AGRICULTURAL RESEARCH PRIORITIZATION FOR AGRO-CLIMATIC ZONES-8, 9 AND 10 OF KARNATAKA

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CERTIFICATE

This is to certify that the thesis entitled "**AGRICULTURAL RESEARCH PRIORITIZATION FOR AGRO-CLIMATIC ZONES-8, 9 AND 10 OF KARNATAKA**", submitted by **Mr. SHIVAKUMAR B. HANJAGIMATH.**, for the degree of **MASTER OF SCIENCE in AGRICULTURAL ECONOMICS**, to the University of Agricultural Sciences, Dharwad, is a record of research work done by him during the period of his study in this University, under my guidance and supervision and the thesis has not previously formed the basis for award of any degree, diploma, associateship, fellowship or similar titles.

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INTRODUCTION

I. INTRODUCTION

The capital formation in agriculture still hovers around only ten per cent of the total net capital formed in the economy. Even to attain modest growth in agriculture sector, all the agricultural resources have already stretched to their limits. While soil erosion takes place unabatedly, water is becoming scarce all over the country. While we still suffer from the illusion of a labour-surplus economy, there is already mounting evidence to suggest that the farmers are unable to attract agricultural labour at wage rates which they can pay. The gains from the green revolution are tapering off and there are no signs of a second green revolution ushering in. There are doubts in many quarters about the sustainability of agricultural growth even at the historical rate of less than three per cent, let alone the proposed rate of growth of 4.5 per cent per annum. With the prospects of expansion of cropped area being very dim, the onus of increasing production rests solely with the increase in productivity. In future, research and development efforts in agriculture are going to assume a more crucial and central role in agricultural development strategy that it ever had in the past.

While the productivity of agricultural research at aggregate level is quite satisfactory, one can easily detect the possibilities of making it much more productive at the level of research institutes and zonal research stations. Policy makers are now demanding a social audit of research stations as against the current practice of regular in-house evaluation and quinquennial reviews by external experts. As the resources allocated to agricultural research are getting scarce and the expectations from research are soaring higher, there is an imperative need to analyse and prioritise the allocation of research resources among the competing research programs and projects. In the past, priority setting in agricultural research was a centralised activity. The whole process of setting research objective and allocating research resources was highly subjective and followed a top-down approach. The National Agricultural Research Project (NARP) attempted to strengthen Regional Agricultural

Research Stations and charged them with the responsibility of solving the location specific problems of a particular agro-climatic zone. Some interactions with the extension workers and farmers was structured through the formation of Zonal Research and Extension Advisory Committee (ZREAC), joint diagnostic field visits and training of subject matter specialists of the agricultural departments. The spirit of NARP was absorbed and implemented with varying degrees of commitment and compliance in different states. The experiments taken up at the Regional Research Stations and sub-stations have undergone some change and they were targeted to provide answer to the queries raised by farmers and extension workers. But many of them have been more in the nature of simple trials rather than as integrated research projects. To consolidate the gains made in NARP phase and further strengthen the location-specific research, the top-down approach followed hitherto for setting priorities has been reversed by the world bank funded National Agricultural Technology Project being implemented at present in the country by the ICAR.

ICAR has a key role in shaping the national research system and in setting national and state research agenda, though the state system has also become mature and assertive. Therefore, the ICAR budget allocation for research, though not complete by itself, is of considerable importance since it is a trendsetter. Table-1.1 shows that though ICAR plan outlay in normal terms has increased more than fourteen fold since the IV Plan (1969-74), its share in agricultural sector outlay has not shown consistent and impressive buoyancy. ICAR's share in agricultural and allied sector outlay has risen from 3.9 per cent in the IV Plan to 5.8 per cent in the VIII Plan (1990-97). Though the size of these grants is relatively small, there is a broad indication that the priority accorded to ICAR has been maintained. Except for a dip in the VII Plan (1985-90), ICAR share has been significantly higher in the post-1980 period. In real terms, ICAR expenditure was stagnant at about Rs.87 crores through the seventies. There was an increase in the VI Plan (1980-85) which could not be

Table-1.1: ICAR outlays through different Five Year Plans

Plan	Agricultural and allied sectors plan outlay (Crores Rupees)	ICAR plan outlay (Crores Rupees)	Share of ICAR in total Agric. Outlay (%)
IV plan (1969-74)	2320 (2197)	91.4 (86.5)	3.9
V plan (1974-78)	4865 (2755)	153.6 (86.9)	3.2
VI plan (1980-85)	5695 (1973)	340.0 (117.7)	6.0
VII plan (1985-90)	10524 (2596)	425.0 (104.8)	4.0
VIII plan (1990-97)	22467 (3707)	1300.0 (214.5)	5.8
IX plan (1997-2002)	42462	-	-

Note: Figures in parentheses denote outlay at constant (1970-71) prices.

fully matched in the VII plan. Thus, in the eighties too there was a stagnation. A major revamping has been attempted in the VIII plan. In the IX Plan (1997-2002), the plan outlay for Agriculture and allied sectors was Rs.42,462 crores at current prices.

Many factors influence the effective utilization of scarce research resources, including quality of scientists, incentive and reward system for conducting good science, timely release of sufficient operating funds, and appropriate physical and managerial infrastructure. In addition, resource allocation across problems, commodities and regions within a research system must be consistent with national objectives, such as efficiency and equity goals. Many research programmes lack systematic and transparent mechanism for allocating research resources; rather resources are allocated by informal mechanisms, such as collective judgement or benefits of individual scientists, historical precedents, political pressures, among others. In a world in which the public sector is being held accountable for the utilization of increasingly scarce public funds, there is a strong case for using more systematic and objective approach to allocate research resources.

In this context, agricultural research prioritisation gains importance, because as compared to any method of research resource allocation, it allocates the scarce research resources across problems, commodities and regions within a research system more effectively and efficiently. Regional balance, sustainability, trade-technology links, demand shifts towards non-food grains, income growth for the poor, among others, are a few of the many new challenges confronting agricultural scientists today. With time, this complexity will grow. Further, on the other hand, availability of public funds for agricultural research is declining. These factors necessitate more analysis and use of some sort of decision rules alongwith technical information. Research planning and prioritisation has thus become a complex and specialised task.

Research priority setting, monitoring and evaluation have recently been introduced as research management tools to efficiently allocate scarce research resources to alternative choices. With squeezing agricultural research resources, research managers explore reasonably appropriate procedure to allocate available limited resources to meet the unprecedented challenges of increasing demand for food, and ever-rising degradation of natural resources. An efficient and well prioritised research resource allocation is reckoned to make maximum contribution in improving the welfare gains of the society. In the process of agricultural research prioritisation, commodities, research themes and regions, which are likely to face stress or which offer opportunities in the context of national objectives, are identified.

Research resource allocation decisions are made at several levels. They are

1. Allocation at the macro–level, especially allocation across commodities and resource based programmes within a national research system.
2. Allocation at the programme or sub programme level, such as the share of resources going to varietal improvement or soil fertility management, or to research on a particular disease (sub-programme level).
3. Allocation at the project level, in which resources are assigned to specific time-bound experimental programmes.

Of course, these various levels are not mutually exclusive. A good priority-setting approach will allow information on national policy objectives to flow downward, and information on researchable problems to flow from the bottom up to influence higher levels of priority setting mechanisms is needed to reconcile these various flows of information and develop consistent priorities across levels.

Even though agricultural research has significantly contributed to agricultural growth world over, it currently faces growing scarcity of resources. In recent years, the Consultative Group on International Agricultural Research (CGIAR) had to face a cut of 20 per cent of

resources provided earlier (Dixit, 1994). Similar is the story with many of the National Agricultural Research Systems (NARS). Further, the decision makers desire information on research pay-offs in order to assess alternative uses of funds. This calls for efficient use of available resources with growing complexity in setting priorities, as there are competing goals of research such as efficiency, equity and sustainability. Thus there is a growing need for evaluation of agricultural research investments and setting priorities for research investment.

Therefore the present investigation was undertaken with the following specific objectives.

1.1 Objectives

1. To estimate the yield gaps in selected crops across production environments.
2. To identify the major production constraints and assess their severity in terms of yield losses in selected crops.
3. To develop priority matrix for allocation of resources across selected commodities and agro-climatic zones.
4. To prioritize agricultural research programmes for selected zones of northern Karnataka.

1.2 Hypotheses

1. There exist wide yield gaps for selected crops in the selected zones of northern Karnataka
2. The yield losses in various crops in the study area are due to major production constraints.

Choice of criteria relevant for priority setting and research resource allocation and analytical approaches play an important role in such an evaluation. The important criteria considered by the earlier studies are growth, efficiency, equity, sustainability and trade issues. Priority setting is carried out by the application of particular methods and analytical approaches to systematically compile information and then organise it to rank research priorities. The process of setting research priorities is as important as the selection of

analytical approach. Scoring approach, benefit-cost analysis, programming model, simulation model and econometric model are the important analytical methods reported for agricultural research priority setting.

The present study assesses the research priorities across research problem areas and agro-climatic zones in the Northern Karnataka. Across research problem areas, crop loss estimates were used to assess the research priorities, as the crop losses provide the potential gain from research. Therefore, for effective priority setting, crop loss estimates are combined with the estimates of investment on research to resolve the problem, the probability of success and extent that the crop loss will be reduced by the research programmes. For priority setting across agro-ecological zones, the simple congruence approach has been widely used in allocating research resources. The major consideration is the potential for spillovers, i.e., the potential for research conducted in one zone to be applied in another zone, either directly as a released technology or indirectly as an input into the research programme of other zones. Potential spillovers depend on agro-climatic similarity and socio-economic factors.

1.3 Presentation of the study

The entire study is presented in six chapters. The chapter I gives an introductory note highlighting the significance of the study and the specific objectives, while chapter II reviews the studies made in the past that are related to the set objectives of the present investigation. Chapter III explains the methodology adopted in the study, including delineation and description of the study area and crops, sampling frame, nature and sources of data and analytical techniques used. The results of the study are presented in chapter IV which are discussed in chapter V. The summary and policy implications are presented in chapter VI.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

An idea of the findings of earlier studies and methods adopted therein are of utmost necessity to evaluate the objectives of the present study. It was hoped that such a review of relevant literature would provide a basis either to compare/contradict the earlier results and thereby suggesting the newer methodologies for future improvement. On the basis of the objectives of the present study, the literature reviewed is presented under following sections.

2.1 Assessment of yields gaps in crop production.

2.2 Identification of major production constraints and estimation of severity of constraints.

2.3 Methodology for development of priority matrix and assessment of priorities for agricultural research.

2.1 Assessment of yield gaps in crop production

A study on of yield gaps of groundnut in Ananthpur region of Andhra Pradesh by Choudhary *et al.* (1980) revealed that the average yield obtained under improved techniques of farming was 12.5 quintals/ha where as the average yield realized under traditional method was only 6.25 quintals/ha, thus showing a gap of 50 per cent in yield between the two techniques of farming.

Herot and Mandac (1981) studied the modern technology adoption and the economic efficiency of Philippines rice farmers. Authors formulated a model to decompose the total yield gap into three components viz., profit seeking behaviour, allocative inefficiency and technical inefficiency. Authors have attributed 78 percent of the yield gap in rice to technical inefficiency (0.9 t/ha) and the 22 percent of the yield gap (0.2 t/ha) was attributed to the profit seeking behaviour and allocative inefficiency.

Panghal *et al.* (1985) estimated the magnitude of gaps in Haryana in attainable yields using simple statistical tools like means and coefficient of variations in a case study of an analysis of attainable yield gaps in important food crops. The study showed that the average realized yield levels of wheat, gram, bajra and rice during the last 16 years were only 44, 25, 16 and 47 per cent of the potential attainable yields respectively.

The maximum gap was noticed in the states of Andhra Pradesh (15.89 q/ha), Maharashtra (6.84 q/ha) and Karnataka (5.82 q/ha) by Ray and Chahal (1986), while studying the magnitudes of yield gap in groundnut. Authors have attributed poor management practices like untimely sowing, improper seed rate and use of untreated seeds were responsible for this gap and have advocated strengthening of the existing extension and training network to narrow down the observed yield gaps.

Madhavswamy and Sheshareddy (1987) observed a fairly wide yield gap in the high yielding variety of jowar in scarce rainfall zone of Rayalaseema. They have revealed a gap of 7.00 quintals per ha between the yields of research station and the best cultivator and a gap of 13.08 quintals per ha between the yields of best cultivator and average cultivator. While the difference between the yield of research station (32.00 q/ha.) and that of average cultivator (11.92 q/ha.) was estimated at about 20.00 q/ha.

Singh and Reddy (1987) studied the adoption level and constraints in transfer of technology with respect to castor crop in southern Telangana zone of Andhra Pradesh. Authors have reported a wide gap of 1108 Kgs per hectare between the actual yield on farmers' field (529Kgs) and the potential yield of 1637 qt/ha) in castor. The authors opined that the existing yield levels of castor could be improved to a considerable extent if farmers followed all the recommended practices, since even the progressive farmers also did not follow all the recommended practices in castor.

The actual productivity of cotton on sample farms was far below the productivity of cotton on demonstration plots in Karnataka. The actual yield of cotton ranged from 1529.2 Kgs per ha on small farms of Dharwad district to 1666.43 Kgs per ha on large farms of Raichur district and the yield gaps were statistically significant at one percent. For Dharwad and Raichur districts, the estimated gap in attainable productivity was found to be 42.4 per cent and 43.95 per cent respectively (Basavaraja *et al.* 1989).

Gyanendra and Pandey (1990) examined the cropping pattern and yield gaps under dryland conditions of Agra district of Uttar Pradesh. The authors grouped yield gaps into three different types. The first type was the difference between the genetic potential yield and the research level yield, and the second type was the difference between yield obtained at research station and yield obtained on progressive farmers' fields, who adopted recommended technology. The third type was the difference between yield on progressive farmers' fields and yield on average farmers' fields of the area.

Holikatti (1991) estimated the total yield gap in Byadagi dry chilli. The yield gap was nearly 52 per cent on both large farms and small farms in Karnataka. Yield gap-I was generally small (25.32%) and was partly attributed to environmental differences and partly to non-transferable components of technology. Compared to yield gap-I, the size of yield gap-II was large (38.07%) and ranged from 36.32 per cent on small farms to 38.74 per cent on large farms. Both biological as well as socio-economic constraints were reportedly responsible for this yield gap-II.

Suryawanshi and Prakash Mahindire (1993) studied the impact of viable technology for promoting oil seeds in Maharashtra. The data from frontline demonstrations laid out by the centers of All India Co-ordinated Research Project on Oilseeds in Maharashtra laid out along adjacent plots of farmers following traditional

practices were used to show the comparative production potentials and benefits accruing from viable technology. At the national level, the recommend technology increased the yield by 36 to 45 per cent in groundnut, 35 per cent in sesamum, 21 to 47 per cent in sunflower, 21 to 63 per cent in safflower and 77 per cent in niger crop. In Maharashtra, the productivity on demonstration plots increased by 53 per cent in groundnut, 22 to 48 per cent in sunflower and safflower over that obtained by the farmers following traditional practices. The analysis showed that significant yield gaps were due to the adoption of improved technologies. The yield gaps in case of kharif groundnut, summer groundnut, sesamum, sunflower and safflower were 56,20, 200, 226 and 640 per cent, respectively,

Patil (1995) studied the magnitude of groundnut yield gaps in Dharwad district of Karnataka. The per-hectare potential yield of groundnut was estimated to be 3,500 Kg, as against the potential farm yield of 1742 Kg. The actual per ha yield of groundnut on farmers 'field was 1289 Kg and it was relatively less on small farms than on large farms. Small farmers exploited hardly 37 per cent of potential groundnut yield was exploited by the small farmers. However, farmers were found to exploit about 74 per cent of potential farm yield in groundnut. This clearly showed the possibility of increasing groundnut output by 26 per cent.

Nagabhushanam and Shreedhar (1997) studied the extent of yield gaps in Karnataka collecting data from 120 paddy growing farmers. The authors reported a narrow gap of 8.63 per cent (Gap-I) between research station yield (19.00 q/ac) and progressive farmers' yield (17.36 q /ac). This yield difference was attributed to the environmental differences and management factors relating to the soil fertility. Further,

the yield obtained by the average farmers (12.40q/ac) showed a wide gap of 26.11 per cent when compared to that obtained by the progressive farmers.

Gaddi (1999) estimated the yield gaps in jowar, groundnut and cotton for north Karnataka. The estimated total yield gaps in jowar, groundnut and cotton were 1454.20 kg, 1762.44 kg and 1526.30 kg per ha respectively. The yield gap-I was highest in the case of groundnut (1269 kg per ha) followed by jowar (1013.47 kg per ha) and cotton (893.50 kg per ha). Yield gap-II was less than yield gap-I for all crops.

Gaddi *et al.* (2002) attempted to estimate the magnitudes of yield gaps, causative factors and constraints for attaining greater farm potential in rabi sorghum production in Karnataka. It is revealed from the findings of the study that the magnitude of the total yield gap was 1454.20 kg per ha, which comprised of relatively higher yield gap-I (1013.47 kg/ha) than yield gap-II (441.06 kg/ha). Farmers in the study area realized 58.83 per cent of the potential yield and 67.78 per cent of the potential farm yield.

Hugar (2002) estimated the yield gaps and constraints in groundnut and sunflower, using four years data from 1991-92 to 1994-95 in North-Eastern Dry Zone of Karnataka. The results indicated that the yield gap-I was found to be very substantial both in groundnut (67.15%) and sunflower (44.48%). The yield-gap-II in groundnut (32.85%) and sunflower (54.52%) was also found to be considerable. The yield gap-III indicated that farmers have harvested only about 65 and 78 per cent of attainable potential yield of groundnut and sunflower, respectively.

2.2 Identification of major production constraints and estimation of severity of constraints.

Ramasamy *et al.* (1997) carried out a study to set priorities for the Research in Southern India comprising Andhra Pradesh, Karnataka, Kerala and Tamil Nadu including

Pondicherry. As a first step, the yield gap in rice was estimated. Secondly, an exhaustive list of constraints in rice production in different environments was prepared. In step three, the severity of each constraint was estimated through quantification of yield losses. Step four focused on research costs required to solve each of the constraint. Step five generated present networth of research project. It was found that most of the yield gap was due to environmental factors. Production losses due to insects were about one third of the total losses. Disease and agronomic problems each contribute about one-fifth of the total losses. Soil problems and the residual were largely due to socio-economic factors. There were 24 important constraints identified. It was found that NPV was highest for weeds in Andhra Pradesh, where as in Karnataka, Tamil Nadu and Kerala, it was highest for traditional problems.

The study conducted in Central, Eastern and North Eastern region of Uttar Pradesh by Singh *et al.* (1999), highlights the constraints to rice and wheat crops in 29 districts of the aforesaid regions. The biological and socio-economic factors considered as yield limiting factors form a basic foundation for delineating and prioritizing research in order to solve problems through technologies to be evolved by research institutions. The developed methodology for Yield-Gap analysis by centers under CGIAR system (IRRI) was used in identifying limits in rice and wheat production. The difference between experimental station and front-line demonstration yields for both crops is termed as yield gap-I. This is attributed to environment and certain components of technology that are not transferable to farmers. While the difference between frontline demonstration yield and actual farmers' yield is named yield gap-II. Gap-I and II have been estimated for district and regions for both crops. A list of responsible limits to yields was prepared and subsequently top constraints as per yield losses have been ranked as per the severity and economic relevance. Further, production loss found in each of the regions and districts

was quantified on the basis of acreage under each crop and yield gap-II. The findings could facilitate research manager in resource allocation to various projects placed on priorities by net present value and internal rate of return.

Roy and Datta (2000) carried out a study on "Prioritizing production constraints and implications for future research for rice-wheat system in Haryana". The study covers the areas of Trans-Gangetic plains. Rapid Rural Appraisal (RRA), participatory rural appraisal (PRA) and focused group meeting (FGM) techniques were used to obtain additional information on clients' constraints. The constraints include technical and socio-economic factors that limit rice and wheat yields. The severity of each constraint was assessed through estimation of yield loss. Yield gap is decomposed into two parts, namely, yield gap-I and yield gap-II. Yield gap-I is the difference between the experiment station's average yield and on-farm experiments' average yield. Yield gap-II is the difference between actual farm yield and the yield attained in on-farm experiments. The results of yield gap estimates reveal that existence of considerable yield gaps in both rice and wheat. In all the crops, yield gap-II was very large compared to yield gap-I. The top ten research problem areas were ranked based on the loss of value of production

Shalander Kumar and Rout (2000) conducted a study on prioritization of constraints in livestock production in Bhola village of Khurla district, Orissa state. Thirty farmers and 6 key informants were selected and information regarding technological needs and problems of livestock management were collected. The farmers were asked to rank the problems by using snowball-sampling technique. The extent of damage or loss due to each problem was estimated with the help of farmers. The rank based quotient for each problem and average yield loss due to problem were estimated in order to work out

village magnitude value of the problem. A total of 9 constraints were identified and prioritized using above methodology.

Jha *et al.* (2002) while prioritizing the constraints in soybean production in soybean based production system under rainfed agro-eco-region (SBPSR) in India, attempted to quantify the extent of losses caused by different production constraints and prioritized on the basis of average losses caused by them. Yield gap-I and Yield Gap-II were assessed by using conceptual model developed by IRRI. Various biotic and abiotic constraints, which are inhibiting soybean production, were identified. In total, 338 thousand tones of output was forgone due to the biotic constraints, where as 329 tonnes was forgone due to abiotic ones. Both the biotic and abiotic constraints along with other technical constraints reduced production by 667.4 thousand tonnes in SBPSR alone. Further 454 kg per ha of Yield Gap-I and 680 Kg per ha of Yield Gap-II were observed in SBPSR. Yield Gap-II alone resulted in a loss of more than 3263 thousand tones of production in the SBPSR region. Poor power supply, high cost of irrigation, scarcity of water and poor irrigation facilities were predominant socio-economic constraints. The other important constraints were untimely or unavailability of inputs, poor technical guidance, high cost of labour and unavailability of quality seeds in required quantities at the time of sowing.

Sexena *et al.* (2002) prioritized the production constraints by estimating the severity of each constraint through estimation of yield loss in dairying in Haryana state. The value of production loss foregone was calculated by multiplying average production loss per animal per annum with breed population and then by prevailing market prices of milk of cow and buffalo. The results indicated that in the case of cross breed, average yield loss due to all constraints is computed to be 1165 lit/animal/year and the total loss

from technical constraints was found to be 788.25 lit/animal/year. Among the constraints mineral deficiency tops the list. In case of indigenous cattle, average yield loss was 662 lit/animal/annum, losses due to technical constraints were estimated to be 544.06-lit/animal/annum. In case of buffaloes, average yield loss was estimated to be 1040 lit/animal/annum out of which, technical constraints caused 775.74 lit/animal/annum.

Thakur *et a l.* (2002) estimated yield gaps, losses and constraints to rice production in Bihar. For the purpose of the study, all the three sets of respondents, namely, researchers, extension personnel and farmers of irrigated, rainfed upland, rainfed lowland and mid land and deep water ecosystem were considered. Yield gap estimates indicated that yield gap-II accounts for 1500 kg per ha, which is 38.75 per cent of attainable rice yield at the best farmer's field. Yield loss estimation conveys the impression that maximum yield loss (39.78%) from technical constraints was attributed to rainfed low land ecosystem, followed by irrigated (35.50%) and deep-water rice ecosystem (4.56%). The results of economic analysis suggest that out of 20 technical constraints eight constraints were causing maximum production loss. The benefit-cost ratio (BCR) for these constraints ranges from 31.3 for stem borer to 4.1 for gall midge. BCR for bacterial leaf blight, brown leaf spot and sheet rot diseases were estimated to be 29.3, 20.0 and 15.1, respectively. Therefore, there is a need to develop genetically potential high-yielding varieties resistance to insect pests and diseases.

2.3 Methodology for development of priority matrix and assessment of priorities for agricultural research

Davis *et al.* (1989) used the average of 1979-81 data while prioritising the agricultural research. A multi-regional international trade model using concepts of economic surplus was employed to derive ex-ante measures of the relative economic benefits of alternative commodity and regional research profiles and the distribution of

these benefits among consumers, producers, importers and exporters. The empirical analysis was conducted at an international level which included all major producing and consuming regions of the world. Relatively homogeneous research domains are defined for each commodity. Spill-over effects from regions where research is conducted to other regions with similar agro-ecology and rural infrastructure raised from 64 to 82 per cent of the total benefits depending on the commodity.

American Society of Civil Engineers (1990) in their report on research in irrigation and drainage list out top priority research needs which are presented under 6 categories. Report mainly emphasized on two critical topics; firstly, the quality of water and secondly, declining water availability. Lastly, they concluded that improved and more economically viable management practices and alternatives must be developed.

Hutchinson and Cook (1988) in their study on research and development opportunities for alternative uses of oats and oat products in northern Ireland examine the relation between production and changing trends in product demand at primary producer, processor and consumer levels. The report outlines interdisciplinary research and development opportunities for increasing the demand and consequently production of oats. General directions are suggested for future research and development of this cereal within the concept of alternative uses. Main emphasis has been given to alternative uses of oats and oat based products.

Mangabat *et al.* (1990) in their study on research priority assessment in Philippine agriculture, primarily discussed the prioritization or ranking of physical commodities for research purposes using quantitative criteria. The paper also reviews and integrates the criteria used by the major agricultural research and planning agencies in their priority setting criteria.

Joen and Halos (1991) conducted intensive field survey of the post harvest systems on 239 cassava farms in Nigeria over 18 months. The processing of cassava, labour requirement, post harvest losses and product quality were discussed. The priority research areas identified were establishing a post-harvest database and developing post-harvest technology packages, which address the technological needs of the female processors.

Jha *et al.* (1995) used the modified congruence analysis for setting the research priorities for Indian agriculture. The analysis involves seven broad steps to arrive at the priority, viz., (1) identification of goals of organization, research objectives and extensity parameters (2) selection of weights of extensity parameters, (3) selection of research priority dimensions (4) construction of Initial Baseline (IBL) (5) Modification of IBL (6) Deriving Final baseline (FBL) (7) Priority setting by commodities and states. State was taken as regional dimension and priority set at this level. The extensity parameters selected for study are value of product, number of people below poverty line, sustainable use of land and export of agriculture produce. The result of IBL set highest priority for most of eastern states and states where dry land agriculture dominates. FBL/VOP ratios imply that most of the eastern states and the dry land areas of Andhra Pradesh, Karnataka and Madhya Pradesh would need more than their proportionate share in terms of VOP. The prioritisation by commodity groups gives greater emphasis for pulses, oilseeds, fruits and vegetables, spices and agroforestry

Joshi *et al.* (1998) while studying the research prioritisation of Rainfed Rice Production System, in India selected the agro-eco-subregions from 4 to 14 and data pertaining to the years between 1991 to 94. Priorities were set at the aggregate level and production system level. Efficiency, equity, poverty and sustainability criteria were used

at aggregate level priority setting. The results of this analysis suggested that about 38 per cent of the total available research resources should be allocated to the rainfed rice production system followed by 21 per cent to sorghum and 19 per cent to groundnut production systems. The results of the priority setting at production system level suggested that within rainfed rice production system, about 61 per cent of the resources should go to crops where as 24 per cent should go to fruits and vegetables, 12 per cent to dairy enterprises and 3 per cent to small ruminants.

Thiombiano and Andriesse (1998) proposed a model for identification of research issues in a case study of research priority setting by a stepped agro-ecological approach for the Sahet of Burkina Faso. It includes a set of criteria to weigh the relevance of identified research projects using an agro-ecological approach by a multidisciplinary team. In this approach, emphasis is placed on the assessment of the impact of these expected results of research projects with regard to productivity, ecological, economical and social sustainability.

Birthal *et al.* (2000) assess the research priorities for livestock sector in India using the data pertaining to the year 1997-98. The study has identified regional species and commodity priorities for allocation of limited research resources in a multicriteria framework with efficiency, equity and trade participation as research objective.

METHODOLOGY

III. METHODOLOGY

This chapter presents hereunder the delineation and description of the study area, nature and sources of data, the sampling design and the analytical techniques employed in the present study.

3.1 Delineation of the Study Area

Karnataka is the eighth largest state in India with an area of 1,91,791 Square kilometers. It is situated between 11.5^0 and 19.0^0 N latitude and between 74^0 and 78^0 E longitude in the southern plateau. According to 1991 census, Karnataka had a total population of 44.61 million comprising 22.86 million males and 21.95 million females with an overall literacy rate of 55.98 per cent. The average annual rainfall of the state is about 1139 mm from both South-West and North-East monsoons. The temperature ranges from 21.5^0 C to 31.7^0C. Important crops grown in the state are jowar, paddy, ragi, maize, bajra and wheat among cereals, red gram, green gram, tur and bengalgram among pulses. Groundnut, sunflower, safflower and sesamum among oilseed crops; chilli, sugarcane, cotton and tobacco among commercial crops; onion, brinjal, potato and tomato among vegetable crops; Mango, sapota, grape, guava and banana among fruit crops; and coconut among the plantation crops

3.2 Description of the Selected Zones

3.2.1 Northern Transitional Zone (Zone-VIII)

The northern transition zone lies between 14^o 13'to 16^o 41' N latitude and 74^0 32' to 75^0 38' E longitude with the altitude ranging from 557.4 to 769.9 m, the lowest being the Haveri taluk (557.4m) and the highest being Dharwad taluk (769.9 m) (Fig. 3.1). The zone is a narrow strip ranging from Chikkodi taluk in Belgaum district in north upto Hirekerur taluk of Haveri district in south (Fig 3.1.), with the total cultivable area of 9.45 lakh hectares, with an irrigated area of 0.82 lakh hectares. The land utilization pattern of this zone is presented in

Table-3.1: Zone wise land use pattern in selected zones for triennium ending 1999-2000

(In ha)

Sl. No	Particulars	Agro- climatic Zones			Overall
		Z-VIII	Z-IX	Z-X	
1.	Area under forest	112922 (9.45)	682191 (67.53)	480979 (41.20)	1276092 (37.84)
2	Land not available for cultivation				
a	Other than agriculture	74701 (6.25)	32966 (3.26)	104880 (8.98)	212547 (6.30)
b	Waste land	26428 (2.21)	16682 (1.65)	80795 (6.92)	123905 (3.67)
	Total	**101129 (7.28)**	**49648 (4.91)**	**185675 (15.90)**	**336452 (9.98)**
3.	Others				
a	Cultivable waste	8852 (0.74)	8938 (0.88)	74489 (6.38)	92279 (2.74)
b	Grazing land	26755 (2.24)	19095 (1.89)	38235 (3.27)	84085 (2.49)
c	Tress and groves	1832 (0.15)	4862 (0.48)	85013 (7.28)	91707 (2.72)
	Total	**37439 (3.13)**	**32895 (3.25)**	**197737 (16.93)**	**268071 (7.95)**
4.	Fallow land				
a	Current	51629 (4.32)	25863 (2.56)	19934 (1.71)	97426 (2.89)
b	Others	14625 (1.22)	7987 (0.79)	19021 (1.63)	41633 (1.23)
	Total	**66254 (5.54)**	**33850 (3.35)**	**38955 (3.34)**	**139059 (4.12)**
5.	Net sown area	877197 (73.41)	211548 (20.94)	264034 (22.62)	1352779 (40.11)
6.	Geographical area	1194941 (100)	1010132 (100)	1167380 (100)	3372453 (100)

Note: Figures in parentheses indicate percentage to zone total

Table 3.1. The zone lies between northern dry zone (Zone 3) in the east and the Hilly zone (zone 9) in the west, occupying 6.357 per cent of the total geographical area of the state. This zone consists of 14 taluks in Belgaum, Dharwad, Haveri and Gadag districts. The details of the taluks are shown in Table 3.2. The total population of the zone is 54 lakhs, with a male population of 27 lakh and that of female around 26 lakhs (1991 census). Out of the total population, about 61.9 per cent is residing in rural areas.

In general, the topography of the zone is undulating in parts of Hirekerur, Hubli, Dharwad, Hukkeri and Belgaum taluks and fairly level in the rest of the area. This zone has the soils ranging from shallow red to deep black. The zone is blessed with both South-West and North-East monsoons, spread over from May to November, which facilitate growing of both kharif and rabi crops. As the soils are of different characters, varied crops are grown suiting to soil type. In this zone different cropping systems and intercropping practices are followed, which is unique in the state. The major rivers flowing through this zone are Ghataprabha, Malaprabha, Bhadra and Varada. The irrigated area in this zone is less as compared to other zones. Major irrigation is through wells.

Among the cereals, sorghum is an important crop grown in the region in all the taluks of the zone. Important pulses crops grown are greengram and tur. Groundnut is an important oil seed crop grown in the zone. Cotton, sugarcane and tobacco are important commercial crops grown in the zone. Important spice crops grown in this region are chilli, onion, garlic and pepper and coconut is an important plantation crop. Mango, guava, sapota and banana are the important fruit crops grown in this region. Important vegetable crops grown are potato, tomato, brinjal, beans and Cole crops.

Table-3.2: Details of Districts and Taluks in Zone-VIII, IX and X

Zone	District	Taluks	NO. of taluks
VIII	Dharwad	Dharwad, Hubli, Kundgol,	3
	Gadag	Shirahatti	1
	Haveri	Savanur, Shiggaon, Haveri, Hirekerur, Ranebennur, Byadagi	6
	Belgaum	Bailhongal, Belgaum, Chikkodi, Hukkeri	4
IX	Uttara Kannada	Sirsi, Siddapur, Supa, Yellapur, Haliyal, Mundgod	6
	Belgaum	Khanapur	1
	Shimoga	Soraba, Hosanagar, Sagar, Thirthahalli	4
	Chickkmagalur	Koppa, Sringeri, Mudigere, N. R. Pura, Chickkmagalur	5
	Dharwad	Kalghatagi	1
	Haveri	Hangal	1
	Kodagu	Virajpet, Somwarpet, Mercara	3
	Hassan	Sakaleshapur	1
X	Uttara Kannada	Karwar, Kumta, Honnavar, Bhatkal, Ankola	5
	Dahshina Kannada	Mangalore, Bantwal, Belthangadi, Puttur, Sullya	5
	Udupi	Udupi, Kundapura, Karkala	3

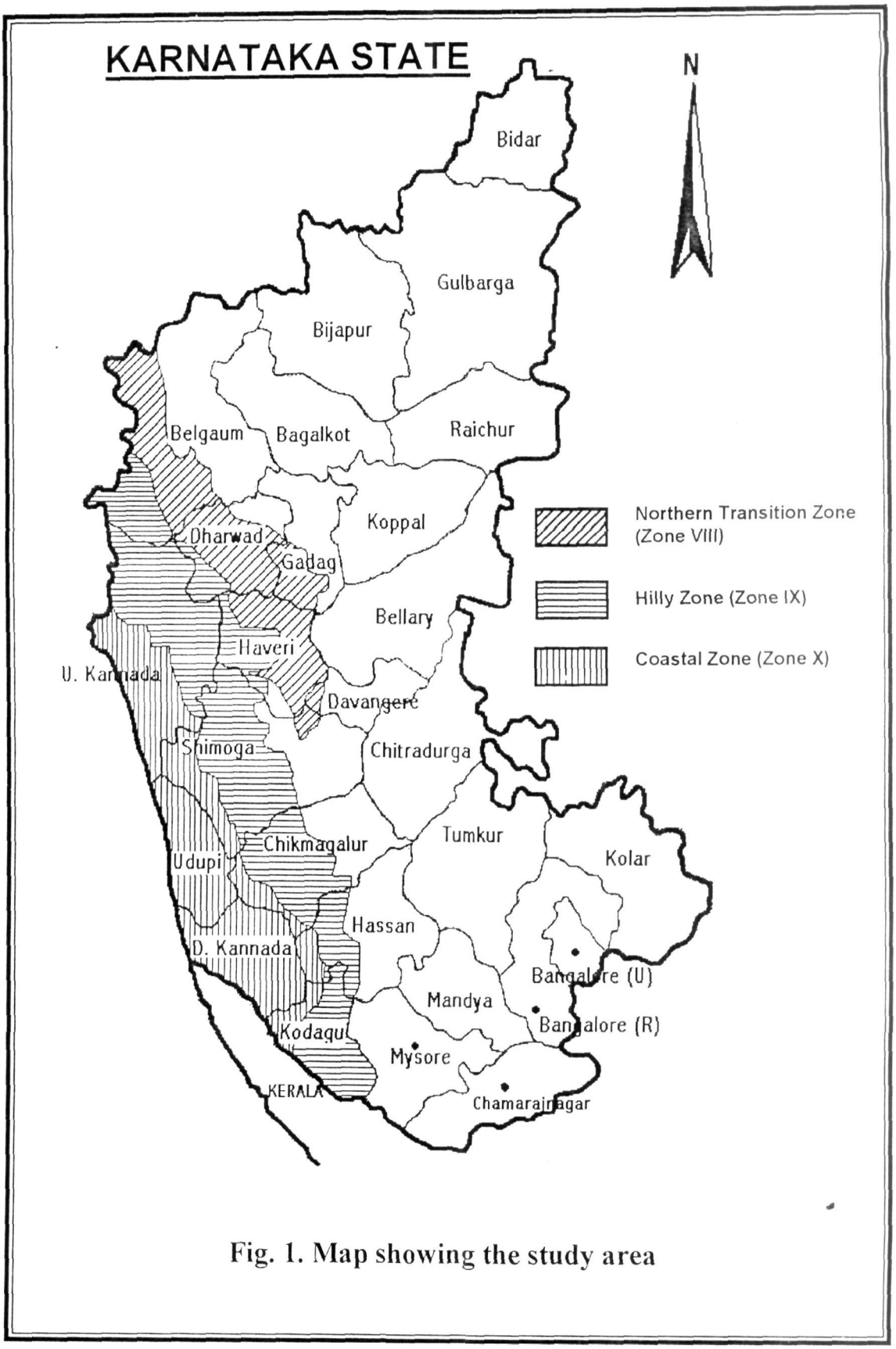

Fig. 1. Map showing the study area

3.2.2 Hilly Zone (Zone-IX)

The Hilly Zone lies between 12°13 ' to 15° 41 ' N latitude and 74° 10 ' to 76° 15 ' E longitude, with the altitude ranging from 800 to 900 m The zone is also called as Malnad zone having distinct agro-climatic features with rolling topography of mountains and deep valleys. This zone has the total geographical area of 2,289,023 ha of which 5,81,525 hectare area is under cultivation with the total cultivable area of 9.45 lakh hectares and with irrigated area of 0.82 lakh hectares. The zone lies between Coastal zone (Zone 10) on the East, Northern Transitional zone (zone 8) on the North and Southern Transitional zone (zone 7) on the West, occupying 6.36 per cent of the total geographical area of the state. This zone consists of 22 taluks in Uttara Kannada, Belgaum, Shimoga, Chickmagalore, Dharwad, Kodagu and Haveri districts, the details of which are shown in Table3.1. The land utilization pattern of this zone is presented in Table 3.1.The total population of the zone is 17.50 lakhs, with a male population of 9.50 lakh and that of female around 8.00 lakh (1991 census).

In general, the topography of the zone is hilly. This zone has the soils ranging from red clay loamy to lateritic soils. The average annual rainfall of the zone is 2209 mm of which about 80 per cent of the annual rainfall is received in normal monsoon and the monthly temperature of the zone varies from 16.6^0 C to 25.2^0 C.

Among cereals, paddy and sorghum are important crops grown in the zone; among pulses, important crops grown are greengram, blackgram and tur. Groundnut is an important oilseed crop grown in the zone. Cotton and sugarcane are important commercial crops grown in the zone; the important spice crops grown in this region are black pepper and garlic, and coconut is an important plantation crop. Mango, guava, sapota and banana are the important fruit crops grown in this region. Important vegetable crops grown are potato, tomato, brinjal, beans and Cole crops

3.2.3 Coastal Zone (Zone-X)

The coastal zone lies between 12^0 30' to 15^0 0' N latitude and 74^0 05' 76^0 00'E longitude with altitude less than 300 m and has the total geographical area of 9,84,307 hectare of which 2,26,873 hectare is under cultivation. The land utilization pattern of this zone is presented in Table 3.1. In general the topography of the zone is coastal in almost all parts of zone. This zone consists of thirteen taluks of Uttar Kannada, Dakshina Kannada and Udupi districts. The total population of this zone is 97 lakhs, with a male population of 46 lakhs and that of female is around 50 lakhs (1991 census). The soils are red lateritic and coastal alluvial. The average annual rainfall of this zone is 3893 mm of which about 80 per cent of annual rainfall is received in the normal monsoon season (June to September). The temperature of the area varies from 23.3^0 C to 50.7^0 C.

The major cereal crops grown in the zone are paddy, jowar, bajra and wheat; among pulses redgram, greengram, blackgram and bengalgram are important crops grown in the zone. Among oilseeds, groundnut, sunflower, sesamum and safflower are important crops. sugarcane and chilli are important commercial crops grown in the zone. Among horticultural crops, banana and grapes (fruit crops) brinjal, tomato (vegetables), are the important crops grown in the zone.

3.3 Sampling Design

The multistage sampling technique was adopted in drawing the sample respondents for the study. In the first stage three zones viz., Zone-VIII Zone-IX, and zone-X zones were purposively selected. In the second stage, in each zone two districts were selected based on the agro-climatic conditions and cropping pattern prevailing. In the third stage, one taluk was selected from each of the six finalized districts. In the next stage, two villages were selected from six finalized taluks, in all twelve villages were selected for the present study. In the final

stage, from each of the selected villages nine sample farmers were chosen at random from different size group. Thus total sample comprised of 108 farmers.

3.4 Nature and Sources of Data

In the present investigation, both secondary and primary data were used. For development of priority matrix, the taluk level data on area, production and prices of each commodity, the data on other indicators of priority setting criteria like sustainability and equity were collected from the Directorate of Economics and Statistics (DES) Bangalore, State Department of Agricultural Marketing Bangalore. Data on aforesaid variables were collected for three years, i.e., from 1997-98 to 1999-2000. For yield gap analysis and prioritization of research, the data on demonstration yield were collected from different Extension Education Units (EEU) Krishi Vignyan Kendars (KVK) and Agricultural Research Stations (ARS) of the study area.

The primary data were collected through personal interviews using pre-tested schedules designed for the purpose. The information on yield gaps and yield losses due to different constraints and information on socio-economic constraints were collected for the year 2001-2002.

3.5 Analytical Techniques

3.5.1 Yield Gap Analysis

Tabular analysis was extensively used in the study. To estimate the magnitude of yield gap in different crops between demonstration plots and farmers' fields, simple tabular analysis was used. For better understanding and meaningful comparisons, percentages and indices relating to yield gaps were computed.

Important concepts of yield gaps used in the present study are briefed below

3.5.1.1 Potential Yield (Yp)

It is the per hectare yield realised at the research station. This yield is considered to be the maximum absolute production potential of crop, since the research station conducting the trials is equipped with all the requisite resources.

3.5.1.2 Potential Farm Yield (Yd)

It is the per hectare yield realised on demonstration plots, wherein the agronomic practices are undertaken by the farmers themselves but under the supervision of agricultural extension workers. Demonstration trails are more or less research station trials conducted by the farmers under the same resource conditions but under the farmers' characteristic agro-climatic conditions. So the potential farm yield (demonstration yield) is considered to be the attainable yield by an average farmer, if such a yield is arrived at by correct and extensive trials under diverse weather conditions.

3.5.1.3 Actual Yield (Ya)

It is per hectare yield realised by the farmers on their farms with their own resources, management practices and preferences.

3.5.1.4 Total Yield Gap (TYG)

It is the difference between Potential Yield (Yp) and the Actual Yield (Ya). This Total Yield Gap comprises of Yield Gap-I and Yield Gap-II.

$$TYG = Y_p - Y_a \quad \ldots(1)$$

3.5.1.5 Yield Gap-I (YG-I)

It is the difference between the Potential Yield (Y_p) and Potential Farm Yield (Y_d).

$$YG\text{-}I = Y_p - Y_d \quad \ldots(2)$$

3.5.1.6 Yield Gap-II (YG-II)

It is the difference between the Potential Farm Yield (Y_d) and Actual Yield (Y_a).

$$YG\text{-}II = Y_d - Y_a \quad \ldots(3)$$

3.5.1.7 Index of Yield Gap (IYG)

It is the ratio of the difference between the Potential Yield (Y_p) and the Actual Yield (Y_a) to the Potential Yield (Y_p), expressed in percentage.

$$IYG = [(Y_p - Y_a)/Y_p] \times 100 \ldots (4)$$

3.5.1.8 Index of Realized Potential Yield (IRPY)

It is the ratio of the Actual Yield (Ya) to the Potential Yield (Y_p), expressed in percentage.

$$IRPY = [Y_a \div Y_p] \times 100 \ldots (5)$$

3.5.1.9 Index of Realized Potential Farm Yield (IRPFY)

It is the ratio of the Actual Yield (Ya) to the Potential Farm yield (Yd) expressed in percentage.

$$IRPFY = [Y_a \div Y_d] \times 100 \ldots(6)$$

3.5.2 Estimation of severity of constraints and calculation of production loss

The severity of constraints was estimated through estimation of yield loss. The procedure for calculating production loss is given below

$$\Phi = n.p.l$$

Where,

Φ = Average yield loss attributed to each constraint (kg/ha),

n = Proportion of area affected (Per cent),

p = Probability of occurrence of a particular constraint (per cent),

l = Absolute yield loss attributed to each constraint (kg/ha).

$$\eta = \Phi . N$$

Where,

η = Total production loss (Quintals),

Φ = As explained above,

N = Area under individual crop in particular zone.

3.5.3 Ranking of socio-economic constraints

Apart from technical constraints the socio-economic constraints also affect the production of different crops and resulted in production loss. Prioritizing socio-economic constraints is more difficult. Crop-wise analysis was not possible as the same set of constraints affect the entire region irrespective of crops or crop systems. Therefore, cardinal measurement of their impact on yield gap could not be tried but the farmers were asked to rank the constraints as per their severity. A comprehensive list of socio-economic constraints was given to them and they were asked to assign the value 1 to the most limiting constraint,

value 2 to the next important one, and so on. Then the rank values were averaged across the villages and a composite score is obtained on the basis of which top ten socio-economic constraints were prioritised.

3.5.4 Development of Priority Matrix

The priority matrix for each selected Zone was developed based on the value of production loss of each commodity. For this Priority matrix was developed by estimating the expected yield (sum of actual yield and production loss), expected value of production loss (by multiplying the ratio of expected yield to actual yield with aggregate value of product) and production loss (difference between the expected value of product and aggregate value of product) then the crops were prioritised based on the production loss, highest value of production loss, i.e., topper in the matrix. This was very helpful in allocating the research resources for the commodity prioritized. Apart from it priority matrix was based on the value of product (VOP) of each crop, Higher the VOP, topper in the matrix.

RESULTS

IV. RESULTS

Consistent with the objectives of the study, the results obtained from the analysis of data and are presented under the following heads.

4.1 Socio-economic characteristics of the sample farmers

4.2 Magnitudes and indices of yield gap

4.3 Estimated production losses in different crops and prioritisation of agricultural research in different crops

4.4 Socio-economic constraints faced by farmers in production of different crops

4.5 Priority matrix for selected zones

4.1 Socio-economic characteristics of sample farmer

Table 4.1 represents the socio-economic characteristics of sample farmers in the study area. Average age of the respondents across the zones was 41.07 years ranging from 40.13 years in the case of zone- IX to 42.11 years in case of zone-X with 84.25 per cent literacy rate. Majority (63.89%) of the sample farm families were of joint type. In the study area, average size of the family was 9.96 members ranging from a high of 10.36 to 9.55 members per family. The land holding pattern in the study area revealed that average size of land holding of the sample farmers was 3.86 ha, of which only 20.44 per cent had irrigation facility. The zone-wise analysis revealed that the highest farm size (4.16 ha) was noticed in zone-X followed by zone-VIII and the lowest was observed in zone-IX (3.59 ha). The proportion of irrigated area was more in zone- IX (27.09%), followed by zone-X (22.31%) and the lowest was observed in zone-VIII (12.05%).

4.2 Magnitudes and indices of yield gap

The results of the estimated yield gaps in different crops are presented in various tables as discussed here under and the same have been depicted graphically.

Table-4.1: Socio-economic Characteristics Features of the Respondent

Sl.	Particulars	Units	Z-VIII	Z-IX	Z-X	Overall
1	Average age of the respondent	Yrs.	40.97	40.13	42.11	41.07
2	Literacy	%	83.30	80.55	88.89	84.25
3	Family type					
a	Nuclear	%	41.66	38.89	27.78	36.11
b	Joint	%	58.33	61.11	72.22	63.89
4	Family Size					
a	Male	Nos.	4.58	3.94	3.97	4.16
b	Female	Nos.	3.64	3.42	3.64	3.55
c	Children	Nos.	2.14	2.19	2.36	2.23
	Total	Nos.	**10.36**	**9.55**	**9.97**	**9.96**
5	Land holding					
a	Rainfed	Ha	3.36 (87.95)	2.62 (72.91)	3.23 (77.69)	3.07 ((79.56)
b	Irrigated	Ha	0.46 (12.05)	0.97 (27.09)	0.93 (22.31)	0.79 (20.44)
	Total	Ha	**3.82 (100)**	**3.59 (100)**	**4.16 (100)**	**3.86 (100)**

Note: Figures in parentheses indicate percent to total
Z-VIII= Zone-VIII, Z-IX=Zone-IX, Z-X=Zone-X

4.2.1 Yield gaps in different crop groups

4.2.1.1 Yield gaps in cereal crops

Yield gaps of paddy, jowar, maize and wheat crops are presented in Table-4.2. In the case of paddy production, the magnitude of total yield gap on overall category was 70.70 quintals per ha and this gap was relatively higher in zone-X (87.74 q/ha) followed by zone-IX (79.75 q/ha) and zone-VIII (44.60 q/ha).

The magnitude of yield gap-I was much higher than yield gap-II in paddy crop. Across all zones Yield gap-I was 50.00 q/ha. The size of yield gap-I in zone-IX and zone-X was more or less same (59 and 60 q/ha respectively) and it was the least in the case of zone-VIII (31 q/ha). The smallest size of yield gap-II (13.60 q/ha) was observed on farms of zone-VIII and the largest (27.74 q/ha) was observed on farms of zone-X.

Jowar production was seen only in zone-VIII and zone-IX wherein the actual yield realised in both the zones were almost same (i.e., 7.32 and 7.08 q/ha, respectively). But the yield gap analysis revealed that the zone-VIII farmers were unable to realise the potential yield on the farm as compared to zone-IX farmers. The magnitude of all types of yield gaps was higher in the case of zone-VIII than in zone-IX. It is apparent from the results presented in table that the size of yield gap-I, yield gap-II and total yield gaps in zone-VIII were 10.00 q/ha, 7.68 q/ha and 17.68 q/ha, respectively, where as the respective yield gaps for zone-IX were 7.00 q/ha, 2.92 q/ha and 9.92 q/ha. Maize and wheat were produced only in zone-VIII wherein the total yield gap of maize was 67.39 q/ha and that of wheat was 8.60 q/ha. In the case of both maize and wheat crops, the yield gap-I constituted around 43 per cent of potential yield and yield gap-II constituted around 27 per cent of potential farm yield.

Table-4.2: Realized Yield Levels and the Estimated Yield Gaps in Cereals in Selected Zones

(Quintals per ha)

Sl No.	Particulars	Paddy				Jowar			Maize	Wheat
		Z-VIII	Z-IX	Z-X	Overall	Z-VIII	Z-IX	Overall	Z-VIII	Z-VIII
1.	Potential yield	80.00	135.00	155.00	123.33	25.00	17.00	21.00	115.00	14.50
2.	Potential farm yield	49.00	76.00	95.00	73.33	15.00	10.00	12.50	65.00	8.25
3.	Actual yield	35.40	55.25	67.26	52.64	7.32	7.08	7.20	47.60	5.90
4.	Yield Gap-I	31.00	59.00	60.00	50.00	10.00	7.00	8.50	50.00	6.25
5.	Yield Gap-II	13.60	20.75	27.74	20.70	7.68	2.92	5.30	17.39	2.35
6.	Total yield gap	44.60	79.75	87.74	70.70	17.68	9.92	13.50	67.39	8.60

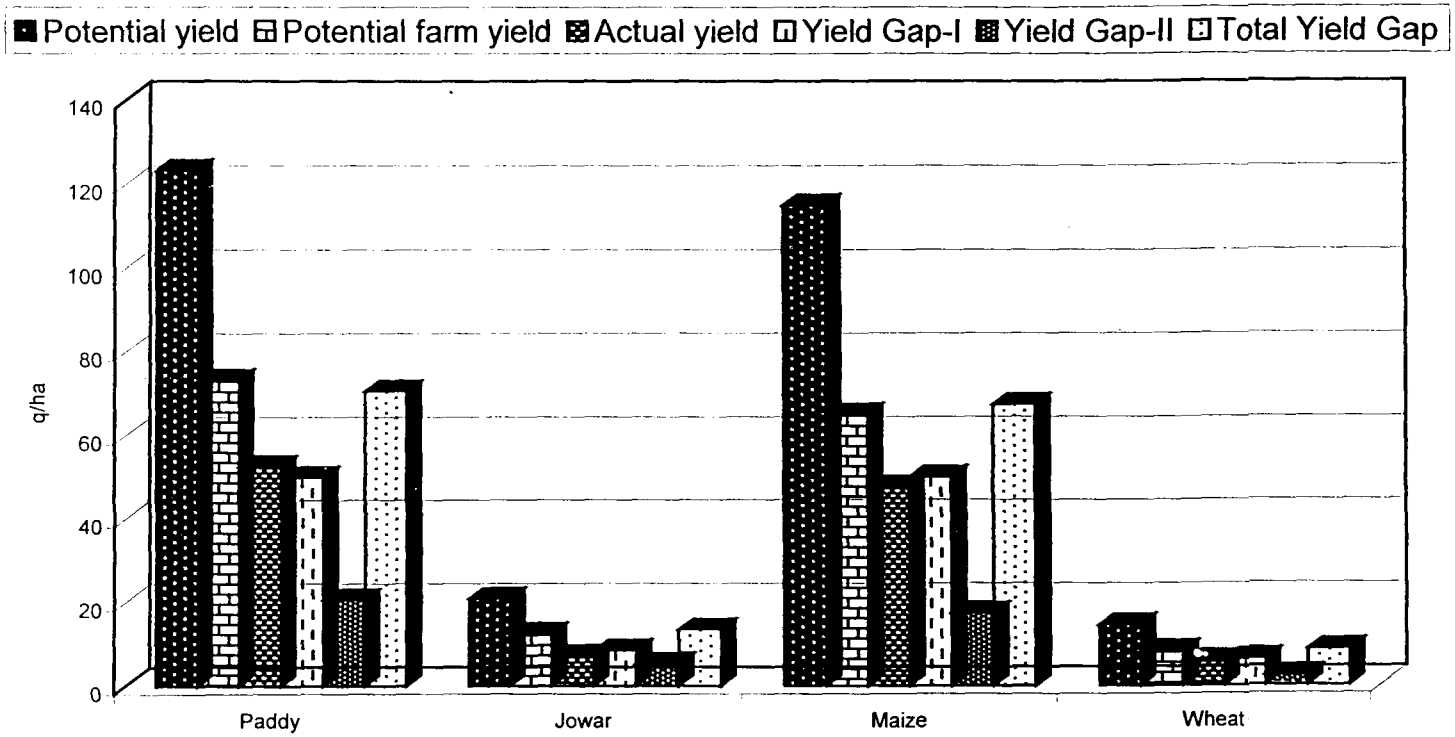

Fig.2: Realized crop yields and the estimated yield gaps in cereal crops for study area (zone-VIII, zone-IX and zone-X)

4.2.1.2 Yield gaps in pulses

Yield gaps were estimated for bengalgram, horsegram, greengram, blackgram and cowpea among pulses and are presented in the Table-4.3. Production of pulse crops was generally not seen in zone-IX. In greengram the magnitude of yield gap-I was higher than yield gap-II in both the zones. The magnitude of yield gap-I was 5 q/ha in zone-X and 4.00 q/ha in zone-VIII which worked out to be 4.50 q/ha for both the zones put together. Yield gap-II was more on farms of zone-VIII (3.29 q/ha) than of zone-X (2.92 q/ha). The size of the total yield gap was 7.60 q/ha across zones, with marginally higher yield gap in zone-X (7.92 q/ha) compared to zone-VIII (7.28 q/ha).

Production of blackgram, cowpea and horsegram was observed only in zone-X. Yield gap-I constituted 25.92 per cent, 37.50 per cent and 39.47 per cent of potential yield respectively in horsegram, blackgram and cowpea. Like wise yield gap-II constitute 41.00 per cent for horsegram, 31.47 per cent for blackgram and 29.61 per cent for cowpea of potential farm yield. The estimated total yield gap of cowpea was around 22 q/ha while it was 3.70 q/ha and 4.43 q/ha for horsegram and blackgram, respectively.

4.2.1.3 Yield gaps in oilseed crops

Estimates of yield gaps in oilseed crops are presented in the Table 4.4 for groundnut, sunflower and soybean. In the case of groundnut production, the magnitude of yield gap-I was highest in the case of zone-VIII (13.00 q/ha) followed by zone-X (11.00 q/ha) and zone-IX (10.50 q/ha). Estimates of yield gap-II revealed that the highest yield gap (7.84 q/ha) was found on farms of zone-VIII and the least (3.97 q/ha) on farms of zone-X. The size of the total yield was 16.79 q/ha for all the three zones.

Sunflower and soybean cultivation was observed only in zone-VIII and zone-IX, respectively. The size of total yield gap in sunflower was 14.88 q/ha and it was 29.70 q/ha in

Table-4.3: Realized yield levels and the estimated yield gaps in pulse in selected zones

(Quintals per ha)

Sl No.	Particulars	Bengalgram	Horsegram	Greengram			Blackgram	Cowpea
		Z-VIII	Z-X	Z-VIII	Z-X	Overall	Z-X	Z-X
1.	Potential yield	18.00	6.75	12.00	15.00	13.50	6.00	38.00
2.	Potential farm yield	11.00	5.00	8.00	10.00	9.00	3.75	23.00
3.	Actual yield	7.08	2.95	4.72	7.08	5.90	2.57	16.19
4.	Yield Gap-I	7.00	1.75	4.00	5.00	4.50	2.25	15.00
5.	Yield Gap-II	3.92	2.05	3.28	2.92	3.09	1.18	6.81
6.	Total yield gap	10.92	3.80	7.28	7.92	7.60	4.43	21.81

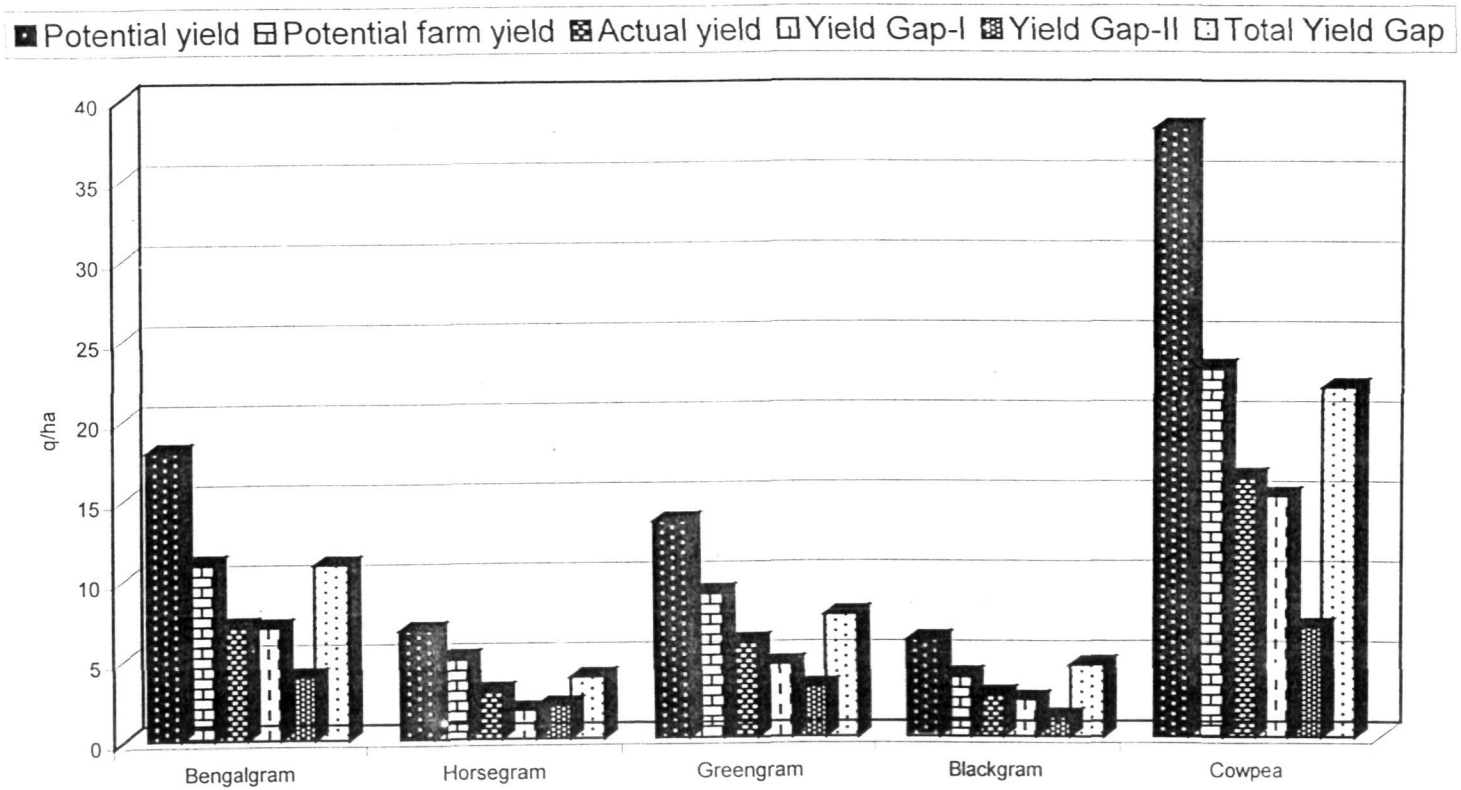

Fig.3: Realized crop yields and the estimated yield gaps in pulse crops for study area (zone-VIII, zone-IX and zone-X)

Table-4.4: Realized yield levels and the estimated yield gaps in oilseeds crops in selected zones

(Quintals per ha)

Sl No.	Particulars	Groundnut				Sunflower	*Soybean*
		Z-VIII	Z-IX	Z-X	Overall	Z-VIII	Z-IX
1	Potential yield	35.00	25.00	25.00	28.33	25.50	50.00
2	Potential farm yield	22.00	14.50	14.00	19.50	14.50	28.50
3	Actual yield	14.16	10.43	10.03	11.54	10.62	20.30
4	Yield Gap-I	13.00	10.50	11.00	11.50	11.00	21.50
5	Yield Gap-II	7.84	4.07	3.97	5.29	3.88	8.20
6	Total yield gap	20.84	14.57	14.97	16.79	14.88	29.70

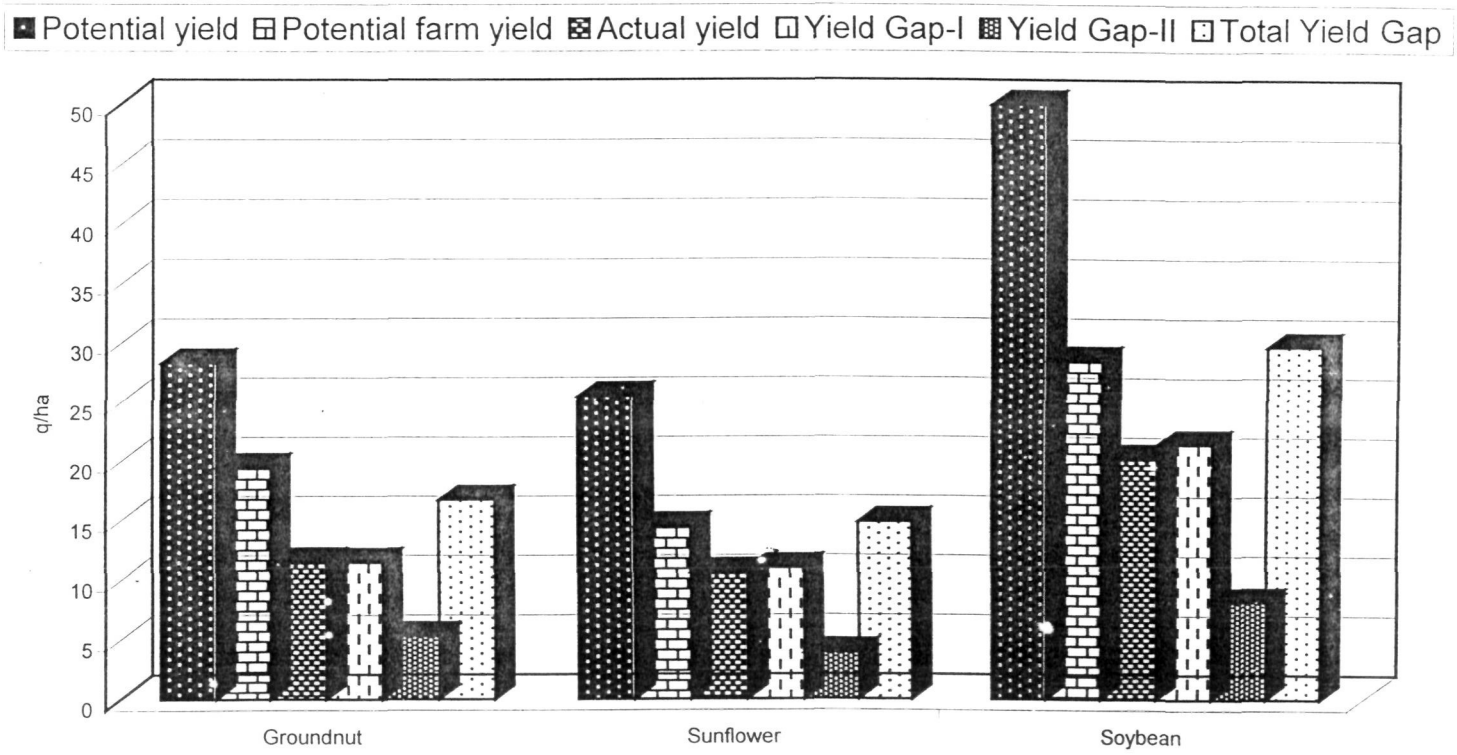

Fig.4: Realized crop yields and the estimated yield gaps in oilseed crops for study area (zone-VIII, zone-IX and zone-X)

soybean. The yield gap-I constituted around 43 per cent of potential yield in both the crops, whereas yield gap-II constituted 26.76 per cent of potential farm yield in sunflower production and 28.77 per cent in soybean production.

4.2.1.4 Yield gaps in commercial crops

Amongst commercial crops, yield gaps for chilli, cotton and sugarcane were estimated and are presented in Table 4.5. In cotton, the size of total yield gap was 12.48 q/ha across zones. This comprised of relatively higher size of yield gap-I (8.75 q/ha) than yield gap-II (3.73 q/ha). Among the different zones, yield gap-I and yield gap-II were higher (10 q/ ha and 4.38 q/ha, respectively) on farms of zone-IX than zone-VIII (7.50 and 3.08 q/ha, respectively) farms.

The magnitude of total yield gap on sugarcane farms across zones was 650.66 q/ha and this gap was marginally higher in zone-X (858.36 q/ha) than in zone-IX (850.28 q/ha), while, it was considerably lower in zone-VIII (263.41 q/ha). The size of yield gap-I in zone-X (650 q/ha) was much higher than that of zone-VIII (150 q/ha) while it worked out to be 471.67 q/ha for the overall sugarcane sample farms. The difference between the potential farm yield and actual yield (yield gap-II) was less on zone-VIII farms (113.41 q/ha) and more on zone-IX (235.28 q/ha) farms.

4.2.1.5 Yield gaps in vegetable crops

Among the vegetable crops, onion, brinjal and okra were grown in zone-VIII, zone-X and zone-IX, respectively (Table-4.6). In the case of onion, the total yield gap was 46.38 q/ha in which yield gap-I accounts for 45 per cent and yield gap-II acccunts for around 75 per cent of the potential farm yield. Likewise, the yield gap-I in brinjal was 22 q/ha which accounts for 48 per cent of the potential yield and yield gap-II was 9.40 q/ha, which accounts for 70 per cent of potential farm yield. In okra, yield gap-I was 28.50 q/ha and yield gap-II was

Table-4.5: Realized yield levels and the estimated yield gaps in commercial crops in selected zones

(Quintals per ha)

Sl No.	Particulars	Chilli	Cotton			Sugarcane			
		Z-VIII	Z-VIII	Z-IX	Overall	Z-VIII	Z-IX	Z-X	Overall
1	Potential yield	17.50	18.00	25.00	21.50	500.00	1450.00	1500.00	1150
2	Potential farm yield	10	10.50	15.00	12.75	350.00	835.00	850.00	678.33
3	Actual yield	7.08	7.41	10.62	9.02	236.59	599.72	641.64	492.65
4	Yield Gap-I	7.50	7.50	10.00	8.75	150.00	615.00	650.00	471.67
5	Yield Gap-II	2.92	3.08	4.38	3.73	113.41	235.28	208.36	185.68
6	Total yield gap	10.42	10.58	14.38	12.48	263.41	850.28	858.36	650.66

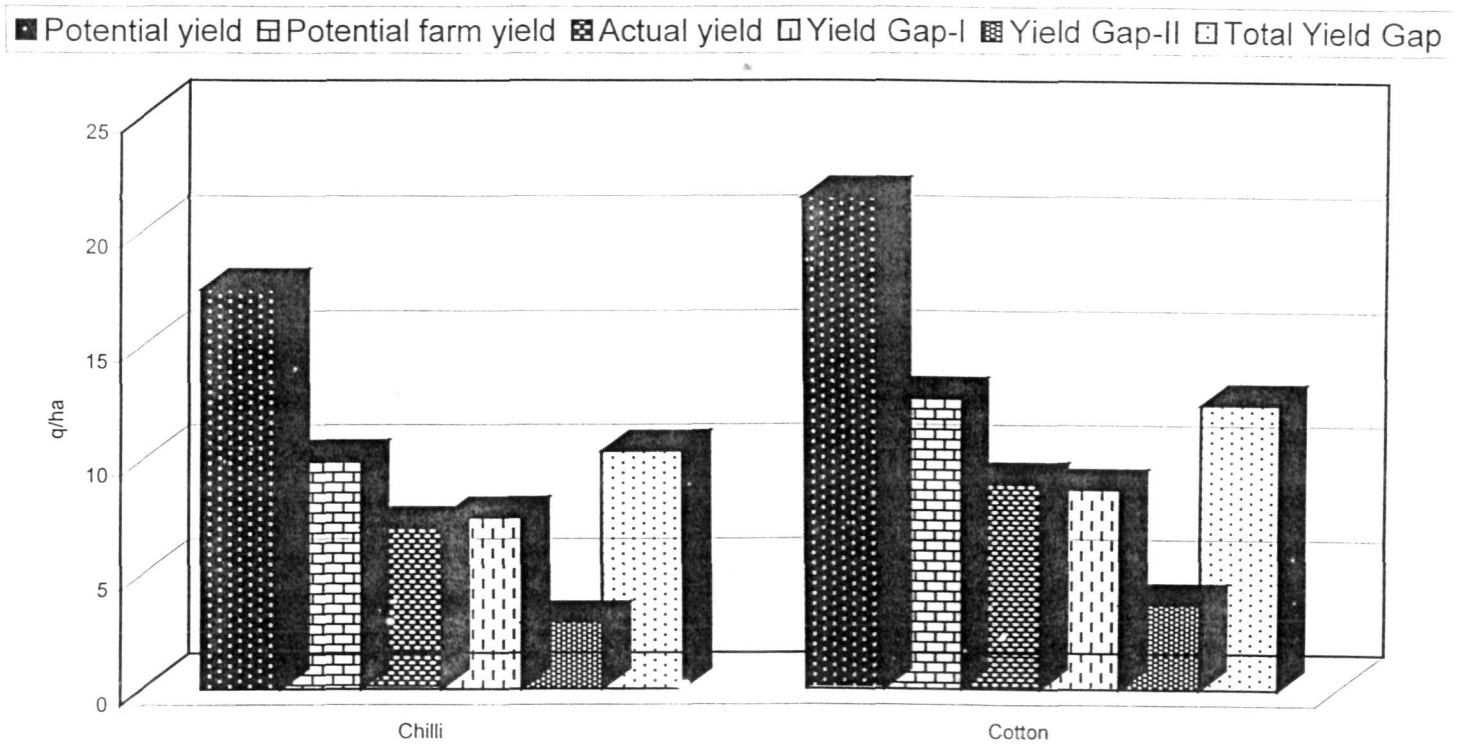

Fig.5: Realized crop yields and the estimated yield gaps in commercial crops for study area (zone-VIII, zone-IX and zone-X)

Table-4.6: Realized yield levels and the estimated yield gaps in vegetable crops in selected zones

(Quintals per ha)

Sl No.	Particulars	Onion	Brinjal	Okra
		Z-VIII	Z-X	Z-IX
1	Potential yield	78.00	55.00	68.00
2	Potential farm yield	44.00	33.00	39.50
3	Actual yield	31.62	23.60	28.32
4	Yield Gap-I	34.00	22.00	28.50
5	Yield Gap-II	12.38	9.40	11.18
6	Total yield gap	46.38	31.40	39.68

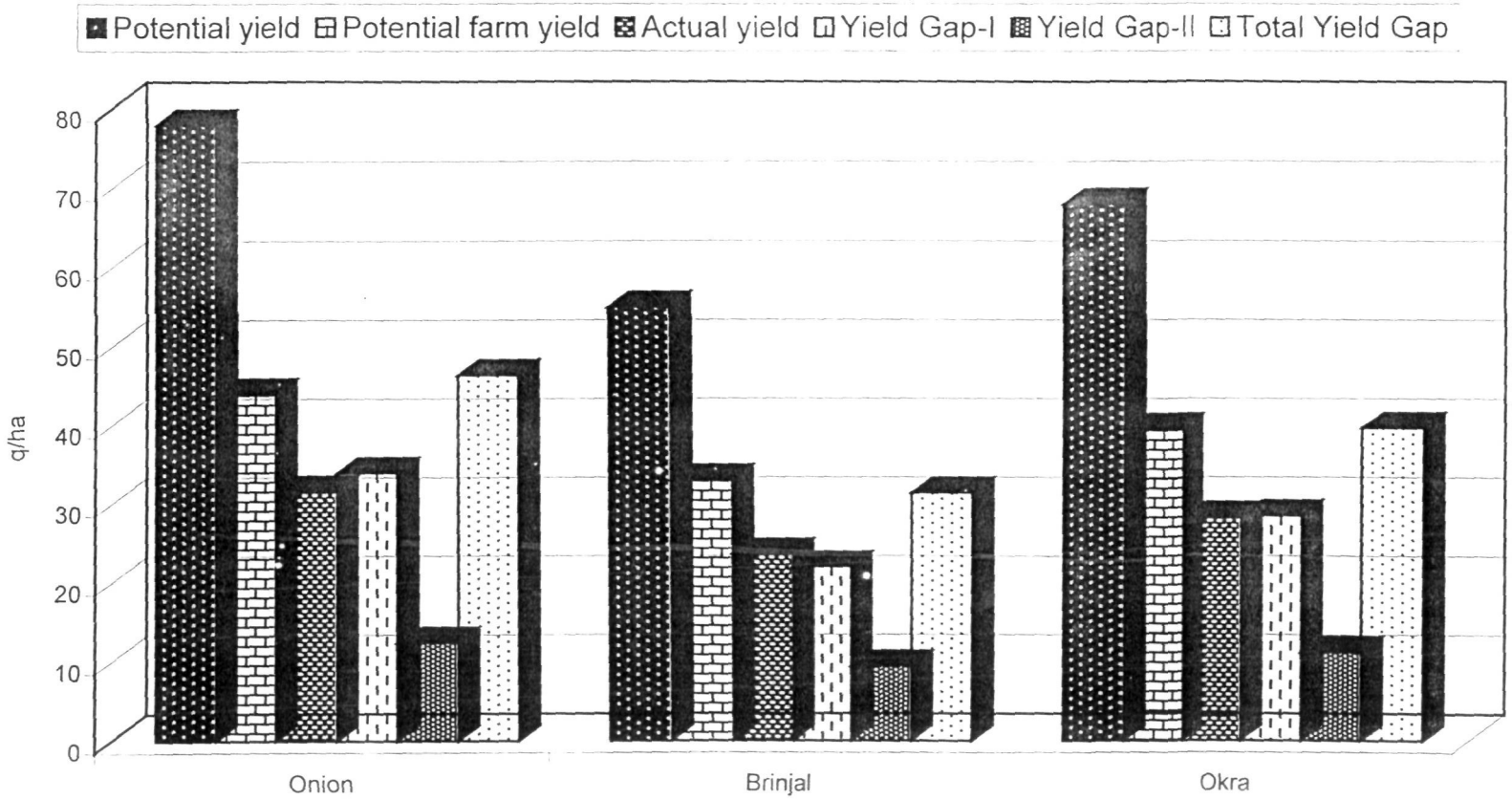

Fig.6: Realized crop yields and the estimated yield gaps in vegetable crops for study area (zone-VIII, zone-IX and zone-X)

11.18 q/ha. These yield gaps constitute for 30 per cent each of potential yield and potential farm yield, respectively.

4.2.2 Estimated Yield Gap Indices

For better understanding of yield gaps, index of yield gap, index of realised potential yield and index of realised potential farm yield were estimated.

4.2.2.1 Yield gap indices in cereal crops

The index of yield gap denotes the extent of unrealized potential yield. Indices of yield gap were worked out for paddy, jowar, maize and wheat crops (Table-4.7). In the case of paddy, index of yield gap was 57.15 per cent across the zones. It was the highest for zone-IX (59.07%) followed by zone-X (56.61%) and zone-VIII (55.75%). Index of realized potential yield in the case of paddy, across the zones was 42.85 per cent. It was relatively higher in the case of zone-VIII (44.25%) than zone-X (43.39%) and zone-IX (40.93%). Analysis of index of realized potential farm yield was 72.24 per cent, 72.69 per cent and 70.80 per cent for zone-VIII, zone-IX and zone-X, respectively. It was around 72 per cent across the zones.

In the case of jowar, the index of yield gap was the higher for zone-VIII (70.74%) than for zone-IX (58.35%), while index of realized potential yield was the lower in the case of zone-VIII (29.26%), than for zone-IX (41.65%) and it was 34.45 per cent for overall farms. Index of realized potential farm yield showed a different trend wherein a higher index (70.80%) was observed in the case of zone-IX and about 59.78 per cent for both zone-VIII and zone-IX.

Maize and wheat were grown in zone-VIII. Index of yield gap was 58.61 per cent for maize and 59.31 per cent for wheat. Index of realized potential yield was around 41 per cent

Table-4.7: Estimated indices of yield gaps in important cereals crops in selected zones

(Per cent)

Sl No.	Particulars	Paddy				Jowar			Maize	Wheat
		Z-VIII	Z-IX	Z-X	Overall	Z-VIII	Z-IX	Overall	Z-VIII	Z-VIII
1	Index of yield gap	55.75	59.07	56.61	57.15	70.74	58.35	64.55	58.61	59.31
2	Index of realised potential yield	44.25	40.93	43.39	42.85	29.26	41.65	34.45	41.39	40.69
3	Index of realised potential farm yield	72.24	72.69	70.80	71.91	48.77	70.80	59.78	73.23	71.52

for both the crops. While the index of realized potential farm yield was relatively higher for maize crop (73.23%) than for wheat (71.25%).

4.2.2.2 Yield gap indices in pulse crops

The indices of yield gap for different pulse crops are presented in Table 4.8. Bengalgram was cultivated only in zone-VIII. It is apparent from the table that index of realized potential farm yield was higher (64.36%) than index of yield gap (60.67%) and index of realized potential yield (39.33%). Similarly, horse gram cultivation was seen only in zone-X. Here also, the index of realized potential farm yield was relatively higher (59.00%) as compared to index of yield gap (56.30%) and index of realized potential yield (43.70%). In the case of greengram, index of yield gap across the zones was 56.73 per cent. It was relatively higher for zone-VIII (60.67%) than for zone-X (52.80%). Index of realized potential yield was 43.27 per cent on over all basis (47.20 per cent in zone-X and 39.33 per cent in zone-VIII). Index of realized potential farm yield for zone-X was the higher (70.80%) as compared to zone-VIII (59.00%).

Black gram and cowpea were cultivated only in zone-X. Index of yield gap and index of realized potential yield were almost same for both the crops i.e., around 57 per cent and around 43 per cent, respectively. While the index of realized potential farm yield was 68.60 per cent for black gram and 70.39 per cent for cowpea.

4.2.2.3 Yield gap indices in oilseed crops

It is apparent from the results presented in the Table 4.9 that index of yield gap for all the three oilseed crops (viz., groundnut, sunflower and soybean) was about 59 per cent across the zones. This gap in the case of groundnut was the higher in zone-X (59.88%) than in zone-IX (58.27%) and zone-VIII (59.54%). Sunflower and soybean production was observed only in zone-VIII and zone-IX, respectively. The index of realised potential yield worked out to be

Table-4.8: Estimated indices of yield gaps in important pulses crops in selected zones

(Per cent)

Sl No.	Particulars	Bengalgram	Horsegram	Greengram			Blackgram	Cowpea
		Z-VIII	Z-X	Z-VIII	Z-X	Overall	Z-X	Z-X
1	Index of yield gap	60.67	56.30	60.67	52.80	56.73	57.13	57.39
2	Index of realised potential yield	39.33	43.70	39.33	47.20	43.27	42.87	42.61
3	Index of realised potential farm yield	64.36	59.00	59.00	70.80	64.90	68.60	70.39

Table-4.9: Estimated indices of yield gaps in important oilseeds crops in selected zones

(Per cent)

Sl No.	Particulars	Groundnut				Sunflower	Soybean
		Z-VIII	Z-IX	Z-X	Overall	Z-VIII	Z-IX
1	Index of yield gap	59.54	58.27	59.88	59.23	58.35	59.41
2	Index of realised potential yield	40.46	41.73	40.12	40.77	41.65	40.59
3	Index of realised potential farm yield	64.36	71.94	71.64	69.31	73.24	71.21

about 41 per cent for all crops and it did not show much variation across zones. The indices of realised potential farm yield was around 71 per cent for zone-IX and zone-X and 64.36 for zone-VIII in case of groundnut, 73.24 per cent in sunflower and 71.21 per cent in case of soybean

4.2.2.4 Yield gap indices in commercial crops

Table 4.10 depicts the estimated yield gap indices for commercial crops. Across the zones, the index of yield gap was estimated at 59.54 per cent, 58.17 per cent and 56.18 per cent in chilli, cotton and sugarcane, respectively. Chilli production was observed only in zone-VIII and cotton production was observed in zone-VIII and zone-IX. Index of yield gap in cotton was the higher (58.83%) in zone-VIII than zone-IX (57.52%). In sugarcane it was the highest (58.64%) in zone-IX than in zone-X (57.22%) and zone-VIII (52.68%). The index of realised potential yield was 41.83 per cent, 43.82 per cent and 40.46 per cent for cotton, sugar cane and chilli across zones. However, the index of realized potential farm yield did not vary considerably among the zones.

4.2.2.5 Yield gap indices in vegetable crops

The production of onion, brinjal and okra crops was observed only in zone-VIII, zone-X and zone-IX, respectively. The index of yield gap (Table-4.11) for onion, brinjal and okra was estimated at 59.46 per cent, 57.09 per cent and 58.35 per cent, respectively, whereas index of realised potential farm yield was around 72 per cent, the index of realised potential yield around 41 per cent for all the crops.

4.3 Estimated losses in the production of different crops

4.3.1 Estimated losses in the production of cereals:

Estimates of total production losses due to different constraints in the cereal production are reported it Table 4.12. In paddy cultivation, the production loss due to insect

Table-4.10: Estimated indices of yield gaps in important commercial crops in selected zones

(Per cent)

Sl No.	Particulars	Chilli	Cotton			Sugarcane			
		Z-VIII	Z-VIII	Z-IX	Overall	Z-VIII	Z-IX	Z-X	Overall
1	Index of yield gap	59.54	58.83	57.52	58.17	52.68	58.64	57.22	56.18
2	Index of realised potential yield	40.46	41.17	42.48	41.83	47.32	41.36	42.78	43.82
3	Index of realised potential farm yield	70.80	70.57	70.80	70.68	67.60	71.82	75.49	71.64

Table-4.11: Estimated indices of yield gaps in important vegetable crops under selected Zones

(Per cent)

Sl No.	Particulars	Onion	Brinjal	Okra
		Z-VIII	Z-X	Z-IX
1	Index of yield gap	59.46	57.09	58.35
2	Index of realised potential yield	40.54	42.91	41.65
3	Index of realised potential farm yield	71.87	71.51	71.70

pests was the highest in the case zone-VIII and IX. It was 32.86 per cent of total production loss in zone-VIII and 32.45 per cent in zone IX. In case of zone-X the top most constraint in the production of paddy was rainfall, which accounted for a loss of 26.97 per cent of total production loss followed by diseases (26.54%), pests (23.97%), soils (12.91%) and seed (7.49%). In zone-VIII, second severe most constraint was a weed causing a loss of 24.65 per cent followed by rainfall (24.41%) and diseases (15.25%). On the other hand, in zone-IX the second severe most constraint was Rainfall with 29.03 per cent of total production loss followed by weeds (12.19%) and diseases (6.92%). Jowar production was seen only in zone-VIII and IX. Nearly one fifth of the production loss in jowar was due to insect pests in both the zones. However, in both the zones the most severe constraint, which tops the list, was diseases with a production loss of 65.97 per cent and 28.05 per cent in zone-VIII and zone-IX, respectively. Maize and wheat production was seen only in zone-VIII and the important constraints for the production of maize crop were pests and diseases causing a production loss of 45.57 per cent and 34.36 per cent, respectively. On the contrary the top most constraints in the production of wheat were rainfall and seed, which constitute 48.54 per cent and 31.25 per cent of total production loss. Further, the top ten constraints based on the aforesaid estimates were identified in each crop based on the production loss and are presented in Table 4.13.

4.3.2 Estimated production losses in the production of pulses

Table 4.14 depicts the estimates of total production losses due to various constraints in the pulses production. Bengalgram, greengram, blackgram, cowpea and horsegram were the important pulse crops grown in the selected zones. Bengalgram production was seen only in zone-VIII wherein seed appears to be the top most constraint (30.85 %) followed by pests and weeds accounting for nearly 20 per cent each of total production loss. In the case of greengram production, rainfall (34.94%) appears to be top most constraint in zone-VIII while incidence of pests (43.90%) in zone-X was the major constraint. In zone-VIII, other

Table-4.12: Estimated production losses in cereals production

(Quintals)

SL	Constraints	Paddy			Jowar		Maize	Wheat
		Z-VIII	Z-IX	Z-X	Z-VIII	Z-IX	Z-VIII	Z-VIII
I	Diseases	0.65 (15.25)	12.14 (6.92)	90.58 (26.54)	35.45 (65.97)	0.99 (28.05)	19.97 (34.36)	0.97 (20.21)
II	Pests	1.40 (32.86)	56.97 (32.45)	81.97 (23.97)	9.77 (18.18)	0.73 (20.68)	26.48 (45.57)	
III	Weeds	1.05 (24.65)	21.40 (12.19)	6.46 (1.89)	5.16 (9.60)	0.73 (20.68)	7.28 (12.53)	
IV	Soil		18.87 (10.75)	44.06 (12.91)				
V	Cultivars			0.75 (0.22)				
VI	Seed	0.12 (2.82)	15.20 (8.66)	25.56 (7.49)	0.76 (1.41)	0.28 (7.93)	4.38 (7.54)	1.50 (31.25)
VII	Rainfall/ Irrigation	1.04 (24.41)	50.96 (29.03)	92.04 (26.97)	2.60 (4.84)	0.80 (22.66)		2.33 (48.54)
	Grand total	**4.26 (100)**	**175.54 (100)**	**341.24 (100)**	**53.74 (100)**	**3.53 (100)**	**58.11 (100)**	**4.80 (100)**

Note: Figures in parentheses indicate percent to grand total

Table-4.13: Ranking of cereal crops yield constraints based on production loss by zones

Rank	Paddy			Jowar		Wheat	Maize
	Zone-VIII	Zone-IX	Zone-X	Zone-VIII	Zone-IX	Zone-VIII	Zone-VIII
I	Weeds	Low rainfall	Salinity/alkalinity due to rain	Black grain smut	Weeds	Low rainfall	Shoot borer
II	Low rainfall	Weeds	Salinity/alkalinity of soil	Army worm	low rainfall	Recommended spacing not followed	Ear head smut
III	Shoot borer	Leaf miner	Udabutta disease	Weeds	Shoot borer	Wilting of plant	Weed
IV	Leaf hopper	Shoot borer	Thrips	Downy mildew	Leaf hopper	Leaf spot disease	Recommended dose not followed
V	Purple rot	Thrips	Red headed hairy caterpillar	Midge	Charcoal rot		Leaf curl
VI	Early/delayed sowing	Plant hopper	Shoot borer	Low rainfall	Early or delayed sowing		Downy mildew
VII	Termites	Recommended dose not followed	Stem rot	Shot borer	Termites		Stem rot
VIII	Stem rot	Early/delayed sowing	Recommend dose not followed	Ear head smut	Stem rot		Army worm
IX	Rust	Leaf spot	Leaf hopper	Recommended spacing not followed	Rust		Recommended spacing not followed
X	Wilting	Deficiency of NPK	Blight	Early or delay sow	Wilting of plant		

constraints faced in the production of greengram were pests (32.59%) and diseases (20.94%). Blackgram, cowpea and horsegram were produced only in zone-X. The major problems in the production of black gram in zone-X were rainfall (34.81%) followed by diseases (29.49%), pests (18.83%) and soil (16.87%). While in the case of cowpea, the production loss was mainly due to constraints like pests (69.22%), diseases (22.35%) and weeds (8.43%). Diseases (48.15%), rainfall (21.83%), soil (12.87%) and seed (9.16%) were the major problems in the production of horesgram in zone-X. Further the top ten constraints are identified in each crop based on the production loss and are presented in Table 4.15

4.3.3 Estimated production loss in the production of oilseed crops

Estimates of production loss due to different constraints in the production of oilseeds crops are presented in Table 4.16. Seed, rainfall, pests and diseases are the most severe constraints for the production of groundnut in the zone-VIII with production loss of 48.40 per cent, 20.03 per cent, 17.95 per cent and 9.62 per cent, respectively. In zone-IX the top most constraint was rainfall (24.61%) followed by seed (23.35%) and weeds (18.47%), while in zone-X production loss due to soil problem was very high (40.77%) followed by pests (36.60%) and diseases (22.63%). Sunflower production was seen only in zone-VIII and soybean production only in zone-IX. In sunflower production severe constraints leading to production loss were pests, rainfall and seed with production loss of 29.25 per cent, 28.77 per cent and 18.77 per cent, respectively. Like wise in soybean, pests (37.93%) and rainfall (38.73%) were the major constraints in zone-IX but weeds (23.34%) was the third most severe constraint in the production of soybean in zone-IX. Among the different constraints top ten constraints are identified for each crop based on the production loss and these are presented in Table 4.17.

Table-4.14: Estimated production losses in pulses production

(Quintals)

SL	Constraints	Bengal gram	Green gram		Black Gram	Cow pea	Horse Gram
		Z-VIII	Z-VIII	Z-X	Z-X	Z-X	Z-X
I	Diseases	0.28 (14.89)	1.87 (20.94)	0.53 (18.47)	1.66 (29.49)	1.75 (22.35)	2.47 (48.15)
II	Pests	0.40 (21.28)	2.91 (32.59)	1.26 (43.90)	1.06 (18.83)	5.42 (69.22)	
III	Weeds	0.40 (21.28)	0.65 (7.28)			0.66 (8.43)	0.41 (7.99)
IV	Soil			0.93 (32.40)	0.95 (16.87)		0.66 (12.87)
V	Seed	0.58 (30.85)	0.38 (4.25)				0.47 (9.16)
VI	Rainfall/ Irrigation	0.22 (11.70)	3.12 (34.94)	0.15 (5.23)	1.96 (34.81)		1.12 (21.83)
	Grand total	**1.88 (100)**	**8.93 (100)**	**2.87 (100)**	**5.63 (100)**	**7.83 (100)**	**5.13 (100)**

Note: Figures in parentheses indicate percent to grand total

Table-4.15: Ranking of pulse crops yield constraints based on production loss by zones

Rank	Bengal gram	Green gram		Black gram	Cowpea	Horse gram
	Zone-VIII	Zone-VIII	Zone-X	Zone-X	Zone-X	Zone-X
I	Leaf miner	Low rainfall	Non suitability of soil	Salinity/alkalinity of soil	Thrips	Leaf spot
II	Weeds	Pod borer	Pod borer	Leaf curl	Leaf curl	Stagnation water logging
III	Early/delayed sowing	Wilting	Powdery mildew	Pod borer	Pod borer	Non suitability of soil
IV	Wilting	Weeds	Leaf eating caterpillar	Non suitability of soil	Weeds	Recommended dose not followed
V	Spacing	Powdery mildew	Stagnation/water logging			Weeds
VI	Low rainfall	Recommended dose	Aphids			
VII		Thrips	Leaf spot			
VIII		Leaf eating caterpillar				
IX		Leaf spot				
X						

Table-4.16: Estimated production losses in oilseeds production

(Quintals)

SL	Constraints	Ground nut			Sunflower	Soybean
		Z-VIII	Z-IX	Z-X	Z-VIII	Z-IX
I	Diseases	0.25 (4.00)	5.86 (15.36)	1.41 (22.63)	0.55 (6.79)	
II	Pests	1.12 (17.95)	6.95 (18.21)	2.28 (36.60)	2.37 (29.25)	2.86 (37.93)
III	Weeds	0.6 (9.62)	7.05 (18.47)		1.33 (16.42)	1.76 (23.34)
IV	Soil			2.54 (40.77)		
V	Seed	3.02 (48.40)	8.91 (23.35)		1.52 (18.77)	
VI	Rainfall/ Irrigation	1.25 (20.03)	9.39 (24.61)		2.33 (28.77)	2.92 (38.73)
	Grand total	**6.24 (100)**	**38.16 (100)**	**6.23 (100)**	**8.11 (100)**	7.54 (100)

Note: Figures in parentheses indicate percent to grand total

Table-4.17: Ranking of oil seed crops yield constraints based on production loss by zones

Rank	Groundnut			Sunflower	Soybean
	Zone-VIII	Zone-IX	Zone-X	Zone-VIII	Zone-IX
I	Recommended spacing not followed	Low rainfall	Thrips	Heliothis	Low rainfall
II	Low rainfall	Recommended spacing not followed	Non suitability of soil	Low rainfall	Weeds
III	Weeds	Weeds	Salinity/alkalinity/acidic	Weeds	Pod borer
IV	Pod borer	Leaf miner	Bud necrosis	Early/delayed sowing	Leaf miner
V	Leaf miner	Leaf spot	Root rot	Leaf spot	
VI	Leaf spot	Pod borer		Recommended spacing not followed	
VII	Red headed hairy caterpillar	Bud necrosis		Charcoal disease	
VIII	Bud necrosis	Recommended dose not followed		Spodoptera	
IX		Grass hopper		Downy mildew	
X					

4.3.4 Estimated production losses in the production of commercial crops

Estimates of production losses due to various constraints in the production of commercial crops are presented in the Table 4.18. In zone-VIII in chilli production major production loss was due to weeds (48.53% of total production loss) followed by rainfall with a production loss of 40.21 per cent.

The cotton production was observed only in zone-VIII and zone-IX. In both the zones, incidence of pests was a severe constraint with a production loss of 42.86 per cent and 90.63 per cent, respectively, followed by rainfall (22.72% and 4.75%, respectively) in both the zones.

In the case of sugarcane production, pests cause the highest production loss in zone-IX and zone-X, which accounted for around 40 per cent of total production loss. In zone-VIII, the major production loss was due to weeds (52.75%), rainfall (15.17%), diseases (10.54%), soil (9.03%) and seed (7.81%) constraints. Further, the top ten constraints are identified in each crop based on the production loss and they are presented in Table-4.19.

4.3.5 Estimated production loss in the production of vegetable crops

Estimates of total production losses due to different constraints in the vegetable crops production are presented in Table-4.20. In the case of carrot, incidence of pests was the top most severe constraint in zone-VIII with a production loss of 57.69 per cent followed by the diseases (19.23%), weeds (15.38%) and soils (7.69%). In zone-X, top constraint was diseases and pests with production loss of around 30 per cent. Other constraints like soil and weeds constituted 22.97 per cent and 17.63 per cent of total production loss, repectively. Tomato production was seen only in zone-X where in diseases was the top most constraint constituting 37.82 per cent of production loss followed by pests (26.06%) seeds (19.61%) and soils (8.80%). Potato production was seen only in zone-VIII. Rainfall, diseases and pests

Table-4.18: Estimated production losses in commercial crop production

(Quintals)

SL	Constraints	Chilli	Cotton		Sugarcane		
		Z-VIII	Z-VIII	Z-IX	Z-VIII	Z-IX	Z-X
I	Diseases	0.40 (6.93)	3.56 (19.03)	0.95 (3.25)	6.53 (10.54)	109.63 (16.55)	351.83 (25.04)
II	Pests	0.25 (4.33)	8.02 (42.86)	26.52 (90.63)	2.90 (4.68)	275.92 (41.66)	531.50 (37.82)
III	Weeds	2.80 (48.53)	2.06 (11.01)		32.68 (52.75)		302.34 (21.51)
IV	Soil		0.26 (1.39)		5.60 (9.03)	9.78 (1.48)	52.59 (3.74)
V	Seed		0.56 (2.99)	0.40 (1.37)	4.84 (7.81)	79.01 (11.93)	
VI	Rainfall/ Irrigation	2.32 (40.21)	4.25 (22.72)	1.39 (4.75)	9.40 (15.17)	187.96 (28.38)	167.00 (11.88)
	Grand total	**5.77 (100)**	**18.71 (100)**	**29.26 (100)**	**61.95 (100)**	**662.30 (100)**	**1405.26 (100)**

Note: Figures in parentheses indicate percent to grand total

Table-4.19: Ranking of commercial crops yield constraints based on production loss by zones

Rank	Chilli	Cotton		Sugarcane		
	Zone-VIII	Zone-VIII	Zone-IX	Zone-VIII	Zone-IX	Zone-X
I	Weed	Boll worm	White fly	Weeds	Low rainfall/irrigation	Weed
II	Uneven distribution of rainfall	Low rainfall	Low rainfall	Deficiency in NPK	Pyrilla	Pyrilla
III	Low rainfall	Weed	Rust	Recommended spacing	Recommended spacing	Termites
IV	Leaf curl	Wilting	Recommended spacing	Uneven distribution of rainfall	Termites	Red rot
V	Leaf hopper	Thrips	Weed	Low rainfall	Leaf hopper	Stagnation/water logging
VI	Leaf miner	Leaf hopper	Wilting	Viral disease	Leaf spot	Root rot
VII	Grass hopper	Powdery mildew`	Thrips	Ratoon stunting`	Red rot	Leaf hopper
VIII		Root rot	Boll worm	Recommended dose not applied	Root grub	Smut
IX		Recommended spacing	Leaf hopper	Powdery mildew	Early/delayed sowing	Saline/alkaline/acid ic soils
X		Leaf spot	Leaf curl	Pyriila	Water logging	Viral disease

were the top constraints in the case of potato with a production loss of 29.35 per cent, 27.32 per cent and 23.23 per cent of total production loss, respectively. Similarly in the case of onion production, diseases, rainfall and weeds were the major constraints in zone-VIII with a production loss of 24.62 per cent, 24.03 per cent and 22.88 per cent of total production loss, respectively.

Cucumber and brinjal production was seen only in zone-X. Pests appear as top most (62.99% and 66.29%, respectively) constraint in case of both the crops. Similarly the second constraint was diseases in case of both the crops constituting production loss of 19.69 per cent and 17.87 per cent, respectively. In zone-IX, for the production of okra, diseases, rainfall and pests were the severe constraints with production loss of 45.14 per cent, 36.41 per cent and 12.14 per cent in that order. Further, the top ten constraints among the identified constraints in each crop were identified and are presented in Table 4.21.

4.4 Socio-economic constraints faced by the farmers in production of different crops

4.4.1 Socio-economic constraints faced by the farmers in the production of cereals

The ranking of top ten research problem areas on the basis of estimated loss in production of paddy in different zones is depicted in Table 4.22. The aggregate data showed that for zone-VIII high cost of production tops the list whereas it ranks second in zone-IX and zone-X. Non-availability of labour during peak season tops the list in zone-IX and zone-X but assumes sixth position in zone-VIII. High wage rate ranked III, VI and VIII for zone-X, zone-IX and zone-VIII, respectively. Low price of product ranked third in zone-IX but seventh for zone-VIII. Reluctance by financing institutions and high cost of credit were the problems faced by the farmers in all the zones with varying degree of severity. Poor transfer of technology, non-availability of quality agro-chemicals, price fluctuations and non-

Table-4.20: Estimated production losses in vegetable production

(Quintal

SL	Constraints	Carrot		Tomato	Potato	Onion	Cucumber	Okra	Brinjal
		Z-VIII	Z-X	Z-X	Z-VIII	Z-VIII	Z-X	Z-IX	Z-X
I	Diseases	0.10 (19.23)	1.29 (29.93)	12.42 (37.82)	17.59 (27.32)	13.02 (24.62)	0.25 (19.69)	0.93 (45.14)	0.79 (17.87)
II	Pests	0.30 (56.69)	1.27 (29.47)	8.56 (26.06)	14.96 (23.22)	6.56 (12.40)	0.80 (62.99)	0.25 (12.14)	2.93 (66.29)
III	Weeds	0.08 (15.40)	0.76 (17.63)	2.53 (7.71)	7.55 (11.72)	12.10 (22.88)		0.13 (6.31)	0.70 (15.84)
IV	Soil	0.04 (7.69)	0.99 (22.97)	2.89 (8.80)	1.80 (2.80)	3.90 (7.37)			
V	Seed			6.44 (19.61)	3.59 (5.57)	4.60 (8.70)			
VI	Rainfall/ Irrigation				18.90 (29.35)	12.71 (24.03)	0.22 (17.32)	0.75 (36.41)	
	Grand total	**0.52 (100)**	**4.31 (100)**	**32.84 (100)**	**64.39 (100)**	**52.89 (100)**	**1.27 (100)**	**2.06 (100)**	**4.42 (100)**

Note: Figures in parentheses indicate percent to grand total

Table-4.21: Ranking of vegetable crops yield constraints based on production loss by zones

Rank	Carrot		Tomato	Potato	Onion	Cucumber	Okra	Brinjal
	Zone-VIII	Zone-IX	Zone-X	Zone-VIII	Zone-VIII	Zone-X	Zone-IX	Zone-X
I	Thrips	Saline/alkaline sois	Recommended spacing not practiced	Uneven distribution of rainfall/irrigation	Low rainfall	RHHC	Leaf curl	Fruit borer
II	Leaf spot	Thrips	Leaf spot	Wilting	Weeds	Stagnation/water logging	Low rainfall	Shoot borer
III	Weeds	Leaf spot	Leaf curl	Thrips	Charcoal disease	Fruit borer	Fruit borer	Weed
IV	Saline/alkaline/acidic soils	Weeds	Leaf eating caterpillar	Weeds	Early/delayed sowing	Powdery mildew	Leaf spot disease	Powdery mildew
V	Leaf hopper	Powdery mildew	Leaf hopper	Powdery mildew	Powdery mildew	Anthracnose		Anthracnose
VI		Grass hopper	Saline/alkaline/ acidic soils	Leaf hopper	Degraded/eroded soils			
VII			Weeds	Recommended dose not followed	Leaf curl			
VIII			Fruit rot	Deficiency of NPK	Leaf miner			
IX				Leaf curl	Deficiency of NPK			
X				White fly				

Table-4.22: Important Socio-Economic Constraints in the Paddy production

SL	Constraints	Zone-VIII		Zone-IX		Zone-X	
		Composite score	Rank	Composite score	Rank	Composite score	Rank
1.	Non availability of quality seeds	3.00	III				
2.	Non availability of labour during peak season	4.50	VI	1.50	I	1.75	I
3.	High wage rate of labour	5.00	VIII	3.25	IV	4.50	III
4.	Non availability of skilled labour	-				6.50	VII
5.	High cost of irrigation	-		4.25	V		
6.	Irregular supply of electricity			6.50	VIII	7.25	VIII
7.	Insufficient water	2.00	II				
8.	Low voltage	7.00	X				
9.	High cost of agro chemicals	-		7.50	X		
10.	Non availability of quality agro chemicals					5.00	V
11.	High cost of chemical fertilizer			5.25	VI		
12.	High cost of credit	4.00	V				
13.	Insufficient scale of finance					7.50	IX
14.	Lack of timely disbursement of credit			7.00	IX		
15.	Reluctance by financing institution	3.50	IV				
16.	Poor transfer of technology					4.75	IV
17.	Unawareness about improved technology	5.75	IX	6.00	VII		
18.	High marketing cost					8.00	X
19.	Low price for product	4.75	VII	3.00	III		
20.	Price fluctuation					6.00	VI
21.	High cost of production	1.50	I	2.50	II	3.00	II

availability of skilled labour were the other problems causing significant loss in paddy production in respect of farmers of zone-X.

Jowar was grown on zone-VIII and zone-IX. In the order of severity, high cost of irrigation, non-availability of quality seeds, poor transportation and low price for the product were the major problems confronting farmers of zone-VIII (Table-4.23). On the other hand, in the case of zone-IX, high wage for labour, non-availability of quality chemical fertilizer, low price for the product and poor transfer of technology were the major socio-economic constraints, which need attention / research invention. Other problems faced by the farmers of both the zones were common with varying degree of severity. Lack of timely disbursement of credit, non-availability of skilled labour, price fluctuations, high cost of production and high cost of marketing were the major problems faced by the farmers of zone-VIII and zone-IX.

In the production of maize and wheat (Table-4.24 and Table-4.25), which were grown on only zone-VIII, non-availability of labour during peak season of harvesting was top the list of constraints. High wage rate for labour, high cost of marketing, low price for the product and high cost of production were the major constraints faced in the production of both the crops with varying degree of severity. However, high cost of agro-chemicals and lack information on prices ranked II and III in the wheat production causing considerable loss.

4.4.2 Socio-economic constraints faced by the farmers in the production of pulses

The socio-economic constraints, which are ranked based on composite score in the production of green gram, were presented in Table 4.26. Lower the score higher the extent of loss. In zone-VIII, price fluctuation and lack of timely disbursement of credit was the top two socio-economic constraints followed by low price for product, non-availability of labour during peak season and poor transportation in order of severity. In zone-X, poor

Table-4.23: Important Socio-Economic Constraints in Jowar Production

SL	Constraints	Zone-VIII		Zone-IX	
		Composite score	Rank	Composite score	Rank
1.	Non availability of quality seed	1.50	II		
2.	Non availability of labour during peak season	4.48	VIII		
3.	High wage rate of labour	4.15	VII	2.50	I
4.	Non availability of skilled labour			7.80	IX
5.	High cost of irrigation	1.00	I		
6.	High cost of chemical fertilizer			7.25	VII
7.	Non availability of quality chemical fertilizer			3.50	II
8.	Lack of timely disbursement credit			6.00	V
9.	Poor transfer of technology	3.28	V	5.25	IV
10.	Poor transportation	2.33	III		
11.	High cost of marketing	4.60	IX	7.50	VIII
12.	Low price for product	3.00	IV	4.50	III
13.	Price fluctuation	5.00	X	7.00	VI
14.	Lack of information on prices	4.00	VI		
15.	High cost of production			8.00	X

Table-4.24: Important Socio-Economic Constraints in Maize Production

SL	Constraint	Zone-VIII	
		Composite score	Rank
1.	Non availability of labour during peak season	1.00	I
2.	High cost of marketing	1.66	II
3.	Lack of information on prices	2.50	III
4.	Price fluctuation	2.90	IV
5.	Irregular supply of electricity	3.80	V
6.	High wage rate of labour	3.82	VI
7.	Low price for product	4.00	VII
8.	High cost of production	4.87	VIII
9.	Poor transfer of technology	5.00	IX
10.	Poor transportation	5.67	X

Table-4.25: Important Socio-Economic Constraints in Wheat Production

SL	Constraint	Zone-VIII	
		Composite score	Rank
1	Non availability of labour during peak season	1.00	I
2.	High wage rate of labour	2.00	II
3	High cost of agro chemicals	3.00	III
4	High cost of marketing	4.00	IV
5	Low price for product	5.00	V
6	High cost of production	6.00	VI
7	High cost of credit	7.00	VII
8	Unawareness about improved technology	8.00	VIII
9	Lack of timely disbursement of credit	9.00	IX
10	Irregular supply of electricity	10.00	X

Table-4.26: Important Socio-Economic Constraints in Greengram Production

SL	Constraints	Zone-VIII		Zone-X	
		Composite Score	Rank	Composite Score	Rank
1.	Poor transportation	4.25	V	1.30	I
2.	High cost of marketing	4.67	VIII	2.35	IV
3.	Low price for product	3.15	III	1.83	III
4.	Price fluctuation	1.35	I	4.83	VI
5.	Non availability of quality seed	4.35	VI	1.80	II
6.	Non availability of labour during peak season	3.63	IV	3.17	V
7.	High wage rate of labour	5.43	IX	5.50	VII
8.	High cost of credit	4.50	VIII	6.67	VIII
9.	Lack of timely disbursement of credit	1.80	II		
10.	Poor transfer of technology	5.66	X		
11.	Unawareness about improved technology			7.00	IX
12.	Poor transfer of technology			7.50	X

transportation was the top constraint followed by non-availability of quality seed, low price for product, high cost of marketing, non-availability of labour during peak season and price fluctuation.

It is apparent from the results presented in the Table 4.27 that in black gram production which was observed only in zone-X, non-availability of quality seed, non-availability of labour during peak season, high wage rate of labour, low price for the product and poor transfer of technology are the severe socio-economic constraints faced by the farmer, in that order.

Socio-economic constraints faced by the farmers of zone-X in cowpea production are presented in Table-4.28. High wage rate of labour was the severe most constraint, followed by non-availability of labor during peak season, low price for product and non-availability of quality seed. Horse gram production also faced the similar constraints except high cost of credit and lack of timely disbursement of credit (Table-4.29).

Socio-economic constraints faced by the farmer in the production of bengalgram are presented in Table-4.30. The production of this crop was observed only in zone-VIII. Producers of bengalgram also faced the similar constraints as observed in other pulse crops. In other words, farmers faced several constraints, like non-availability of labour during peak season, high cost of marketing and reluctance by financing institutions in that order of severity.

4.4.3 Socio-economic constraints faced by the farmers in the production of oilseeds

Socio-economic constraints faced in the production of groundnut are presented in Table 4.31. High wage rate of labour and non-availability of labour during peak season were the common severe problems across the zones. In zone-VIII, non-availability of quality seeds, low price for product and insufficient water are the other socio-economic constraints

Table-4.27: Important Socio-Economic Constraints in Blackgram Production

SL	Constraints	Zone-X	
		Composite Score	Rank
1.	Non availability of quality seed	1.25	I
2.	Non availability of labour during peak season	1.83	II
3.	High wage rate of labour	3.25	III
4.	Low price for product	4.17	IV
5.	Poor transfer of technology	4.83	V
6.	High cost of marketing	5.15	VI
7.	Poor transportation	6.17	VII
8.	Lack of timely disbursement of credit	7.00	VIII
9.	Poor transportation	7.25	IX
10.	High cost of production	8.00	X

Table-4.28: Important Socio-Economic Constraints in Cowpea Production

SL	Constraints	Zone-X	
		Composite Score	Rank
1.	High wage rate of labour	1.50	I
2.	Non availability of labour during peak season	1.98	II
3.	Low price for product	2.25	III
4.	Non availability of quality seed	2.75	IV
5.	Unawareness about improved technology	3.75	V
6.	High cost of credit	5.50	VI
7.	High cost of chemical fertilizers	6.25	VII
8.	Lack of timely disbursement of credit	7.50	VIII
9.	Poor transfer of technology	8.00	IX
10.	Poor transportation	8.25	X

Table-4.29: Important Socio-Economic Constraints in Horsegram Production

SL	Constraints	Zone-X	
		Composite Score	Rank
1.	Low price for product	1.89	I
2.	High wage rate of labour	2.25	II
3.	Non availability of skilled labour	3.18	III
4.	Non availability of quality seed	4.50	IV
5.	High cost of chemical fertilizers	5.25	V
6.	High marketing cost	5.85	VI
7.	Unawareness about improved technology	6.25	VII
8.	Non availability of labour during peak season	6.75	VIII
9.	Reluctance by financing institution	7.20	IX
10.	Poor transportation	8.00	X

Table-4.30: Important Socio-Economic Constraints in Bengalgram Production

SL	Constraints	Zone-VIII	
		Composite Score	Rank
1.	Non availability of labour during peak season	2.55	I
2.	High cost of marketing	3.00	II
3.	Reluctance by financing institution	3.50	III
4.	Lack of timely disbursement of credit	4.75	IV
5.	High cost of credit	5.62	V
6.	High wage rate of labour	6.00	VI
7.	Low price for product	6.83	VII
8.	Insufficient scale of finance	7.50	VIII
9.	High cost of production	8.00	IX
10.	Unawareness about improved technology	8.25	X

Table-4.31: Important Socio-Economic Constraints in Groundnut Production

SL	Constraints	Zone-VIII		Zone-IX		Zone-X	
		Composite score	Rank	Composite score	Rank	Composite score	Rank
1	Non availability of quality seeds	1.00	I				
2	Non availability of labour during peak season	3.25	III	3.60	IV	1.35	I
3	High wage rate of labour	3.50	IV	4.83	V	4.50	III
4	Non availability of skilled labour	5.00	VII				
5	High cost of irrigation			6.50	VIII	3.00	II
6	Insufficient water	4.33	V	5.25	VI		
7	Irregular supply of electricity			7.00	IX		
8	High cost of agro chemicals					7.60	IX
9	Non availability of quality agro chemicals			7.50	X		
10	Non availability of quality chemical fertilizer			6.25	VII		
11	High cost of credit					6.00	VI
12	Insufficient scale of finance						
13	Lack of timely disbursement of credit					7.50	VIII
14	Reluctance by financing institution			2.75	II		
15	Poor transfer of technology	6.75	IX			6.70	VII
16	Unawareness about improved technology	4.80	VI			4.75	IV
17	High marketing cost	6.00	VIII	1.80	I		
18	Low price for product	3.00	II	3.00	III	5.25	V
19	Price fluctuation	8.00	X				
20	High cost of production					8.00	X

observed in the order of severity. In zone-IX, high marketing cost, reluctance by financing institutions, low price for product, non-availability of labour during peak season, high wage rate of labour and insufficient water constrained the groundnut production in that order of severity. In the case of zone-X, other constraints faced include high cost of irrigation, unawareness of improved technology, low price for product and high cost of credit.

In sunflower production (Table-4.32) in zone-VIII, non availability of labour during peak season, high cost of marketing, non-availability of skilled labour, lack of timely disbursement of credit and high wage rate of labour were the severe most constraints in that order.

In zone-IX, insufficient quantity of seed tops the socio-economic constraints list in soybean production, followed by low pride for product, insufficient quantity of credit and non-availability of fertilizer in time.

4.4.4 Socio-economic constraints faced by the farmers in the production of commercial crops

The results presented in the Table 4.34 revealed that sugarcane production was observed in all the three selected zones. In the case of zone-VIII, non-availability of skilled labour was the top most severe constraint and the second severe constraint was high wage rate of labour followed by high cost of seed, non-availability of quality agro-chemicals and low price for product. The high cost of production was the top most severe constraint in zone-IX followed by high cost of seed, irregular supply of electricity, high wage rate of labour and high marketing cost. In the case of zone-X, the labour related constraints appeared among the top socio-economic constraints. The top most severe constraint was high cost of production. Next severe constraint was low price for product followed by lack of timely disbursement of credit and non-availability of skilled labour. The high wage rate of labour was not that severe.

Table-4.32: Important Socio-Economic Constraints in Sunflower Production

SL	Constraints	Zone-VIII	
		Composite Score	Rank
1.	Non availability of labour during peak season	2.25	I
2.	High cost of marketing	3.75	II
3.	Non availability of skilled labour	4.18	III
4.	Lack of timely disbursement of credit	4.75	IV
5.	High wage rate of labour	6.00	V
6.	Poor transfer of technology	6.68	VI
7.	Low price for product	7.20	VII
8.	Insufficient scale of finance	7.88	VIII
9.	Unawareness about improved technology	8.25	IX
10.	High cost of production	8.59	X

Table-4.33: Important Socio-Economic Constraints in Soybean Production

SL	Constraints	Zone-IX	
		Composite Score	Rank
1.	Insufficient quantity of seed	1.10	I
2.	Low price for the product	2.85	II
3.	Insufficient quantity of credit	3.50	III
4.	Non availability of fertilizers on time	4.28	IV
5.	Lack of information on prices	4.80	V
6.	High cost of marketing	5.25	VI
7.	Unawareness about improved technology	6.73	VII
8.	High cost of agro chemicals	6.95	VIII
9.	Lack of timely disbursement of credit	8.00	IX
10.	Non availability of quality agro chemicals	8.56	X

Table-4.34: Important Socio-Economic Constraints in Sugarcane Production

SL	Constraints	Zone-VIII		Zone-IX		Zone-X	
		Composite score	Rank	Composite score	Rank	Composite score	Rank
1	High cost of irrigation	6.00	VI				
2	High cost of agro chemicals	7.80	IX				
3	High marketing cost			5.60	V		
4	High cost of credit			7.85	VIII		
5	High cost of production	6.25	VII	1.30	I	1.25	I
6	Low price for product	5.00	V			2.38	II
7	Lack of timely disbursement of credit	7.38	VIII	8.90	X	3.80	III
8	Non availability of skilled labour	1.80	I	7.25	VII	4.20	IV
9	Non availability of quality agro chemicals	4.25	IV	6.74	VI	4.80	V
10	High cost of seed	3.25	III	3.45	II	5.48	VI
11	Non availability of seeds on time					6.25	VII
12	Unawareness about improved technology			8.20	IX	6.80	VIII
13	High wage rate of labour	2.55	II	4.88	IV	7.00	IX
14	Irregular supply of electricity	8.25	X	3.80	III	8.00	X

The socio-economic constraints faced by the farmers in cotton production are presented in Table 4.35. The production of this crop was observed only in zone-VIII and zone-IX. In the case of zone-VIII, non-availability of labour during peak season was the severe most constraint. On the contrary in the case of zone-IX, low price for product was the top most severe constraint, while the other constraints faced were similar in both the zones with varying degree of composite score and rank.

The chilli production was observed only in zone-VIII and the socio-economic constraints therein are presented in Table-4.36. Insufficient quantity of seed was the top most severe constraint, followed by low price for the product, insufficient quantity of credit, non-availability of fertilizer on time and lack of information on prices.

4.4.5 Socio-economic constraints faced by the farmers in the production of vegetables

The important socio-economic constraints in the production of vegetables, viz. onion, brinjal and okra are presented in Tables 4.37 through 4.39, respectively. The onion production was observed in zone-VIII only wherein the non-availability of quality seeds was the severe most constraint followed by low price for the product, insufficient quantity of seed, price fluctuation and lack of timely disbursement of credit, in that order. The brinjal cultivation was observed only in zone-X. High cost of production, low price for the product, high cost of agro-chemicals and marketing and lack of timely disbursement of credit were the important constraints faced by the producers of brinjal in zone-X.

In okra production by the farmers of zone-IX, the lack of information on prices was the severe most constraint followed by high cost of chemical fertilizer, low voltage, insufficient quantity of credit and high cost of marketing.

Table-4.35: Important Socio-Economic Constraints in Cotton Production

SL	Constraints	Zone-VIII		Zone-IX	
		Composite Score	Rank	Composite Score	Rank
1.	High wage rate of labour	6.28	VI		
2.	Low price for product	5.60	V	2.80	I
3.	High cost of marketing	2.35	II	3.25	II
4.	Price fluctuation			4.25	III
5.	Non availability of labour during peak season	2.00	I	5.00	IV
6.	Unawareness about improved technology	6.88	VII	5.33	V
7.	High cost of credit	7.28	VIII	6.28	VI
8.	Poor transfer of technology	8.20	X	6.88	VII
9.	Lack of timely disbursement of credit	5.25	IV	7.20	VIII
10.	Reluctance by financing institution	4.80	III	8.00	IX
11.	Poor transportation	8.00	IX	8.25	X

Table-4.36: Important Socio-Economic Constraints in Chilli Production

SL	Constraints	Zone-VIII	
		Composite Score	Rank
1.	Insufficient quantity of seed	1.10	I
2.	Low price for the product	2.85	II
3.	Insufficient quantity of credit	3.50	III
4.	Non availability of fertilizers on time	4.28	IV
5.	Lack of information on prices	4.80	V
6.	High cost of marketing	5.25	VI
7.	Unawareness about improved technology	6.73	VII
8.	High cost of agro chemicals	6.95	VIII
9.	Lack of timely disbursement of credit	8.00	IX
10.	Non availability of quality agro chemicals	8.56	X

Table-4.37: Important Socio-Economic Constraints in Onion Production

SL	Constraints	Zone-VIII	
		Composite Score	Rank
1.	Non availability of quality seed	1.26	I
2.	Low price for the product	2.80	II
3.	Insufficient quantity of seed	3.45	III
4.	Price fluctuation	4.00	IV
5.	Lack of timely disbursement of credit	4.80	V
6.	Lack of information on prices	5.73	VI
7.	Insufficient quantity of credit	6.25	VII
8.	Unawareness about improved technology	6.80	VIII
9.	Non availability of quality agro chemicals	7.25	IX
10.	High cost production	8.00	X

Table-4.38: Important Socio-Economic Constraints in Brinjal Production

SL	Constraints	Zone-X	
		Composite Score	Rank
1.	High cost of production	2.65	I
2.	Low price for the product	3.20	II
3.	High cost of agro chemicals	3.80	III
4.	High cost of marketing	4.25	IV
5.	Lack of timely disbursement of credit	4.95	V
6.	High cost of chemical fertilizers	5.65	VI
7.	Unawareness about improved technology	6.75	VII
8.	Lack of information on prices	7.25	VIII
9.	Non availability of quality agro chemicals	7.80	IX
10.	Insufficient quantity of credit	8.20	X

Table-4.39: Important Socio-Economic Constraints in Okra Production

SL	Constraints	Zone-IX	
		Composite Score	Rank
1.	Lack of information on prices	1.28	I
2.	High cost of chemical fertilizers	1.86	II
3.	Low voltage	2.80	III
4.	Insufficient quantity of credit	3.25	IV
5.	High cost of marketing	5.00	V
6.	Low price for the product	5.28	VI
7.	Unawareness about improved technology	6.00	VII
8.	High cost of irrigation	6.83	VIII
9.	Lack of timely disbursement of credit	7.20	IX
10.	Non availability of quality agro chemicals	8.00	X

4.5 Priority matrix for selected zones

Priority matrix was developed purely on the basis of efficiency parameter. Priority matrix for each selected zone was developed based on the value of product estimated for the triennium ending 1997-98 to 1999-2000. The crops with the high value of product (VOP) topped the priority matrix.

The developed priority matrix for zone-VIII is presented in Table-4.40. Results show that the two commercial crops (viz., sugarcane and chilli) were the top prioritized crops with value of product (VOP) of Rs.427.16 crore (29.03 per cent of total agricultural value of product) and Rs.323.40 crore (21.98 per cent of total value of product of agriculture), respectively followed by groundnut and three cereal crops namely maize, paddy and jowar with VOP of Rs.118.20 crore, Rs.99.08 crore, Rs.82.93 crore and 80.58 crore. The other crops, which come under top ten priorities, are onion, cotton, bengalgram and greengram.

The priority matrix for zone-IX is presented in Table-4.41. Here also, sugarcane was the top the priority matrix with VOP of Rs.136.77 crore followed by paddy and arecanut with VOP of Rs.134.04 crore and Rs.35.96 crore, respectively. Potato, groundnut, chilli, cotton, maize, onion and banana were among the top ten commodities that toped the matrix.

In zone-X (Table-4.42), the two important plantation crops, viz., arecanut and coconut ranked first and third, respectively with a VOP of Rs.3954.81 crore and Rs.101.36 crore (88.36 and 2.26 per cent of total VOP). Second rank goes to paddy crop with 8.00 per cent contribution to total VOP of agriculture. Banana was the most important crop in zone-X next only to coconut with VOP of Rs.26.21 crore (0.59%) followed by sugarcane, groundnut, pepper and chilli.

Table-4.40: Priority matrix for Zone-VIII (Triennium ending 1997-98 to 1999-2000) **(Rs. crores)**

Sl.No.	Crop	Value of Product	Percent to total
1.	Sugarcane	427.16	29.03
2.	Chilli	323.40	21.98
3.	Groundnut	118.20	8.03
4.	Maize	99.08	6.73
5.	Paddy	82.93	5.63
6.	Jowar	80.58	5.46
7.	Onion	77.50	5.27
8.	Cotton	69.22	4.70
9.	Bengalgram	33.56	2.28
10	Greengram	33.48	2.28
11	Potato	22.78	1.55
12	Tomato	21.32	1.45
13	Wheat	19.66	1.34
14	Mango	10.38	0.71
15	Sunflower	9.71	0.66
16	Safflower	8.72	0.59
17	Brinjal	8.70	0.59
18	Tur	5.18	0.35
19	Areca nut	4.85	0.33
20	Horse gram	3.98	0.27
21	Banana	3.52	0.24
22	Sesamum	2.21	0.15
23	Coconut	2.09	0.14
24	Blackgram	0.92	0.06
25	Niger	0.84	0.06
26	Navane	0.65	0.04
27	Grape	0.51	0.03
28	Castor	0.24	0.02
29	Linseed	0.11	0.01
30	**Total**	**1471.48**	**100.00**

Table-4.41: Priority matrix for Zone-IX (Triennium ending 1997-98 to 1999-2000) (Rs. crores)

Sl.No.	Crop	Value of Product	Percent to total
1.	Sugarcane	136.77	33.33
2.	Paddy	134.04	32.66
3.	Arecanut	35.96	8.76
4.	Potato	20.73	5.05
5.	Groundnut	16.97	4.13
6.	Chilli	14.34	3.49
7.	Cotton	11.24	2.74
8.	Maize	68.97	1.68
9.	Onion	63.22	1.54
10.	Banana	57.86	1.41
11.	Mango	3.58	0.87
12.	Greengram	3.48	0.85
13.	Jowar	3.36	0.82
14.	Safflower	2.59	0.64
15.	Linseed	2.01	0.49
16.	Tomato	1.89	0.47
17.	Horsegram	1.08	0.26
18.	Brinjal	0.77	0.19
19.	Blackgram	0.73	0.18
20.	Pepper	0.41	0.10
21.	Tur	0.41	0.10
22.	Coconut	0.34	0.08
23.	Bengalgram	0.28	0.07
24.	Sunflower	0.20	0.05
25.	Niger	0.08	0.02
26.	Wheat	0.06	0.01
27.	Sesamum	0.05	0.01
	Total	**581.42**	**100.00**

Table-4.42: Priority matrix for Zone-X (Triennium ending 1997-98 to 1999-2000)

(Rs. crores)

Sl.	Crop	Value of Product	Percent to total
1.	Arecanut	3954.82	88.36
2.	Paddy	358.15	8.00
3.	Coconut	101.36	2.26
4.	Banana	26.22	0.59
5.	Sugarcane	16.85	0.38
6.	Groundnut	9.27	0.21
7.	Pepper	2.91	0.07
8.	Chilli	1.97	0.04
9.	Brinjal	1.45	0.03
10.	Tomato	1.45	0.03
11.	Mango	0.91	0.02
12.	Blackgram	0.52	0.01
	Total	**4475.88**	**100.00**

4.5.1 Prioritisation of crops in selected zones based on total value of production loss

In each selected zone, the crops are prioritized based on the total value of production loss: the grater the production loss, higher the rank given. It was very useful in taking the decisions on allocation of limited research resources across crops and constraints.

Table-4.43 presents the list of prioritized crops in zone-VIII. chilli, onion, sugarcane, Jowar and paddy were the top five prioritized crops in this zone. chilli tops the list with a total production loss of Rs.42.51 crores followed by onion, sugarcane, jowar and paddy with Rs.23.15 crore, Rs.19.97 crore, Rs.13.63 crore and Rs.12.47 crore. On the other hand, in zone-IX (Table-4.44), sugarcane was the top prioritized crop with a production loss of Rs.8.39 crores followed by paddy, cotton, groundnut and jowar with a production loss of Rs.7.31crore, Rs.4.07 crore Rs.2.54 crore and Rs.0.35 crore respectively.

The list of prioritized crops in zone-X are presented in Table-4.45. Paddy was the top prioritized crops with production loss of Rs.23.06 crores followed by sugarcane and groundnut with a total production loss of Rs.1.26 crore and Rs.0.85 crore, respectively. The other prioritised crops for zone-X contrarly to zone-IX are tomato (Rs.0.13 crores) and brinjal (Rs0.05 crores).

Table-4.43: Priority matrix for Zone-VIII

SL	Crop	On sample farms				Estimated for the entire zone-VIII		
		Actual Yield (q/ha)	Production loss (q/ha)	Expected yield (q/ha)	Ratio of expected to actual yield	AVOP* (Rs.Crores)	EVOP* (Rs.Crores)	Production loss (Rs.Crores)
1	Chilli	7.08	0.93	8.01	1.13	323.40	365.91	42.51
2	Onion	31.62	9.44	41.06	1.30	77.50	100.65	23.15
3	Sugarcane	236.59	11.06	247.65	1.05	427.16	447.13	19.97
4	Jowar	7.32	1.24	8.56	1.17	80.58	94.21	13.63
5	Paddy	35.40	5.33	40.73	1.15	82.93	95.40	12.47
6	Groundnut	14.16	0.98	15.14	1.07	118.20	126.34	8.14
7	Cotton	7.41	0.81	8.22	1.11	69.22	76.75	7.53
8	Greengram	4.72	0.77	5.49	1.16	33.48	38.94	5.46
9	Potato	30.52	6.71	37.23	1.22	22.78	27.79	5.01
10	Wheat	5.90	1.00	6.90	1.17	19.66	22.99	3.33
11	Maize	47.60	1.30	48.90	1.03	99.08	101.78	2.70
12	Sunflower	10.62	2.53	13.15	1.24	9.71	12.03	2.32
13	Bengalgram	7.08	0.36	7.44	1.05	33.56	35.27	1.71
	Total							**147.94**

* AVOP= Actual Value of Production; EVOP= Expected Value of Production

Table-4.44: Priority matrix for Zone-IX

SL	Crop	On sample farms				Estimated for the entire zone-IX		
		Actual Yield (q/ha)	Production loss (q/ha)	Expected yield (q/ha)	Ratio of expected to actual yield	AVOP* (Rs.Crores)	EVOP* (Rs.Crores)	Production loss (Rs.Crores)
1	Sugarcane	599.72	36.79	636.51	1.06	136.77	145.16	8.39
2	Paddy	55.25	3.01	58.26	1.05	134.04	141.35	7.31
3	Cotton	10.62	3.85	14.47	1.36	11.24	15.31	4.07
4	Groundnut	10.43	1.56	11.99	1.15	16.97	19.51	2.54
5	Jowar	7.08	0.74	7.82	1.10	3.36	3.71	0.35
	Total							22.67

* AVOP= Actual Value of Production; EVOP= Expected Value of Production

Table-4.45: Priority matrix for Zone-X

SL	Crop	On sample farms				Estimated for the entire zone-X		
		Actual Yield (q/ha)	Production loss (q/ha)	Expected yield (q/ha)	Ratio of expected to actual yield	AVOP* (Rs.Crores)	EVOP* (Rs.Crores)	Production loss (Rs.Crores)
1	Paddy	67.26	4.33	71.59	1.06	358.15	381.21	23.06
2	Sugarcane	641.64	48.13	689.77	1.08	16.85	18.11	1.26
3	Groundnut	10.03	0.92	10.95	1.09	9.27	10.12	0.85
4	Tomato	75.00	6.84	81.84	1.09	1.45	1.58	0.13
5	Brinjal	23.60	0.74	24.34	1.03	1.45	1.50	0.05
	Total							25.35

* AVOP= Actual Value of Production; EVOP= Expected Value of Production

DISCUSSION

V. DISCUSSION

The main focus of the study is to estimate the magnitude of yield gaps and constraints responsible for yield gaps, production loss due to different constraint and prioritisation of agricultural research based on the production loss caused by different constraints. The results of the study presented in the previous chapter are illustrated in this chapter with reasons. The main focus is to throw light on the some of the causes responsible for the major trends observed in the findings and are discussed under the following heads

5.1 Socio-economic profile of the respondents.

5.2 Magnitudes and indices of yield gaps.

5.3 Prioritization of research in different crops.

5.4 Socio-economic constraints faced by the farmers.

5.5 Priority matrix for selected zones.

5.6 Prioritization of crops in selected zones based on total value of production loss

5.1 Socio-economic profile of the respondents

The socio-economic characteristic features of sample farmers presented in Table 4.1 are disused here. Average age of the sample farmer was around 40 years in all the three selected zones. As regards to education level of farmers, among all the selected Zones, the proportion of literates was slightly higher (88.89 %) in zone-X. It was mainly due to the fact that, zone comprises of Dakshina Kannada district whose literacy rate is 100 per cent. However, for rest of the zones also the literacy rate was more than 80 per cent.

The family size of the sample farmers was nearer to ten and the proportion of children population was less compared to adult mail and female population in all the zones Majority of the sample farm families were joint families (63.89) as a result the family size appears to be bit high.

The average size of land holding (4.16 ha) was higher in zone-X where in most of the large farmers had very large size of landholdings of more than 10 ha. The irrigated area was very high in case of zone-IX and zone-X and most of the farmers have various sources of irrigation like bore wells, tube wells, canals and open wells. Where as in zone-VII the proportion of irrigated area was very low.

5.2 Magnitudes and indices of yield gaps

With advent of new technology in agriculture, significant improvement in crop productivity was noticed. However, resource mix and appropriate management practices become pre-requisite for adopting and for success of new farm technology, which are often beyond the reach of a majority of the farmers. Results of the study revealed that the productivity of cereals, pulses, oil seeds, commercial crops and vegetables on sample farms was much lower than those recorded on research plots and demonstration plots.

5.2.1 Magnitudes and indices of yield gaps in cereals

There existed a wide gaps between the potential yield, demonstration plots yield (potential farm) and the actual yield of cereals on the farmers fields (Table 4.2 to 4.6). As for as the potential farm yield is concerned in case of cereal crops, it was 73.33 q/ha in the case of paddy crop. Like wise the potential yield was 12.50 q/ha for jowar, 65 q/ha for maize and 8.25 q/ha for wheat and this has resulted in 10.69 q/ha, 5.30 q/ha 17.40 q/ha and 2.30 q/ha of higher output, respectively compared to those realized by the farmer in the study area. It was interesting to note that the size of Yield Gap-I was more than Yield Gap-II for all cereal crops. So a greater amount of potential yield was left untapped. This implied that the technology developed at research station could not be fully replicated on the demonstration plots.

The results of the study are in contrast to those obtained by Madhavaswamy and Sheshareddy for HYV jowar (1987) and Roy and Datta (2000) for rice-wheat system where in, the authors reported smaller size of Yield Gap-I than Yield Gap-II. The findings of the study are in conformity with the studies of Chowdhary *et. al.* (1993), Patil (1995) for groundnut and Gaddi (2000) for Jowar, cotton and groundnut, who reported comparatively higher magnitude of Yield Gap-I over Yield Gap-II.

In case of paddy crop, the size of Yield Gap-I was marginally higher in zone-X than in zone-IX. Zone-VIII farmers were better off in exploiting the potential farm yield through better resource utilization than their counter parts did in zone-IX and zone-X. Like wise in jowar crop the actual yield realized by the sample farmers in zone-VIII and zone-IX was around 7 q/ha but the Yield Gap-I was very high in zone-VIII compared to zone-IX farms. The index of potential farm yield results revealed that the zone-IX are better off in exploiting the resources compared to zone-VIII farmers where in only 48.77 potential farm yield was realized on their farm.

The results on realized potential farm yield in maize and wheat (zone-VIII) revealed that farmers are able to realize around 70 per cent of potential farm yield. Hence 30 per cent of the potential yield was left untapped due to various biological, physiological and cultural practices. The resultant index of potential yield was also less.

5.2.2 Magnitudes and indices of yield gaps in pulses

As for as pulse crops are concerned, the results on indices of yield gaps revealed that yield performance of pulses on the farmers fields in zone-VIII was very poor in case of green gram and bengal gram and they were able to realize only 59 per cent of potential farm yield. Where as in the case of greengram farmers realised 70.80 per cent of potential farm yield in zone-X. Performance of farmers in zone-VIII was also poor with respect to bengalgram

where in they were able to realize only 64.36 per cent of potential farm yield. Performance of zone-X farmers in all the pulse crops production was very good and farmers able to realize around 70 per cent of potential farm yield. However, in the study area (zone-VIII) still there was a scope to tap the potential yield of bengalgram to the extent of 30 to 35 per cent through adoption of better management and cultural practices.

5.2.3 Magnitudes and indices of yield gaps in oilseeds

With regard to the yield gaps in oil seed crops, the potential yield of groundnut was relatively higher in zone-VIII compared to their counter parts in zone-IX and zone-X. The magnitudes of Yield Gap-I and Yield Gap-II were also higher in zone-VIII. It could also be revealed from the Table-4.4 that in zone-VIII there existed a wide gap between the potential yield and the potential farm yield and also there was wide gap between the potential farm yield and the actual yield realised on the farmers field. With regard to the performance of groundnut crop in different zones, the index of potential farm yield for zone-IX was relatively higher (71.94%). Where as, the index of potential farm yield on zone-VIII was still lower (64.36%). Better yield performance of crops in zone-IX may be attributed to the assured rainfall received in the Zone. This zone covers malnad taluks like Haliyal of Uttar Kannada and the Khanapur taluk of Belgaum districts.

The estimated indices of yield gaps for groundnut stood at 59.23 per cent in the overall study area. So there existed a tremendous scope to increase the performance of this crop on farmer field. It may not always be possible to realize 100 per cent potential yield due to difference in environmental conditions. However. farmers can realize major portion of potential yield by over coming the perceived constraints.

Potential farm yield in zone-VIII for sunflower was very less compared to potential yield and has resulted in higher magnitude of Yield Gap-I, where as, the difference between

potential farm yield and actual yield was less. This implied that, there exists a smaller Yield Gap-II than Yield Gap-I. Index of yield gap stood at 58.35 per cent and it revealed a higher scope to improve the production of sunflower. Soybean crop also showed more or less similar results with respect to the magnitudes and the indices of yield gaps and there will be a long way to reach the higher production. This suggests that, there is a need to educate the farmers regarding better management practices through adoption of new technology, cultural practices and optimum use of resources.

5.2.4 Magnitudes and indices of yield gaps in commercial crops

The results on yield gaps and yield gap indices in commercial crops showed that the size of Yield Gap-I in cotton was relatively higher in zone-IX than zone-VIII. This showed a wide gap between the potential yield and the potential farm yield. Where as, the comparison between the Yield Gap-I and Yield Gap-II showed that there was wide difference between the Yield Gap- I and Yield Gap-II. The magnitude of Yield Gap-I was higher than the Yield Gap-II for all commercial crops. In case of sugarcane, the Yield Gap-II accounts for nearly 25 per cent of potential farm yield. This implied the yield realised by the farmers in the study area is far lower than the potential farm yield. The highest magnitude of Yield Gap-II was observed in zone-IX and the lowest being noticed in zone-VIII. Farmers could reach the potential farm yield by minimising or by over coming the perceived constraints. Nearly 70 per cent of potential farm yield was realised by the sample farmer (Table-4.10), hence 30 per cent of additional output could be realised by the farmer, if all the recommended package and production technology in commercial crops was adopted. Among the three commercial crops, the index of potential farm yield was almost same (71.64%) for sugar cane, cotton (70.68) and chilli (70.80%). Hence, sample farmer were in better position in exploiting the potential farm yield in the case of all the three commercial crops. The indices of realised potential

yield showed that the potential yield index was the highest (43.82%) in sugar cane followed by the cotton (41.82%) and chilli (40.46%).

5.2.5 Magnitudes and indices of yield gaps in vegetable crops

Among the vegetable crops onion, brinjal and okra were grown in zone-VIII, zone-X and zone-IX respectively (Table-4.6). In the case of onion, the Total Yield Gap was 46.38 q/ha and Yield Gap-I accounted for 45 per cent of potential yield and Yield Gap-II accounts for around 25 per cent of potential farm yield. Like wise the Yield Gap-I in brinjal was 22 q/ha and accounted for 48 per cent of the potential yield and Yield Gap-II (9.40 q/ha), which accounted for 28.48 per cent of potential farm yield. In okra, the magnitude of Yield Gap-I was 28.50 q/ha and Yield Gap-II was 11.18 q/ha. These two kinds of yield gaps constituted about 30 per cent of the potential yield and the potential farm yield, respectively.

The index of yield gap (Table-4.11) for onion, brinjal and okra was estimated at 59.00 per cent, 57.09 per cent and 58.35 per cent, respectively. Where as, the index of realized potential farm yield and the index of realized potential yield were around 40 per cent and around 71 per cent for all the crops, respectively. This implied that about 29 per cent of potential farm yield was left untapped.

5.3 Prioritization of research in different crops

The present study prioritises the research for five important crop groups viz., cereals, pulses, oilseeds, vegetables and commercial crops in selected zones in North Karnataka. Prioritisation was done with main intention of finding the ways to reduce the yield loss by controlling the severe problems that occur in production of different crops.

5.3.1 Research prioritization in cereals

The present study prioritized the research for paddy, jowar, maize and wheat in cereal crops. Paddy production was observed in all the selected three zones, where as jowar production was not observed in zone-X and maize production was observed only in zone-VIII.

In paddy production, weed infestation was the top most research problem in zone-VIII followed by low rainfall. Where as, rainfall was the severe most problem in zone-IX. Shoot borer, leafhopper and purple rot were the other problems among five prioritized constraints needs attention for research in zone-VIII. Like wise in zone-IX weeds, leaf miner, shoot borer and thrips were the other constraints. While, in zone-X salinity/alkalinity of soils due to rain and salinity/alkalinity due to application of heavy dose of fertilizer were the top two prioritized research problems. Udbatta disease, thrips and red headed hairy caterpiller were the other severe constraints among the top five prioritized research problems.

In jowar production, weed infestation, low rainfall and untimely sowing were the common research problems identified in zone-VIII and zone-IX. Black grain smut topped the list of prioritized research problems in zone-VIII and it was weed in zone-IX.

Low rainfall, uneven spacing, plant wilt and leaf spot disease were the top prioritized research problems for wheat production in zone-VIII. In maize, shoot borer was the top prioritized research problem followed by ear head smut, weed, non application of recommended dose of seed and leaf curl were the most important research problem got the priority in zone-VIII.

The going discussion revealed that the constraints like incidence of pests and diseases, low rainfall, weed and to some extent deviation from the recommended cultural practices

draw the immediate attention of research invention to contain the problem. Elimination or partial solution for these priority constraints would increase the farm production and improve the socio-economic condition of the farmers. There is a need to popularize integrated pest management and evolving research for genetic resistance has to be made especially to control bole worm, which is a major problem for cotton in the study area. Some kind of mechanism may be evolved to over come the losses due to weeds. Even though spraying of herbicide is practiced, it is to the limited extent and crop specific. Hence there is a need to evolve integrated weed management practices to contain this problem. In some parts of study area where sugarcane is predominantly grown, there is an acute shortage of water due to frequent power supply failure and in case of canal irrigation, there is a loss of water and frequent breakage of canal structures. The task here is to ensure regular power supply to the farm sector and proper lining of canals and distributaries where ever canal irrigation persists. Recommended package of practices are not followed irrespective of the crops across the zones. The task here becomes the establishment of strong extension network so as to educate the farmers regarding recommended package of practices.

5.3.2 Research prioritisation in pulses

It is apparent from the results presented in Table-4.14 and Table-4.15 of result chapter that, the major constraints faced in bengalgram production (zone-VIII)) were incidence of leaf miner, weeds, untimely sowing, crop wilt, not following of recommended crop spacing and untimely rainfall. These research problems caused considerable production loss in the case of bengalgram. Greengram was grown in zone-VIII and zone-X. Pod borer, powdery mildew, leaf eating caterpiller and leaf spot were the major constraints faced by the farmers of both the zones. However, low rainfall was the most severe constraint for farmers of zone-VIII and non-suitability of soils for zone-X farmers. Stagnation/water logging, problem of

aphids were the other constraints faced by the farmers in the production of green gram in zone-X. While for zone-VIII farmers, wilting of plant, weeds and incidence of thrips were the other constraints. In the case of blackgram, soil salinity/alkalinity appeared to be the top most constraint followed by leaf curl, pod borer and non-suitability of soils. The constraints were similar in the cultivation of cowpea including thrips and weeds. In horsegram, leaf spot, stagnation/water logging, non-suitability of soil, non-application of recommended seed rate and weed were the top prioritised research problems.

5.3.3 Research prioritisation in oilseed crops

Among the three important oilseed crops viz., groundnut, sunflower and soybean, production of groundnut and sunflower was observed in zone-VIII, while, zone-IX farmers produced only groundnut and soybean and zone-X farmers produced only groundnut. However, Table-4.17 indicates the priority research problems for the entire oilseed production system.

With regard to prioritisation of research in zone-VIII, the not following of the recommended spacing and incidence of heliothies topped the list in groundnut and sunflower production, respectively. This indicated the urgency for research intervention to contain the damage. Low rainfall and weeds were other important problems that reduce the production to a large extent in both the crops. Pod borer was an important insect pest that affected the groundnut production moderately and ranked IV in the list. Other important diseases causing the production loss in groundnut were leaf miner and red headed hairy caterpiller. The important diseases were leaf spot and bud nacrosis with next ranks. Like wise in sunflower production, untimely sowing and not following of recommended spacing were important cultural problems and ranked as IV and VI in research priority. In addition to these leaf spot,

charcoal and downy mildew were the important diseases appeared in the top ten research problems.

In zone-IX, low rainfall, problem of weeds, pod borer and leaf miner were the common problems effecting groundnut and soybean production. These ranked top four constraints in soybean production, while these got I, III. VI and IV ranks, respectively in groundnut production. For soybean weeds appeared as an third top most constraint and the important diseases were leaf spot and bud nacrosis. Groundnut was the only oilseed crop grown in zone-X was not so popular and important crop. Thrips, non-suitable and saline/alkaline/acidic soils, bud necrosis and root rot were the top ranked research problems.

It was evident from the results presented in the Table-4.17 that the above mentioned research problems will reduce the production loss if the control measurers are taken effectively. In all most all the zones rainfall and cultural practices appeared as the important ranked problems among top ten in the respective crops. With regard to soil problem, which was observed only in zone-X, require immediate research intervention in containing the same.

5.3.4 Prioritisation of research in commercial crops

Among commercial crops considered for the study, prioritization of research was done for sugarcane, chilli and cotton. Zone-VIII farmers have grown chilli, cotton and sugarcane, while the production of sugarcane was noticed in zone-X. Zone-IX farmers produced cotton and sugarcane crops.

Problems of weed, uneven distribution and low rainfall, leaf curl, leaf hopper, leaf miner and grass hopper were prioritized for research for chilli production in zone-VIII in that order. In cotton production bole worm appears to be the top most research problem among

the top ten research problems followed by low rainfall, weeds, wilting of plant, insects like thrips and leaf hopper, powdery mildew, leaf spot and root rot diseases and not following of recommended spacing. Production of sugarcane was severely affected by weeds and NPK deficient soils. Other research problems were low rainfall, viral disease, ratoon stunting, cultural practices, powdery mildew and pyrilla

With regard to research prioritization in zone-IX, cotton production was severely affected by pests (white fly, bole worm, thrips and leaf hopper), diseases (rust, wilting of plant and leaf curl) and weeds. Hence, there is need to find immediate solution for these problems. Like wise in sugarcane, rainfall and pyrilla were the main contributors for production loss and were ranked I and II, respectively. The other serious problems were pests and diseases.

5.3.5 Research prioritization in vegetable crops

The prioritization of research was done for carrot, tomato, potato, onion, cucumber, okra and brinjal. Zone-VIII farmers produced carrot, onion and potato, where as, zone-IX farmers produced carrot and okra only and zone-X farmers produced tomato, cucumber, okra and brinjal.

Zone-VIII experienced the severe effect of thrips, leaf spot, weed, soil problems and leaf hopper insect in carrot production and were the main problems needs immediate attention for research prioritisation. The potato and onion production was severely affected by uneven and low rainfall and appeared to be the top most constraint for both the crops. The important diseases like wilting of plant, powdery mildew and leaf curl and ranked as II, V and IX respectively affected the potato production. The important insect pests for potato were thrips, leaf hopper and white fly with rank of III, VI and X in the top ten prioritised research problems. Non-application of recommended dose of seeds appeared as important cultural

problem and deficiency of NPK in soil also were the other important soil related research problems. Like wise in onion, weed infestation, charcoal disease, early/delay sowing, powdery mildew, degraded/eroded soils, leaf curl, leaf miner and deficiency of NPK appeared as important research problems in that order.

In the case of zone-IX, carrot production faced the severe problem of salinity of alkalinity of soils and affected the production relatively to greater extent. Other important problems that caused loss in production included diseases and pests. In the same manner the okra production was severally affected by the leaf curl, low rainfall, fruit borer and leaf spot need to be given priority for research.

In the case of zone-X, soil related problems were not severe problems like in the case of other crops. In tomato production, farmers have not followed the recommended spacing and should got the top most priority for research which caused the marginally high production loss. This was followed by leaf spot, leaf curl, insect pests (leaf eating caterpiller and leaf hopper, salinity and acidity of soils, weed and fruit rot disease. In other three crops viz., cucumber, okra and brinjal diseases and pests were the most important research problems need top priority while directing the research efforts.

From the fore going discussion it is apparent that vegetable production was severely affected by the pests and diseases and it calls for the immediate concern of researcher to resolve the problem by finding the suitable integrated chemical/cultural measures or by evolving new varieties resistant to above mentioned pests and diseases.

5.4 Socio-economic constraints faced by the farmers

From the results on the socio-economic constraints in paddy production it was revealed that in all the selected zones, high wage rate of labour and non availability of labour were the important constraints in the study zones. Due to decreasing work force in agriculture, there is a need to invent labour intensive implement that must have the low cost and accessible to small and medium farmers. Insufficient water was the second most sever constraint followed by non-availability of quality seed in zone-VIII, hence government agencies and private sector agencies should ensure supply of quality seeds to the farmers. High cost of production ranked as the top most constraint, to reduce this farmers should be made aware about the improved technology to reduce the cost of production. Farmer in both zone-IX and zone-X expressed high wage rate of labour and high cost of production as severe constraints. Therefore, there is need to invent the labour saving equipments that will able to reduce the labour requirement and cost of production.

Cultivation of jowar was observed only in zone-VIII and zone-IX, wherein farmers expressed poor transfer of technology, high cost of marketing, low price for product, price fluctuation and labour problems as severe constraints. In this regard, there is a need to regularize the marketing functions to reduce the high marketing cost. At the same time, there is a need to develop strong extension network to transfer the technology developed by different agencies to farmers.

In wheat and maize crops, farmers of zone-VIII expressed that non-availability of labour, high cost of marketing and production and price related problems to be the most severe constraints. There is a need to find solution for these problems to improve the socio-economic status of the farmers and to encourage them to continue the production of these crops.

In pulse production (viz., green gram, bengal gram, black gram, horse gram and cowpea), farmers of zone-X faced the sever effect of non-availability of quality seed in the production of black gram. In this regard, there is a need to develop sufficient quantity of quality seeds, to improve the productivity of the crop. Again they expressed that the labour problem was severe in the form of high wage rate and non-availability during peak season for all the crops. In zone-VIII, farmers growing green gram and bengal gram expressed that non availability of labour during peak season and high wage rate of labour were the sever socio-economic constraints. Hence, to over come the problem of labour shortage and to reduce the cost of labour, either mechanization or labour saving devices have to be invented. Recently, research efforts have been made in some of the State Agricultural Universities to invent implements/devices that reduce the use of labour and all the Universities in the country can replicate this.

While, in the case of oil seed crops production, farmers in zone-VIII faced the problem of non availability of quality seeds in groundnut production. This was mainly due to unawareness of farmer about the improved technology. Where as in zone-IX, farmers expressed that the present marketing cost was very high and the price received for the product was low due to involvement of too many middlemen in the marketing of the produce. For this, there is a need to find efficient marketing channel that would be remunerative to both consumer and producer.

The results presented in the Table 4.34 revealed that sugarcane production was observed in all the three selected zones. In the case of zone-VIII, non availability of skilled labour was the top most constraint followed by high wage rate of labour, high cost of seed, non availability of quality agro chemical and lack of timely disbursement of credit. The high cost of production was the top most sever constraint in zone-IX followed by high cost of

seed, irregular supply of electricity, high wage rate of labour and high marketing cost. In the case of zone-X, the labour related constraints were appeared among the top the socio-economic constraints. The most severe constraint was high cost of production next important constraint was low price for product followed by lack of timely disbursement of credit and non-availability of skilled labour. The high wage rate of labour ranked IX. In view of intensive requirement of inputs to produce the sugarcane, it requires huge capital and this need to be timely supplied by the financial institutions. Also, transportation arrangement for sugarcane from production point to the processing place needs to be provided to the farmers in order to reduce the high marketing cost. This facility is being given by some of the private sugar factories, which need to be extended by the Co-operative and Public sector sugar factories.

The socio-economic constraints faced by the farmer in cotton production presented in Table 4.35 revealed that the cotton production was observed only in zone-VIII and zone-IX. In the case of zone-VIII, non-availability of labour during peak season was the severe constraint, like wise in the case of zone-IX, low price for product topped the list. Whereas, in both the zones, other constraints faced were similar with varying degree of composite score and rank. High cost of pesticides and poor quality affected crop production to a considerable extent. Hence, there is a need to popularize IPM technology, which, helps in reducing the cost incurred for agro-chemicals and ensure pest and disease control effectively.

Chilli production was observed only in zone-VIII and the estimates of socio-economic constraints (Table 4.36) showed that insufficient quantity of seed was the top most constraint followed by low price for the product, insufficient quantity of credit, non-availability of fertilizer and lack of information on prices. The low price for the produce is attributed for the

untimely rainfall during fruit set stage, which affected the quality of chilli fruits and fetched low price. In this direction, varieties, which can overcome this problem, need to be evolved.

The important socio-economic constraints in the production of vegetables viz. onion, brinjal and okra were presented in Tables 4.37 to 4.39 respectively. Onion production was observed in zone-VIII only, where in, non-availability of quality seeds was the severe constraint followed by low price for the product, insufficient quantity of seed, price fluctuation and lack of timely disbursement of credit. Brinjal cultivation was observed only in zone-X. High cost of production, low price for the product, high cost of agro chemicals, high marketing cost and lack of timely disbursement of credit were the important constraints faced. As vegetables are perishable products, the fluctuation in the price is bound to occur with the change in the supply of the same. Hence, necessary infrastructure facilities need to be provided to the farmers for storage of vegetables. The farmers growing onion in Bijapur district are practicing local storage method, wherein, they can store the produce for 3-4 months. In this direction, modification of this storage structure with the scientific background will help to reduce the loss during storage and prolong the storage period.

In okra production, the lack of information on prices appears to be the top most constraint followed by high cost of chemical fertilizer, low voltage, in sufficient quantity of credit, high cost of marketing, low price for product.

It is apparent from the fore-going discussion that, socio-economic constraints also need attention through research on policy intervention. Non-availability of labour and high wage rates, which obviously lead to high cost of production and needs a priority. Thus, labour saving equipments would help in reducing high cost of production. Farmers felt that, they were not able to get remunerative returns due to low price. Thus, terms of trade need to be in favour of agriculture. There seems to be no parity between input prices and output prices.

Hence, there is a need to maintain parity by the government intervening in the market with appropriate price policy. At the same time, policies are needed to encourage use of bio-pesticides and bio-fertilizers to substitute poor quality of agro-chemicals as expressed by majority of the farmers in the study area. Policies are also need to ensure institutional finance is adequate and timely available to the farmers. Government and private agencies should ensure supply of quality seeds and agro chemicals. Frequent breakage of canal and decreasing water table were the major areas of concern that affected the productivity of crops. Finally, transfer of technology developed by the SAU's linked with a strong co-ordination of the state department of agriculture is need of the hour.

5.5 Priority matrix for selected zones

It is apparent from the results presented in chapter-IV that there should be a trade-off in research resource allocation for different crops. The developed priority matrix calls for efficient research resource allocation in the crops that are location specific and produced by the farmer on large area. In zone-VIII, sugarcane and chilli were the prioritized crops that needs a more additional research resources that can be sacrificed by the other crops. Similarly, sugarcane was the top prioritized crop for the research in zone-IX, for which higher allocation of research funds is needed. This crop contribute around 33.00 per cent to total VOP in agriculture.

In zone-X, arecanut was the top prioritized crop, which accounted for 88.36 per cent of total VOP in agriculture and this crops needs additional research resources to improve its production performance, which requires the sacrifice from less important crops in terms of value of product.

5.6 Prioritization of crops in selected zones based on total value of production loss

Total value of production loss was taken as the guideline for the prioritization of different crops, since it was thought that saving in the production loss amounts to gain in production. Hence grater the production loss, higher the rank given to the crop, and vice-versa.

The results of the study revealed that in all the selected zones, the location specific crops were severely affected by different technical constraints mainly due to low rainfall and resistance of disease and insect pest to different practices adopted by the farmers to control diseases and pests. It is clear from the results (Table-4.43-4.45) that in zone-VIII, chilli, onion, sugarcane, jowar and paddy were the top five prioritized crops. The production loss due to various agro-biological constraints in these crops was to the extent of Rs.42.51 crore to Rs.12.47 crore. In zone-IX, sugarcane, paddy, cotton, groundnut and jowar were the top five prioritized crops. Where in the loss of production was as high as Rs.8.39 crores to as low as Rs.0.35 crores. As in zone-IX, paddy, sugarcane and groundnut were the top three prioritized crops followed by tomato and brinjal in zone-X. The loss in the output in this case was to the tune of Rs.0.05 crores to Rs.23.06 crores. In each zone prioritized crops are amongst the crops predominantly cultivated in the respective zones.

SUMMARY AND POLICY IMPLICATIONS

VI. SUMMARY AND POLICY IMPLICATIONS

Agricultural research prioritization is simply a process which identifies commodities, research themes and regions which are likely to face stress or which offer opportunities in the context of national objectives. It also has to take long-term view on natural resource conservation and sustainability issues.

Agricultural research prioritization gain importance, because as compare to any method of research resource allocation, it allocates the scare research resources across problems, commodities and regions within a research system more effectively and efficiently. Research resource allocation decisions are made at different levels and are broadly classified into allocation at the macro level, allocation at the programme or sub-programme level and allocation at the project level.

Agricultural research has significantly contributed to agricultural growth, a phenomenon observed world over. But, currently, agricultural research system faces growing scarcity of resources. In recent years, the Consultative Group on International Agricultural Research (CGIAR) has to face a cut of 20 percent of resources provided earlier (Dixit, 1994). Similar is the story with many of the National Agricultural Research Systems (NARS). Further, the decision makers desire information on research pay-off in order to assess alternative uses of funds. This calls for efficient use of available resources with an growing complexity in setting priorities as there are competing goals of research such as efficiency, equity and sustainability. Thus, there is a growing need for evaluation of agricultural research investments and setting priorities research investment.

In priority setting analysis, choice of relevant criteria and choice of analytical approaches play an important role. The important criteria considered are growth, efficiency, equity, sustainability and trade issues. Scoring approach, benefit-cost analysis, programming model, simulation model and econometric model are the important analytical methods reported for agricultural research priority setting.

Present study was undertaken with an intension to assess the research priorities across research problem area and across agro-climatic zones in northern Karnataka. Crop loss estimates were used to assess the research priorities, as the crop losses provide only the potential gain from research.

Across agro-ecological zones, for priority setting the simple congruency approach has been used in allocating research resources across zones. The major consideration is the potential for spillovers i.e., the potential for research conducted in one zone to be applied in another zone, either directly as a released technology or indirectly as an input into the research programme of other zones. Potential spillovers depend on agro-climatic similarity and socio-economic factors. The specific objectives of present study include

1. To estimate the yield gaps in selected crops across production environments.
2. To identify the major production constraints and assess their severity in terms of yield losses in selected crops.
3. To develop priority matrix for allocation of resources across selected commodities and agro-climatic zones.
4. To prioritize agricultural research programmes for selected zones of northern Karnataka.

6.1 Methodology

Both primary and secondary data were utilized in the present study. The data on the performance of different crops at demonstration plots were collected from various Research Stations, Extension Education Units and Krishi Vignan Kendra's coming in the jurisdiction of the University of Agricultural Sciences, Dharwad. The taluka wise data on the area and yield of important commodities were collected form the respective District Statistical Office and from the Directorate of Economics and Statistics, Bangalore. The taluka-wise data on the prices of important commodities were collected from the State Agricultural Marketing Board, Bangalore.

Multistage sampling technique was adopted in deciding the sampling frame. In the first stage, three zones viz., zone-VIII, zone-IX, and zone-X zones were purposively selected. In the second stage, in each zone two districts were selected based on the agro-climatic conditions and cropping pattern prevailing. In the third stage, one taluk was selected from each of the six finalized districts. In the next stage, two villages were selected from six finalized taluks. In all twelve villages were selected for the present study. Finally, from each of the selected village nine sample farmers were chosen at random from different size group and thus total sample comprised of 108 farmers.

6.1.1 Analytical Techniques

Tabular presentation was extensively used in the study to compare and contrast the percentages and averages.

The methodology developed by the IRRI was used in the present Yield Gap Analysis. For better understanding and meaningful comparisons, percentages and indices relating to yield gaps

were computed. The severity of different technical constraint in the production of different crops was estimated by calculating the production loss due to particular constraint, then among these constraints top ten constraints were identified based on the severity of constraint. The priority matrix was developed based on the VOP of the crops in all the zones.

6.2 Findings of the Study

6.2.1 Socio-Economic characteristic features of sample farmers

Based on the size of land holding, the sample farmers were classified into small, medium and large farmers. The results on important socio-economic characteristics of respondents revealed that, the average age of respondents was more than 40 years emphasizing the predominance of older person in decision-making process. Average literacy rate across the zone was 84.25 per cent. The average family size was 9.96 members and most of them were joint families (63.89%).

6.2.2 Magnitudes and indices of yield gap

The results of the study revealed that the productivity of all the crops on sample farms was much lower than those recorded on research plots as farmers have not been able to follow all the package of practices fallowed on research plots and reap the full benefits of new technology. The analysis of results on yield gaps in most of the crops indicated that the size of Yield Gap-I was more than Yield Gap-II for all crops considered in the study. So, a greater amount of potential yield was left untapped on the demonstration plots. This implied that the technology developed at research station could not be fully replicated on demonstration plots, which was attributed to the difference in the environmental factors and partly to the non-transferable component of technology like cultural practices.

Among the different cereal crops paddy, jowar, maize and wheat crops grown in the study area were considered. In the case of paddy, the magnitude of Yield Gap-I and Yield Gap-II were higher in zone-X. In jowar production, the highest farm yield was observed in zone-VIII (7.32 qt/ha). Whereas, across the zones, the average farm yield realized was 7.20 qt/ha. The average size of Yield Gap-I was 8.50 qt/ha for the overall study area.

The results on estimated indices of yield gaps revealed that, farmers were able to reach only about 70 percent of potential farm yield. The lowest index of realized potential yield was observed for jowar (29.26 qt/ha) in zone-VIII.

In the case of pulse crops, size of Yield Gap-I ranged from 5.00 qt/ha (green gram) to 15 qt/ha (cowpea). Nearly 43 per cent of potential yield of black gram was exploited in zone-X. Index of realized potential farm yield was the highest for green gram (70.80%) in zone-X.

In case of oil seed crops, for the overall study area the magnitudes of Yield Gap-I and Yield Gap-II were 11.50 qt/ha and 5.29 qt/ha. Farmers exploited around 40 per cent of the potential yield in all the zones. Where as, the potential farm yield exploited ranged from 64 to 71 percent. Similar results were observed for sunflower and soybean in zone-VIII and zone-IX, respectively. In all, farmers realized about 40 per cent and 70 per cent of potential yield and potential farm yield, respectively.

6.2.3 Production loss due to different technical constraints

Results on production loss due to different constraints in cereals revealed that loss due rainfall/irrigation accounts for one fourth of production loss in all the zones for all the crops except jowar (4.84%) and wheat (48.54%) in zone-VIII. Production loss due to diseases was the highest for jowar (65.97%) in zone-VIII. Paddy production was also severely affected by

diseases and pests. Rainfall and incidence of some of the severe diseases were the main prioritized research problems.

In pulse production, diseases pests and rainfall were the severe constraints. In Zone-VIII, low rainfall was the prioritized research problem in all the crops. Where as, in Zone-X soil problems appeared as the prioritized research problem for all the crops and in some cases the cultural problems were the prioritized research problem.

From results of the socio-economic constraints in paddy production, high wage rate of labour and non-availability of labour appeared to be the major one in the overall study area. High cost of production, poor transfer of technology, high marketing cost, low price for product, price fluctuation and non-availability of quality agro-chemical were among the top ten constraints faced in the study area.

6.2.4 Priority matrix for selected zones

The results on the priority matrix revealed that in zone-VIII, commercial crops like sugarcane and chilli were top prioritized with value of production (VOP) of Rs.427.16 crore (29.03 %) and Rs.324.40 crore (21.98%) in total value of product in agriculture. These were followed by groundnut, maize, jowar and paddy with a respective VOP of Rs.118.20 crore, Rs.99.07 crore, Rs.80.58 crore and Rs.22.93 crore. Onion, cotton, bengalgram and greengram were the other top ten commodities.

With respect to the VOP, sugarcane (Rs.136.77 crore) was the most important crop in zone-IX followed by paddy (Rs.134.04 crore) and arecanut (Rs.35.96 crore). Potato, groundnut, chilli, cotton, maize, onion and banana were among the top ten commodities

In zone-X the two important plantation crops viz., arecanut and coconut have got the first and third rank, respectively. Paddy occupied the second position with a contribution of eight per cent to total VOP of agriculture. Banana was the next important crop with VOP of Rs.26.21 crore (0.59%) followed by sugarcane, groundnut, pepper and chilli.

6.2.5 Prioritization of crops in selected zones based on total value of production loss

Total value of production loss was taken as the guideline for the prioritization of different crops, since it was thought that saving in the production loss amounts to gain in production. Hence, grater the production loss, higher the rank given to the crop, and vice-versa.

The results of the study revealed that in all the selected zones, the location specific crops were severely affected by different technical constraints mainly due to low rainfall and resistance of disease and insect pest to different practices adopted by the farmers to control diseases and pests. In zone-VIII, chilli, onion, sugarcane, jowar and paddy were the top five prioritized crops. In zone-IX, sugarcane, paddy, cotton, groundnut and jowar were the top five prioritized crops. As in zone-IX, paddy, sugarcane and groundnut were the top three prioritized crops followed by tomato and brinjal in zone-X. In each zone prioritized crops are amongst the crops predominantly cultivated in the respective zones.

Policy implications

In the present study, the magnitudes of yield gaps, severity of technical constraints in the production of various crops, production loss due to various constraints, prioritization of crops and constraints therein were examined. The detailed examination of all these aspects would help guide the public policy formulation. In this connection, the important policy implications that could be drawn from the findings of the study area are as follows.

1. The results of the priority matrix developed based on total value of production loss revealed that, in zone-VIII, chilli, onion, sugarcane, jowar, and paddy were the top five prioritized crops. The production loss in these five crops together accounts for Rs.91.76 crore. These crops require additional research resources to minimize the production loss, and hence, enhance productivity.

2. In zone-VIII, the production losses in top five crops were mainly due to diseases, pests and low rainfall. Hence there is a need to develop and/or transfer the varieties that are resistant to relevant diseases and pests and also to develop and/or transfer effective water conservation practices to tackle the problem of low rainfall.

3. Sugarcane, paddy, cotton, groundnut and jowar were the top prioritized crops for zone-IX. These crops were predominantly grown in the zone. The production loss in these five crops together accounts for Rs.22.67 crore. Therefore, there is a need to intensify research activities that would lead to reduction in production loss for these crops.

4. In zone-IX, the important constraints for the production of top five prioritized crops (viz., sugarcane, paddy, cotton, groundnut and jowar) were identified to be low rainfall and weeds. Non-adoption of recommended spacing also appeared among the top five prioritized constraints in groundnut, cotton and sugarcane. Other severe constraints were leaf miner and leaf spot in groundnut, leaf miner, shoot borer and thrips in paddy, shoot borer and leaf hopper in jowar, white fly and rust in cotton and pyrilla, termites and leaf hopper in sugarcane. All these crops are commercially important crops in this zone. Hence, there is a need to intensify research activities on these agro-biological constraints by sacrificing the research resources invested in other less important crops.

5. In zone-X, paddy, sugarcane, groundnut, tomato and brinjal were the top five prioritized crops. The production loss in these five crops together accounts for around Rs.25.35 crore. Therefore, this production loss could be reduced to some extent by consolidating and concentrating research on these crops.

6. Soil related problem (like salinity or alkaline soils) or non-suitability of soils for production of crops were the severe most constraint in the production of all the top five prioritized crops in zone-X. Udubatta disease, thrips and red headed hairy caterpiller were the other severe constraints causing the loss in the production of paddy. Likewise in sugarcane, weeds, pyrilla, termites and red rot were the major problems. In groundnut, thrips, bud necrosis and root rot were the severe constraints. Tomato and brinjal production was severely affected by diseases and pests. Hence, there is an immediate concern expected of the agricultural scientists in addressing the soil related problems faced by the farmers in cultivating these crops, in developing integrated pest and disease management practices or in developing varieties in the above mentioned crops that are resistant to relevant diseases and pests.

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APPENDICES

Appendix-I: Estimated Production Losses in Cereals Production

(Quintals)

Sl	Constraints	Paddy			Jowar		Maize	Wheat
		Z-VIII	Z-IX	Z-X	Z-VIII	Z-IX	Z-VIII	Z-VIII
I)	**Diseases**							
a	Wilting of plant	0.10	2.11	0.78	-	-	0.24	0.76
b	Charcoal rot	0.30	-	-	-	-	-	-
c	Downy mildew	-	-	-	3.71	0.68	2.57	-
d	Rust	0.10	2.35	4.72	-	-	-	-
e	Leaf spot disease	-	6.84	9.23	-	-	-	0.21
f	Black grain smut	-	-	-	31.03	0.21	-	-
g	Stem rot	0.10	0.84	17.72	-	-	3.00	-
h	Anthracnose		-	0.46	-	-	-	-
i	Udabatta disease	0.05	-	25.58	-	-	-	-
j	Blast	-	-	3.83	-	-	-	-
k	Blight	-	-	14.81	-	-	-	-
l	Leaf blight	-	-	0.88	-	-	1.00	-
m	Leaf curl	-	-	-	-	-	3.63	-
n	Ear head smut	-	-	12.13	0.61	-	9.53	-
o	Root rot	-	-	0.44	-	0.10	-	-
p	Sugary disease	-	-	-	0.10	-	-	-
	Sub total	**0.65 (15.25)**	**12.14 (6.92)**	**90.58 (26.54)**	**35.45 (65.97)**	**0.99 (28.05)**	**19.97 (34.36)**	**0.97 (20.21)**
II	**Pests**							
a	Shoot borer	0.80	16.27	18.01	1.68	-	16.05	-
b	Termites	0.10	-	1.30	-	-	-	-
c	Root grub	-	-	1.57	-	-	-	-
d	Thrips	-	11.96	20.11	-	-	-	-
e	Red headed hairy caterpillar	-	-	19.21	-	-	-	-
f	Leaf eating caterpillar	-	-	0.26	-	-	-	-
g	Bug	-	-	-	0.05	-	-	-
h	Grass hopper	-	-	3.31	-	-	8.12	-
i	Leaf hopper	0.50	-	14.83	-	-	-	-
j	Army worm	-	2.62	3.19	5.27	0.63	2.08	-
k	Leaf miner	-	17.63	-	-	-	0.23	-
l	Plant hopper	-	8.49	-	-	-	-	-
m	Midge	-	-	-	2.77	0.10	-	-

Sl	Constraints	Paddy			Jowar		Maize	Wheat
		Z-VIII	Z-IX	Z-X	Z-VIII	Z-IX	Z-VIII	Z-VIII
	Sub total	**1.40 (32.86)**	**56.97 (32.45)**	**81.97 (23.97)**	**9.77 (18.18)**	**0.73 (20.68)**	**26.48 (45.57)**	
III	**Weeds (Sub total)**	**1.05 (24.65)**	**21.40 (12.19)**	**6.46 (1.89)**	**5.16 (9.60)**	**0.73 (20.68)**	**7.28 (12.53)**	
IV	**Soil**							
a	Non suitability to crop	-	-	3.36	-	-	-	-
b	Topography-Undulated	-	-	1.88	-	-	-	-
c	Poor water holding capacity	-	1.68	2.40	-	-	-	-
d	Salinity/ Alkalinity/ Acidic	-	10.05	34.12	-	-	-	-
e	Deficiency in N/P/ K	-	3.57	2.30	-	-	-	-
f	Degraded/ Eroded soil	-	3.57	-	-	-	-	-
	Sub total	-	**18.87 (10.75)**	**44.06 (12.91)**	-	-	-	-
V	**Cultivars**							
a	Non availability of recommended cultivar	-	-	0.75	-	-	-	-
	Sub total			**0.75 (0.22)**				
VI	**Seed**							
a	Spacing	-	0.46	1.80	0.48	-	0.30	1.50
b	Recommend dose	-	7.48	15.32	0.07	0.28	4.08	-
c	Early or delay sowing	0.12	7.26	8.44	0.21	-	-	-
	Sub total	**0.12 (2.82)**	**15.20 (8.66)**	**25.56 (7.49)**	**0.76 (1.41)**	**0.28 (7.93)**	**4.38 (7.54)**	**1.50 (31.25)**
VII	**Rainfall/ Irrigation**							
a	Low	1.04	50.96	-	2.60	0.80	-	2.33
b	Uneven Distribution	-	-	2.55	-	-	-	-
c	Stagnation/ Water logging	-	-	36.24	-	-	-	-
d	Salinity/ Alkalinity	-	-	53.25	-	-	-	-
	Sub total	**1.04 (24.41)**	**50.96 (29.03)**	**92.04 (26.97)**	**2.60 (4.84)**	**0.80 (22.66)**	-	**2.33 (48.54)**
	Grand total	**4.26 (100)**	**175.54 (100)**	**341.24 (100)**	**53.74 (100)**	**3.53 (100)**	**58.11 (100)**	**4.80 (100)**

Note: Figures in parentheses indicate percent to grand total

Appendix-II: Estimated Production Losses in Pulses Production

(Quintals)

SL	Constraints	Bengal gram	Green gram		Black Gram	Cow pea	Horse Gram
		Z-VIII	Z-VIII	Z-X	Z-X	Z-X	Z-X
I	**Diseases**						
a.	Wilting of plant	0.28	1.10	-	-	-	-
b.	Powdery mildew	-	0.59	0.45	-	-	-
c.	Leaf spot	-	0.18	0.08	1.66	1.75	2.47
	Sub total	**0.28 (14.89)**	**1.87 (20.94)**	**0.53 (18.47)**	**1.66 (29.49)**	**1.75 (22.35)**	**2.47 (48.15)**
II	**Pests**						
a.	Pod borer	-	2.39	0.93	1.06	1.23	-
b.	Leaf eating caterpillar	-	0.21	0.20	-	-	-
c.	Thrips	-	0.31	-	-	4.19	-
d.	Aphids	-	-	0.13	-	-	-
e.	Leaf miner	0.40	-	-	-	-	-
	Sub total	**0.40 (21.28)**	**2.91 (32.59)**	**1.26 (43.90)**	**1.06 (18.83)**	**5.42 (69.22)**	-
III	**Weeds (Sub total)**	0.40 (21.28)	0.65 (7.28)	-	-	0.66 (8.43)	0.41 (7.99)
IV	**Soil**						
a	Non suitability to crop	-	-	0.93	0.95		0.66
	Sub total			**0.93 (32.40)**	**0.95 (16.87)**		**0.66 (12.87)**
V	**Seed**						
a.	Spacing	0.22	-	-	-		-
b.	Recommend dose	-	0.38	-	-		0.47
c.	Early or delay sowing	0.36	-	-	-		-
	Sub total	**0.58 (30.85)**	**0.38 (4.25)**				**0.47 (9.16)**
VI	**Rainfall/ Irrigation**						
a.	Low	0.22	3.12	-	-		-
b.	Uneven Distribution	-	-	-	-		-
c.	Stagnation/Water logging	-	-	0.15	-		1.12
d.	Salinity/ Alkalinity	-	-	-	1.96		-
	Sub total	**0.22 (11.70)**	**3.12 (34.94)**	**0.15 (5.23)**	**1.96 (34.81)**		**1.12 (21.83)**
	Grand total	**1.88 (100)**	**8.93 (100)**	**2.87 (100)**	**5.63 (100)**	**7.83 (100)**	**5.13 (100)**

Note: Figures in parentheses indicate percent to grand total

Appendix-III: Estimated Production Losses in Oilseeds Production

(Quintals)

Sl	Constraints	Ground nut			Sunflower	Soybean
		Z-VIII	Z-IX	Z-X	Z-VIII	Z-IX
I	**Diseases**					
a.	Leaf spot disease	0.17	3.50	-	0.45	-
b.	Bud necrosis	0.08	2.36	1.02	-	-
c.	Charcoal disease	-	-	-	0.08	-
d.	Downy mildew	-	-	-	0.02	-
e.	Root rot	-	-	0.39	-	-
	Sub total	**0.25 (4.00)**	**5.86 (15.36)**	**1.41 (22.63)**	**0.55 (6.79)**	-
II	**Pests**					
a.	Pod borer	0.55	2.53	-	-	0.96
b.	Thrips	0.03	-	1.27	-	-
c.	Red headed hairy caterpiller	0.12	0.32	-	-	-
d.	*Helicoverpa armigera*	-	-	1.01	2.34	0.95
e.	Leaf miner	0.42	3.64	-	-	-
f.	Grass hopper	-	0.46	-	-	-
g.	Spodoptera	-	-	-	0.03	0.95
	Sub total	**1.12 (17.95)**	**6.95 (18.21)**	**2.28 (36.60)**	**2.37 (29.25)**	**2.86 (37.93)**
III	**Weeds (Sub total)**	**0.6 (9.62**	**7.05 (18.47)**		**1.33 (16.42)**	**1.76 (23.34)**
IV	**Soil**					
a.	Non suitability to crop	-	-	1.27	-	-
b.	Salinity/ Alkalinity/ Acidic	-	-	1.27	-	-
	Sub total			**2.54 (40.77)**		
V	**Seed**					
a.	Spacing	3.02	7.68	-	0.44	-
b.	Recommend dose	-	1.23	-	0.36	-
c.	Early or delay sowing	-	-	-	0.72	-
	Sub total	**3.02 (48.40)**	**8.91 (23.35)**		**1.52 (18.77)**	
VI	**Rainfall/ Irrigation**					
a.	Low	1.25	9.39	-	2.33	2.92
	Sub total	**1.25 (20.03)**	**9.39 (24.61)**		**2.33 (28.77)**	**2.92 (38.73)**
	Grand total	**6.24 (100)**	**38.16 (100)**	**6.23 (100)**	**8.11 (100)**	**7.54 (100)**

Note: Figures in parentheses indicate percent to grand total

Appendix-IV: Estimated Production Losses in Commercial crop Production

(Quintals)

SL	Constraints	Chilli	Cotton		Sugarcane		
		Z-VIII	Z-VIII	Z-IX	Z-VIII	Z-IX	Z-X
I	**Diseases**						
a	Leaf spot disease	-	0.38			50.63	
b	Powdery mildew	-	0.63		1.65		
c	Wilting of plant	-	1.51	0.28			
d	Leaf curl virus	0.40	0.08	0.13			
e	Rust	-	0.34	0.54	0.13		
f.	Red rot	-			1.00	46.32	196.00
g	Ratoon stunting	-			1.87		
h	Grassy shoot	-			1.88	1.88	30.00
i.	Smut	-					55.13
j.	Root rot	-	0.62			10.80	70.70
	Sub total	**0.40 (6.93)**	**3.56 (19.03)**	**0.95 (3.25)**	**6.53 (10.54)**	**109.63 (16.55)**	**351.83 (25.04)**
II	**Pests**						
a	Root grub		0.14			28.26	10.50
b	Shoot borer				0.92	25.74	
c	Termites				0.60	56.43	221.00
d	Bole worm		5.46	0.21			
e	Thrips		1.39	0.23	0.13	8.00	
f.	Ash weevil		0.05				
g	Leaf hopper	0.10	0.72	0.18	0.15	56.00	61.00
h	Pyrilla				1.10	92.49	239.00
i.	White fly		0.26	25.84			
j.	Midge			0.06		9.00	
k	Leaf miner	0.08					
l.	Grass hopper	0.07					
	Sub total	**0.25 (4.33)**	**8.02 (42.86)**	**26.52 (90.63)**	**2.90 (4.68)**	**275.92 (41.66)**	**531.50 (37.82)**
III	**Weeds (Sub total)**	**2.80 (48.53)**	**2.06 (11.01)**		**32.68 (52.75)**		**302.34 (21.51)**
IV	**Soil**						
a.	Topography-Undulated		0.26				
b.	Salinity/Alkalinity/ Acidic						52.59
c.	Deficiency in N/ P/ K				5.20	8.58	

SL	Constraints	Chilli	Cotton		Sugarcane		
		Z-VIII	Z-VIII	Z-IX	Z-VIII	Z-IX	Z-X
d.	Degraded/ Eroded soil				0.40	1.20	
	Sub total		**0.26 (1.39)**		**5.60 (9.03)**	**9.78 (1.48)**	**52.59 (3.74)**
V	**Seed**						
a.	Spacing		0.48	0.35	3.04	59.29	
b.	Recommend dose		0.08		1.80	19.72	
	Sub total		**0.56 (2.99)**	**0.40 (1.37)**	**4.84 (7.81)**	**79.01 (11.93)**	
VI	**Rainfall/ Irrigation**						
a.	Low	0.42	3.74	1.39	4.50	172.96	
b.	Uneven Distribution	1.90	0.51		4.90	15.00	
c.	Stagnation/ Water logging						167.00
	Sub total	**2.32 (40.21)**	**4.25 (22.72)**	**1.39 (4.75)**	**9.40 (15.17)**	**187.96 (28.38)**	**167.00 (11.88)**
	Grand total	**5.77 (100)**	**18.71 (100)**	**29.26 (100)**	**61.95 (100)**	**662.30 (100)**	**1405.26 (100)**

Note: Figures in parentheses indicate percent to grand total

Appendiex-V: Estimated Production Losses in Vegetable Production

(Quintals)

SL	Constraints	Carrot		Tomato	Potato	Onion	Cucumber	Okra	Brinjal
		Z-VIII	Z-X	Z-X	Z-VIII	Z-VIII	Z-X	Z-IX	Z-X
I	**Diseases**								
a.	Leaf spot disease	0.08	0.99	5.83	-	-	-	0.15	-
b.	Powdery mildew	0.02	0.30	-	5.74	3.92	0.15	-	0.45
c.	Wilting of plant	-	-	-	10.76	-	-	-	-
d.	Leaf curl	-	-	4.83	0.34	2.10	-	0.78	-
e.	Charcoal disease	-	-	-	0.25	7.00	-	-	-
f.	Rust	-	-	-	0.25	-	-	-	-
g.	Black scurf	-	-	-	0.25	-	-	-	-
h.	Anthracnose	-	-	-	-	-	0.10	-	-
i.	Fruit rot	-	-	1.76	-	-	-	-	0.34
	Sub total	**0.10 (19.23)**	**1.29 (29.93)**	**12.42 (37.82)**	**17.59 (27.32)**	**13.02 (24.62)**	**0.25 (19.69)**	**0.93 (45.14)**	**0.79 (17.87)**
II	**Pests**								
a.	Shoot borer	-	-	-	-	-	-	-	1.13
b.	Leaf eating caterpiller	-	-	4.56	-	-	-	-	-
c.	Red headed hairy caterpiller	-	-	-	-	-	0.60	-	-
d.	Grass hopper	-	0.31	-	-	-	-	-	-
e.	Leaf miner	-	-	4.00	-	1.36	-	-	-
f.	Thrips	0.28	0.96	-	9.58	-	-	-	-
g.	Leaf hopper	0.02	-	-	4.68	-	-	-	-
h.	White fly	-	-	-	0.30	-	-	-	-
i.	Fruit borer	-	-	-	-	-	0.20	0.25	1.80
j.	Bihar hairy caterpiller	-	-	-	0.40	-	-	-	-
	Sub total	**0.30 (57.69)**	**1.27 (29.47)**	**8.56 (26.06)**	**14.96 (23.23)**	**6.56 (12.40)**	**0.80 (62.99)**	**0.25 (12.14)**	**2.93 (66.29)**
III	**Weeds (Sub total)**	**0.08 (15.38)**	**0.76 (17.63)**	**2.53 (7.71)**	**7.55 (11.73)**	**12.10 (22.88)**		**0.13 (6.31)**	**0.70 (15.84)**
IV	**Soil**								
a.	Salinity/ Alkalinity/Acidic	0.04	0.99	2.89	-	-	-	-	-
b.	Deficiency in N/ P/ K	-	-	-	1.80	1.20	-	-	-
c.	Degraded/ Eroded soil	-	-	-	-	2.70	-	-	-

SL	Constraints	Carrot		Tomato	Potato	Onion	Cucumber	Okra	Brinjal
		Z-VIII	Z-X	Z-X	Z-VIII	Z-VIII	Z-X	Z-IX	Z-X
	Sub total	**0.04 (7.69)**	**0.99 (22.97)**	**2.89 (8.80)**	**1.80 (2.80)**	**3.90 (7.37)**			
V	**Seed**								
a.	Spacing	-	-	6.44	2.16	0.60	-	-	-
b.	Recommend dose	-	-	-	0.68	-	-	-	-
c.	Early or delay sowing	-	-	-	0.75	4.00	-	-	-
	Sub total			**6.44 (19.61)**	**3.59 (5.57)**	**4.60 (8.70)**			
VI	**Rainfall/ Irrigation**								
a.	Low	-	-	-	18.90	12.71	-	0.75	-
b.	Salinity/ Alkalinity	-	-	-	-	-	0.22	-	-
	Sub total				**18.90 (29.35)**	**12.71 (24.03)**	**0.22 (17.32)**	**0.75 (36.41)**	
	Grand total	**0.52 (100)**	**4.31 (100)**	**32.84 (100)**	**64.39 (100)**	**52.89 (100)**	**1.27 (100)**	**2.06 (100)**	**4.42 (100)**

Note: Figures in parentheses indicate percent to grand total

Appendix-VI

SCHEDULE

UNIVERSITY OF AGRICULTURAL SCIENCES, DHARWAD

"Agricultural Research Prioritisation for Selected Agro-climatic Zones in Northern Karnataka"

Farmers Schedule

I. General Information

1. Name of the farmer : _____
2. Village: _____ 3. Taluka: _____ 4. District: _____
5. Age: _____ 6. Education: _____ 7. Caste: _____ (SC/ST/OBC/GEN)
8. Family size: Male: _____ Female: _____ Children: _____ Total: _____
9. Family members fully engaged in agriculture: Male: ____ Female: ___ Children: ____
10. Family type: Joint/Nuclear
11. Main occupation: _____ 12. Subsidiary occupation: _____
13. Land holdings and use pattern

RF / IR	Area (acres)				Land use (Acres)				Land revenue (Rs/ac/yr)
	Own	Leased-in*	Leased-out*	Total	Field crops	Horti-culture	Permanent fallow	Others	
Rainfed									
Irrigated@									
Total									

* If leased-in: Rent paid Rs_____acre/year If leased-out: Rent received: Rs_____acre/year

@ If irrigated, source of irrigation: Open well/Bore well/Tank/Canal/Others

14. Cropping pattern

Season/Crop	Area (Acres)	Production (q)		Rate (Rs/q)		Appx. cost of Production (Rs/Acre)
		Main Product	By Product	Main Product	By Product	
Kharif						
1						
2						
3						
4						
Rabi/Summer						
1						
2						
3						
4						

II. Technical Constraints

Crop:_____ Area:_____acres. Season: K/ R/ S
Variety:Local/HYV/Hhb Nar.Name:_____ Situation:IR/RF
Potential yield:_____q/ha Actual yield:_____q/ha Yield gap:___q/ha

SL	Constraints	Details	Area affected (ac)	Yield loss		PoO (Yrs)
				%	Qtls	
1.	Soil	Non-suitability to crop/variety				
		Topography-Undulated				
		Poor water holding capacity				
		Salinity/Alkalinity/Acidic				
		Nutrient Deficiency in N/P/K				
		Degraded/eroded soil				
2.	Cultivars	Non-availability of recommended cultivar				
3.	Seed	Recommended spacing not followed				
		Non-application of recommended dose/unawareness				
		Early or Delayed sowing				
4.	Insects	i)				
	(Name)	ii)				
		iii)				
		iv)				
		v)				
5.	Diseases	i)				
	(Name)	ii)				
		iii)				
		iv)				
		v)				
6.	Weeds	i)				
	(Name)	ii)				
		iii)				
		iv)				
		v)				
7.	Rainfall/ Irrigation	Low				
		Uneven distribution				
		Stagnation/ Water logging				
		Salinity/ Alkalinity				
8.	Others					
	Total			**100**		

III. Socio-economic Constraints (most serious ten constraints)

SL	Constraints	Details	Rank
1	Seed	High cost	
		Non availability of quality seed	
		Non availability on time	
		Insufficient quantity	
2	Labour	Non availability during peak season	
		High wage rate	
		Non availability of skilled labour	
3	Irrigation	High cost	
		Insufficient water	
4	Electricity	High cost	
		Irregular supply	
		Low voltage	
5	Agro chemicals	High cost	
		Non availability of quality agro chemicals	
		Non availability on time	
6	Chemical fertilizers	High cost	
		Non availability of quality chemical fertilizers	
		Non availability on time	
7	Credit	High cost	
		Insufficient scale of finance	
		Lack of timely disbursement of credit	
		Reluctance by Financing institutions	
8	Transfer of technology	Poor	
		Unawareness of improved technology	
9	Storage facility	Non availability	
10		Far away	
	Marketing	Poor transportation	
		High cost	
		Lack of storage facility at market	
		Low consumer Preference	
11	Prices	Low	
		Fluctuating	
		Lack of information on prices	
12	Production cost	High	
13	Others (Specify)		

AGRICULTURAL RESEARCH PRIORITISATION FOR AGRO-CLIMATIC ZONES 8, 9 AND 10 OF KARNATAKA

SHIVAKUMAR B. HANJAGIMATH **2003** **Major advisor: Dr. V.R.Kiresur**

ABSTRACT

Agricultural research of late, faces acute scarcity of financial and human resources. thus, given limited resources, there is an urgent need for efficient allocation of the same. In this context, agricultural research prioritisation assumes importance, and therefore, an attempt was made in this study to prioritise agricultural research by zones, crops and agro-biological constraints.

The study was conducted in three agro-climatic zones of Karnataka, viz., Zone-VIII, Zone-IX and Zone-X. Two districts were selected from each of the selected zone. From each district, one taluk was selected at random and two villages were selected from each of the selected taluks randomly. Finally, nine farmers were selected at random from each of the selected villages. Thus, the sample comprised of 108 farmers. The study used both primary and secondary data. The present study used simple tabular analysis for the yield gap estimation and prioritization of research programmes based on production loss due to different constraints.

Results revealed that the gap between the research station yield and demonstration plot yield was much wider as compared to the difference between actual farm yield and potential farm yield. It was mainly due to the environmental differences and farmers management practices. Ranking of constraints based on yield loss indicated that most of the crops across zones were severely affected by rainfall, pests, diseases and weeds. Soil related problems were the severe most problem in the Zone-X.

Among several socio-economic constraints, fluctuations in price of output, non-availability credit on time, non-availability of labour during peak season, high wage rate and unawareness of improved technology were the most severe constraints faced by the farmers in the study area.

Prioritization based on production loss revealed that, chilli, onion, sugarcane, jowar and paddy in Zone-VIII; sugarcane, paddy, cotton groundnut and jowar in Zone-IX; and paddy, sugarcane, groundnut, tomato and brinjal in Zone-X were the top five prioritized crops which deserve more attention. Future resource allocation for research could be done based on these prioritised crops and constraints for achieving better research productivity.