed Parakeet, Large Indian Parakeet, Red vented Bulbul, House Crow, Jungle Crow, Small Green Barbet
Pomegranate	Ripening	2-20%	Rose-ringed Parakeet, Large Indian Parakeet, House Crow, Jungle Crow
Grape	Ripening	2-27%	Purple Sunbird, Red vented Bulbul, Rose-ringed Parakeet, Koel, Rosy Pastor, Common Myna, Golden Oriole
Date palm	Ripening	0.1-1%	Rose-ringed Parakeet, Bank Myna, Common Myna, Brahminy Myna, House Crow, White throated Munia
Apple	Ripening	5-13%	Slaty headed Parakeet, Rose- ringed Parakeet, Large Indian Parakeet, Blossorn headed Parakeet, Himalayan Bulbul, Jungle Crow, Red billed Blue Magpie, Great Hill Barbet, White cheeked Bulbul, Streaked Laughing Thrush, Scaly bellied Green Woodpecker
Banana	Ripening	19.4%	Small Green Barbet, House Crow, Jungle Crow, Common Myna
Kinnow	Ripening	3-16%	Rose-ringed Parakeet, Jungle Crow, Indian Treepie, Black headed Oriole, Small Green Barbet, Lesser Golden backed Woodpecker
Pecan nut	Ripening	6-50%	Rose-ringed Parakeet, Large Indian Parakeet
Papaya	Ripening		Koel, House Crow, Jungle Crow, Red vented Bulbul, Brahminy Myna, Small Green Barbet

*The values of crop losses are for individual fields do not represent for the entire state.*

*Source: Survey reports of coordinated centres of AINP on Agricultural Ornithology*

### **(b) Fruit crops**

Reports from Himachal Pradesh reveal that apple, pecan nut and kinnow suffer 5-12.5, 6-50 and 3-16 per cent of fruit damage respectively on account of birds. Of the 11 bird species recorded feeding on apple in the State, Slaty headed Parakeet and Rose ringed Parakeet were the most important. Likewise the two parakeet species viz., Rose ringed Parakeet and Large Indian Parakeet were the major depredators of pecan nut. In case of Kinnow, Rose ringed Parakeet and House Crow caused maximum damage. Banana fruits suffers about 21 per cent damage by birds mainly by Little Green Barbet, House Crow and Jungle Crow in Kerala. Pomegranate has been a favorite fruit crop for birds (Roseringed Parakeet and House Crows) inflicting up to 20 and 5.5 per cent damage in Gujarat and Andhra Pradesh, respectively. Guava fruits were mainly attacked by Rose ringed Parakeet recording moderate bird damage (up to 5 per cent) in Punjab and Andhra Pradesh, but was high (4.5- 24.5 per cent) in Rajasthan. Ripe fruits of papaya was mainly damaged by Koel, Brahminy Myna, Red vented bulbul, Jungle Babbler and Jungle crow in Gujarat and Kerala. Grape orchards of Rangareddy district (Telangana state) suffered 2 to 27 per cent bird damage due by Rose ringed Parakeet, Rosy Pastor, Koel, and sunbirds caused significant damage. Similarly, Common Crow, Jungle Crow,

Rose ringed Parakeet and Common Myna were the depredatory birds of oil palms. The damage was higher both in south Gujarat (10 to 27 per cent) and West Godavari district (3.3 to 30 per cent) of Andhra Pradesh. Pariah kites damage in oil palm gardens at NCZ of Andhra Pradesh was reported for the first time was to the tune of 30-50 per cent.

### **(c) Aquaculture**

In coastal districts of Andhra Pradesh, 23 species of birds were identified to cause damage to the Fish / Prawn seedlings to the tune of 3-11 per cent. The major species includes Dabchicks, Little kingfisher, White Breast Kingfisher, pied Kingfisher. At harvesting stage the incidence of damage ranges between 16-22 per cent and the major species includes Brahminy Kite, Herons and Egrets.

## **2.6.2.1. Management techniques for depredatory birds**

### **(a) Traditional methods**

**(i) Machan:** A *machan* is erected amidst crop fields. A semicircular mat made of bamboo splits is put on the *machan* to prepare a small hut for shelter which is locally called *dhagla*. Sometimes, instead of semicircular mat, an umbrella type structure made of leaves of *Butea monosperma* and bamboo sticks (locally called *dengcha*) is placed on *machan*. Loud calls are made from the *machan* to keep away the birds. Stones are thrown by locally made equipment called *gophana* (sling) to drive away birds.

**(ii) Pitcher-effigy (scare crows):** Pitcher-effigies (locally called *byawana*, *taoon*, etc) are created by the farmers with locally available material. An old pitcher (terracotta vessel), having black outer surface, is hoisted upside down on a vertically erected wooden pole of a man's height to symbolize the head of a man having black hair. Sometimes the head shape is created by using black cloth also. Then, a horizontal stick is tied to the vertical pole to resemble arms raised to shoulder level. An old shirt (*kurta*) is spread on the wooden structure to make an effigy of a man working in field. These effigies are said to be effective in repelling raiding birds from crops.

**(iii) Drum beating:** Drums are beaten from some elevated places or *machans* to keep away the flocks of grain eating birds. This method is said to be effective against the raid of locusts also.

### **(b) Eco-friendly management methods for controlling depredatory birds**

As a part of All India Net Work Project on Vertebrate Pest Management, multi-location trials for evaluation of different eco-friendly management practices were carried out to determine their efficacy, feasibility and economic viability under different agro climatic zones. Following eco-friendly management practices have been evolved for minimizing losses caused by depredatory birds;

**(i) Habitat manipulation:** Creating continuous disturbances to the nesting sites of the depredatory breeding birds in and around the cropped areas force them to leave breeding grounds and shift to other areas. For parakeets in addition to manual destruction of nests,

closing the entrance of the nests has proved effective in reducing their population. Planting of some fruit bearing trees like Manila tamarind (*Pithecolobium dulce*), Flame of the forest (*Butea monosperma*) Mulberry (*Morus alba*) and Toothbrush tree (*Salvadora persica*) in and around cropped areas attract many granivorous birds during fruiting period and thus their impact is reduced at vulnerable stage of the crop (maize).

**(ii) Block plantation:** Cultivation of sunflower, safflower, mustard, sesame, groundnut, bajra, sorghum and maize in huge blocks with a minimum of 20 acres significantly reduces the damage by birds.

**(iii) Reflective ribbon for bird scaring:** Reflective ribbon is a polyester film (1.5 cm width) with a shining metallic coating red on one side and silver on the other. Such strips, preferably 15 to 20 m long, are fixed parallel to the crop at 0.5 m height above the crop and at 5 m intervals using bamboo poles and strings. For better reflection, the ribbon should be fixed in north-south direction. During sunshine, the reflection of sunlight and humming noise produced by the wind scares away the birds from the crop fields. The technique is very effective at least for 15-20 days and is easily acceptable to the farmers. Birds like rose ringed parakeet, house crow and mynas on the crops like sunflower, maize, sorghum, pearl millet and orchards are scared by this device. The reflective tapes have proved effective against the Demoiselle cranes in groundnut and also against many depredatory birds in other cereals and fruit crops. However these ribbons are less effective under poor light condition and when the crop is grown in isolation

**(iv) Reflective Paper plate:** This method is highly cost effective during the milky stage of the crop. In this, the paper plates are arranged on the stalk behind the flower such that the reflective surface faces outside, so that the sun rays are reflected back. This prevents the birds' vision when approaching the crop. However in case of poor sunshine, if birds approach the crop they may not find suitable perch on the flower due to slippery surface of the plates.

**(v) Bird resistant hybrids:** The seeds of these hybrids are protected by morphological traits i.e., concave-shaped heads, horizontally-oriented heads and long head to stem distance. These plants need to be planted in north-south rows to avoid overlapping of plants. Between 40 – 60 days, stopping of irrigation to the crop leads to bending of the head towards the ground. Due to heavy bearing of the seeds, the head starts swinging when the birds try to perch on them, making this position uncomfortable and difficult for the bird to feed.

**(vi) Automatic mechanical bird scare or pyrotechnic method:** Automatic bird scare is a sound producing device which works continuously for a whole day with 1 kg of calcium carbide and water. One-hectare areas can be covered with this method and is found effective in reducing crop losses by birds. Care must be taken about the frequency of firing and change of positions and directions to avoid bird getting habituated and rendering the intervention ineffective.



**(vi) Botanical repellents:** Neem cake solution is prepared by soaking neem cake @ 200- 300 g/l of water and kept for fermentation for 8 - 10 days. The fermented solution is then decanted and this solution is used as spray fluid. This solution when sprayed on the crops was found effective in controlling bird damage in Maize. Spraying of botanical formulation like BBR+ and Fortune Azar (Neem formulation) in the field, reduced number of visiting birds and resulted in higher yields.

**(vii) Spraying of egg solution/ rock salt solution:** Spraying of egg solution/ rock salt solution @ 25 ml/l of water was very effective in control of bird damage in sunflower, safflower, mustard, sesame, ground nut and other food crops. Second spray is recommended after 10 days, if damage is seen. Application of this innovative method results into 30-70 per cent increase in the yields of different crops.

**(viii) Seed treatment for protecting sprouting seeds:** Thiram (0.5 per cent) and Copper-oxochloride are very effective in reducing the seedling losses due to birds in maize, chickpea soybean, sunflower and groundnut. However, it is yet to be investigated whether the reduction in early seedling vigor by thiram treatment has any significant effect on the crop yield.

**(ix) Bio-acoustics:** The acoustic equipment is very effective in driving away birds from crop fields. It consists of micro SD card with 20 watt amplifier, 1 (one) speaker, 1 (one) 12 v battery and 1 (one) solar panel. Pre-recorded alarm, predatory and distress calls of birds are embedded and played. Depending on the intensity of bird activity, the frequency of play should be set up at regular time intervals. Broadcasting of such distress calls of depredatory birds keeps the birds away from sunflower, sorghum and also other crops.

**(c) Management of peafowl:** During sprouting stage, fixing of jute rope around the crop with the help of pegs at 1m intervals and 30 cm above ground tying the rope across the entire crop in checkered pattern forming squares of 1m x 1m prevents entry of peafowl into the crop fields. This technique proved effective and reduced 98 per cent damage in all crops. During maturity stage of crop, fixing of jute rope 30 cm above the ground around in three rows using wooden pegs prevents peafowl damage all along the border rows. By using this technique, crops like wheat, rice, short varieties of sunflower, groundnut, cotton, bhindi, tomato, brinjal and cabbage etc can be effectively protected to the extent of 90 per cent from peafowl damage.

### **2.6.3. Higher vertebrates**

#### **2.6.3.1. Management of wild boar**

The wild boar is one of the most widely distributed large mammals occurring in North Africa, Europe and Asia. Worldwide, there are 16 species of wild boars and wild pigs. The species present in India is Eurasian wild boar (*Sus scrofa cristatus*). It is distributed in almost all the states of the country. In recent years the species is majorly indulging in crop raiding becoming a major pest in agricultural ecosystem. Wild boars are omnivorous, living on crops, roots, tubers and carrion. They normally move in groups and their activity is more during early morning and evening hours, peculiarly active at dawn & dusk than in the actual day period.

They possess a unique feature of identifying cropped areas through their smell sensory mechanism.

Keeping in view the severity of the problem associated with this wild animal species, in agricultural landscape, the AINP on Vertebrate Pest Management has extensively studied the behavior and pest status of wild boar and developed some eco-friendly, cost effective strategies to manage the wild boar damage in agricultural fields.

**(a) Physical barriers:**

- **Barbed wire/ GI wire fence:** It consists of erecting of barbed wire fence around the field in three rows, with first row at the height of 30 cm from the ground. This is highly effective in preventing wild boars from entering into the cropped area. The cost of such barrier as worked out stand at Rs 8,000/- per acre (Barbed wire Rs: 6,855 - 7,000; Labor cost Rs: 1,000) and was found economical. Similarly a simple three row (30 cm height) GI wire fencing fixed around the crop with the help of poles, threaten the animal coming in contact with GI wire and is scared away. The cost involved in erecting such fence is around Rs: 2,000/- per acre. It is learnt, that recently Anand Agricultural University, Gujarat has designed barbed wire fencing technique for which Govt of Gujarat is considering to provide subsidy to the farmers.

- **Circular razor fence:** The iron wire fixed with sharp razor blades at regular distance is erected, separated by a gap of 1(one) foot from the cropped area as border by forming circular rings. The blades cause serious damage to the wild boar trying to enter into the field. This not only prevents the animal to enter into the field but also scares away other animals, because the entangled animal makes alarm calls which deter other wild boars. The cost per acre is estimated at Rs: 19,000 (Rs. 18,000 for the wire + Rs: 1,000 labor) in erecting this type of physical barrier.

- **Chain link fence:** It is an easy and most effective way of fixing a barrier which is more durable in nature. Chain link meshes of 90 cm height can be fixed around the crop by maintaining a distance of 30 cm away from the crop. The cost of the chain link fence (including labour) comes to Rs: 11,000/- per acre. Anand Agricultural University, Gujarat has designed barbed wire fencing technique and it is learnt that the Government of Gujarat is considering to provide subsidy to the farmers and promote this technology.

- **Solar fence:** This is a permanent type of physical barrier arranged around the cropped area which has been gaining greater popularity in the recent years, especially in case of high value and remunerative crops. In this method, a solar fence is fixed around the crop with 12 volts electricity flowing through it with the help of solar plates. The shock received by the animal during the contact does not kill the animal but certainly wards off the animal coming in contact and other animals following it are also scared due to the alarm calls of the shocked animal. The cost of erecting such a fence as worked out stands at Rs 90,000 per acre.

- **HDPE nylon fish net as physical barrier:** The fish nylon net (HDP, UV stabilised, 2'' mesh and 1.5mm thickness) using bamboo or strong wooden poles should be erected around the crop at a vertical height of about 3 – 4 feet. It is advised to drill nails onto the poles at a regular interval of 10-15 cms, to ensure safe fixing of the net. Insert the nylon rope in between

the mesh net and fix horizontally on the ground by using small wooden pegs. This method prevents entry of the animal into the fields, and if by chance an animal enters, it will be entangled and sends alarm calls scaring which deter away the other wild boars. Erecting of fish net around the field reduces the wild boar damage to the tune of 70-90 per cent.

- **Arrangement of three rows in 'niwar' soaked in kerosene:** The *niwar* soaked in kerosene solution for about 2 hrs is arranged around the crop in 3 rows, at an inter-row spacing of 30 cm, with the help of wooden poles. The dominating smell of kerosene does not allow wild boars to identify the crop. This method is generally effective for 10-15 days.

- **Arrangements of coconut ropes soaked in mixture of sulphur + pig oil:** Coconut rope is arranged in three rows around the crop (@ inter-row spacing of 30 cm) with the help of wooden poles. Solution of sufficient quantity of sulphur with local / domestic Pig oil smeared on the coconut ropes. This mixture generates the typical smell, thereby repelling wild boars from the cropped area. For an effective use of this method, two such applications should be done at an interval of 10 days.

**(b) Biological barriers**

- **Planting of thorny bushes around the crop:** Different xerophytic species like *Euphorbia sp*, *Opuntia sp*, *Zizipus sp* and *Agave sp* etc can be planted on the bunds around the crop. The thorny nature of, these species will keep the wild boars from the crops by constraining their entry. The wild boars making unsuccessful trials of entry suffer injuries and make alarm calls, making other animals to flee from the scene. Likewise, planting of *karonda* (*Carrissa carandus*) around the crop as a bio-fence effectively prevents the entry of wild boars into the cropped area owing the thorny nature. Using *karonda* as a border crop provides enormous benefits to the farmer through additional yield of *karonda* fruits and value added products of medicinal importance.

- **Four rows of castor around the crop:** Planting of 4-5 rows of castor with close spacing (high density with row to row 45cm and plant to plant 30cm) around the maize / sorghum / sugarcane crop reduces the wild boar damage. Wild boars being capable of identifying the crop only through smell can't do so owing to the strong odour emitted by the castor successfully masking the odour emitted by the crop. Damage in castor by wild boar is also not possible due to the non-palatable nature of the plants with high amount of alkaloids and glucocides. In this approach farmer gets an additional income through castor. Usage of castor as border crop is also practicable in crops like pulses and oil seeds. This method effectively controls the wild boar damage to the extent of 75-90 per cent.

- **Use of four rows of Safflower as barrier crop:** The practice of having 4-5 rows of high density safflower crop (row to row 30 cm and plant to plant 10cm) as border around groundnut was found to be most promising in preventing the damage by wild boar. Safflower crop by being thorny in nature will cause great amount of inconvenience and injury to wild boar. In addition, safflower crop emits strong chemical odour effectively masking the odours

emitted by ground nut crop. By using this, extent of damage by wild boar can be minimised to the level of 75 – 90 per cent and also provides added income realised through safflower crop.

**(c) Trenching**

Digging of 90 cm wide and 60 cm deep trench around the cropped area at a distance of one foot from the crop keeps away the wild boars from the field. Apart from being effective for wild boar management, this method also serves as an excellent source for water conservation in the rainfed areas.

**(d) Bio-acoustics**

The bio-acoustic technology utilises sounds of predators, distress and alarm calls of target and their closely related animal species. The calls are broadcast in the field by using an electronic platform with sound drives. Bio-acoustics convey the message to wild boars, that '*this area is dangerous*' in their own language. On hearing the sounds, the target animals avoid the area, thus securing the crop against possible damage. The sounds are natural and safe on humans, birds and animals. The equipment produces fixed volume of 110dB at source covering an area of 8-10 acres while ambient noise level is around 42 dB. At 37 dB of ambient noise, the equipment can cover upto 19 acres. The equipment should be ideally installed when the animal damage is beginning. Bio-acoustics is effective in dispersing wild boar from the cropped area to an extent of 92 per cent.

**2.6.3.2. Management of nilgai**

The *nilgai* (*Boselaphus tragocamelus*), a member of deer family is the largest Asian antelope most commonly seen in farmland or scrub forest of central and northern India. Females and males remain segregated for most of the year, except for when the males join the females for breeding. Breeding groups consist of one dominant male and one to many females. Mating usually occurs from December to March, with the resulting calves born in September and October. Crop-raiding by locally over-abundant populations of *nilgai* has been widely reported in many parts of the country. Due to prolonged breeding activity and lack of potential predators, *nilgai* population has increased considerably becoming locally over-abundant in the States of Gujarat, Uttar Pradesh, Haryana, Punjab, Rajasthan, Madhya Pradesh and Delhi.

In recent years, reports indicate that *nilgai* population outside the protected area is roughly around 5 lakhs. *Nilgai* were found to be capable of causing extensive damage to most agricultural crops not only by foraging but also through trampling. In low density areas, losses to wheat, gram, moong, guar and cotton crops were 20-30, 40-55, 40- 45, 20-35 and 25-40 per cents, respectively. Whereas in high density areas, their damage to wheat, gram and moong was 35-60, 50-70 and 45-60 per cents, respectively. The damage caused by *nilgai* has become a matter of serious concern and cries for effective management. With growing nilgai attack, farmers have begun to find it hard to grow certain crops like pulses. Following strategies may be considered for management of *Nilgai* from agricultural landscape.

**(a) Erecting wire fences/stone walls**

Use of barbed wire fencing (5-6 strands) to a height of about 6-7 ft effectively prevents the entry of *Nilgais* into cropped areas. However, it needs regular maintenance as it is subject to damage when the animals try to make a forced but unsuccessful entry. Erecting stone walls around the crop fields is a more effective and long lasting solution, mainly recommended for high value crops and fruit orchards.

**(b) HDPE nylon fish net as physical barrier**

The fish nylon net (HDP, UV stabilised, 2'' mesh and 1.5mm thickness) using bamboo or strong wooden poles may be erected by inserting a nylon rope in between the mesh net, and erecting it around the crop vertically at a height of about 6 feet. Insert the nylon rope in between the mesh net and fix horizontally (2 feet) on the ground by using small wooden pegs. This method prevents entry of the animal into the fields, and if by chance it enters it will be entangled (since the animals are having hooved feet). Such an entanglement will stimulate alarm calls from the animals, which will deter other nilgais from attempting an entry into the cropped area.

**(c) Planting of thorny bushes around the crop**

After digging deep trenches around the field, different xerophytic species like Cacti sp *Euphorbia caducifolia*, and *Opuntia* sp and other local thorny bushes like *Ziziphus* sp, *Prosopis juliflora* etc can be planted in close spacing on the high bunds made from the soil collected after trenching around the crop. *Nilgais* after unsuccessful trial of entry get injuries and make alarming calls, which makes the other animals also to flee from the scene.

Likewise, planting of *karonda* (*Carrissa carandus*) around the crop as bio-fence prevents effectively the entry of *nilgai* into the cropped area owing to thorny nature besides it not being preferred as food. Using *karonda* as a border crop gives enormous benefits to the farmer by providing additional income in the form of *karonda* fruits.

**(d) Planting of castor around the crop**

This method is widely being popularised in maize and sorghum crops by planting 4-5 rows of tall varieties of castor with close spacing (high density with row to row spacing of 45 cm and plant to plant spacing of 30 cm) around the main crop. *Nilgais* being capable of identifying crops only through smell can't do so owing to the strong odour emitted by the castor, successfully masking the odour emitted by the main crop. Damage to castor by *nilgai* is also not possible due to the non-palatable nature of the plants, thanks to its high amount of alkaloids and glucosides. By this method, farmer also benefits from an additional income from castor. Usage of castor as border crop is practicable in both *Kharif* and *Rabi* seasons, and the same crop can be used as border crop in crops like pulses and oil seeds.

**(e) Guarding**

Constant vigilance during the crop season employing sticks, noise, shouting etc is also practised by the farmers in many parts of the country. According to the farmers, it is one of the most successful strategies for preventing crops from by *nilgai*. Use of trained dogs can scare away these wild animals as their barking not only deters but also warns the farmer about the crop

raiding activities of *nilgais*.

**(f) Solar shock fence**

This is a permanent type of physical barrier arranged around the cropped area which has been gaining popularity of late. It is being widely practised to prevent attack by *nilgai* in high value remunerative crops. In this method a GI wire is drawn around the crop in 6 rows, with 12 volts electricity passing through with the help of solar plates and regulator. The contact shock to the animal may not kill it but merely wards it off. Additionally, the alarm raised by it can be expected to scare away other nearby animals that were likely following to raid the crop.

**(d) Bioacoustics :** As vide para 2.6.3.1 (d)

## **2.7. Management of Vertebrates and Associated Legal Issues**

*Nilgai* and wild boar are protected under schedule-III of the Wildlife Protection Act, 1972, though their conservation status as per IUCN is categorised as 'least concerned', i.e their population is high and at a level where their conservation is not necessary. Realising the seriousness that this species is posing to agriculture, a few provisions of the Act need to be reviewed. Under the Act there is a provision to declare the animal as vermin by shifting it to Schedule-V under some special circumstances. Section 62 of the Wildlife Protection Act empowers the central government to declare any wild animal, apart from rare and endangered species, to be classified as vermin, for a specified period of time. Section 11(1) (b) of the Act empowers the Chief Wildlife Warden or authorised officers to permit hunting of an animal or a group of animals specified in Schedule II, III and IV in a specified area if it has become dangerous to human life or property or is disabled or diseased beyond recovery by ordering in writing and stating the reasons thereof a person can be permitted to hunt such animal or cause such animal to be hunted.

Taking cognizance of the Act, Union Government has declared wild boar as vermin in 13 districts of Uttarakhand; *nilgai* and wild boar in 31 and 10 districts of Bihar, respectively; and monkey in Municipal limits of Shimla in Himachal Pradesh for a specified period of time. In Rajasthan and UP, killing of *nilgai* is permitted (under special circumstances) with permission of Divisional Forest Officer and District Collector, respectively. In Gujarat Panchayats are empowered to issue killing permit.

### **2.7.1. Implications of invoking Section 62 on the implementation of the WPA-1972**

- a) The preamble of the WPA, 1972 states that it is an Act to provide for protection of wild animals, birds and plants. But, as defined under S.2 (36). The term 'wild animal' covers only the animals listed in Schedules I to IV. Thus, the direct implication of declaring any wild animal as vermin under S.62 is to preclude it from the definition of wild animal, and consequently remove it from the ambit of the WPA, 1972 and the jurisdiction of the Chief Wildlife warden (CWLW) and Other Authorities (OA) prescribed under the said Act. However, vermins are still covered by the term 'wildlife'

as defined under S.2(37) and, therefore, eligible for protection in a sanctuary under S. 29 and in a National Park under S.35(6).

- b) S.62 is not in itself a Human-Wildlife Conflict (HWC) mitigation tool and does not put any person or authority under any legal obligation to undertake hunting (killing / capturing) of the animals involved in HWC. It simply exempts the public at large from seeking permission from the Chief Wildlife Warden (CWLW) or an Authorised Officer (AO) before undertaking hunting of the animal notified as vermin. The advisory dated 24.12.2014 is based on the assumption that such an exemption would enable the people suffering on account of HWC to culling of the problem animals. But, in practice, the affected people may not have the resources (e.g. weapon and ammunition) or the will to undertake such an exercise. On the contrary, there are good chances that the professional hunters and traders would take advantage of the relaxation given under S.62 motivated purely by commercial interests in the guise of the conflict arising from human wildlife interface.
- c) As soon as a wild animal is notified as vermin, it is no longer subject to the prohibition of hunting/ injuring /capturing imposed by S.9 and restrictions on hunting /injuring / capturing imposed by S.11 and S.12. A person would be free to hunt / injure / capture a vermin by any method including poisoning, snaring and electrocution; hunt / injure /capture a vermin in any numbers without any regard to sex, age or breeding season; and he won't be liable to submit any report / return to the CWLW or the AO. Obviously, use of S.62 for mitigating HWC is not a scientific method and is fraught with serious consequences for the future survival of the species in question. As stated in Para 3, vermins have been persecuted in the past and history may repeat itself once again under such a circumstance.
- d) A live vermin, after its capture, or an animal article / trophy / meat derived from a vermin, after killing it, ceases to be a government property as defined under S.39, and the hunter / trapper would be free to dispose of the animal in question or its derivatives in any manner that he likes. For example, a person will be eligible to carry out trade without a licence required under S.44 in respect of rhesus monkeys captured from areas where these are notified as vermin. Similarly, a person will be able to serve in any hotel / dhaba the meat obtained from wild boars and blue bulls (nilgais) killed in areas where these are notified as vermin without requiring a licence under S.44. It may be mentioned that most of the State Forest Departments (SFDs) in India follow a 'no trade' policy in respect of wild animals but it won't be possible for them to follow a similar policy in respect of a species notified as vermin.
- e) In general, the WPA, 1972 follows a policy of discouraging hunting and culling of wild animals in the country. The Act banned game hunting in India in 1991 by amending S.9 and deleting S.10 and S. 13-17. The Act permits hunting of wild animals involved in HWC under S.11 but with many riders, and can be undertaken only under the control

of the CWLW and the AOs. While permitting hunting for the purpose of population management under S.62, the Act specifically prohibits killing, poisoning or destroying of wild animals. It is evident that use of S.62 is against the aforesaid policy of the WPA, 1972.

- f) It follows that invoking S.62 by the central and state governments as a tool for mitigating HWC would tantamount to absolving themselves of their constitutional obligations in respect of the animal in question and to pass over the buck to the public at large. Whether such an action is justified from the constitutional, ethical and scientific points of view is a question that needs serious attention and therefore a restraint is advised in deploying the provisions of law.

### **2.7.2. Implications of invoking Section 62 on the Foreign Trade Policy**

The Foreign Trade Policy issued by the Central Government prohibits the commercial import and export of all wild animals covered by the WPA, 1972 and their derivatives. As stated in Para 4, notification of any species as vermin under S.62 precludes it from the definition of a wild animal, and consequently, exempts it from the prohibition on export under the Foreign Trade Policy. In particular, rhesus monkeys, captured from the areas where they are notified as vermin, will be eligible for export despite the 'anti-export' policy for wild animals followed by the Central Government.

### **2.7.3. Section 62 vis-a-vis the animal welfare issues**

- It is highly probable that the notifications declaring wild animals as vermin under S.62 will be opposed by the Animal Rights activists and challenged in the courts of law.
- It may be mentioned that destruction of a wild animal under the authority of S.11, S.12, S.29 and S. 35(6) of the WPA, 1972 has the sanction of S.11 (3) (c) of the Prevention of Cruelty to Animals Act, 1960 (PCA-1960). But culling of animals notified as vermin under S.62 of the WPA, 1972 does not get a similar sanction, and may be challenged as a violation of the PCA, 1960.
- As stated in Para 4, a person is free to hunt / injure /capture a vermin by any method including poisoning, snaring and electrocution and the CWLW would have no control on hunting with regard to sex, age or breeding season. There are, therefore, good chances that hunting / capturing of problem animals notified as vermin might violate the provisions of the PCA, 1960 and the Rules made there under.
- The issue of managing HWC by shooting of the problem animals was examined by the Himachal Pradesh High Court in the two PILs, viz. CWP Nos. 8149 / 2010 and 8284 / 2010, filed by the Animal Rights activists. The High Court, in its interim order issued on 6.1.2011, stayed the operation of the permits issued by the HP Forest Department (HPFD) under S.11 (1) (b) for shooting of rhesus monkeys indulging in crop-depredation and asked the Department to experiment with non-lethal methods for mitigation of the conflict. The High Court commented that: *"If tackling the problem is by annihilating the problematic monkeys, we are afraid that the State has not*



*understood and applied its mind to its constitutional obligation, fundamental duties and the statutory intent behind the Wildlife (Protection) Act.*” The courts are likely to take a similar stand in respect of notifications issued under S.62.

## **2.8. Policy Recommendations**

The vertebrate pest management strategies, especially for rodents and birds as mentioned in the preceding sections are very effective and need to be popularised on a larger scale for protecting the crops from their menace. The All India Network Project (AINP) on Vertebrate Pest Management (VPM) has been focussing on dissemination of such technologies to farmers, capacity building activities for State extension officials. However, the State departments have to take a lead in transfer of these technologies to end users for protecting the standing crop from raids and damages. Hence, training of the State Extension Machinery is more important.

As far as higher vertebrates like wild boars and *nilgais* are concerned, the technologies listed above are effective and eco-friendly and can be gainfully adopted by the farmers. It is further added that these strategies when deployed mainly help in repelling/ deterring these animals from the cropped areas. However, *Nilgai* and wild boar are not a problem of single village or farmer, and therefore community approach is needed for effective management, besides intervention by respective state governments to sort out legal issues. Community participation along with active involvement of Agricultural and Forest Departments, can be effective in combating the problem of *nilgai* and wild boar in agricultural lands.

The raids by wild vertebrates in crop fields is due to destruction/ deterioration of their natural habitats. Therefore, a joint effort is required through Joint Management Approach (JMA) involving the Departments of Forests, Agriculture and the farmers for effective and sustainable management of wild animals. *Nilgai*, because of its name also carries a socio-religious taboo. Government and citizens must respect the natural habitats, while undertaking developmental activities including construction of infrastructure, particularly, on the periphery of the forest lands or protected areas. There is an urgent need to understand the impact of such activities and to restrict such interventions particularly in case of most critical wildlife habitats.

It would be preferable if the wild animals are captured and translocated to their natural habitats (forests). But their natural habitats too need to be upgraded by planting preferred food plants and also by fencing the forest areas adjacent to crop fields. In addition, the state and union governments should consider review of the provisions of the Wildlife Protection Act, for declaring such animals as vermin as per the need in the specified region and for a specified period when they become a serious menace to crop production for a specified period. Therefore, effective management of these vertebrate pests (rodents, birds, *nilgai* and wild boars) without compromising the welfare of the animals is important in crop protection and ensuring that farmers derive the fruit of their labour.

## **2.9. Annotation**

A pest can be defined as an organism that causes, or is perceived to cause, or is likely to cause

economic or aesthetic damage to humans or their property. Vertebrate pests, while not as numerous or pervasive as disease or invertebrate problems, remain however a real concern.

Worldwide, rats and mice are the most notorious of all the vertebrate pests that plague humankind. Of these, the Norway Rat, (*Rattus norvegicus*) and the House Mouse, (*Mus musculus*) are the most common ones. Adult Norway Rats are robust, weighing 10-17 ounces and are 13-18 inches in total length. Among the six antelopes reported in India, three species, namely *nilgai*, black buck and four horned antelope were reported as crop raiders. Similarly, of the nine deer species, only spotted deer has been reported to be involved in crop damage on the fringes of forest blocks. Out of 13 species of primates listed, five species are involved in crop damage across different agro-ecological regions.

Birds can cause problems in farm and home garden situations by their roosting, nesting and feeding habits, depending on the species. The most common culprits are crows, starlings, woodpeckers, pigeons, house (“English”) sparrows, robins, and geese.

Other species may be occasional pests. Squirrels can become troublesome when they attack fruit, nut and vegetable crops. They are also incessant raiders of bird feeders and bird nests and can damage ornamental trees by clipping twigs and stripping bark. In areas where nesting places are scarce, they will gnaw into attics and wall voids, causing serious damage.

#### **Key Extracts**

- The context for an increased human-wildlife conflict is on the rise, and management of vertebrate as pests is sensitive, and hence a challenge.
- Vertebrate pests can range from small rodents to large mammals like elephants. Deforestation reduces forage zones for animals, causing them to seek food from farms, resulting in human-wildlife conflict.
- Before implementing direct control action involving the use of traps or poison, there is a need to assess alternative ways by which the animals can be managed. Appropriate care should be taken to ensure that animal welfare is not compromised.
- Options can include elimination of harbourage, clearing dense vegetation, removing rubbish around structures, fencing systems, “scare devices” (scare-crows, hanging flashers, flags, balloons) etc. are possible preventive options.
- Capacity building of extension officers in vertebrate pest management is important to maintain a bio-diversity friendly agricultural system.



## **Chapter 3**

### **Crop Risk Management in Agriculture**

*Crop production (both across agriculture and horticulture) is highly risk-prone at all its stages of growth. The concomitant risks and uncertainties can be effectively resolved by adopting a comprehensive and farmer-friendly crop insurance scheme like the Pradhan Mantri Fasal Bima Yojana (PMFBY). Crop Insurance has evolved to a great level in India and further interventions can make it more effective and sustainable.*

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#### **3.1. Agriculture – Risk Prone Profession**

As discussed in chapter 1 of this volume, agriculture is exposed to multiple risks at all its stages of value chain - pre-production, production and post-production segments. The cultivation stages that constitute the pre-production and production stages are biological in nature, and are hence vulnerable to several endogenous and exogenous factors, rendering the occupation highly uncertain.

In the recent years, climate change has been accentuating the erratic and unpredictable nature of monsoons causing extensive financial losses in terms of crop failures, damage to agricultural infrastructure etc.

Since long, Government has been operating disaster response and compensating the losses incurred by farmers on account of drought, floods, hailstorm etc. The corpus of NDRF (National Disaster Response Fund) and SDRF (State Disaster Response Fund) has been substantially strengthened during the 14<sup>th</sup> Finance Commission Period of 2015-16 to 2019-20. Yet, compensation that a farmer receives on account of his individual losses is not adequate and is in general found unsatisfactory.

Hence, there has always existed a need for a strategy that can yield comprehensive solution to the risks and uncertainties associated with crop production. When these are taken care of, the farmer can be expected to adopt new technologies, management practices and investments with greater vigour and benefit from higher productivity and production.

In the above context, crop insurance has come to be recognised as a more satisfactory and comprehensive solution to the need for transferring the cost of potential losses due to natural disaster or contingent situation.

##### **3.1.1. Evolution of Weather based insurance in India**

The seeds of crop insurance as a counter to risk in agriculture were sown in India in the second half of the twentieth century, and has evolved steadily over the last about 50 years. India took the first step to crop insurance in 1972 by launching a pilot for cotton crop. Soon it was realised that the 'farm yield' based insurance was very difficult to implement. This realisation led to launching of a pilot on 'area-yield' based parametric crop insurance in 1979 that got converted into a countrywide programme as 'Comprehensive Crop Insurance Scheme (CCIS) in 1985.

This was followed in the year 1997 by the Experimental Crop Insurance Scheme (ECIS). This scheme received a big boost in 1999 when the then government made substantive changes in the scope & content to amend the programme as National Agricultural Insurance Scheme (NAIS). For the first time, this enabled insurance for non-loanee farmers, coverage of annual commercial/horticulture crops, higher levels of risk cover etc.

Other roll outs included the Pilot Scheme on Seed Crop Insurance (PSSCI) in 2000, the Farm Income Insurance Scheme (FIIS) in 2003, Weather Based Crop Insurance Scheme (WBCIS) in 2007 and the National Crop Insurance Programme (NCIP) in 2013. The performance of these schemes was spasmodic. It is against this background that the insurance based crop risk cover was revisited, intensely debated and thoroughly revamped and that resulted in the launch of a comprehensive and market-led new crop insurance scheme in 2016 under the title of “Pradhan Mantri Fasal Bima Yojana (PMFBY)”. Further, all the aforementioned schemes except for WBCIS (Weather Based Crop Insurance Scheme) were discontinued.

While PMFBY is area-yield based, parallelly weather based scheme now called ‘Restructured Weather Based Crop Insurance Scheme’ (RWBCIS) for horticultural crops continues to be in operation.

Weather as an index of crop insurance has played a supplementary role to yield insurance since 2003. Despite mandatory nature of insurance (in respect of loanee farmers), crop insurance penetration in India has been historically low. Of the total gross cropped area (GCA) of about 194 million hectares (net cultivated area of 141 million ha.) a little over 40 million hectares were insured in the year 2014-15 for a sum of approximately Rs.85,000 crore. This was merely 20 per cent of GCA with just about 6 per cent of Crop GDP insured. The low level of crop insurance penetration was what drove the government in 2016 to revamp the insurance programme, which promises to take penetration to 50 per cent of GVA within next three years (2019-20). The key action areas identified by the government in launching PMFBY are:

- (i) affordable premium rates for farmers;
- (ii) large scale enrolment of non-loanee farmers through better & broader insurance coverage and assisted enrolment through Common Service Centres (CSCs);
- (iii) improvements in enrolment process to capture details of each individual farmer;
- (iv) improvement in the underwriting and claim processing timelines using effective IT interface;
- (v) transparent yield estimation process using technology assisted audit; and
- (vi) individual farm assessment and settlement of losses in case of localised losses.

Among a series of improvements in PMFBY, is the substantive jump in the average sum insured per hectare, as against the significantly below the output value of the crop (almost less than 50 per cent of the value of the crop) in the earlier scheme. The PMFBY sought to eliminate

the coverage gap by removing artificial capping of the sum-insured and the premium rate. PMFBY also moved the insurance product to risk based premium regime supported by up-front subsidies in premium. In order to make it farmer-friendly, PMFBY charges a low and uniform premium of 2 per cent for all 'Kharif' crops, 1.5 per cent for all 'Rabi' crops and 5 per cent for commercial/horticulture crops. The difference between the premium paid by the farmer and the actuarial fair premium (APR) is subsidised by the government (shared by central and state governments on 50:50 basis).

Besides PMFBY, there are two other schemes launched simultaneously. These are Restructured Weather Index Based Insurance Scheme (RWBCIS) and Unified Package Insurance Scheme (UPIS). The latter, UPIS intends to meet all insurance needs of a farmer through a single insurance scheme, and is running as a pilot as of now.

Thanks to concerted efforts of all concerned stakeholders, an extent of over 57 million hectares of gross cropped area was covered during 2016-17 for a sum insured of Rs. 205,000 crore with a premium volume of Rs. 21,500 crore (US\$ 3.3 billion), making it the third largest line of insurance in the country behind Motor and Health lines. Now, India also ranks as the third largest crop insurance market across the globe behind United States of America and China.

In 2017-18, the corresponding figures were a coverage of 47.52 million ha. of gross cropped area for a sum insured amount of Rs. 1916.34 billion and a premium volume of Rs. 243.51 billion.

### **3.2. Protecting the Farmer under PMFBY**

Farmer is at the heart of the PMFBY. It is, therefore, pertinent to take note as to how the government has largely taken care of the farmers' interests in revamping the crop insurance scheme. For, this will help in effecting further changes as needed. The key aspects of PMFBY are:

- i. **Safety net for the farmers:** The minimum sum insured is equivalent to the production cost, so that every farmer has a safety-net to protect his investments in terms of all the paid-out costs.

It is mandatory to insure the farmer for the notified crop at the scale of finance. The added advantage here is, that the farmer also gets substantive production loan. In due course the sum insured may be extended to cover value of production, which means marketing risk gets to be addressed.

- ii. **Threshold yield:** Threshold Yields (TYs) are set in a manner as to provide a reasonable protection covering all medium and larger magnitude of losses. Threshold Yield is about 80 per cent of the average of past seven years' yield, excluding upto a maximum of two calamity years. Exclusion of calamity years in calculating TY offers better protection to the farmers.

- iii. **Affordable premium:** Keeping in mind the poor purchasing capacity of the farming community, farmers' share of premium is fixed at 1.5 to 2 per cent for food crops & oilseeds and 5 per cent for commercial crops. Besides being low, it is also uniform (kharif-2 per cent; rabi-1.5 per cent, and commercial/horticultural crops 5 per cent). On an average, the premium subsidy is about 80 per cent of the risk premium.
  
- iv. **Protection for key localised losses:** Indian index insurance is a unique program which comes with a 'top-up' cover for paying losses of 'localised risks', like hailstorm, landslide, inundation and post-harvest losses on individual farm basis. This is a unique insurance which uses 'yield index' for deciding losses of widespread calamities and 'farm yield' for assessing losses of localised perils / calamities.
  
- v. **Credit linkage:** Insurance is mandatory for loanee farmers of scheduled banks, and the insurance incepts the moment crop credit is approved. The banks also finance the premium component, which is a unique feature to help farmers tide over the liquidity issue at the commencement of crop season.
  
- vi. **Multi-agency approach to minimise administrative cost:** Thanks to the involvement of multiple agencies, the administrative cost of running the program is less than 2 per cent. Banks effectively work as the distribution channels and claim disbursement points. State agencies provide yield assessment services and also promote insurance education & awareness. While for most crop insurance programs around the world the administrative & operating expenses are well over 15 per cent, India through its multi-agency approach has managed to keep the administrative expenses within 2 per cent.
  
- vii. **Closed-ended financial liabilities (premium subsidy):** There was a time, when the claim subsidy model was an open-ended financial commitment. The government under PMFBY has shifted to a completely close-ended model, so that the fund requirements are budgeted more accurately. An estimate puts 1-in-100 year event to burn over 35 per cent of the total sum insured. Assuming a sum insured amount of Rs. 350,000 crore (at 40 per cent penetration), a 1-in-100 year event can lead to a loss of over Rs.120,000 crore (as against expected premium of approx. Rs. 40,000 crore).
  
- viii. **Ease of enrolment:** The government has launched a dedicated portal in 2016 for enrolment of farmers, which can be used by the individual farmers and the participating banks. This makes underwriting quicker, and gradually moves the operations to a 'paperless' system. What's more important is, that this platform can facilitate transition to 'individual farm' based crop insurance in the future. In fact, one of the major demands of the farmers is to adopt individual farm as the insurance unit. As deployment of technology improves and the credibility of loss estimates become more authentic it may be possible to meet this demand at a later date.

- ix. **Special drive for enrolment of non-loanee farmers:** The government aims at scaling up the insurance penetration to about 50 per cent of the gross cropped area by 2019, and has opened up channels like Common Service Centres (CSC) to service non-loanee farmers. This feeds the larger objective of de-risking the agriculture, since large number of farmers continue to remain outside the ambit of institutional credit mechanism even today.
  
- x. **Transparent tender process and level playing ground for selection of insurers:** The government has adopted a transparent system of allowing all insurance providers to participate in the selection, besides rolling out consistent and uniform rules for evaluating the premium bids.
  
- xi. **Yield / loss assessment audit system:** The manual crop yield assessment process has been brought under the audit system with mandatory digital proof and uploading of pictures and data into a government portal. With increasing density of smart phones, this can become a universal possibility. Many states have taken the proactive step of empowering their field staff with smart phones and operational cost.

### **3.3. Performance in 2016-17 - Claims and Settlement of Claims**

The year 2016-17 was a standard normal monsoon. However, a few states including Tamil Nadu, Karnataka, etc. had suffered due to poor monsoons. These states indeed received substantial benefits by way of larger crop insurance compensation. In Tamil Nadu, the quantum of claim approved / paid was over Rs. 2,500 crore against a gross premium of Rs. 1,000 crore. Karnataka too, received good compensation for Kharif 2016 and the Rabi 2016-17. Overall, despite a normal monsoon during 2016-17, the claim ratio for the year was expected to be 75 per cent.

For 2017-18, states, namely, Odisha, Chhattisgarh, Maharashtra, etc. suffered either because of poor rains or pests like brown plant hopper, pink boll worm etc. It is expected that these states will receive commensurate compensation. With substantial claims payable in Chhattisgarh, Haryana, Madhya Pradesh, Maharashtra, Odisha, etc., the Kharif 2017 claim ratio is expected to be upwards of 90 per cent.

This is a reasonably good settlement status of claims, notwithstanding that there is dissatisfaction among many. One of the reasons for this is, the failure to appreciate that premium is paid to buy a risk cover in the unknown future. Normally in a cycle of 5 years the good and bad years split into a ratio of 3:2. It would, therefore, be more appropriate to evaluate the effectiveness and resilience of PMFBY over cycle of 5 years.

Any evaluation on a yearly/seasonal basis is statistically not sound. Many a time farmers tend to view crop insurance in the form of a bank deposit with assured yield. However, there can be a system where a certain percentage of the windfall gain, that insurance companies gain in a



good year may be utilised to offset against the premium paid by the farmers. This will allay the perception among farmers and their interest-keepers, that the insurance agencies make profits at the cost of farmers.

### **3.4. Challenges to PMFBY**

Some of the major challenges to fulfilling the intended mandate of PMFBY are discussed below:

#### **i. Coverage of non-loanee farmers**

The extent of loanee farmers who get automatically and compulsorily covered under PMFBY, stands at an average low of 46 per cent of the total land holdings in the country. The escalation to realise the targeted 50 per cent coverage of GCA by 2019 will depend upon bringing non-loanee farmers under the cover of crop insurance. The approach to enhancing of insurance coverage in this context should be:

- increase institutional credit to as many farmers as possible, with particular focus on small and marginal farmers;
- make special efforts to cover non-loanee farmers, particularly by updating & digitising land records and making lessees, share-cropper etc. eligible for loans;
- promote the concept of Joint Liability Groups (JLGs), which can be made eligible for loans and insurance cover simultaneously; and
- computerise all PACSs (Primary Agriculture Cooperative Societies) in quick time, so that small & marginal farmers who normally are their clientele can be monitored for pushing up credit coverage and concomitantly insurance cover.

The coverage of non-loanee farmers in most states since the roll out of PMFBY has been low.

#### **ii. Low coverage in rainfed and remote areas**

The number of bidders in the drought-prone rainfed areas have been relatively lesser, resulting in premium rates as high as 25 per cent. Ironically, the intensity of vulnerability is higher in rainfed systems, and it is the farmers here that deserve risk cover on priority. The challenges that rainfed and such other less endowed areas face need to be addressed, including by providing additional incentives.

#### **iii. Non-coverage of all crops**

Over the last 2 years, the states have been notifying only select crops, depriving all crops that deserve risk cover. One of the critical way forward to increase area coverage is to notify all/as many crops as cultivated in the states.

#### **iv. Lack of awareness**

All farmers are as yet not aware of the existence and benefit of PMFBY. A wholesome

ICT strategy is needed to create awareness and orient the farmers to avail themselves of crop insurance benefit. Higher volume can be expected to drive down the premium rates. The State Level Coordination Committee and District Level Monitoring Committee on Crop Insurance need to be strengthened and capacitated. This would also help to suggest timely adjustments in scheme implementation for maximum coverage in association with financial institutions and insurance companies.

**v. Delayed/non-payment of claims**

One of the major complaints of the majority of the farmers has been about delay in or non-payment of claims. All complaints, including in regard to non-payment may not always be correct. It however demonstrates the need for a robust process backed by technology, that will assure the farmers, that their genuine claims are appropriately settled and in time. Any deviation in this regard will prove to be discouraging and affect the volumes in the long run.

### **3.5. Recommendations for Improvement**

By 2018-19, potentially there could be coverage of over Rs. 350,000 crore of sum insured, requiring over Rs. 30,000 crore premium subsidy. This is best realised if the transparency, reliability and sustainability issues are taken care of in administering the program. Also, with huge premium subsidy bill, the government needs to sense that there is a value for the funds.

While PMFBY is well conceived, its success and the utility to the farming community will largely depend on the execution on the ground. A few important areas to ponder in this regard are:

i. In almost all countries running multi-peril insurance with state support, the prices are set by the government or an independent agency, and the insurance providers primarily compete for service quality and value added services. However, under PMFBY in India the insurers compete for prices to win the clusters / districts. With price as the sole deciding factor, it's very important that pricing follows stability and sustainability. The Government or the National Technical Support Unit (NTSU) should issue detailed guidelines, instead of letting the matter be decided by the insurance or reinsurance industry. Further, the price discovery should happen for longer duration, so that driven by higher volumes, price quotes can be expected to be lower.

ii. Present 'cluster' size in key states is too large. This effectively prevents the small to mid-size insurance companies to participate in tender process. This to some extent kills the spirit of competition by exclusion of small players. The number of clusters has to be substantially increased in key states of Rajasthan, Madhya Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu, Odisha, Gujarat etc. Competition is good for the health of scheme.

iii. The states have to make sure that the tender for settlement of premium rates and insurers is completed well before the start of the crop season. Both, during 2016 and 2017 the last tender for Kharif went into August, depriving the non-loanee farmers an opportunity to enrol. Some

states also tend to wait for monsoon forecast (April and June) before deciding on PMFBY. This is not a healthy practice, and, it is important, that all formalities are completed before the crop lending starts in April for Kharif and September for Rabi.

Some states also raise requests for extending the cut-off date for buying the insurance. This is against fair play, and will in the process provoke insurers to frontload costs on such score.

iv. The insurance culture has to prevail and the farmers in general come to accept insurance as a standard risk mitigation practice. This requires streamlining the enrolment dates in line with crop cycle. Since PMFBY provides for enrolment before the crop is planted, the states should promote availing of crop insurance facility without waiting for completion of sowing. Further, both loanee and non-loanee farmers need to be covered and in time.

v. Incentivise early participation of non-loanee farmers: To minimise adverse selection and to encourage farmers to enrol early in the season, the insurers should be encouraged to offer premium discount to farmers. As an illustration, say for a Kharif crop in a particular district the actuarial premium is 10 per cent and the farmers' share is 2 per cent, farmers enrolling before 31st May may be offered a premium concession of 0.5 per cent, thus having to pay only 1.5 per cent, instead of 2 per cent. The difference may be borne by the insurer. This can to some extent minimise the adverse selection and moral hazard, and also last day rush for enrolment of farmers. Such concessions by the insurers may be met from the windfall gains they may make in a good year. They may create a sinking fund to meet such demands.

vi. While the central government has been making adequate budgetary allocation, some states are found to be faltering in timely release of premium subsidy affecting both timely payment of claims and the solvency of insurers. Dedicated budget at state level can help in timely succour to the distressed farmers.

vii. In order to incentivise and encourage the states to make adequate budgetary allocation towards premium subsidies, the following subsidy sharing pattern is suggested:

SN	Incentivised Subsidy Sharing	Centre: State
1	States' releasing premium subsidies by 30 <sup>th</sup> Sep for Kharif & 31 <sup>st</sup> March for Rabi <b>OR</b> 100% transparency in CCEs with CCE App	55:45
2	States' releasing premium subsidies by 30 <sup>th</sup> Sep for Kharif & 31 <sup>st</sup> March for Rabi <b>AND</b> 100% transparency in CCEs with CCE App	60:40

Integrating Crop Cutting Experiments (CCEs) with funding pattern of premium, the states can be motivated to bring focus on transparency by deploying technology and systems of yield and loss estimates.

viii. Yield estimation has been the subject of greater concern for states and insurers. The huge numbers of needed CCEs combined with lack of transparency in conducting the same, is affecting the confidence in data generated. Innovative technology on yield estimation and yield audit are necessary to improve the quality and reliability. This emanates the need for rationalizing the number of CCEs by utilizing space technology. High resolution spectral images will help in first level assessment of standing crop and eliminate the need for undertaking 100 per cent CCEs as may have been initially targeted. This combined with mandatory digital proof using smart phones and the presence of all concerned parties including the insurers will enhance data integrity and help sustain interest in the scheme on the part of all the parties.

ix. PMFBY becomes a meaningful risk mitigation tool, and the insurance unit is a village. States, in the interest of farmers should also strive to notify smaller insurance units, though they have the latitude to decide on the unit of insurance.

x. Multiple insurers for non-loanee farmers: With the government targeting to increase the penetration to 50 per cent by 2019, major increase in penetration has to come from non-loanee farmers, who are not only large in number, but are likely to remain outside the coverage efforts. This being the case, the government may like to allow, not just the L1 bidder, but L2 & L3 bidders also to service non-loanee farmers at the premium rate quoted / finalised for L1 bidder. Practically, L1 is decided merely on the basis of premium quote and the L1 bidder (insurer) may not have adequate resources / infrastructure to effectively service non-loanee farmers. It may, therefore, be good to involve at least three insurers in any given district to service the non-loanee farmers. The apprehension that a farmer may avail insurance for the same crop from more than one insurer can be contained by using the checks and balances already provided in portal based enrolment. A centralised database will help in checking more than one claims.

xi. Presently CSCs are left to source and service non-loanee enrollment more as a business model. This may not be enough. The insurance industry should take initiative and invest in creating a communication strategy targeting the non-loanee farmers. The insurance companies should be given state-wise targets for coverage of non-loanee farmers (based on crop loan coverage during previous years) and may also be incentivised. The primary aim should be to de-risk agriculture in the larger interest of farmers' welfare and national growth.

xii. There is still considerable leakage in coverage of loanee farmers. The government should examine whether loanee farmers' participation should be linked to availability of active credit limit for the season or go beyond that to consider 3-year revolving credit cycle.

xiii. Technology deployment: There has been serious challenge in timely assessment and payment of localised calamities, prevented sowing and post-harvest losses. While insurance companies are not well equipped to deal with the large scale requests, it can be made time-bound as well as seamless if all the land records are digitised on a GIS platform. On one hand this will effectively resolve the matters involving 'Area Correction Factor', and on the other

hand, it will help in linking the affected / damaged crop fields to insurance coverage on near 'real-time' basis.

**Digitizing land records on a GIS platform can be a single most important facility that can upgrade the quality of crop insurance administration. Hence, this deserves priority, for it can spawn multiple advantages beyond PMFBY.** Additionally, there have been challenges in reconciliation of farmers' data and the premium remitted by the banks during 2017-18. An additional measure of making premium remittance through the portal itself using Pay.Gov can help address the reconciliation errors and enable a quick closure and acceptance of applications and claim settlement.

xiv. Rate adjustment for multi-year contract: PMFBY should provide for premium adjustment based on claim ratio in case of multi-year contracts to ensure that the interest of both the parties (state and insurer) is balanced. This is needed, because at the end of a claim free year the state may be tempted to go for tender again as lower premium rates can be expected.

xv. Tenant farmers have no structural recourse to enrol except as a non-loanee farmer. A few states have passed certain Acts/Ordinances giving the right to avail crop loans, (eg. Andhra Pradesh has 'Land Cultivators License Act, which is recognised by the Banks for offering credit to lessees). All states should be encouraged to adopt similar legal provisions, and also undertake a drive to identify and enrol tenant farmers, if necessary with adequate financial support to finance the premium, and they should resort to legal remedies to recognise sharecroppers, lessees etc. The proposed Model Land Cultivators License Act should be brought out by NITI Aayog at the earliest, so that the states/UTs can legislate appropriately. In the alternate, the already released Model Land Lease Act may be amended to incorporate the provisions of AP Act.

xvi. Insurers can process and settle the claims, subject to: (i) completion of portal based enrolment and data reconciliation; (ii) receipt of acreage sown / planted area at IU level for the current season; (iii) receipt of the yield data based on requisite no. of CCEs; and (iv) receipt of subsidy in full.

There has to be ownership and accountability at the state government level to comply with these key requirements for insurers to process and release the claim amount. Hence, this framework needs to be put in place on priority.

xvii. Greater awareness: The scheme has three (3) key stakeholders at the state level - Department of Agriculture/Horticulture, Financial Institutions and the Insurers. These three must draw up a joint strategy and put in concerted efforts to generate greater awareness about PMFBY and its process among the farmers. Multi-media campaign and workshops/training programmes organised by SAUs/KVKs/Banks/Agriculture-Horticulture department will help in making progress.

xviii. **Change Agents:** The three (3) key stakeholders should appoint Change Agents in the field with a specific mandate to handhold the farmers to integrate them into PMFBY/RWBCIS process. At the first instance, these Change Agents will themselves need to be trained about the scheme details and sensitised about the process of interaction with farmers. Further, the insurance brokers may be given required freedom to cover non-loanee farmers.

The Change Agents can target input dealers, office bearers/representatives of Gram Panchayats, and field Revenue Officers in using their services for effective outreach programme.

xix. **Farmers' feedback:** An effective way of promoting coverage of both loanee and non-loanee farmers is to seek and respond to farmers' feedback. This will help in allaying all their doubts and fears and building their confidence in the scheme.

The Change Agents and Extension Service Providers should take up feedback mechanism as a serious intervention in promoting PMFBY.

xx. **Policy enrolment dates:** Presently, the cut-off dates for premium payments are uniform across India. This may not suit the diverse agro-climatic conditions of the country. It may be preferable that the states have the flexibility in determining cut-off dates for premium. Further, dates for release of claims may be placed in such a manner, that they are completed before the onset of the following sowing season. This will support the farmers in deploying their claim money to purchase inputs for the ensuing cropping season.

### **3.6. Data Integrity for Credibility**

There are three (3) principle stakeholders of the scheme. These are:

- Farmers
- Bankers
- Insurance companies

The governments (centre and state) constitute the fourth leg of this quarter, but can be treated as an outside party, with primary responsibility of facilitating the tripartite agreement among the three stakeholders and umpiring the operation of the 'Agreement' in a fair & objective manner. However, farmers will always remain the primary recipients of their (governments') favour in dispute resolution and they deserve that priority given their relative status of weakness and high degree of risk that agriculture is exposed to.

It is natural, that each of the three key stakeholders will be driven by their respective interests and will tend to work towards realisation of them. This attitude and approach is certainly not in the long term interest of optimising their respective benefits in a fair manner and thereby sustaining the crop insurance scheme.

Hence, the critical importance of an institutional mechanism, that promotes transparency and competition. This is best achieved by deployment of technology, that can remove human predilections and bias and generate accurate and real time data in an efficient manner. In this context, the importance and type of technology needed to be and already deployed are discussed. The stages at which this is required are:

- i. **Enrolment of loanee and non-loanee farmers** – Details of individual loanee farmers are uploaded by banks on National Crop Insurance Portal through offline utility, online or through CBS integration. Enrolment of non-loanee farmers is done, apart from by the banks, directly or through Common Service Centre (CSC) on the portal. The Aadhar Number along with land records / details are also captured for authenticity and to establish their insurable interest.
- ii. **Discovery of premium rates** – Remote sensing data including both satellite and drone, weather data alongwith other agro-climatic inputs and their derivatives such as NDVI, NWDI etc. are used for classification of risk for cluster formation to rationalise the premium rate being quoted by the empanelled insurance companies.
- iii. **Estimation of crop yields and crop loss, particularly on account of natural calamities etc.** – CCE Agri App / Smartphones are used to capture and transmit geo-coded, date and time stamped CCE report on real time basis to the portal to ensure accuracy and transparency and prompt calculation of final average yield on the portal itself. Parallely to supplement / substitute CCE yield data, Remote Sensing Technology (RST) data and other agro-climatic inputs are also used to estimate the sown area and crop losses. However, due to non-availability of high resolution RST data and over shorter durations, the RST technology is currently deployed for selected crops at sufficiently higher level of district and sub-district and not at village / village panchayat level, as will be more effective.
- iv. **Settlement and release of claims** – The National Crop Insurance Portal incorporates the claim calculation module for auto calculation of claims based on the threshold yield uploaded by the State and UT Governments and the real time actual yield data arrived from CCEs on the portal itself. The data of claims of individual farmers with claim id and lot number is further shared with the concerned insurance company, which makes payment to the concerned farmers electronically and uploads the details on the portal.

Over the last 2 years since the launch of PMFBY, the technology platform has got more robust, and with further improvements, the transparency and creditability of data generated will enhance. What is critical is the commitment of all the stakeholders to use the deployed technology.

### **3.7. Restructured Weather based Crop Insurance (RWBCIS)**

The scheme, PMFBY is an efficient mechanism for addressing the farm level vagaries and climatic risks and provide financial support to the farmers. However, there are crops for which historical yield data is not available or the yield estimation process does not exist, but are also exposed to climatic risks and production loss. Since the historical production data is not available to enable risk analysis and their coverage under PMFBY, Restructured Weather Based Crop Insurance Scheme (RWBCIS) has been designed.

The RWBCIS scheme uses weather parameters as “proxy” for crop yields in compensating the cultivators for deemed crop losses. Pay-out structures are developed to the extent of losses deemed to have been suffered using the weather triggers.

The advantages of RWBCIS are that, it is transparent, quick and automatic apropos the claim calculation and settlement, and it is suitable for areas where yield data is not available and can be used as an effective tool to address challenges with Crop Cutting Experiments, data discrepancy in yield estimation and possible errors committed in reporting the yield data.

However, there is lack of sufficient past weather data and government/private managed weather stations to appropriately represent all notified insurance units across the country. Developing term sheets is a specialised process and there is lack of expertise in this regard. It is needed to be developed by keeping in view the overall crop phenology, crop growth cycle, agro-climatic situations and weather requirements, such that they are neither too aggressive nor too lenient. When it is too aggressive, it leads to definite claim pay out and when lenient, pay-outs are avoided even in case of adverse weather conditions.

In 2016-17, an extent of 1.68 million hectares of cropped area for a sum insured amount of Rs. 103.19 billion was covered with premium volume of Rs. 16.53 billion under RWBCIS. It is clear that this scheme is yet to pick up for various reasons.

While both PMFBY and RWBCIS are being implemented on area approach basis, the latter has striking advantages over yield based PMFBY. The distinct advantage under RWBCIS comes from claim payments on the basis of variation in proxy weather data against the defined weather index / perils. This makes administration and payment of claims much simpler than the yield based PMFBY, where under payment of claims is dependent on CCEs generated data which is an extremely cumbersome process and requires huge resources including manpower.

Moreover, the scope for manual interference is relatively more in conduct of CCEs in comparison to electronically transferred weather data on real time basis. This becomes the source of ‘data doubt’ among different stakeholders, causing resultant delays and disputes around the claim settlement. On the other hand under RWBCIS, where the deviation in weather against the trigger weather index is immediately calculated, the claim calculation can be fast tracked at the end of the risk period.



Despite its obvious advantages, the RWBCIS has not been able to gain much traction in comparison to PMFBY. In fact, evidence shows a shrinking foot-print of the weather index based scheme from approximately 96.37 lakh ha. during Kharif 2014 to 62.95 lakh ha. in Kharif 2015 under erstwhile WBCIS to 12.75 lakh ha. in Kharif 2016 to 7.47 lakh ha. in Kharif 2017, the latter two seasons under RWBCIS. Similarly, in case of Rabi the coverage shrank from 31.40 lakh ha. in 2015-16 to just 4.09 lakh ha. in 2016-17. While the downward trend calls for introspection RWBCIS's loss is PMFBY's gain.

Payment of claims under PMFBY is provided on the basis of resultant yield losses irrespective of the nature of adverse climatic condition. However, claims in RWBCIS are triggered against each individual / combination of two weather perils within a defined risk period. Hence, designing of weather term sheet to correlate actual crop losses with defined weather perils is very complex which results in relatively high basis risk.

Therefore, there exists huge scope to arrive at a proper correlation between variation in weather and yield losses, on the basis of crops and regions. A comprehensive study can be undertaken to develop and establish such correlations.

Secondly, although the infrastructure of AWS (Automatic Weather Gauge Stations) has increased over time, due to multiple agencies in the segment, obtaining coordinated weather data on real time basis is still a challenge. Hence, there is a need for creation of National Weather Data Grid at the earliest.

It appears, therefore, that it will be quite some time before RWBCIS can become a popular insurance instrument for risk mitigation and will at best be used as an alternative, wherever availability of past yield data and estimation of current yield / crop loss for PMFBY is still a challenge as in the case of horticulture and commercial crop especially the perennial ones.

The scale up of RWBCIS is conditional upon building an expansive network of weather monitoring stations, namely, Telemetric Weather Stations. These should be able to generate auto-date at regular intervals encompassing temperature, relative humidity, wind speed, rainfall (both amount & intensity).

While establishing such centres may not be very difficult, their maintenance is a challenge. Hence active involvement of local self-governments like the Gram Panchayats is important. It may also work to rope in private sector to both establish & maintain. However, multiple uses of data and of different nature will have to be created, for different activities, so that it can be run on enterprise Model. This calls for developing a suitable policy in this regard.

### **3.8. Unified Package Insurance Scheme (UPIS)**

The UPI Scheme has been developed with the objective of providing various micro-insurance products to the farmers' under one umbrella and make it convenient for them to buy insurance variants (PMFBY, PMJJBY, House & Contents Insurance, Student Safety Insurance,

Agriculture Tractor Insurance, Agriculture Pump-set Insurance) as per the identified requirement at highly competitive premium rates. It has in total 7 sections, out of which PMFBY is mandatory and 2 other sections have to be opted for mandatorily. This scheme is currently being run as a pilot with various challenges in implementation.

Firstly, there is very little interface between farmer and banks for enrolment under crop insurance as farmers get covered automatically based on KCC (Kisan Credit Card) eligibility, whereas most of the other sections require farmer to enrol and provide relevant details and fill an application.

Different sections have different coverage periods, like, PMFBY is bi-annual while other sections are annual. However, with the efforts under Pradhan Mantri Jan Dhan Yojna, most of the farmers have option to get insured under PMSBY and PMJJBY and therefore, opting for other components is purely voluntary for the farmers and thus leads to low enrolment under the scheme.

Despite being a well-intentioned intervention, UPIS has had a limited uptake. It was intended to be launched in 45 districts. However, only 28 districts across 10 states agreed initially to come on board and finally only 6 implemented the pilot, where too the scheme petered off after the initial launch.

The main reason appears to be the mix of the seven products i.e. crop, life, assets etc. with diverse periodicity, which tend to deter the proper assuming of risks and accountability by the insurers. The demand from the stakeholders to make compulsory selection of two of the six other schemes optional has defeated the purpose of providing several insurance products under one umbrella scheme.

It is however to be appreciated, that UPIS (Unified Package Insurance Scheme) intends to provide multiple risk cover under a single root, and therefore efforts must be made to impart success by revisiting it.

### **3.9. Annotation**

Crop insurance has evolved slowly and steadily in India over the last about 50 years since 1972, as a risk mitigation tool. Based on decades of experience with different formats of crop insurance, the government has rolled out a highly comprehensive, farmer friendly and market led 'Pradhan Mantri Fasal Bima Yojana (PMFBY)' in 2016. Alongside this area and yield based insurance cover, the Restructured Weather Based Crop Insurance Scheme (RWBCIS) for horticultural & commercial crops (where yield & loss estimates are not feasible as yet) and the 'Unified Package Insurance Scheme (UPIS)' for a bouquet of insurance service under one umbrella, have also been rolled out. However, PMFBY alone can be said to be in robust operation, relative to the other two.

Over the last 2 years since its commissioning in 2016, PMFBY has done well in terms of

coverage of Gross Cropped Area (GCA) and settlement of claims. However, there is much that can be done to improve in respect of both. There have been complaints from the farmers about delay in and non-payment of claims, some of which are perceived and some real.

In order to sustain this market-led initiative, it is important to enhance the volume of operations by greater coverage of GCA, cafeteria of crops and farmers (both loanee and non-loanee categories). For this to happen, the three (3) main stakeholders, viz. the farmers, the bankers and the insurers must commit themselves to transparent and institutional system of enrolment, estimation of yields and losses, timely settlement of claims and release of claims due.

The scheme PMFBY bears immense potential to grow up as an effective crop risk mitigation tool. Parallely, efforts are needed to create a facilitative environment for robust operation of RWBCIS and UPIS. RWBCIS based on area-weather based index possesses growth potential in case of crops having no historical production data, only if a robust infrastructure to capture the relevant weather parameters is created.

### **Key Extracts**

- Agriculture being highly susceptible to risks, the Government of India over the last 50 years has tested several formats of crop insurance schemes so as to protect the farmers from natural calamities and ensure their credit eligibility for the next season.
- Based on performance and evaluation and learnings of the earlier schemes, Government has rolled out a more robust and farmer-friendly insurance cover called 'Pradhan Mantri Fasal Bima Yojana (PMFBY)', which is yield indexed.
- PMFBY provides comprehensive insurance cover and financial support to farmers in the event of failure of any of the notified crop as a result of natural calamities, pests & diseases. The scheme is open to all food & oilseed crops and annual commercial/horticultural crops for which past yield data is available and for which requisite number of Crop Cutting Experiments (CCEs) are conducted as part of the General Crop Estimation Survey (GCES). The unit of insurance is Village/Gram Panchayat for major crops; and for other crops the unit of size may be above this level.
- The Restructured Weather Based Crop Insurance Scheme (RWBCIS) for horticultural & commercial crops (where no yield & loss estimates are feasible as yet) and 'Unified Package Insurance Scheme (UPIS)' for a package of insurance service under one umbrella have also been rolled out. However, both these are as yet to get robust.
- Managing risk to crop helps to stabilise the income of the farmers and encourages the resilience and capacity to adopt innovative practices. Various refinements to the schemes are required and underway.
- Since the launch of PMFBY in 2016, it has done well as seen from the coverage of gross cropped area and settlement & release of claims.



## Chapter 4

### Risk Management in Livestock

*Livestock is integral to farming and its promotion is essential in developing a comprehensive farmers' income strategy. Though the livestock are not as weather-vulnerable as the crops are, they too are prone to various risks and need a risk management intervention. The existing livestock insurance scheme has lower penetration levels and efforts are recommended to make it more robust, on the lines of Pradhan Mantri Fasal Bima Yojana. Redesigning of the existing scheme to make it more farmer-friendly is the first effort needed.*

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#### 4.1. Background

The major risks in the agricultural crop sector, which include extreme weather events, as also pest incidents have normally found priority for developing comprehensive risk transfer solutions. Crop insurance emerged in India in 1972 and gradually evolved in different formats over the last about 50 years, as one of the critical risk mitigation tools. Having matured into a comprehensive scheme called 'Pradhan Mantri Fasal Bima Yojna' (PMFBY) it came to be launched in 2016 replacing its immediate predecessor schemes. PMFBY is area-yield index based; is farmer-friendly; and market led in discovery of premium rates. While the Implementing Agencies (IAs) charge the Actuarial Priced Premium Rate (APR), farmer has to pay just 2 per cent for kharif and 1.5 per cent for rabi crops and 5 per cent of the APR for commercial/horticultural crops. In parallel, weather-indexed 'Restructured Weather Based Crop Insurance Scheme (RWBCIS)' and 'Unified Package Insurance (UPI)' have also been rolled out, but are yet not robust like the area-yield indexed PMFBY.

The PMFBY mandates compulsory cover for all farmers who take crop loans; and simultaneously non-loanee farmers are encouraged as well. Since its launch in 2016, the performance has been satisfactory in general, considering the coverage of Gross Cropped Area (GCA), average sum insured and settlement and release of claims. This is not to say, that everything is optimal. There is lot more to be done in increasing the penetration, covering non-loanee farmers, deployment of technology for ushering in greater transparency in and accuracy of data generation, particularly in respect of yield and loss estimates etc., besides settlement and release of claims to the satisfaction of the farmers. The scheme provides comprehensive insurance to farmers to cover the yield losses of their crops due to Nat-Cat events, which are beyond human control. Ever since the launch of PMFBY scheme, there has been active participation of all the stakeholders in creating awareness among the farmers in enhancing the area penetration and broadening the scope for coverage of crops. Currently, 18 insurance companies (Implementing Agencies) are empanelled to implement the scheme. However, the situation is a little different when it comes to risks faced by livestock farmers.

##### 4.1.1. Risks in livestock farming

Farmers in India, more particularly the small and marginal, practise integrated farming comprising crop and livestock based systems. Livestock is also vulnerable to weather deviations and natural calamities, though to a comparatively lesser extent than the crop sector. As per NSSO, 2013 based on sample surveys, income of the farmers for the Agriculture Year,

July 2012 to June 2013, the farmer's average annual income is characterised by a ratio of 60:40 vis-à-vis farm: non-farm income. The farm income comprises income from agriculture and livestock, and the ratio of 60 breaks into 49 and 11 respectively. This implies, that the total farm income, which is already low as it is (Rs. 6,426 per month/agricultural household, NSSO 2013) can be secured, and supported to grow only if livestock sector also benefits from a comprehensive risk negotiation intervention. Risk management is required and not just as a part of the strategy to enhance the income of the farmers, but also to allow the small and marginal stakeholders greater safety to their income diversity. Hence, the necessity of a robust and farmer-friendly 'Livestock Insurance Scheme (LIS). It is, therefore, suggested that the existing scheme be upgraded with the following desired objectives:

- Supports the farmers to cope with economic losses due to death of livestock owing to diseases and other named perils.
- Supports farmers' income enhancement strategies.
- Promotes livestock rearing as an alternate source of income for the farming community.
- Encourages farmers to rear high yielding milch animals.
- Brings in more organised financial services to livestock sector.
- Provides resilient livestock rearing practices with use of technology and optimization of costs.

#### **4.2. Livestock in India and its Importance for Farming Sector**

Livestock is an integral part of livelihood of rural population contributing significantly to the economy of Indian agriculture. Indian agriculture which is vulnerable to vagaries of monsoon, benefits from livestock in mitigating associated risks, as it provides alternative employment and income opportunities. It is one of the critical examples of coping mechanism against crop failure, that has been conventionally adopted by the farmers. Livestock relative to crops is more resilient to situations of drought, its incomes are more perennial and aids in nutrition security of the country's population. More than 70 per cent of rural households practise livestock as an integral part of the farming system, and by gender women participation in this sector is high and they account for 69 per cent. Rural women are seen as a category whose lives have been closely linked to animal farming. Successful homemakers, are easily discerned as those who could leverage their animal stock to take care of the family and farm needs.

Livestock contributes about 25.6 per cent of the agricultural GDP and in turn about 4.11 per cent to the national GDP. In India, the growth of livestock sector is highly uneven. One can see clear difference in growth between leading states like Punjab, Haryana and Gujarat and other states like Odisha, where growth is yet to catch up.

Although the share of agriculture in total GDP of the nation's economy has decreased gradually over the year, the share of the livestock sector in total GDP has remained close to 5 per cent

over the same period, underlining the growing relative importance of the sector in generating economic growth from agriculture. The livestock industry faces various risks, which can be placed in two broad categories:

- Livestock Farming/Productivity risks
- Market risks.

#### **4.2.1. Livestock farming risks**

These are the risks associated with the production/farming of livestock as explained below-

- i) **Need for breed improvement:** The productivity of livestock in India is quite low compared to some advanced countries and hence the need to focus on improving the breeds.
- ii) **Adequacy of feed and fodder unavailability:** Since animal husbandry is mostly practised by small and marginal farmers, there is always a trade-off dilemma for the farmers to decide on growing fodder or foodgrain crops. As a consequence, the availability of fodder and feed in adequate quantity and desired quality is always a challenge.
- iii) **Diseases:** Cattle diseases cause enormous losses by way of cattle deaths, treatment costs, production and productivity losses, etc.

#### **4.2.2. Market risks**

These majorly include price volatility, poor accessibility to markets and related infrastructure as outlined below:

- i) **Market infrastructure:** It is still a big challenge for small farmers. The livestock sector is handicapped due to inadequate marketing and processing infrastructure and also institutional framework. Rather, they are dependent on the non-formal unorganised market facilities, as a result of which, primary producers do not get remunerative prices or a fair share in the consumer's rupee. The dairy cooperatives handle only about 8 per cent of milk production. Even today major share of marketable surplus of milk and other livestock products is transacted outside the organised sector, resulting in reduced price realization by farmers, besides incurring post-production losses and wastages.
- ii) **Price volatility:** Definitely, price is factor of demand supply equations. However, in the case of milk and meat, these equations keep changing at rapid pace imparting high risk on account of the highly perishable nature of milk.

#### **4.2.3. Risk management measures**

Farmers acquire knowledge of their own context; risk identification; risk analysis, risk assessment; and selection of the most suitable option for avoiding, preventing or managing the risks (Hardakar et al 1992). There are two ways to mitigate risks:



(i) **Risk reduction:** There are various measures adopted to reduce the risk and these include promotion of artificial insemination (AI) for breed improvement; cattle health and nutrition support programme by government agencies etc. However, the outreach of such benefit is confined to very limited population.

(ii) **Risk sharing/transfer:** Forward contracts, future and options contracts are some ways of sharing the market risks, but are not as yet popular in practice. As regards risk cover through insurance, the market in animal husbandry is predominantly monopolised by public companies. The private sector has started venturing into insurance market only after 2001.

However, the insurance market in animal husbandry has not matured as yet, unlike in the case of crop insurance.

### **4.3. Livestock Insurance Schemes in Operation and their Penetration**

Over the last more than 40 years, central and state governments have been deeply involved with livestock insurance. Deregulation of the private cattle insurance market in 2003, has spurred further growth in India. Presently, four public insurers and more than eight private players are active in livestock insurance. Government of India launched the first livestock insurance in 1970s for asset building purpose among poorer segments of the farmers. Between 1972 and 2000, the state-owned General Insurance Corporation (GIC) was the only body permitted to transact insurance business, and it did so through its then subsidiary companies listed below:

- National Insurance Company Ltd,
- New India Assurance Company Ltd,
- Oriental Insurance Company Ltd and
- United India Insurance Company Ltd.

In the year 2000, the insurance market was liberalised permitting the private sector to develop and sell insurance products. Nevertheless, the four (4) aforementioned state-owned companies still continue to transact a significant share of all insurance business, and dominate the livestock insurance market. Further, livestock insurance is still mostly limited to cattle, though the existing scheme envisages to cover various animals. The insurance penetration is still low and stands at about 7 per cent of the cattle population, despite the scheme being as old as 14 years. The uptake in case of other species including sheep, goat, camel, pig, buffalo, bullock, camel etc., as of date is very low. The details of the traditional insurance products covered under the existing scheme are presented in Annexure I, as also in the following section.

### **4.4. Livestock Insurance Scheme**

The Livestock Insurance Scheme (LIS) is now in operation across the country as a 'Risk Management' component of National Livestock Mission (NLM). It came to be initiated as a centrally sponsored scheme (CSC) during the X Five Year Plan on a pilot scale. Thereafter it

was scaled up and is now available for implementation in all the districts of the country. Further, it can be extended to any newly created district too.

#### 4.4.1. Animals covered and subsidy criterion

- The indigenous/cross-bred milch animals, pack animals (horse, donkey, mule, camel, pony, cattle/buff male) and small ruminants (goat, sheep, pig, rabbit, yak and mithun) are covered.
- The subsidy benefit is however restricted to 5 (five) animals per beneficiary per household for all animals, with the exception of sheep, goat, pig and rabbit.
- In case of sheep, goat, pig and rabbit the subsidy is restricted to five (5) numbers of 'cattle unit' (CU) per beneficiary per household.
- However, the beneficiary is free to insure more than 5 animal including sheep, goat, pig and rabbit by paying the full premium.
- A household for the purpose of LIS is defined on the same lines as in case of MGNREGA.

#### 4.4.2. Pattern of financial assistance

**Table 4.1 Normal areas**

Category	Central Share	State Share	Beneficiary Share
BPL / SC / ST	40%	30%	30%
APL	25%	25%	50%

**Table 4.2 North East region, hill areas, LWE districts**

Category	Central Share	State Share	Beneficiary Share
BPL / SC / ST	50%	30%	20%
APL	35%	25%	40%

**Table 4.3 Difficult areas**

Category	Central Share	State Share	Beneficiary Share
BPL / SC / ST	60%	30%	10%
APL	45%	25%	30%

*Source: Department of Animal Husbandry, Dairy and Fisheries Development (DAHDF)*

Note: BPL: Below Poverty Line; APL: Above Poverty Line; SC / ST: Schedule Caste / Schedule Tribe

Normal Areas: All areas which do not fall under the subsequent categories

North East Region: Seven NE States and Sikkim

Hill Areas: Designated Hill Areas

LWE districts: Districts notified as Left Wing Extremist (LWE) affected

Difficult Areas: Notified Difficult Areas like: Leh, Ladakh, Kargil areas or above 11,000 ft. height from sea level.

#### 4.4.3. Implementing agency

The scheme is implemented through the State Implementation Agency (SIA) such as State

Livestock Development Board / Agency. In states where no such Board / Agency exists, the Director of the State Department of Animal Husbandry serves as the CEO.

#### **4.4.4. Selection of Insurance Company(ies) and premium rate**

The CEO is empowered to lay down the terms and conditions and select the Insurance Company(ies) based on a transparent and competitive bid process. Some of the features include:

- The whole state is considered as a single unit.
- The selection criterion for an insurance company encompass premium rate offered, capacity to provide services, service efficiency and fulfilment of the terms and conditions.
- Both public and private sector companies can participate in the bid.
- The insurance cover is primarily offered for the death of the animal.
- On an insurance cover, if any, offered by a company for any type of disability in addition to death of the animal, the same may be considered but no subsidy shall be available to the beneficiary.
- However, in case the additional cover is offered as a package along with the animal death cover, and the premium eligible limit, the same can be accepted.

The eligible limit of premium is as presented in Table 4.4.

**Table 4.4 Limits of premium rates**

SN	Types of Areas	Premium Rate (Percentage)	
		One Year Policy	Three Year Policy
1.	Normal Areas	3.0	7.5
2.	North East Region Hill Areas LWE Affected Districts	3.5	9.0
3.	Difficult Areas	4.0	10.5

Note: under no circumstances, the rate of premium should exceed 3%, 3.5% and 4.0% for annual policies and 7.5%, 9.0% and 10.5% for three-year policies.

#### **4.4.5. Commencement of policy and claim settlement**

- i) The policy cover comes into effect as soon as the basic formalities comprising identification of animal, its examination by the Veterinary Practitioner, assessment of its value, tagging and payment of premium by the livestock owner, are fulfilled.

- ii) The examination of the animal at the stage of issuing the policy and conduct of post mortem and issuance of Report are to be carried out by a Veterinary Practitioner registered with the Veterinary Council of India.
- iii) The animal is insured for its current market price, which is assessed jointly by the livestock owner and the Insurance Company, preferably in the presence of the Veterinary Officer or the Block Development Officer (BDO).
- iv) The insured animal is to be uniquely identified and ear tagged. The cost of fixing the identification mark is to be borne by the Insurance Company.
- v) If the claim becomes due, the payment of insured amount has to be paid within 15 days after submission of the prescribed documents, and failure to do so will invite a penalty @ 12 per cent of compound interest per annum to be paid to the beneficiary. If the claim is rejected by the Insurance Company, the beneficiary is to be given the reasons under intimation and the State Implementation Agency (SIA).

#### **4.5. Challenges of Livestock Insurance Scheme**

The following challenges are observed in livestock insurance market for various stakeholders including the insurer and reinsurers:

##### **i) Identification problem**

Most of the companies are still using traditional ear tag as an identification mark for the animal. Farmers are dissatisfied with this as it is hard to ensure, that the animal retains the tag intact over long period of time. It could drop off while roaming or when engaged in routine tussle of animals. Further, the tag is also painful to the animals and farmers are not happy about it.

Lack of standardised identification system, makes it difficult for the insurers to detect fraudulent claims. This affects the sustainability of the insurance portfolio and may also result into the downsizing of the insurance business or increase in the premium rates, making the insurance proposition unviable for the farmers as well as the lending organization. Ultimately, it causes delay in claim settlement process, besides building up additional cost of identification/dispute handling to the company. Hence, there is need for alternate and technology based identification systems like microchips etc.

##### **ii) Moral hazards and adverse selection**

Moral hazard issues can arise in livestock insurance, when an indemnity affects a farm's bio-security investment. While the insurance agency would prefer that farmers take every available precaution to prevent occurrence of disease, inadequacies relating to budget, animal health services and time constraints limit the quality of services available on the farms. In such an environment, with problems of high moral hazard, the indemnity turns out to be higher than expected by the insurers, who in subsequent year(s), may react by raising the premium. The downside of such a cycle is reduced uptake.

Adverse selection might arise when farmers are assigned the task of reporting disease. If the farmer reports disease, he or she will incur costs related to that reporting and if the disease is not declared, another set of expected costs will have to be incurred. If the farmer perceives that expected costs are smaller when disease is not reported, he is most likely to choose this option. It is important to note, of course, that not everyone would act this way. However, in the case of highly contagious diseases, only a few bad outcomes, perhaps even a single instance, can cause significant economic damage. The probability of these two behaviours is a key challenge before the insurer in case of livestock.

**iii) Underwriting and actuarial pricing**

By and large, proper documentation is not practised in the agriculture sector including animal husbandry, making it difficult for an underwriter to get data on the risk characteristics of animals and their health status. Similarly, without proper history of frequency and severity of loss data, it is tough to come up with pricing model and deciding on premium of livestock insurance products. In such situations, there is high probability of missing out on some of the systemic risks which were hitherto covered in premium of clients. Therefore, the basis of fixing the premium gets obscure.

**iv) Difficulty in valuation**

The value of cattle is a factor of its age and production capacity. This again varies with the geography. The information regarding the value of cattle is not available generally, and due to lack of strong and authentic productivity database, such valuation exercise is often done based on visual estimation. In a particular geography too, there are number of breeds for cattle, with differing values making the valuation more difficult. It is therefore, important to carry out valuation by using the services of a recognised Veterinary Practitioner / Veterinary Officer of the Department and the like.

**v) Outreach of delivery channels and high costs of penetration**

The coverage of current insurance scheme being low, the beneficiaries are very thinly & sporadically scattered. Animal husbandry support system, which is normally provided by government departments, is also not adequate in most places and where available, the response is not always responsive. The situation of poor animal health services and low penetration as on date is a vicious cycle, that has to be broken by aggressive expansion of the scheme including undertaking awareness generation. However, the critical factor in increased acceptance of the scheme will depend upon its ease and perceived benefits. The volume of business has to increase substantively for rationalization of premium rates.

**vi) Poor awareness about livestock insurance**

Most of the livestock rearers are small and marginal farmers and landless agricultural labour, whose awareness about insurance products is very low. This calls for the functionaries of the State Department of Animal Husbandry, Livestock Board, Milk Cooperatives and Federation etc., to own up the responsibility of popularizing the scheme among the livestock farmers. It would also help to utilise the services of women SHGs to increase penetration of the scheme.

**vii) Poor documentation and record keeping**

In general, farmers don't focus on proper record keeping. This can, however, improve, if schemes like livestock insurance become popular and penetration increases.

viii) In discovery of premium rates, the whole state is considered as a single unit. This may keep out smaller players, who may not be capable enough to cover the entire state. Restriction of entry on account of such a policy may restrain fair play and discovery of competitive rates of premium.

ix) The pattern of financial assistance under the existing scheme expects the farmers (both below and above BPL norms) to bear a substantive part of the premium. This naturally causes exclusion of a large number of small & marginal rearers with no or very small parcels of land.

x) The process of claim settlement and adherence to release are not monitored adequately and to the satisfaction of the insured farmer.

#### **4.6. Ideal Regulatory Environment for Livestock Insurance**

**i) Distribution channel**

It would be useful to legally recognise NGOs, Micro-Finance Institutions (MFIs) and SHGs (particularly women SHGs) as “micro insurance agents”. This will add to the existing banking infrastructure and strengthen the capacity to enhance livestock penetration.

**ii) Rural and social obligations**

The insurers go rural mainly because of social and rural obligations stipulated by regulation under the micro-insurance quota system. At the same time, this was encouraged by the financing institutions to hedge their own risk while lending to the poor. This mindset and approach tends to primarily take care of the needs of the rural lending banks rather than the needs of the customers-the livestock farmers. An ideal regulatory reform should address this while keeping a close watch on quality of insurance sold and servicing of the customers, and not merely fulfilling the obligations of catering to the rural poor.

Government should overhaul the Livestock Insurance Scheme and approach it the way crop insurance schemes (PMFBY and RWBCIS) have been designed. In these Insurance Companies see an opportunity for business and therefore become active stakeholders. Simultaneously, the scheme design keeps the farmers' interests as the primary concern by keeping their share of premium low and uniform.

**i) Investment in livestock management system**

Constant government support for prevention, control and regulation of various risk management practices is necessary. Adequate infrastructure is required for ensuring bio-security, proper quarantine services and system to prevent the spread of diseases across the

state and national borders. This will minimise the risk environment and support cost-effective livestock insurance policy.

**ii) Use of technology**

The technology platforms being envisioned to facilitate financial inclusion should enable livestock insurance transaction too.

Mobile transactions linked to a registered bank account are becoming popular. The regulations are in place to protect the client interests. In order to develop this platform as a lucrative revenue model and popularise the same among low income section of the society including in rural area, large number of services need to be linked to mobile platform. This will trigger entry of large number of service providers and support scheme penetration. Incentivizing the insurance sales agent to sell livestock insurance product to low income client would increase the product uptake through mobile banking channel. The para-vets, veterinary doctors, stockman, in the field can serve as micro-insurance agents with right incentive structure.

Better cash management system, improved rural infrastructure along with positive incentives to private partners/agents will aid in promoting the use of mobile banking/biometrics card and ultimately help in livestock insurance uptake as an alternate mechanism for animal identification.

Application of technology in insurance enrolment and improved claim service management should be given due weightage. It is also important that animal identification and health check-up are done by empanelled veterinary doctors; and information relating to tagging of animal and other relevant details are shared with the insurance companies. Digitally captured health certificates and post-tagged animal pictures could be uploaded via mobile application. Thereafter, processing of final claims may be done basis carcass inspection and verification of animal identification marks and this compared with the digital images taken and stored at the time of enrolment and tagging.

These ICT and smart phone based applications will help improve the efficacy of extension provision, marketing, and information dissemination. This will also improve creditability of data among the concerned stakeholders including the insurance agencies.

**iii) Identification of animals**

On the lines of 12 digit Aadhar number (bio-metric based unique identification number) for human population, technologies like RFID (Radio Frequency Identification) and micro-chips may be deployed for animal identification. Identification of the right animal is the major challenge in livestock insurance.

It is a welcome move of the Government, that it targets to tag 88 million cattle (cows and buffaloes) with a 12 digit UID (unique identification) number. This is being done to reach out vaccination and other animal management programmes. However, this tagging would also be

useful in insurance enrolment by enabling accurate animal identification and better claim service management (steps from premium payment to claim settlement). This will ultimately help in livestock insurance uptake. Such universal tagging combined with Apps that cater to digital capture of animal pictures post- tagging and upload, hold lot of potential as additional support system for animal identification.

What is required is to build and operate a robust Livestock Insurance Portal (LIP) on the lines of PMFBY Portal, with open access to all concerned stakeholders to upload insurance data relating to enrolment, reports of disease & death, post-mortem certification and claim verification & settlement.

**iv) Premium subsidy**

Similar to PMBFY scheme, there is need for the government to support Livestock Insurance Scheme with subsidies on premium to farmers to increase the insurance penetration and bridge the protection gap. The premium rates to be paid by the farmers should be uniform and low. For this purpose, the animals may be categorised as large and small ruminants, irrespective of the primary purpose for which they are reared (milch, meat, paca purpose etc).

**v) Building database**

With a view to bringing down the product costs, database of claim histories, risk profiles, etc need to be built. This will help in adopting actuarial premium pricing. Regulatory measures adopted for diligent upkeep of data will definitely help in a more efficient pricing and innovative way of product development. Hence, adequate investments in research and actuarial services are required to improve pricing of the product.

Government of India through the National Livestock Mission (NLM) has been provisioning for annual budgets to support the state governments in implementation of Livestock Insurance Scheme. The states have the freedom to opt for the scheme. Only a few states like Tamil Nadu, Odisha, Maharashtra, Karnataka, Gujarat, Telangana and Andhra Pradesh are seen to be active and efforts are needed to encourage other states to adopt. Increased participation will drive increased volume across the country, and thereby larger number of public & private sector Insurance Companies can be expected to bid for the states.

#### **4.7. Indicative Product Structure for Livestock Insurance**

The existing Livestock Insurance Scheme certainly needs to be restructured and redesigned to make it more relevant and acceptable among the livestock farmers. Some suggestions are made for offering the livestock rearers a more robust insurance scheme.

**i) Risks to be covered**

Livestock insurance primarily covers death of the cattle due to diseases and accidents (including fire, lightning, flood, cyclone, strike, riot and civil commotion), contracted or occurring during the period of insurance.



Add-on Cover: Permanent Total Disability (PTD) cover is an add-on optional cover, which can be offered with additional premium payment.

Challenges with PTD cover: PTD benefits are normally excluded as it is not easy to identify the actual cause of claim and is a tedious process to settle the claim. This issue needs to be addressed. While, the 'death only' cover makes the product simple and hassle-free in implementation, inclusion of PTD as an add-on will make the scheme more attractive. Today, the add-on is available to the farmer at his own cost. An element of subsidy on add-on cover is essential. An appropriate protocol to identify 'PTD'.

**ii) Premium rate**

This is a function of multiple factors including type of cattle, breed, geography, age of animal etc. Different breeds have different mortality rate depending on the geography, age and type of cattle. Buffalos have a lower mortality rate as compared to cows. In totality, the premium rate will differ from state to state depending on the past claim experience. Actuarial Priced Premium Rates (APR) for different coverage periods can be arrived at on the basis of historical data and breed category. Ideally, the premium rates should be determined via a closed bidding system as followed in case of crop insurance programme and the respective state governments should be able to share the relevant data for pricing as well.

**iii) Deductibles**

Deductible options to be provided basis the risky profile of the breed covered.

**iv) Coverage**

Generally, the insurance is offered for one year coverage; however, in case of loan-linked cattle the coverage term may be upto 3 years on the basis of the loan tenure.

**v) Sum insured**

Market value varies from breed to breed, area to area and from time to time. The Veterinarian's recommendation based on his examination should be considered for acceptance of insurance/settlement of claims.

Sum Insured should not exceed 100 per cent of the market value of the animal.

For loan-linked cattle, the Sum Insured may be the same as the loan amount.

Add on covers e.g. geographical extension for transit of animals beyond 80 km can be provided basis additional premium payment. This will be beneficial if the animal is being sold to places in nearby districts/states and the policy could continue to exit even if there is a shift in location.

**vi) Age group**

The suggestions in this regard presented in Table 4.5

**Table 4.5 Animal category-wise suggestion of age for coverage**

Animal Category	Suggested Age
Milch cows	2 years (or age at 1 <sup>st</sup> calving) to 10 years
Milch Buffaloes	3 years (or age at 1 <sup>st</sup> calving) to 12 years
Stud Bulls	2 years (or earlier i.e, age at sexual maturity) to 8 years
Bullocks(castrated bulls/male buffaloes)	2 years to 12 years

**vii) Suggestions for cattle enrolment and processing**

Enrolment:

- Insurance company appointed Veterinarian to visit the identified cattle.
- Complete the enrolment procedure using mobile app, by capturing the details of insured animal, owner of the animal, along with photographs.
- Ear tagging of the animal is done, which will be a unique identity used for further processes.
- Once the policy is issued, the animal owner receives notification on his mobile about the policy details along with helpline numbers.

Claim settlement process:

- Farmer to inform the insurance company about the death of the animal within the stipulated time.
- Insurance company to initiate the verification process through appointed Veterinarian and insurance company's representative.
- Veterinarian to examine the carcass and submit the report along with photographs and death examination certificate.
- Insurance company to verify the documents vis-à-vis the data collected at the time of enrolment of the animal.
- Insurance company to pay the claim amount to farmers online and within the prescribed timeline.
- A decentralised dispute resolution mechanism would need to be in place.

**4.8. Annotation**

The animal husbandry sector comprising large and small ruminants with a range of species holds a key position in the livelihood of rural population. This includes both the landholding and the landless classes. The livestock may not be as weather-vulnerable as the crop sector is, making it therefore a climate-resilient activity and an instrument of de-risking agriculture. However, livestock sector too is prone to risks including death, permanent damage, disease etc arising from different types of natural calamities.

The currently operational 'Livestock Insurance Scheme' though open to various species of animals is mostly limited to cattle & buffalo in coverage. Here too, the penetration is as low as 7 per cent, notwithstanding the launch of the scheme in 2004. The scheme suffers from several inadequacies, and the insurance cover is limited to death of the animal alone.

Given the new farm-income oriented agricultural strategy in which livestock sector is recognised as an engine of growth, risk management assumes importance. It is, therefore, necessary to revisit the existing scheme and design it to make it more comprehensive covering the risks and farmer-friendly in terms of premium obligation, besides supporting it the way PMFBY is being promoted.

#### **Key Extracts**

- For the farmers, animal farming integrates well with the family's economic crusade against uncertain income flows from other agricultural activities.
- Breed improvement, adequacy of feed and fodder unavailability, diseases are the major risks associated with livestock farming.
- Marketing risks relate to the possibility of lower sales and prices, loss of market access due to a wholesale buyer or processor relocating or closing, or if a product fails to meet market standards or packaging requirements.
- Artificial insemination (AI) for breed improvement; cattle health and nutrition support programme by government agencies etc., risk sharing /transfer, and use of technology are important measures for reducing risk in livestock.
- Since 2004, a risk cover called 'Livestock Insurance Scheme' has been in operation and is open to a range of animals.
- However, the scheme has been limited in its success, when seen from the coverage of only cattle & buffalo to the exclusion of others, besides the penetration being as low as 7 per cent of the population of species eligible.
- In order to promote livestock sector, a comprehensive risk cover is critical, and hence the existing scheme needs to be redesigned on the lines of Pradhan Mantri Fasal Bima Yojana (PMFBY) available for crops, which is farmer-friendly and market driven.

## Annexure to Chapter 4

### Annexure 1: Livestock insurance in India – Overview of traditional products overview

Insurance scheme	Sum insured	Risks covered	Insured	Coverage	Premium	Comment
<b>Scheme related Policies of the Govt</b>	Marked value (fixed by purchase committee) or sum insured, whichever is less  Sum Insured will not exceed 100% of the market value	Death  Permanent Total Disability	Only high yielding cattles/cross-breds are considered  <i>Milch Cows</i> -2 years(or age at first calving ) -10 years  <i>Milch Buffaloes</i> -3 years(or age at first calving ) -12 years  <i>Indigenous/ 1<sup>st</sup> exotic cross bred female calves</i> -4 months to 32 months or calving whichever is earlier	<b>Death</b> Coverage: on pre-agreed value basis  <b>Permanent Total Disablement:</b> 75% of Sum Insured	2.25% of market value(with premium subsidy of 50% upto 2 animals)+ additional premium of 0.85% of market value for Permanent Total Disablement (PTD) + additional premium of 1% for Transit beyond 80 km	95% of policies are credit linked which runs for one year only.  Average term of policy is 1-3 years.  Premium subsidies of 50% only for high yielding cattle upto a maximum of 2 animals per beneficiary  The rate of premium should not exceed 4.5% for annual policies and 12% for three-year policies.
<b>Non-scheme policies</b>	Marked value (fixed by Veterinarian) or sum insured, whichever is less  Sum Insured will Not exceed 100% of the market value	Death  Permanent Total Disability	Includes all cattle, however due to owners commercial motives typically priority is high yielding cattle's  <i>Milch Cows</i> -2 years(or age at first calving ) -10	<b>Death:</b> Sum Insured or market value before illness. <i>Pregnant Cattle:</i> Indemnity restricted to 50% if the animal died, when it was pregnant for less than 4 months  <i>Milch Cattle:</i> Indemnity of	4% - 6% of Market value + Additional premium of 1% for PTD+ Additional premium of 1% for transit beyond 80 km	80% of policies are credit linked Average term of policy is 1-3 years. This often includes retagging in their premium price, which is not the feature of scheme policies

Insurance scheme	Sum insured	Risks covered	Insured	Coverage	Premium	Comment
			<p>years</p> <p><b>Milch Buffaloes</b>-3 years(or age at first calving ) -12 years</p> <p><b>Indigenous/</b> 1<sup>st</sup> exotic cross bred female calves-4 months upto the date of 1<sup>st</sup> calving or minimum age limit for adult females</p>	<p>50% if death occurred during dry period</p> <p><b>Permanent Total Disablement:</b> Limited to 70% (for Draught Animals)</p>		

**Annexure 2: Indicative livestock insurance penetration plan and budget outlay**

<b>Estimation of Premium Outlay for Livestock Insurance</b>					
Assumptions:					
Total Livestock Population estimates is as of 2012 census					
Assumption that Total Rural Households is taken as per 2012 census and other reports published					
Assumption that 75% of rural households own Livestock and average of 3 insurable animals					
Livestock population consists of Cattle, Buffalo, Sheep and Goat only					
Average increase of 5% in value of livestock every year					
Number of Insurable animals to increase by 4% every year					
Current insurance penetration is estimated at 7% and the plan is to reach a penetration level of 50% over 5 year period					
Total Livestock Population as per 2012 Census	512,050,000				
No. of Rural Households as per 2011 Census	154,285,700				
No. of Households Owning Cattle	115,714,275				
Average Insurable Cattle per household	3				
No. of Insurable Animal	347,142,825.00				
Average Price of a Livestock	14,842.82				
Average Premium Rate	4%				
Category of Animal	No. of Animals	Average Price / Animal (INR)			
Total Exotic / Crossbred cattle	39,732,000	30,000			
Total Indigenous Cattle	151,172,000	12,000			
Total Buffalo	108,702,000	35,000			
Total Sheep	61,288,000	3,500			
Total Goat	135,173,000	2,500			
Total number of Animals (including Cattle, Buffalo, Sheep and Goat)	496,067,000				
Possible Insurance Coverage of Rural Households: 15-50% over 5 year period					
Projection of Coverage	Year 1	Year 2	Year 3	Year 4	Year 5
Expected Penetration %	15	25	35	45	50
Premium Outlay for Cattle Insurance (in INR Billion)	33.76	56.27	78.77	101.28	112.53



## **Chapter 5**

### **Technology Based Risk Management**

*Of the multiple risks associated with agriculture, weather deviations stand out visibly. If accurate weather forecasts are shared with the farmers in real time, it will help them to take timely and appropriate decision relating to their production plan. Both speed and accuracy of data collection, analysis, interpretation and dissemination to the clients is critical, for the Advisory to become relevant. The modern suit of technology comprising remote sensing, drones, sensors, telemetric stations, smart phones, data computation and ICT makes it possible to negotiate risks in agriculture.*

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#### **5.1. Introduction**

The First order economic activities in India provide livelihood to majority of its population and these activities, are to a large extent, dependent on climatic conditions. Any deviation(s) from normal condition(s) is/are bound to affect these activities negatively and in turn the socio-economic life of the dependent population and also the national economy at macro level. In view of its importance, India has had a tradition of undertaking monitoring and forecasting of the weather situations and advising the concerned stakeholders through meteorological forecasts, alerts, early warnings and advisory communication. However, weather condition being local or area specific, higher the resolution of data, better would be the benefits from such weather related communication services.

Agriculture and allied sectors, on which majority of India's population depends for income and employment will stand to benefit immensely from these services. Further, the weather information and forecast services are of great importance in planning and managing the activities of various other sectors including Industries, Urban Development, Disaster Management, etc.

India Meteorological Department (IMD), Government of India has been on this task of providing meteorological services in India. The IMD began regular weather services for the farmers in 1945 in the form of "**Farmers' Weather Bulletin**" and broadcasts through All India Radio (AIR) in regional languages. In 1971, on the recommendation of the National Commission on Agriculture (NCA), it launched **Agro-Meteorological Advisory Services (AAS)**, a comprehensive tool tailored to meet farmers' need and the quality of services has been improved steadily since then.

At the district level, such advisories are prepared containing past weather, forecast for next 5 days and a weather-based agro-meteorological inputs that include pest and disease information. The phenological stages of plant development are included in crop specific advisories to offer farmers needed guidance on cultural practices. The information is intended to help farmers maximise output and avert crop damage or loss. Agro-Met Advisory Services use three dissemination channels – mass media, group awareness campaigns and individual contacts – in order to reach larger number of farmers.

However, it is evident that the present infrastructure of IMD needs to be further strengthened



to cater to the needs of the community across various sectors.

### **5.1.1. Technology and risk management**

Deployment of technology will help in capture of real time data on various parameters on a larger/universal scale, its transmission and computation with accuracy, interpretation and dissemination as an Advisory in quick speed. This can, therefore, become a powerful tool in the hands of the farmers to take rational decisions relating to production based on Forecast-stimulus, precautions in response to 'Alerts and Early warning' etc.

The new generation technologies encompassing Automatic Weather Stations (AWSs), Space technology, Geo-Positioning Systems, Information Technology, Drones, Smart Phones and the like provide the contemporary society with a powerful set of tools to mobilise data, analyse, interpret and transfer over space and time at speed and power, hitherto unknown. It is almost like playing God, that enhances the human power to know the likely future, and therefore, be in a state of greater readiness to face and overcome both endogenous and exogenous adversities. This possibility can help in minimising losses and securing incomes.

Such a technology based feasibility can best be explained on the already tested Model of Karnataka, a state that is one of the most drought prone regions of the country. An ICT enabled Model has been built for effective meteorological services for sectoral decision support system. In the following sections, the structure and operation of this Model as also its effectiveness in managing extreme events are described.

## **5.2. A Unique Model of Meteorological Services**

Karnataka, eighth largest state in the country in terms of geographical area (19.1M. sq.km) is home to 6.11 crore people (2011 Census) accounting for 5.05 per cent of India's population. Karnataka is one of the states having largest rainfed agriculture area in the country (about 7.01M Ha out of the net cultivated area of 10.5 M Ha). The rainfed agriculture in the state is highly dependent on seasonal monsoon rainfall. Of the total normal annual rainfall of about 1150 mm, more than 70 per cent is received during the southwest monsoon season alone. Further, the spatial and temporal distribution of rainfall is highly erratic and thus it has a huge impact on the agriculture activities in the state.

In order to capture the variation in the weather condition and in turn to cater to the needs of weather information to different sectors, including the farming sector, a unique model of Meteorological Advisory Services has been designed, developed and operationalised in the state through Karnataka State Natural Disaster Monitoring Centre (KSNDMC), Bengaluru. This model is unique in many ways and addresses all the aspects of **lab to land concept** and caters to the real needs of the different communities across the state. This system comprises:

- Installation of field sensors – for monitoring of various weather and hydrological parameters on the ground at very high spatial and temporal resolution.

- Transmission of the data to a central computational facility.
- Data processing & analysis, alert recognition mechanism.
- Forecasting through appropriate mathematical simulation models.
- Customized information & advisory generation.
- Dissemination of the information and advisories directly to the users.

Since it has been ICT enabled at all levels, the entire system functions efficiently with minimal manual intervention.

### **5.2.1. Weather monitoring at high spatial and temporal resolution**

The KSNDMC has established a network of GPRS enabled and solar powered Telemetric Rain Gauges at all the 6,000 Gram Panchayats (25 sq. km each) and 923 Telemetric Weather Stations at all the 747 Hoblis (sub-Tehsil : 200 sq. km each) and 176 Micro-Watersheds in the state. The weather data comprising temperature ( $T^{\circ}\text{C}$ ), relative humidity (RH %), Wind Speed (m/s), wind direction (degrees), rainfall amount (mm) and intensity (mm/hr) data is collected at an interval of every 15 minutes through these weather monitoring stations.

The network density of weather monitoring stations is the highest and first of its kind in the country. Also, the temporal resolution of the data collected (96 data points a day / station) through this network of stations is useful for the researchers to develop simulations and related advisories.

The monitoring network is able to capture the highly erratic distribution of rainfall and weather parameters both in terms of space and time. The observed data is utilised for developing advisories to the farming community.

**Figure 5.1 Installation of TRG and TWS**



**Telemetric Rain Gauge (TRG)**



**Telemetric Weather Station (TWS)**

The Centre (KSNDMC) has established a state-of-the-art facility to collect data at very high

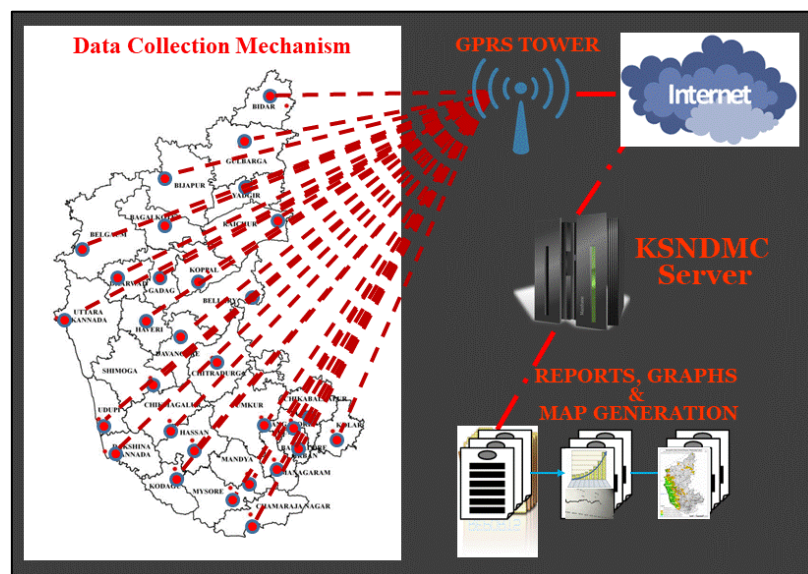
spatial and temporal resolution and to undertake data analysis, information and advisory generation, and dissemination to the stakeholders at near-real time through auto-mode. The necessary computer/web applications have been developed indigenously. There is very little manual intervention in generation of reliable, accurate and seamless data. As a result, the time interval between data collection and decision making is almost at near-real time.

The seamless rainfall data obtained from the network of TRGs is used to calculate the rainfall deficiency at Hobli / Taluk level on daily / weekly / monthly basis and the data is also computed against the 'Normal' rainfall to determine the extent of 'Dry Spell' at Hobli level on weekly basis. It is also used to determine the break-monsoon condition and temporal and spatial distribution of rainfall in the state. Both rainfall deficiency and extent of dry spell parameters are used to assess the occurrence, intensity and spread of 'drought' condition at Hobli / Taluk level in the state.

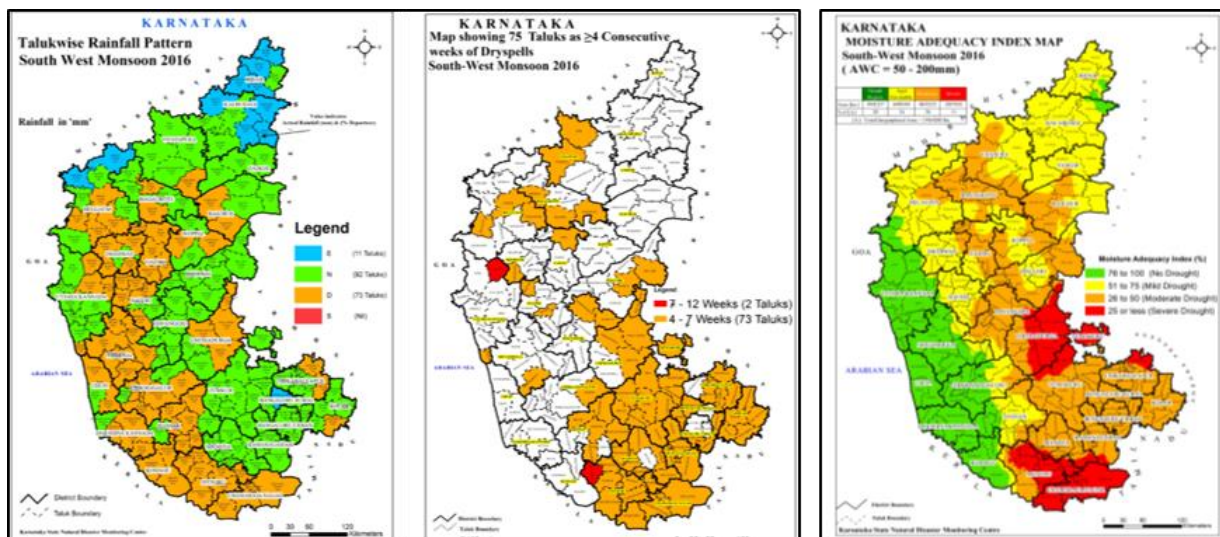
The database of observed weather parameters is utilised for calculating, Potential-Evapotranspiration (PET), Actual Evapotranspiration (AET) and Moisture Availability Index (MAI) at Taluk level on weekly basis. The calculated PET / AET / MAI based on ground level weather parameters are used in conjunction with Satellite based crop condition indices like Normalized Difference Vegetation Index (NDVI), Normalized Difference Wetness Index (NDWI) and Vegetation Condition Index (VCI), for assessing agricultural crop condition in the state on weekly basis.

The reservoir storage and inflow data collected on daily basis, by the State Department of Water Resources (DoWR, Karnataka) for all the major reservoirs in the state, are used to derive Reservoir Storage Index (RSI) and Stream Flow Index (SFI) for assessing the hydrological status across the state on weekly basis. Similarly, minor irrigation tank storage data is also used to assess the hydrological condition in the state.

**Figure 5.2 Weather data collection mechanism operational in Karnataka**



**Figure 5.3 Rainfall deficiency, Dry Spell and Moisture Adequacy Index in Karnataka (Kharif 2016)**



Ground water level data, collected by the Ground Water Directorate, Govt. of Karnataka and Central Ground Water Board (CGWB) on monthly basis, is used to assess the fluctuation in Ground water level and derive Ground Water Drought Index (GWDI) on monthly basis.

### 5.2.2. Weather forecast

Weather forecast at very high temporal and spatial resolution is another critical segment that enables to generate effective Meteorological advisory. The KSNDMC generates Rainfall / Weather Forecast for the State of Karnataka every day in collaboration with national agencies like Space Application Centre (SAC), Ahmadabad and Satish Dhawan Space Centre (SDSC-SHAR), Sriharikota and Indian Space Research Organization (ISRO).

Weather forecasts are generated regularly with three different time scales, viz.,

- Short term
- Medium term
- Long term

These are discussed in the following paragraphs.

**Short Range Weather Forecast:** Includes forecast for rainfall, temperature, cloud cover, wind speed and direction at Gram Panchayat level for the entire state at 12 hrs format for the following three days. Also the forecast is revised every day.

**Medium Range Weather Forecast:** The rainfall forecast at Gram Panchayat level at 24 hrs format for the following 10 days is generated every day.

**Long Range Weather Forecast:** KSNDMC provides 5-day weather forecast generated by IMD, weekly cumulative rainfall outlook for two weeks generated by National Environmental

Prediction Centre (NCEP). In addition, long range weather outlook generated by IMD is also made available.

The weather data observed on the ground is also ingested into some of these weather forecasting models and it has been to be useful in correcting and improving the Model output over the years.

### **5.2.3. Ready-to-Use weather information**

High spatial and temporal resolution data thus collected from the ground on various parameters are converted into information. Subsequently, in conjunction with the weather forecast, the meteorological information is used to generate customized weather Advisories and disseminated to the users. This has enabled the stakeholders at all levels to use the inputs in policy planning, implementation and decision making more accurately and in right time. These are discussed below:

#### **5.2.3.1. Drought monitoring & management**

Based on the observed weather data and the weather forecast at Hobli / Taluk level, drought condition is reviewed by the State Department of Agriculture, on weekly basis. Subsequently, the assessment reports are made available to all the line departments to plan and implement appropriate measures relating to their respective domain as well as collectively.

Similarly, by considering the Drought Assessment Report based on the ground level observation and the weather forecast, the Weekly Weather Watch Committee headed by the Additional Chief Secretary (ACS) and Development Commissioner and with Principal Secretaries / Secretaries of all the line departments of the State as members, reviews the drought condition and guides the implementation of mitigation measures by concerned departments.

Also, the Cabinet Sub-Committee on Drought headed by the Revenue Minister (with Cabinet ministers of Agriculture, Horticulture, Animal Husbandry, Rural Development, Water Resources and Food & Civil Supplies and Law as members) periodically reviews the drought condition and guide the implementation of mitigation measures.

The results of science & technology based assessment of drought condition at Hobli / Taluk level on daily / weekly basis are used by the State Government to identify and notify the areas affected by drought and rollout mitigation measures in time. The data is also used to prepare and submit memorandums to seek financial assistance under NDRF from Govt. of India.

#### **5.2.3.2. Mechanisms of crop assessment survey**

Along with observed weather data, the Dynamic Crop Information is highly essential in crop planning, implementing crop insurance and also to provide input subsidy during drought.

As part of Crop survey project taken up in Karnataka during the month of Oct / Nov 2017, the details of crop(s) standing over each parcel (hissa-wise and farmer-wise) along with photographs were collected. Almost 90 per cent of the farmers in Karnataka were covered. The

data was retained with the State e-Governance Department. The individual farmer's crop type and other details were updated in 'Bhoomi', an indigenously developed computer Application for managing the land records. The mobile number or Aadhaar number of individual farmer was also collected, to be used for providing value added services to the farmers. The data, continuously updated for each season, is planned to be used for crop insurance validation, crop acreage calculation, deciding location of crop cutting experiments along with remote sensing inputs and predicting the yield of crops.

Also, the data available with Karnataka State Remote Sensing Applications Centre (KSRSAC) on soil, ground water level depth (based on nearby ground water observation wells), land-use, high resolution satellite data, soil nutrient parameters (based on the soil health card scheme) was also used for advising the farmers. In addition, the data related to various surface water resources (like lakes/tank, pond river, reservoirs etc.) and the availability of water in a particular month was made available to farmers depending on irrigation sources.

This successful initiative bears the potential for regular adoption in the states now.

#### **5.2.3.3. Management of water resource**

The information on the weather, based on the high resolution data, and weather forecast is also being used for efficient management of the water resources in the state.

For instance, by considering the available water storage in the Reservoirs, the current inflow based on the current rainfall activity in the catchment and expected inflow based on the rainfall forecast, the water is allocated / utilised for drinking, industries and irrigation for the agriculture. In this process of decision making about utilization of available water, the need of water for drinking purpose is given first priority during the distress years. Only after this critical need is met, is a decision taken on quantity and time for releasing the water for irrigation purposes. **During the Kharif 2016 season, guided by weather information and forecast the state government decided not to release water for irrigation of paddy in the command areas of Cauvery river basin. The Policy makers and Govt. executives collectively conveyed the decisions to the farmers and advised them not to take up paddy cultivation and instead to opt for short-term alternate crops during the season.**

The decision on utilization of available water in the minor irrigation tanks and also the ground water usage has been based on weather information and forecast in the state.

The data has been used for resolving inter-state water disputes over water sharing in case of Cauvery River with Tamil Nadu; and Mahadayi River water sharing in case of Goa. The data and forecast are used for assessing the abundance or distress in a given season.

#### **5.2.3.4. Implementing insurance schemes**

The high resolution weather data collected from the ground level has been used for implementation of Crop Insurance Scheme in the state which is considered as a risk transfer

mechanism.

The weather data is used at different levels. First, it is used in designing the Term-sheets in case of Restructured Weather Based Crop Insurance Scheme (RWCIS), wherein area specific and crop specific term sheets are designed by using high resolution historical weather data by the agencies. Then, those term-sheets are evaluated to check any bias in fixing triggers and also for making the insurance product more realistic and fair to farmers. The agencies are asked to redesign the Term-sheets, if necessary. In the next phase, when the farmers submit their claim, they are evaluated by using the observed weather data pertaining to their farm location during that season.

The significance of this approach is, that the errors are minimised in loss assessment and thus farmers stand to benefit from making more accurate claims. This is mainly because of the reduced distance between the weather observatory and the farmland under assessment. The confidence level on the system is seen to have significantly increased among both the beneficiary and the benefactor.

Similarly, the ground level weather data is also being used by the public for claiming insurance for the damage / loss of property incurred due to weather aberration. Incidences of damage to industrial sheds or the chimneys due to high wind activity are being established and assessed using the weather data collected from the TWS station network. Likewise, damages to the poly-houses installed for floriculture and/or cash crop cultivation are also assessed using the weather data. The observed data from the nearby TWS or TRG station is used to corroborate the incidence of weather aberration beyond a threshold, and accordingly the insurance claims are being settled between the parties.

#### **5.2.3.5. Power generation and Grid load management**

Based on the weather data and rainfall forecast, the available water in the reservoirs is utilised for hydro-electric power generation. The data is used to foresee the power supply needs of multiple users – agriculture, industry and domestic consumes in both rural and urban areas. The data is also of great help in managing the power grid load across the state.

For instance, when the soil moisture condition is good and the rainfall forecast also suggests sufficient rainfall for agriculture purpose, the farmers don't use electricity to lift ground water using the pump sets. Thus, the demand for electricity is seen to have come down relatively in these regions. With the consequent case of the load on the power grid, the surplus electricity could be diverted and utilised in the areas with relatively higher demand.

#### **5.2.3.6. Monitoring and management of urban flood**

As elsewhere in the country, where major cities have been experiencing higher incidence of Urban Flood, Karnataka's cities too are no exception. The high resolution weather information and forecast is of great importance in finding an effective and long lasting solution to this disaster.

On a pilot basis, based on ward level high resolution rainfall data and high resolution rainfall forecast, KSNDMC has developed a **Hydrological** model to generate and issue location specific Inundation / Flood forecast for the City of Bengaluru during any rainfall event in the city. The Flood forecast issued about 6-8 hrs in advance has been found to be of great help to the civic authorities, responsible for managing the city. They could take appropriate and timely decision to optimally manage the resources in terms of manpower and machineries, in handling the adverse situation arising from inundation or food in the city area.

The Traffic Police has also been using the information and forecast for managing the traffic congestion and emanating from or accidents inundation or flood.

### **5.3. Significance of High-Resolution Agro-Met Services**

The strategies adopted to achieve self-sufficient status in foodgrain production have not resulted in proportionate increase in the farmers' income in the country. It has now been well recognised, that the nation whose food security the farmers have ensured, will now in turn needs to secure the farmers' income.

Adequacy of farmers' income is important in surmounting the agrarian challenge characterised by low average farmer's income and high incidence of poverty among the farming community. It is ironical that the farmers, an asset owning class can also suffer from poverty. As high as 22 per cent of the country's farmers live below poverty line (Census 2011). High Resolution Agro-Met services have a significant role to play in doubling farmers' income by offering inputs in advance of the risk occurrence.

#### **5.3.1. Doubling farmers' income and role of weather information**

There could be various mechanisms to achieve growth in farmer's income within as well as outside the farm sector. Within the farm sector, the increase in income can be through higher production / yield per unit area (as there are yield gaps of the order of 25–100 per cent across various crops especially in dryland regions, and in some high-value crops even in irrigated areas). It will also be because of lower costs of production and higher market prices, or/and a combination of both. The other mechanism for achieving higher production is through increasing cropping intensity with selection of suitable crops, optimizing the inputs and diversification towards high-value crops coupled with stabilised market prices.

Agriculture is heavily dependent on weather conditions and hence, agricultural productivity is directly influenced by variations in weather conditions. Similarly, in respect of livestock the sources of weather related risks are numerous and diverse: delayed onset of monsoon, drought, land degradation, erosion, hailstorm, depleted water resources, flooding, early frosts and many more.

The Inter-Ministerial Committee on Doubling Farmer's Income, Government of India has identified seven (7) sources of growth, influencing farmers' income, and the vulnerability of



these sources to climate variations are presented in Table 5.1.

**Table 5.1 Matrix of influences on envisaged sources of farm income growth**

<b>Proposed source of increasing income</b>	<b>Extent of vulnerability to climatic variations</b>	<b>Utility of early information of impending climate event</b>
Increase in productivity of crops	Significant	Moderate
Increase in production of livestock	Moderate	Moderate
Improvement in efficiency of input use	Moderate	Significant
Increase in crop intensity	Significant	Moderate
Diversification towards high value crops	Significant	Moderate
Improved price realization by farmers	Moderate	Negligible
Shift of cultivator to non-farm jobs	Negligible	Negligible

Accurate weather information and related advisories can result in improved decision-making and management of agricultural risks by farmers. Such services help in developing sustainable and economically viable agricultural systems, decrease in use of plant protection chemicals, reduced input costs, losses and risks, improved production and quality, increased use efficiency of water, labour and energy and conservation of natural resources.

Weather information plays a major role in the entire crop cycle right from selecting suitable crop/variety up to post-harvest operations and marketing. Hence, the meteorological services can help the farmers exploit the potential of good weather and minimise the impact of bad weather on day to day basis, as well as for long term planning in agriculture. Precise weather information is useful for farmers in two different ways. These are:

- i. **Weather-based strategic agronomic planning resulting in improving yield:** For optimal productivity at a given location, crops and cropping practices must be such that their cardinal phased weather requirements match the temporal march of the relevant weather elements, and at the same time endemic periods of pests, diseases and hazardous weather are avoided. In such strategic planning of crops and cropping patterns, short period weather data, both routine and processed (such as initial and conditional probabilities), have a vital role to play.
- ii. **Minimizing crop loss due to occurrences of erratic and adverse weather:** Agronomic strategies have to be devised to cope with the effects of erratic and adverse weather on agricultural production. For example, delay in the start of crop season can be countered by using short duration varieties of crops and thicker sowings; and the effects of frosts can be prevented by resorting to irrigation or lighting trash fires. Medium range weather forecasts with a validity period that enable farmers to organise and carry out appropriate cultural operations to cope with, are clearly useful.

### **5.3.2. Community help-desk for information dissemination**

To disseminate the Agro-Met information, forecast and advisories directly to the farmers, a

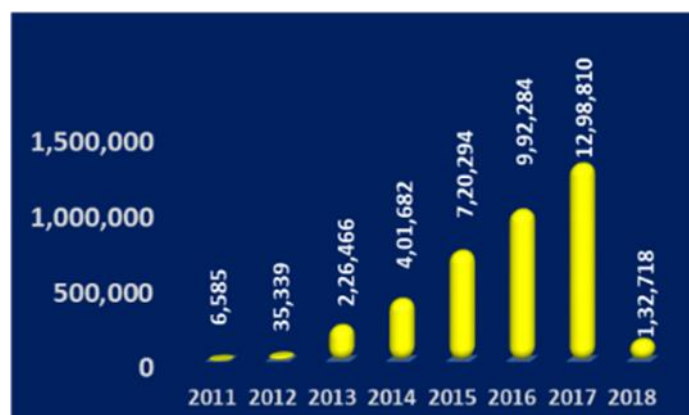
24x7 Interactive Help Desk “**Varuna Mitra**” has been put in place in Karnataka at KSNDMC. Some of the unique features of this dissemination model are,

- The farmers can get the information on what they need and when they need.
- Provides Agro-Met Advisories directly to the farmers through interactive telephony in the language and frequency a farmer can comprehend.
- Information on rainfall, temperature, humidity, cloud cover, wind speed information and forecast is made available (highest spatial resolution in the country at present) at the Gram Panchayat level.
- The information and Advisories are based on high spatial and temporal resolution ground level weather observation and same resolution weather forecast.
- Alerts on extreme weather events, information on reservoir status, stream flow etc., are also made available to the users.
- Voice recording of each call is used to improve the service and also to address the complaints.

The farmers have been calling Varuna Mitra and collecting customized information pertinent to their respective Gram Panchayats and using the information and advisories for planning their agricultural activities encompassing land preparation, sowing, inter-crop cultivation, application of fertilizers, spraying pesticides and harvesting. Though it is not a Toll-Free service, the number of calls have been increasing annually and lakhs of farmers are seen to be benefitting from the VARUNA MITRA Services.

The information is also disseminated to the field level officers of the Department of Agriculture, Horticulture, Animal Husbandry, Sericulture, Water resources, Raitha Samparka Kendras (RSKs), Farmers facilitators under Soil Enrichment Program, Krishi Vigyana Kendras (KVKs), and Agriculture Universities, besides Print and Electronic Media.

**Figure 5.4 Year-wise call details of Varuna Mitra Help Desk**



### **5.3.3. Impact evaluation of 'Varuna Mitra Services'**

A team of researchers from the Institute for Social and Economic Change (ISEC), Bengaluru

has carried out a study to evaluate and assess the impact of Varuna Mitra help desk services on the farmers. Through multi-stage random sampling technique, the assessment was carried out by directly contacting the farmers in three districts in three different regions with High Rainfall (>1200mm), Moderate Rainfall (600-1200mm) and Low Rainfall (<600mm) based on the annual rainfall which represent 8 of the 10 agro-climatic zones of Karnataka. The farmers who obtained information from Varuna Mitra helpdesk service during July 2016 to June 2017 were randomly interviewed using a pre-tested questionnaire. Apart from farmers, other stakeholders were also interviewed to assess the impact of Varuna Mitra more comprehensively.

In this evaluation, the impact of Varuna Mitra services was assessed on cost of cultivation, yield, income and post-harvest losses considering two situations, namely, with and without weather information from KSNDMC. The difference between the decision taken with-information and without-information was expressed in physical and monetary values, which was considered as an incremental change, that can be positive or negative depending on the impact indicator. Reduction in cost of cultivation, increase in income (attributed to increase in yield and price), increase in yield and decrease in post-harvest losses was considered as gain, whereas increase in cost of cultivation, decrease in income, decrease in yield and increase in post-harvest losses was considered as loss.

Overall impact was estimated by aggregating the stage-wise impact to arrive at per acre and per farm impact by using the information provided by Varuna Mitra. Finally, the impacts were presented in terms of two indicators, namely (i) **Net gain or loss** using the results of cost of cultivation, net income and post-harvest losses; and (ii) **Yield**. The impact of Varuna Mitra information specifically on rainfall was presented for major crops viz., paddy, arecanut, coffee, finger millet, jowar, mango, redgram, maize, cotton, tomato and chilli.

The results showed that the performance of the Helpdesk has been impressive. This also stood substantiated from the increase in number of calls since its inception from a low of 6,565 in 2011 to 10.42 lakh in 2016 and 12.92 lakh in 2017. It represents a Compound Annual Growth Rate (CAGR) of 61.55 per cent between 2016 and 2017 considering all 30 districts in Karnataka. The corresponding growth rate between 2013 and 2017 was at 51.46 per cent. In terms of the pattern of calls during the drought years, it was found that the number of calls increased with the increase in number of districts experiencing drought. Particularly, the frequency of calls was highest in 2016-17 as the year experienced the lowest rainfall over the period of previous 46 years. If the calls continue to increase at the same growth rate, the projected number of calls by 2020 are 63.57 lakh.

Among the queries made during 2016-17, about 99.53 per cent were with regard to rainfall and / or weather related which is a very crucial input for planning or executing agricultural operations and securing the standing crop. The sub-sectoral analysis of the purpose for which the calls were made, it was seen that majority of the farmers sought information relating to agriculture (90.39 per cent), followed by horticulture (8.65 per cent), animal husbandry (0.39 per cent) and sericulture (0.57 per cent).

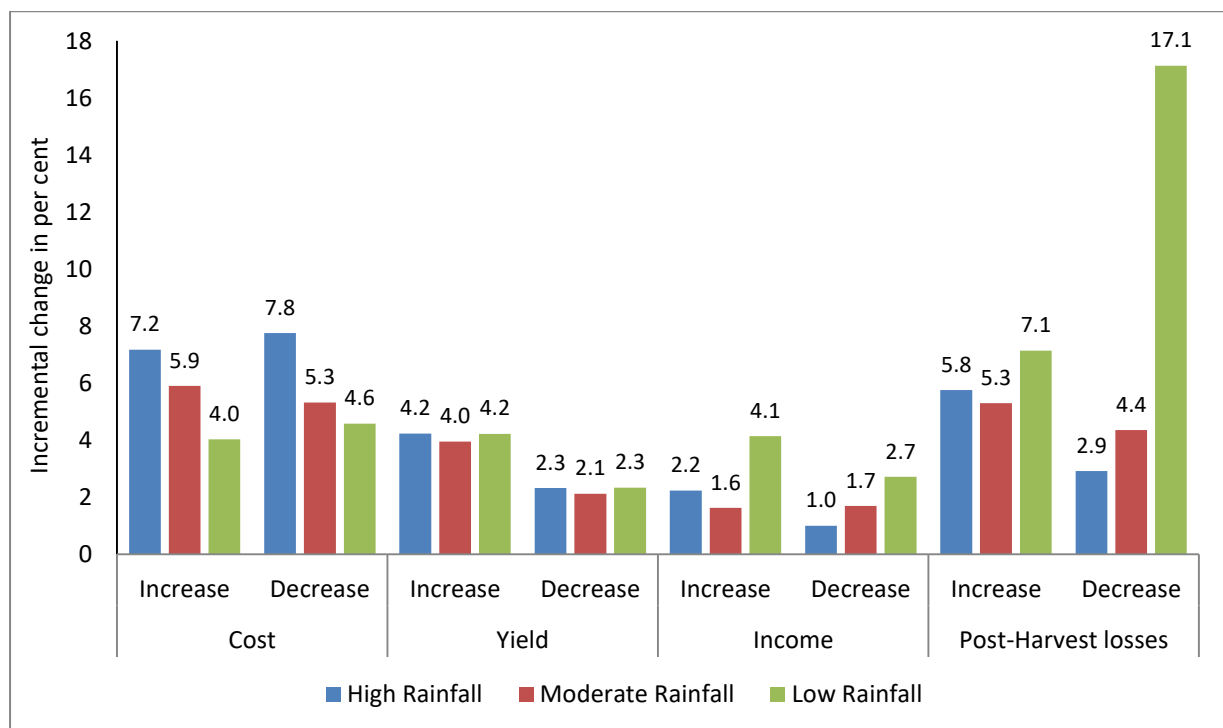
Almost all the farmers contacted during the survey preferred getting necessary information through direct interaction in the local language (Kannada) over the phone as it would facilitate in clarifying doubts, besides experiencing higher level of confidence in the information received during the course of the interaction. Each farmer fetching information from Varuna Mitra in turn shared it with at least 12 farmers in his/her area. Most farmers across seasons opined that the quality of calls was good (83.64 per cent) and only a small number stated that it was poor (1.25 per cent). The probable reasons for the latter were poor network and busy lines. Apart from this however, there exists scope for quality improvement of the services. A majority of the farmers sought short term rainfall forecast for one to three (1-3) days and indicated a wide range of accuracy levels of these predictions. Overwhelming proportion of farmers (62.50 per cent) indicated that the accuracy of prediction realised was to the extent ranging from 60 to 90 per cent.

Farmers had interacted with Varuna Mitra at different stages of crop cultivation from sowing to harvesting. Of more than 2000 farmers contacted for this exercise, 49 per cent reported decrease in input cost, 49.70 per cent reported increase in yield, 53 per cent reported increase in net income and 40 per cent reported decrease in post-harvest losses.

**Percentage incremental change in cost, yield, income, and post-harvest losses**

An overall decrease in cost by 6.71 per cent and increase in income by 1.86 per was observed by the farmers. Across regions, the highest decrease in cost was seen in high rainfall region (7.75 per cent), followed by moderate rainfall region (5.32 per cent).

**Figure 5.5 Incremental change in cost, Income and Post-Harvest losses**



In the case of post-harvest losses, the losses decreased by 17.13 per cent, especially in low rainfall region.

In the case of moderate and high rainfall regions, decrease in post-harvest losses was 4.36 per cent and 2.93 per cent respectively.

In the case of percentage change in yield, highest incremental increase was seen in jowar (16.17 per cent) followed by finger millet (8.83 per cent) and coffee (8.36 per cent)

Most of the farmers from all the three rainfall regions indicated a decrease in costs, increase in yield, increase in income and decrease in post-harvest loss. Though the amount of decrease and increase appear to be the same, there is significant difference in the number of farmers who indicated it. Decrease in cost was mentioned by 49 per cent of farmers. The highest decrease in cost to an extent of Rs. 6,273/ac with rainfall information, was witnessed among 57 per cent of coffee farmers who indicated the decrease at stages of irrigation and fertilizer application.

With the forecast of rainfall for couple of days, the farmers could save the irrigation cost which otherwise would have been incurred. Another important stage that requires rainfall information is flowering period during February-March, especially in case of *Coffea robusta* where farmers irrigate for the blossom. Other crops that followed coffee in terms of decrease in cost were arecanut (Rs.2571/ac), tomato (Rs.2218/ac) and mango (Rs.1268/ac).

#### **5.4. Annotation**

In India, farming is particularly vulnerable to vagaries of weather, largely due to severe fluctuation in monsoon cycle in the region. Understanding the timing, duration and intensity of the monsoon is vital for effectively managing many of these sector-specific activities. To capture and analyse the frequency and nature of weather events, it requires high resolution data on weather parameters.

A bouquet of tools consisting of alerts, early warnings, forecasts, and advisories based on ground level observation at a very high level of spatial and temporal resolution have proved to be effective. The farmers and other stakeholders have found these inputs to be highly valuable in planning and execution of suitable crop management strategies at micro-level. The benefits to the farmers are manifest in two ways:

- minimization of input cost and crop loss arising from weather aberration; and
- facilitating the farmers to adopt appropriate crop management strategies to realise higher yields.

It is now possible to build a robust technology platform by combining the power of new technologies. These include remote sensing, drones, sensors, data analytics and composition, mobiles etc. apart from Telemetric Rain Gauge (TWG) and Telemetric Weather Stations (TWS). This infrastructure can help in developing several indices to monitor extreme weather events like drought, flood etc and forewarn the farmers to take necessary measures for

mitigation of risks.

The assessment of the Agro-Met Service Model adopted in Karnataka shows that it can contribute in a big way in negotiating weather related risks and resulting in increased the farmer's income. This model should be customized and emulated in other parts of the country as a useful component of the strategy for doubling farmers' income.

There is scope to replicate a similar institutional mechanism for providing sector-specific Meteorological Advisory Services in respect of non-agricultural economic activities.

#### **Key Extracts**

- Deployment of technology helps in capture of real time data on various weather parameters on a large scale, its transmission and computation with accuracy, its interpretation and dissemination in quick speed.
- The natural risk in agriculture can be minimised by appropriate weather prediction, proper dissemination of climatic information, and early warning systems for flood, cyclones and other weather related hazards.
- India Meteorological Department (IMD) has immense experience in assessing and providing meteorological information across the country. The IMD began regular weather services for farmers in 1945 in the form of "Farmers' Weather Bulletin" and broadcasts through All India Radio (AIR) in regional languages. In 1971, on the recommendation of the National Commission on Agriculture (NCA), it launched Agro-Meteorological Advisory Services (AAS), a comprehensive tool tailored to meet farmers' need and have steadily improved the quality of service since then. The currently possible technology-led platform like that of 'Meterological Advisory Services' of Karnataka can prove more relevant to the farmers in risk negotiation and higher income realisation. Hence, this platform deserves replication across the country, with suitable modifications by the states and uts.
- Weather forecast at very high temporal and spatial resolution is another critical requirement that enables accurate forecasting and to generate effective meteorological advisory information.



## **Chapter 6**

### **Recommendation and Policy Frame work**

*Governmental support like crop & livestock insurance, weather forecast infrastructure, minimum support price and enterprise facilitative policies should be designed to minimise both the natural and anthropogenic risks in agriculture.*

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The agricultural system is risk prone, and while these need to be negotiated and managed, there is also the need to build resilience and capacity to face risks. The ability to take risks also allows the various actors in the agri-value system to explore and develop new markets. The ability to circumvent hazardous events and be resilient in the face of inclement occurrences empowers sustainable economic activity.

Strategic direction and policy frame work have an important role to play in the agricultural system. The risks are both endogenous and exogenous in nature, affecting the biotic system in agricultural sector and the external services and industries that depend on agricultural produce. Following are a broad set of recommendations for risk management.

- Risks to the biological set of activities stem from the dependence on weather based events. Irrigation and effective water management systems, especially in rainfed areas, form an important component of risk management. Greater focus on strategic development of irrigation facilities for most vulnerable farmers is necessary. This includes water harvesting through the small and micro-irrigation systems, as a source of protective irrigation at critical stages(s) of crop growth in the event of deviation in rainfall. Further, water use efficiency through adoption of micro-irrigation systems and crop alignment in tune with agro-climatic condition and availability of water are important.
- Greater emphasis is required on developing varieties that are tolerant to various stresses relating to temperature, water and salinity levels. The agricultural R&D community may take on crop and region differentiated development to avoid duplication of efforts.
- There is urgent need to bridge the gap in time taken and affordability, between lab and land. Technologies developed should be appropriately communicated to maximum number of farmers. One of the important factors, that can impact the level of adoption of new technology, is its ability to bring monetary gains to the farmers.
- Adopt good agricultural practices like diversified cropping systems, conservation agriculture for carbon sequestration, water saving technologies, organic farming and integrated farming systems, and afforestation to minimise human-induced risks in agriculture. Watershed based, management of resources is a comprehensive and scientific approach to risk management.
- Build the concept of National Seed Reserve (NSR) for making seed available to the



farmers at the time of re-sowing during risks. This would serve well in case of contingent situations. In order to incentivise the states to promote NSR, the losses, that may be suffered on reserves when not used as seeds should be compensated. A sinking fund/corpus fund may be created to meet such demands.

- Create awareness, among extension officers and farmers, about suitable technologies for vertebrate pest management so as to minimise Human-Wildlife Conflict. Adopt technologies and strategies that preferably help in repelling/detering animals from the cropped areas instead of those that cause harm or death of the wildlife. Various physical and biological barriers such as thorny plants, trenching, stone walls, etc. can be created to suit the requirements.
- Larger vertebrates like elephants, *nilgai* and wild boar are not a problem of single village or farmer; and therefore it is necessary to adopt a community approach along with active involvement of Agricultural and Forest Departments, farmers and other stakeholders for their management
- The PMFBY is currently the most robust scheme for crop insurance. In order to enhance its penetration and make it more productive, efforts are needed to cover non-loanee farmers; as also notify larger number of crops for coverage. A robust technology platform comprising remote sensing, drones, sensors, smart phones and computation would help in imparting greater creditability to the data on estimation of yield & loss among different stakeholders. This is essential for sustaining a market-driven scheme like the PMFBY.
- Since PMFBY is limited by availability of historical yield data which is not available in case of all crops, it would be necessary to develop and move towards weather based insurance viz yield based insurance as in RWCIS. In order to promote this scheme prerequisite infrastructure is universally spread Telemetric Weather Gauges (TWGs) etc. which can generate data on various parameters like temperature, relative humidity, windspeed and others, at fixed regular intervals. This entails roll out of a policy that would attract investments including from the private sector.
- Price discovery for crop insurance should consider adopting longer duration so as to benefit farmers with lower insurance prices. The government or the National Technical Support Unit (NTSU) should issue detailed guidelines, to help stabilise insurance prices.
- To enable fair play, timely implementation of the scheme is necessary and States should not seek extensions to cut-off dates for buying insurance. This uncertainty adds to insurers' risks and results in frontloading of costs. States should promote availing of crop insurance facility without waiting for completion of sowing.
- Policy enrolment cut-off dates can also be adjusted and kept flexible to suit cropping patterns and regional agro-climatic conditions. Similarly, release of claims can be adjusted to suit payment closure before next sowing season.

- Some states are found to be faltering in timely release of premium subsidy, affecting both timely payment of claims and the solvency of insurers. Dedicated budget at state level should be created to avoid such delays.
- To resolve matters such as “Area Correction Factor” and time bound assessment and payment of insurance, technology such as digitising of land record on a GIS platform is recommended. This will also spawn multiple advantages beyond PMFBY.
- Efforts should be made to ease access to insurance by non-loanee farmers. Involving at least three insurers in a given district to service non-loanee farmers is suggested. Suitable checks and balances, including portal based enrolment and centralised database, will mitigate apprehensions of duplicated insurance on same crop.
- The perception among the farmers that the insurance companies are garnering undue profits at their cost, needs correction for their sustained interest in a market-driven scheme like PMFBY. It is hence suggested, that a system be adopted whereby a certain percentage of the windfall gain made by the insurance agencies during normal years is utilised to offset particularly the premium payments made by the farmers. It is further suggested, that this can be sustained if the insurance agencies create a Corpus Fund for depositing small percentages of their annual profits on yearly basis.
- In order to increase coverage of non-loanee farmers, state governments may promote more than one insurance agency at the district level. They may consider to offer L2 and L3 bidders work order to cover non-loanee farmers at L1 price.
- As a priority digitize land records on a GIS platform. This can be the single most important facility that can upgrade the quality of crop insurance administration. It possesses the potential to spawn several advantages even beyond PMFBY.
- Tenant farmers have no structural recourse to enrol except as a non-loanee farmer. All states should be encouraged to undertake a drive to identify and enrol tenant farmers, if necessary with adequate financial support to finance the premium, and they should resort to legal remedies to recognise sharecroppers, lessees etc.
- The proposed Model Land Cultivators License Act should be brought out by NITI Aayog at the earliest, so that the states/UTs can legislate appropriately. In the alternate, the Model Land Lease Act may be amended to cater to the credit eligibility of such a category of lessees, sharecroppers, etc. and who by virtue of a loan sanction get automatically covered under PMFBY.
- Change Agents can be appointed to spread greater awareness and facilitate insurance uptake by farmers and as part of an insurance feedback mechanism.
- Unified Package Insurance Scheme (UPIS) must be made robust as it offers various advantages, including welfare packages, which more appropriately cover the secondary

risks that arise from primary crop failure.

- The 'Livestock Insurance Scheme (LIS), though operational since 2004, has very poor penetration, covering only 7 per cent of eligible animal population. Greater efforts need to be made on promoting this scheme, on lines of the PMFBY. The scheme needs to support farmers to cope with economic losses from all kinds of livestock and can be made more robust, as a market led and farmer-friendly programme. Currently the support under the scheme is restricted to primarily cover death of the animal and not the risks that may arise from disability and other hazards.
- The LIS should also be designed so as to promote resilient livestock rearing and also to encourage farmers to rear high yielding milch animals, practice artificial insemination (AI) for breed improvement and avail of cattle health and nutrition support programme by government. This can be on similar strategy as in PMBFY which encourages them for adoption of innovative practices.
- There is need to generate data on the risk characteristics of animals with health status document, without which it is tough to come up with pricing model and deciding on premium of livestock insurance products.
- A robust system of creating a unique identity based on technologies like RFID, microchips, etc. is critical to enhance the extent of coverage.
- Extensive use of IT and ICT systems is recommended to support management of insured assets. This will include technologies for remote/automated crop surveys, ID tagging of livestock, health monitoring, etc.
- The weather forecasting model based sharing of 'Meterological Advisories' with the farmers in Karnataka has proved the usefulness in negotiating weather related risks. The farmers who received the Advisories succeeded in reducing potential loss and reap higher incomes. The 'Varun Mitra', the platform for such Advisories may be replicated across all the states and UTs.
- Online enrolment portals, like in case of PMFBY, should be developed for LIS so that livestock owners, including small ruminants' owners also have easy access to LIS.
- Create awareness to promote insurance programmes which come with a 'top-up' cover for paying losses of 'localised risks', like hailstorm, landslide, inundation and post-harvest losses on individual farm basis. This may differentiate index to use 'yield index' for deciding losses of widespread calamities and 'farm yield' for assessing losses of localised perils / calamities.
- A technology platform can be gainfully employed in risk management. To manage weather related risks, spatially and temporally differentiated weather forecast of key phenomena with a 3 week lead-time can be further refined. Such information should

also be directly communicated to State extension offices, with designated key triggers to activate pre-emptive contingency actions at district and block level.

- Improve the density of weather monitoring stations (humidity, barometric pressure, temperature), including at Gram Panchayat level. This can be allocated to farmer friends at each village or done through private entrepreneurs. Each GrAM centre can also be installed with weather recording instruments and alert mechanism.
- Deploy technology for real time data on various parameters on a larger/universal scale, its transmission and computation with accuracy, interpretation and dissemination as an Advisory in quick speed. This can, therefore, become a powerful tool in the hands of the farmers to take rational decisions relating to production based on forecast-stimulus, precautions in response to 'Alerts and Early warning' etc.
- Long term climate shifts should be disseminated with the dynamic or expected variations in boundaries climatic zones, so that scientists can apply the information to build relevant crop plans and crop varieties & technologies for focus regions.
- Historic data on climate and weather can be linked to each GrAM (Gramin Agri-Market) by way of kiosks. This will facilitate on-demand access and evaluation at farmers' assembly centres at village level. Using interactive telephony in the language a farmer can comprehend to make weather advisories readily accessible to farmers need to be widely adopted.

The other volumes of the DFI Report, also include multiple recommendations that ultimately mitigate risks faced by farmers and build on the capacity of the agricultural system to negotiate a variety of economic and environmental threats. The premier resolve of the agricultural system and various stakeholders should aim at bringing about an **Income Revolution in agriculture, distinct from the erstwhile approach on having a Green Revolution.**

From the farmers' perspective, the green revolution resulted in greater outputs of specific and limited types in specific regions in the country. The enhanced production which initially could easily be absorbed locally and domestically (on account of food deficit) has now escalated into a challenge, exposing the farmers to risks at a commercial level, including market risks. Looking forward, only with associated economic transformation, a **Farm Income Revolution** should satisfy & sustain India's agricultural system.

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**Annexures**

**Annexure: Chapter 2 - Vertebrate Pest Management**

**Plate 1: Rodent damage pattern in different crops**



**Fig. 1. Damage in rice field**



**Fig. 2. Damage in wheat field**



**Fig. 3. Damage in mustard field**



**Fig. 4. Damage in groundnut field**



**Fig. 5. Damage in sugar cane field**



**Fig. 6. Damage in range land**

**Plate 2: Rodent management methods**



**Fig. 7. Bund management**



**Fig. 8. Burrow fumigation**



**Fig. 9. Trapping**



**Fig. 10. Bait Preparation**



**Fig. 11. Bait Placement**



**Fig. 12. Trunk Banding**

**Plate 3: Bird damage pattern in different crops**



**Fig. 13. Damage in bajra**



**Fig. 14. Damage in maize**



**Fig. 15. Damage in sunflower**



**Fig. 16. Damage in sorghum**



**Fig. 17. Damage in oil palm**



**Fig. 18. Damage in safflower**



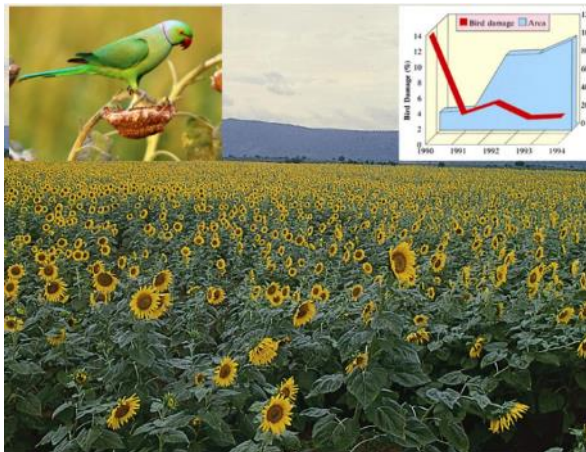
**Plate 4: Bird management methods in different crops**



**Fig. 19. Wrapping of maize cobs in four rows along the borders**



**Fig. 20. Erection of reflective ribbon one feet above the crop in NS direction**



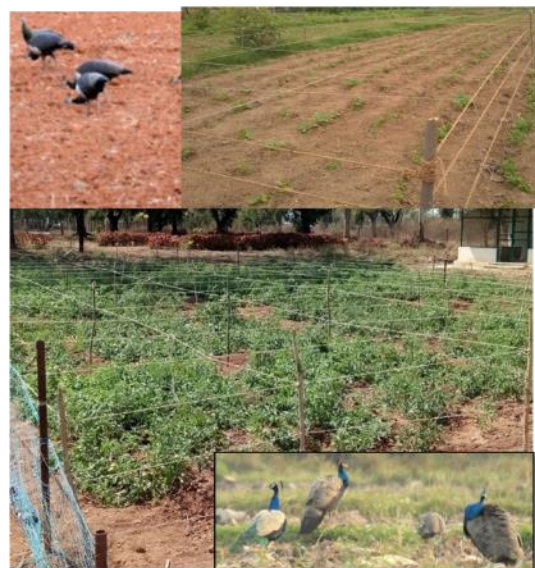
**Fig. 21. Trapping**



**Fig. 22. Bait preparation**



**Fig. 23. Bait placement**



**Fig. 24. Trunk banding**

**Plate 5: Wild boar damage pattern in different crops**



**Fig. 25. Damage in rice crop**



**Fig. 26. Damage immediately after sowing**



**Fig. 27. Damage in maize**



**Fig. 28. Damage in sugar cane**



**Fig. 29. Damage in mustard**



**Fig. 30. Damage in vegetables**

**Plate 6: Wild boar management methods in different crops**



**Fig. 31. Circular razor fence around the crop**



**Fig. 32. HDPE fish net around the crop**



**Fig. 33. High density planting of Castor around maize/sorghum**



**Fig. 34. High density planting of safflower around ground nut, chickpea and vegetables**



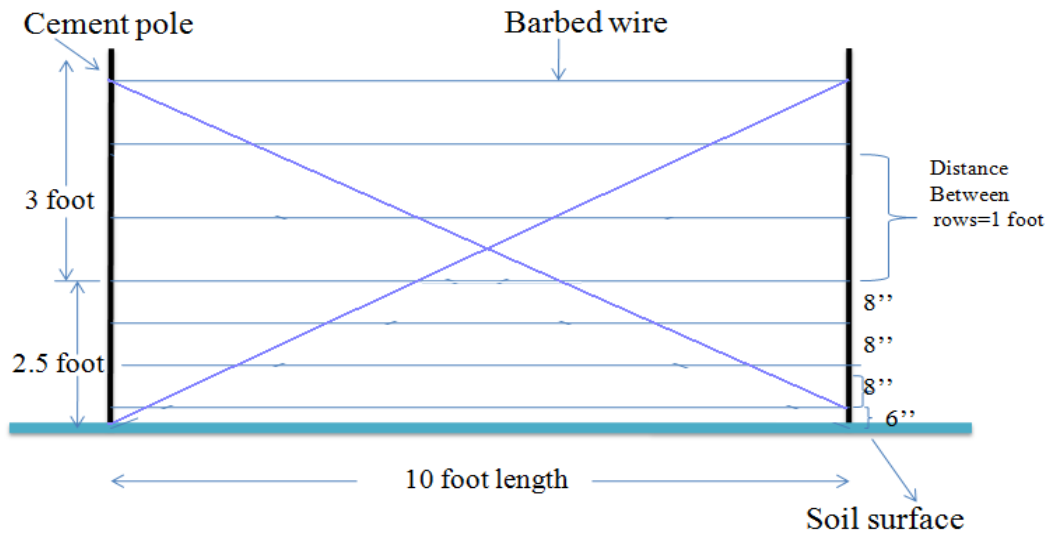
**Fig. 35. Trenches around the crop**



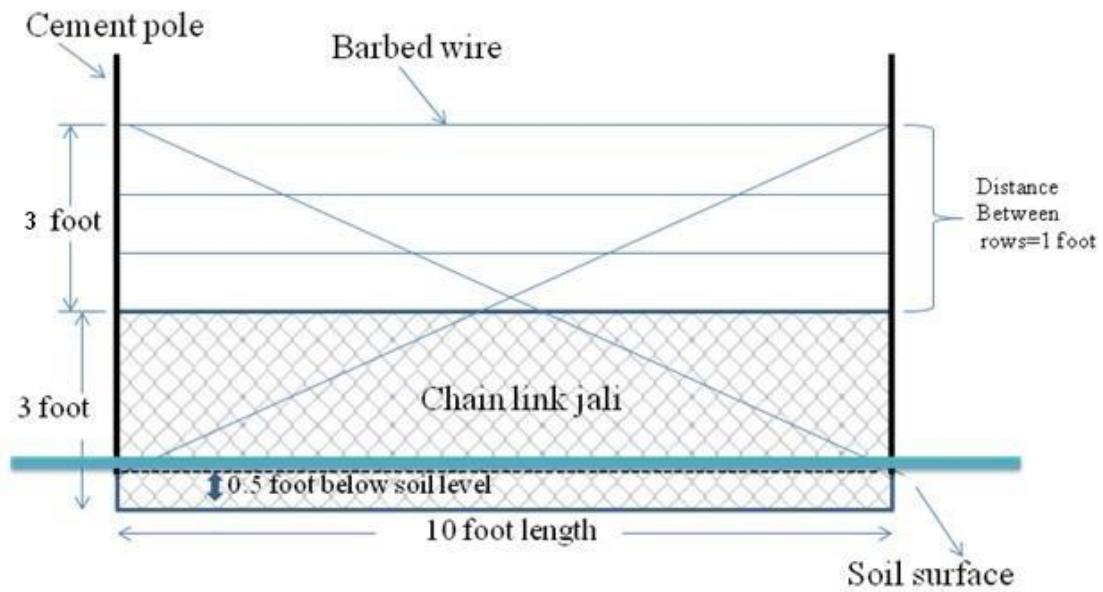
**Fig. 36. Bio acoustics- A potential device to reduce crop damage by birds and Wild boar**

**Plate 7: Fencing technology designed by Anand Agricultural University, Anand for wild animal management in Agriculture**

**barbed wire fence**



**Chain link jail +Barbed wire**



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