Report of the

Quinquennial Review Team
on
Directorate of Weed Science Research
&
AICRP–Weed Control
(2006 – March, 2012)

Directorate of Weed Science Research
Jabalpur – 482 004

For official use

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Acknowledgement

The Chairman and members of the Quinquennial Review Team (QRT) wish to express their sincere thanks to **Dr. S. Ayyappan**, Secretary, DARE and Director General, Indian Council of Agricultural Research (ICAR), New Delhi for providing the opportunity to review the work done during 2006-2012 by the Directorate of Weed Science Research (DWSR) and All India Coordinated Research Project on Weed Control (AICRP- WC), Jabalpur.

The team highly appreciates the support extended by **Dr. A.K. Singh**, DDG (NRM), ICAR and **Dr. J.C. Dagar**, ADG (Agronomy), ICAR for their suggestions and help in the review process. It acknowledges the Vice-Chancellors and other SAU officials and scientists as well Principal Investigators of AICRP-WC centers of the concerned State Agricultural Universities for their cooperation and for providing the required information. The QRT would also record its sense of appreciation to the farmers, representatives of herbicide industry, state government agricultural officials and Director of NBAII, Bengaluru for their valuable inputs during the interactions.

The team is thankful to **Dr. A.R.G. Ranganatha,** the then Director and **Dr. A.R. Sharma**, Director, DWSR for providing all the facilities and logistics during the review process and in preparation of the final report. The assistance provided by the Coordinating Unit of AICRP- WC and Technical Cell, DWSR in preparation of the background information for this report is sincerely acknowledged.

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Chairman

Contents

A. INTRODUCTION

1.0 Background

Realizing the problem of weeds in crop fields and need for weed research in India, a Coordinated Weed Control Scheme on wheat, rice and sugarcane was initiated as early as in 1952 in 11 States of the country by ICAR to monitor the weed flora and also to find out the relative feasibility of economic weed control. Later, a number of Crop Research Institutes of ICAR and State Agricultural Universities were involved in weed control research.

Subsequently during the VII Five Year Plan, a nodal centre was set up to carry out basic, strategic and applied research in weed science. Consequently, the National Research Centre for Weed Science (NRCWS) came into existence in April, 1989, which was further upgraded to Directorate of Weed Science Research (DWSR) in January, 2009.

1.1 Composition of the QRT

The present Quinquennial Review Team (QRT) for Directorate of Weed Science Research and All India Coordinated Research Project on Weed Control was constituted by the ICAR vide its letter no: 14-9/2010.IA.II dated 29.03.2011 (revised dated 06-09-2011) under the Chairmanship of Dr. S.C. Modgal, Former Vice Chancellor, GBPUA&T, Pantnagar. The composition of QRT is as follows:

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1.2 Terms of Reference of Quinquennial Review Team

A. Institute

i. Research achievements and their impact

To critically examine and identify the research achievements of the Institute, Projects/KVKs its Regional Stations and Sub-Stations, AICRPs operated by them *vis-a-vis* sectoral programmes since the previous QRT and critically evaluate them. Commensurate with the objectives, mandates and resources of the organization, the socio-economic impact of research on farmers/ beneficiaries and transferability of results to farmers through extension should be critically reviewed.

ii. Research relevance and budget allocation

To examine the objectives, scope and relevance of the research programmes and budget of DWSR and AICRP-WC for the next five years in relation to overall national plans, policies and long- and short-term priorities and also the Perspective Plan and Vision 2030 documents.

iii. Relationship / collaborations with SAUs and other stakeholders

To pinpoint whether the research programmes of the past and proposal for future are in harmony with the Vision of ICAR (HQ) and the programme of related Centres of research and Agricultural Universities, State Government, Private Sector and IARCs.

iv. Linkages with clients/ end-users

To examine the kinds of linkages established with the clients and end users of research results, i.e. farmers/fishermen and the extent of interest displayed in conducting "On-Farm Research" on farmers' fields and in organizing demonstrations/training courses for the transfer of technology to extension agencies and KVKs of the ICAR.

v. Proposed changes in organization, programmes and budget

To examine whether any change in the organizational setup are called for manpower and funds allocation.The decentralization in day-to-day working and the transparency should be highlighted. Further, the Committee may also examine the resource generation efforts and implementation of Project-based Budgeting.

vi. Constraints

To examine constraints hindering the Institute in achievement of its objectives and implementation of its programme and goals, and to recommend ways and means of minimizing or eliminating them.

vii. Looking forward

To look into any other points considered relevant by the Committee or referred to it by the DG/GB, the Institute Director or the Management Committee, in respect of future project development, prioritization action and management changes.

B. AICRP-Weed Control

1. To analyze growth of manpower, number of co-operating centres, both in terms of funds as well as staff resources
2. To critically examine and evaluate achievements of the AICRP in research
3. Budget
4. Organization and management
5. Annual Workshops (Group meetings)

B. THE REVIEW PROCESS

QRT had a briefing at the ICAR HQ on 09.08.2011 by Dr. A.K. Singh, Deputy Director General (NRM). The DDG highlighted the importance of quinquennial review and hoped that its recommendations will provide vital inputs in formulating the XII plan proposals of DWSR and AICRP-WC**.** He was of the opinion that DWSR should concentrate on basic research, whereas AICRP-WC centres may focus on management aspects. He requested the QRT to give pragmatic recommendations for the benefit of stakeholders, particularly the farmers. Subsequently, the QRT took up the review of DWSR and AICRP-WC centres as indicated in Table 1.

Table 1. Details of visits made by the QRT to DWSR and different centres of AICRP-WC for review

Date	Venue	Participation	Purpose
9 August, 2011	Krishi Anusandhan Bhavan-II, ICAR New Delhi	Dr. S.C. Modgal, Chairman Dr. A.K. Singh, DDG (NRM) Dr. J.C. Dagar, ADG (Agro) Dr. M.K. Porwal, Member Dr. B.C. Barah, Member Dr. P.K. Pathak, Member Dr. A.R.G. Rangnatha, Director, DWSR Dr. R.P. Dubey, Member Secretary	Meeting of QRT with DDG (NRM)
5-6 September, 2011	DWSR, Jabalpur	Dr. S.C. Modgal, Chairman Dr.M.K. Porwal, Member Dr.B.C. Barah, Member Dr. R.P. Dubey, Member Secretary	To review the work of DWSR, Jabalpur
21-23 September, 2011	GBPUAT, Pantnagar	Dr. S.C. Modgal, Chairman Dr. M.K. Porwal, Member Dr. R.J. Rabindra, Member Dr. B.S. Parmar, Member Dr. B.C. Barah, Member Dr. R.P. Dubey, Member Secretary	To review the work of AICRP-WC centres *viz.* GBPUAT, Pantnagar; CSKHPKV, Palampur; PAU, Ludhiana and CCSHAU, Hisar
11-13 October, 2011	RVSKVV, Gwalior	Dr. B.S. Parmar, Member Dr. M.K. Porwal, Member Dr. R.J. Rabindra, Member Dr. B.C. Barah, Member Dr. R.P. Dubey, Member Secretary	To review the work of AICRP-WC centres *viz.* RVSKVV, Gwalior; SKRAU, Bikaner; NDUAT, Faizabad; and CSAUAT, Kanpur

28 November-01 December, 2011	UAS, Bengaluru	Dr. S.C. Modgal, Chairman Dr. M.K. Porwal, Member Dr. R.J. Rabindra, Member Dr. B.S. Parmar, Member Dr. B.C. Barah, Member Dr. R.P. Dubey, Member Secretary	To review the work of AICRP-WC centres of UAS, Bengaluru; UAS, Dharwad; TNAU, Coimbatore and KAU, Thrissur
10-12 January, 2012	OUAT, Bhubaneswar	Dr. S.C. Modgal, Chairman Dr. M.K. Porwal, Member Dr. R.J. Rabindra, Member Dr. B.S. Parmar, Member Dr. R.P. Dubey, Member Secretary	To review the work of AICRP-WC centres *viz.* OUAT, Bhubaneswar, RAU, Pusa; BAU, Ranchi; IGKV, Raipur; V.B., Sriniketan and AAU, Jorhat
01-03 February, 2012	ANGRAU, Hyderabad	Dr. S.C. Modgal, Chairman Dr. M.K. Porwal, Member Dr. R.J. Rabindra, Member Dr. B.S. Parmar, Member Dr. B.C. Barah, Member Dr. R.P. Dubey, Member Secretary	To review the work of AICRP-WC centres *viz.* ANGRAU, Hyderabad; AAU, Anand; MAU, Parbhani and DBSKKV, Dapoli
01-02 May, 2012	DWSR, Jabalpur	Dr. S.C. Modgal, Chairman Dr. R.J. Rabindra, Member Dr. B.S. Parmar, Member Dr. B.C. Barah, Member Dr. A.R. Sharma, Director, DWSR Dr. R.P. Dubey, Member Secretary	To prepare the first draft of QRT report
16-17 May, 2012	NRCPB,Pusa Campus, New Delhi	Dr. S.C. Modgal, Chairman Dr. R.J. Rabindra, Member Dr. B.S. Parmar, Member Dr. B.C. Barah, Member Dr. M.K. Porwal, Member Dr. P. Anand Kumar, Member Dr. A.R. Sharma, Director, DWSR Dr. R.P. Dubey, Member Secretary	To finalize the QRT report

At the outset, the QRT examined the recommendations of fourth QRT, and during the review specifically looked into compliance by the DWSR and AICRP-WC centres. It was brought to the attention of the QRT that there was substancial delay in communicating the recommendations at different levels, due to which, the compliance is at different stages. The present QRT recommends the Director, DWSR and Project Coordinator of AICRP-WC to kindly ensure full compliance of the recommendations.

During the visit to DWSR and centres of AICRP-WC, the QRT reviewed the significant research achievements and their overall works for the period 2006- March,2012. It also held discussion with stakeholders (Annexure- I).

At the end of the review process, the Chairman, QRT held an interactive meeting with the Institute Management Committee (IMC) of DWSR on 30-06-2012. The recommendations of the QRT were presented in the meeting.The IMC appreciated the efforts made by the QRT and the comprehensive recommendations made on all aspects. It was suggested that a mechanism for effective implementation of the recommendations on weed management emanating from AICRP-WC centres and DWSR should be taken up with the help of respective state governments. After thorough discussion, the QRT report was adopted by the IMC. The proceedings of the IMC meeting are enclosed in the Annexure-II

Significant Research Achievements (2006 - March, 2012)

1. DWSR

1.1 Weed biology and eco-physiology

i. The longevity of seeds of *Parthenium hysterophorus*, *Cassia sericea*, *Phalaris minor*, *Echinochloa glabrascence*, *Echinochloa crusgalli*, *Medicago denticulata* and *Rumex dentatus* could be extended by immersing in liquid preservatives at ambient temperature.

ii. Maximum germination of wild oats was obtained after 12 months of dry storage at room temperature, and GA3 at 500 ppm was also found effective in enhancing the germination.

iii. Physical damage of seed coat resulted in 95% germination of *Vicia sativa,* confirming that dormancy was due to hard seed coat.

iv. In *Chenopodium album,* combination of KNO_3 (2%) + ethrel (100 ppm) resulted in enhanced germination.

v. In wheat, *Chenopodium* caused 42% reduction in yield under ambient CO_2 condition while it was 46% under elevated CO_2. Early maturity was observed in wheat under elevated CO_2. Wheat yield reduction was relatively higher due to competition by *Phalaris minor* compared to *Chenopodium album*.

vi. Profuse tillering and prolific root growth was observed in *Phalaris minor* under elevated CO_2. The elevated CO_2 resulted in an increase in dry weight of chickpea (45%), *Lathyrus sativus* (151%), *Phalaris minor* (140%), *Medicago denticulata* (55%) and *Chenopodium album* (132%) as compared to ambient CO_2.

vii. Documentation of seed identification characters along with seed and plant images has been done for 50 weed species, and the work is continuing.

1.2 Weed management techniques

i. In soybean, higher weed-control efficiency was achieved in notched disc rotary weeder (77%) compared to multi-weeder (72%) and three-tined hand cultivator (70%) based on weed count data. The modified wick applicator performed better than the standard prototype.

ii. Cropping systems did not influence the weed dynamics. However, the lowest density of *A. sterilis*, and *C. album* was noticed under transplanted rice-wheat system and *L.*

aphaca and *M hispida* in direct-seeded rice - wheat system. Among weed control measures, significantly lesser density of *Avena sterilis* and *Chenopodium album* was recorded with continuous use of clodinafop at 60 g/ha fb 2,4-D at 0.5 kg/ha, while the lowest population of *M. hispida* and *L. aphaca* was noticed with sulfosulfuron at 25 g/ha.

iii. In niger-tomato cropping system, soil solarization for a period of 45 days either alone or in combination with FYM and crop residue provided season-long weed control by reducing the emergence all weed species. Application of recommended dose of metribuzin at 0.5 kg/ha reduced the emergence of all weed species, except *P. niruri* and *C. communis* in niger, and *A. ludoviciana, C. intybus* and *M. hispida* in tomato.

iv. In dry-seeded rice-wheat system, continuous zero tillage (ZT-ZT) had higher emergence of weeds than continuous conventional (CT-CT) and rotational tillage systems. Tilling land during rice season was more effective in reducing weed population than tilling during wheat season.

v. In zero-till direct-seeded irrigated rice-wheat system, seeding of rice after receipt of first flush of monsoon and sequential application of pretilachlor at 0.75 kg/ha as pre-emergence followed by 2,4-D at 0.50 kg/ha and fenoxaprop at 0.07 kg/ha as post-emergence should be adopted for obtaining higher yield and benefits from dry-seeded rice.

vi. In direct-seeded rice-chickpea, maximum seed yield (2.81 t/ha) was noticed with pendimethalin, followed by one hand weeding under conventional tillage. Zero-till direct-seeded rice followed by zero-till chickpea system was the best combination for maximizing system productivity, profitability and energy efficiency.

vii. Under organic weed management, application of FYM at 16 t/ha + 2 hand weedings reduced the weed dry biomass significantly as compared to inorganic and integrated treatments in rice. In wheat, stale seedbed along with reduced row spacing resulted in better weed control.

viii. In soybean, the lowest weed dry biomass and highest grain yield were recorded under FYM at 10 t/ha with 2 HWs. Wheat grain yield was highest under FYM at 10 t/ha with berseem as intercrop.

ix. In cauliflower, effect of vermicompost (mixed), vermicompost (*Parthenium*) and FYM was almost similar on weed density. Application of fluchloralin at 1.0 kg/ha + 1 HW was found very effective in controlling the weeds and increasing the yield of cauliflower.

x. In okra-tomato cropping system, the lowest weed dry biomass at 60 DAS and significantly highest yield were recorded in okra and tomato under FYM at 10 t/ha with black polythene mulch treatment.

xi. Cowpea-pea-cowpea and greengram-pea-greengram as intercropping combined with herbicide application significantly reduced the weed population and weed dry matter in mango and citrus orchards. Application of glyphosate (2.0 kg/ha) in each season and two mechanical weedings resulted in significantly the lowest weed density and biomass throughout growing season.

xii. Weed shift from annual species to perennial species was observed under weedy check in newly-planted mango orchard.

xiii. In System of Rice Intensification (SRI), the lowest weed density and weed dry biomass were recorded with fenoxaprop at 60 g/ha + almix at 4 g/ha at 15 DAP, and pretilachlor at 0.75 kg/ha + cono-weeder at 20 DAP and bispyribac-sodium at 15 g/ha applied at 15 DAP, which also produced higher grain yield.

1.3 Herbicide as a tool in weed management

i. In long-term herbicide experiment, significantly lower weed dry biomass was noticed with butachlor at 1.5 kg/ha over weedy check in rice. In wheat, continuous use of clodinafop-propargyl at 60 g/ha followed by 2,4-D at 0.5 kg/ha significantly decreased the population of *P. minor* and *A. luidoviciana*. However, continuous use of sulfosulfuron at 25 g/ha and isoproturon at 1.0 kg/ha was most effective in reducing the population of *M. hispida* and *C. album*, respectively.

ii. In transplanted rice, metsulfuron-methyl at 4 g/ha, penoxsulum + cyhalofop at 150 g/ha combination of metsulfuron + carfentrazon at 30 g/ha with non-ionic surfactant were effective against weeds. In direct-seeded rice, application of cyhalofop + penoxulum at 150 g/ha as ready-mix controlled all the weeds and recorded higher grain yield.

iii. In wheat, pinoxaden, metsulfuron-methyl + carfentrazon-ethyl at 22.5 g/ha with 0.2% non-ionic surfactant, metsulfuron and clodinafop were effective against grassy weeds, especially *Avena ludoviciana*.

iv. In soybean, continuous use of fenoxaprop caused weed flora shift from grasses (*E. colona* and *Dinebra* sp.) to broadleaved weeds, whereas the problem of grasses, particularly *Dinebra* sp. and *Paspaladium* sp., was substantially increased in imazethapyr treated plots.

v. Application of imazethapyr at 100 g/ha, penoxsulum at 22.5 g/ha, propaquizafop at 75 g/ha and quizalofop-ethyl at 50 g/ha were found effective in reducing population as well as dry matter of weeds, specially *Echinochloa colona*, *E. glabrescence*, *Dinebra retroflexa* and *Cynodon dactylon* in soybean.

vi. In jute, application of fenoxaprop-p-ethyl at 67 g/ha was effective against grassy weeds, while metsulfuron-methyl at 4 g/ha and oxyflourfen at 300 g/ha were effective against broad-leaved species.

vii. In mustard, application of pendimethalin (38.7 CS formulation) at 700 g/ha controlled all the weeds effectively.

viii. Use of mulches like black polythene, or fluchloralin followed by fenoxaprop-p-ethyl resulted in efficient weed control in *Withania somnifera* (ashwagandha).

ix. *Aspergillus* was the most sensitive, while *Penicillium* was the most resistant to herbicides. Sulfosulfuron did not show any toxic effect to the PSFs, while clodinofop exhibited maximum toxicity.

x. Degradation of applied butachlor was faster and the residues remained in the soil for three weeks under continuous field capacity. Alternate wetting-drying of the soil increased the half-life of butachlor, pretilachlor and pendimethalin compared to when the soil was continuously kept at field capacity.

xi. Residues of oxyfluorfen, butachlor and anilofos in pond water were 0.022 to 0.0025 µg/ml, 0.137 to 0.0036 µg/ml and 0.151 and 0.0064 µg/ml, respectively between 0 and 90 days. The herbicide dissipated slowly in water as compared to soil.

xii. Persistence of herbicides revealed that 0.0031 and 0.0036 µg/g residues of oxyfluorfen, and 0.014 and 0.041 µg/g residues of butachlor were detected from grain and straw of rice, respectively.

xiii. Cutin of *Phalaris* and *Avena* slowed down degradation process of isoproturon by quenching the photolysis and consequently increased the half-life (75.0 and 114.8 min, respectively) as compared to standard glass surface (52.8 min).

xiv. Chloroform and dichloromethane were found to be the most suitable solvents for extraction of epicuticular waxes from rice, wheat, *Echinocloa colona*, *Phalaris minor* and *Avena luduiviciana*.

xv. Three major metabolites isolated from photodegradation of propaquizafop in the environment through LC-MS/MS analysis were identified as: 2-[4-[(6-chloro-2-quinoxalinyl)oxy] phenoxy]propanoic acid, 2-[[[[1-methylethylidene]amino]oxy] p-benzyl]-6-chloro-2-quinoxalinolate, and 2-[[[1-methylethylidene] amino]oxy]ethyl 2-[4-[(6-chloro-2-quinoxalinyl) oxy] phenoxy] propanoate.

1.4 Bio-pesticides and biocontrol of weeds

i. The allelochemical hydroquinone was phytotoxic to coontail (*Ceratophyllum demersum)* at 0.01 mM and was also toxic to rice (*Oryza sativa*) but only at 5.0 mM.

ii. Plant parts of *Azadirachta indica* were phytotoxic to the alligator weed (*Alternanthera philoxeroides* (Martius) due to oxidative stress. Tropical soda apple (*Solanum viarum* Dunal.) plant parts also showed potential phytotoxicity to submerged and floating aquatic weeds.

iii. Most effective herbicidal property of allelochemical crude of *Lantana* leaf was shown by the n-pentane soluble fraction. It was lethal to floating weed lemna at 100 ppm, and the test plants were killed in about 5 days.

iv. Toluene and hexane soluble fractions from neem leaf allelochemical crude were lethal to *Pistia* at 100 ppm. The treated plants were killed in about 10 days.

v. Chloroform soluble fraction of tropical soda apple leaf allelochemical crude was lethal to *Pistia* at 100 ppm, while acetone soluble fraction was lethal to *Pistia* and *Ceratophylum* at 75 ppm. Methanol soluble fraction of the tropical soda apple leaf allelochemical crude was lethal to *Ceratophylum* and *Pistia* at 50 ppm and to *Lemn*a at 75 ppm.

vi. Bioagents along with spray of glyphosate at 1.5 kg/ha caused suppression of water hyacinth but the water quality was also affected adversely. There was no mortality of fish in all herbicide sprays.

vii. Two species of lepidopteron insects were collected from Pantnagar in Uttarakhand and Kanpur in U.P., and were identified as *Spodoptera litura* (Lepidoptera) and *Hymenia recurvalis* (Fabricius). *Hymenia recurvalis* was having damage potential on *Trianthema portulascastrum,* and was also found feeding on *Amaranthus viridis, Chenopodium album*, tomato and sorghum.

viii. A rust disease on *Lagascea mollis* was first observed at Hyderabad, and subsequently at Jabalpur and Bhopal. Growth and seed production of the weed were significantly reduced due to application of rust bioherbicide. In the following mustard crop, seed bank of *L. mollis* was reduced by 91% in bioherbicide applied plots as compared to 98% reduction in imazethapyr applied plots.

ix. *Fusarium oxysporum* was found efficient for killing water hyacinth in 15 days of inoculation provided with injury caused by *Neochetina*. There was rapid wilting and death of the plants when the beetles were applied 10 days in advance of the application of the fungus.

x. *Pseudomonas fluorescens* and *Trichoderma viride* isolated from the native rhizosphere of chickpea were found to induce systemic resistance in chickpea against *Cuscuta*. Defense enzymes, *viz*. peroxidase, polyphenol oxidase and catalase were activated upon the application of microbes. *T. viride* activated more amounts of polyphenol oxidase, while *P. fluorescens* was found to activate other two enzymes.

xi. Molecular tool based on 16S rRNA gene was standardized for characterization of heterotrophic bacteria in agricultural environment. Bacteria associated with aquatic and terrestrial weeds were isolated and characterized using biochemical tests and 16S rRNA gene approach. Gene sequences determined in this study have been deposited in the GenBank database, with accession numbers: JN638742 through JN638750, and JN944746 through JN944751.

xii. Heterotrophic bacteria were isolated from weedy and herbicidal agricultural soils and characterized using 16S rRNA gene approach, with accession numbers from JN944752 to JN944773. Adoption of molecular techniques led to the realization that indigenous bacteria associated with weeds and agricultural soils are more diverse and not affected adversely by herbicide application.

xiii. *Aspergillus niger* was screened from soil as chlorimuron degrading agent with two major routes. One route involved the cleavage of sulfonylurea bridge, resulting in the formation of two major metabolites, viz. ethyl-2-aminosulphonyl benzoate, and 4-methoxy-6-chloro-2-amino-pyrimidine. The other route was the cleavage of sulfonylamide linkage, which forms the metabolite *N*-(4-methoxy-6-chloropyrimidin-2-yl) urea. Two other metabolites, saccharin and *N*-methyl saccharin, formed from the major metabolite-II were also identified.

xiv. About 7 lakh beetles of *Zygogramma bicolroata* were released throughout India involving colony residents, farmers, ICAR institutes, SAUs and Krishi Vigyan Kendras, which resulted in reducing *Parthenium* intensity. *Zygogramma bicolorata* also established and controlled *Parthenium* in large areas in Maharashtra.

1.5 Transfer of technology

i. During the period from 2006-10, 210 FLDs in *kharif* crops, viz. rice, soybean and maize, and 240 FLDs in *rabi* crops, viz. wheat, chickpea, fieldpea and mustard were conducted using chemical, cultural, mechanical and biological weed management technologies. In general, the demonstrated techniques showed 35-50% lower weed population and 30-40% higher yield compared with farmer's practice.

ii. The benefits of soil solarization were also demonstrated in various locations in vegetable crops. Improved weed management including bio-control techniques for weed management in non-cropped situations and aquatic bodies were demonstrated in 20 different locations around Jabalpur.

iii. Twenty-one training programmes, including two National Level MTCs were conducted on various aspects of modern weed management technologies for SMS, KVK personnel, IFFCO and state agriculture officials, NGOs and progressive farmers. Six awareness campaigns on management of *Parthenium* were organized.

iv. Twenty-four *Kisan Melas* and *Kisan Sangoshthis* were organized, and weed management technologies were exhibited in 10 agricultural exhibitions at the national level.

v. Extension publications (123) in the form of video documentaries, pocket bulletins, articles for newspapers/magazines, posters, books and success stories were prepared.

1.6 Weed utilization

i. Identification of weedy plants for phytoremediation of heavy metal contaminated sites was done. The highest accumulation ratio for lead was observed in *Vetiveria zizinoides* (17.6), followed by *Arundo donax* (12.5), *Calotropis procera* (5.4), *Sphaerantha indicus* (2.7) and *Argemone asteracantha* (2.4). The highest Mn accumulation ratio was also observed in *Vetiveria zizinoides* (6.4), followed by *Arundo donax* (6.0), *Ipomoea carnia* (5.4), *Sphaerantha indicus (4.7), Hyptis suaveolense* (3.7). Drain water enhanced weed density in wheat, which was found to be due to increased germination, shoot and root length of *Avena ludoviciana.*

ii. Vermicompost with half decomposed material was prepared from weed biomass of *Echinochloa colona, Parthenium hysterophorus, Medicago hispida,* and wheat straw by adding 25% cow dung. About 30 t of vermicompost was produced.

1.7 Externally-funded schemes

i. Biosafety research trials level-1 for transgenic stacked corn hybrids ('MON 8903' x 'NK603') revealed tolerance to K salt of glyphosate. There was 100% control of weeds at all the doses of K salt of glyphosate in 'Hishell' and '900 M Gold' transgenic hybrids. These transgenic entries also showed resistance against *Chilo partelus.* The grain yield of transgenic hybrids ranged from 9-10 t/ha, which was 3-4 times more than conventional hybrids.

ii. A National Invasive Weed Surveillance (NIWS) project was initiated from 2006-07 for early detection of the five invasive weed species, viz. *Cenchrus tribuloides, Solanum carolinense, Cynoglossum officinale, Viola arvensis, and Ambrosia trifida*. This project was run in 10 states, *viz*. Andhra Pradesh, Chhattisgarh, Gujarat, Karnataka, Kerala, Orissa, Madhya Pradesh, Maharashtra, Tamil Nadu and West Bengal. Out of the 22 centers, 13 centers reported the incidence of alien weed, *Solanum* sp., *while* the Kerala center reported incidence of *Cenchrus echinatus* and *Cynoglossum*.

Comments of QRT

i. DWSR should give more emphasis on basic aspects of weed management, and applied research could be undertaken by its coordinating centres.

ii. Perfect linkage among agronomy, basic sciences and extension disciplines for giving a holistic approach to weed science is needed.

iii. Since weeding operation is mostly done by women, there is a need to improve the efficiency of weeding tools to lessen the drudgery faced by them.

iv. Effective linkages between DWSR, farmers, KVKs, state departments, herbicide industry, NGOs etc. is very much required.

v. Studies on the effect of cropping systems on weed seed bank are needed.

vi. Soil health under System of Rice Intensification (SRI) should be studied.

vii. Economic analysis showing B:C ratio should also be calculated at farmers' field level.

viii. Only herbicides registered with CIB should be recommended to farmers.

ix. QRT suggested to critically study the effect of herbicides and their metabolites in the food chain including human. In addition to fish mortality due to herbicides, other

transformations occurring in the amphibians may also be studied. DWSR should come out with recommendations on safety aspects of herbicides application.

x. Studies should be done on finding allelo-chemicals for weeds in field crops.

xi. Studies on interaction effects of temperature and CO_2 in FACE on important field crops are needed. The QRT suggested presenting quantitative data from studies conducted in Open Top Chambers. The data on reduction in yield loss in wheat by increase in CO_2 need to be verified. The experiments may be repeated in bigger plots with minimum six replications and statistically analysed.

xii. An efficient workable combination of chemical, mechanical and biological means of weed control needs to be developed. In order to decrease the herbicide load in soils, efficient power weeders are required to be developed.

xiii. Results of studies on soil solarization have given encouraging results. Hence, effective popularization campaign should be made.

xiv. Recommendations having FYM as a component should be location-specific as its method of preparation and nutrient content vary from location to location.

xv. Development of precision application technology for new generation ultra-low dose herbicides should be given priority.

xvi. The QRT pointed out that lower level of adoption of weed management technology is not commensurate with the huge benefits as reported. Hence, some detailed scientific analysis on this aspect by the extension scientist is very much required.

xvii. Extension scientist should record the problems identified by the farmers, which would be worked upon by the scientists.

2. AICRP-Weed Control

Visit of QRT to GBPUAT, Pantnagar during 21-23 September and review of the work of the coordinating centres, *viz*. GBPUAT, Pantnagar; CSKHPKV, Palampur; CCSHAU, Hisar; and PAU, Ludhiana.

2.1 GBPUAT, Pantnagar

i. Incidence of non-grassy weeds like *Caesulia axillaris*, *Commelina* spp. and sedges, such as *Cyperus difformis* and *Fimbristylis miliacea* increased in transplanted rice when butachlor was used continuously. Similarly, *Lathyrus aphaca*, *Medicago denticulata* and *Melilotus indica* and *M. alba* increased in wheat due to continuous use of isoproturon and 2,4-D.

ii. Survival of *P. minor* at recommended doses of isoproturon was noticed for the first time in 2008. About 40-49% population of *P. minor* from different locations of Udham Singh Nagar and Nainital survived with isoproturon at 1.0 kg/ha. In subsequent years, the same trend was observed.

iii. In long-term trial on tillage, weed seed bank was higher in conventional tillage as compared to conventional tillage in rice, and zero tillage in wheat. Zero-tilled wheat produced significantly higher grain yield than conventional and reduced tillage.

iv. In sugarcane, pre-emergence application of metribuzin at 800 g/ha or ametryn at 2.0 kg/ha with two hoeings at 60 and 90 days after planting, and metribuzin fb hoeing fb 2,4-D were found effective.

v. Sulfosulfuron applied at 25 and 50 g/ha persisted in soil up to 15 and 30 days, respectively in wheat. No detectable residue (0.001 µg/gsoil) was observed after 45 days of application.

vi. Pendimethalin residues were below detection limit (0.002 µg/g) in soil and potato tuber at harvest.

vii. Chlorimuron-ethyl persisted in soil for more than 45 days at higher dose (12 g/ha) in soybean. Residues were below detection limit at harvest in soil, pods and straw.

viii. 2,4-D persisted for 30 days in water, and the residues were below detectable limit on 45th day of application at both recommended and double recommended doses.

ix. Adoption of recommended weed management practices increased the yield over farmers' practice by 30% in soybean, and 8 and 12% in rice and wheat, respectively.

Comments of QRT

i. Studies on economics and social factors for weeding, and characterization of the weed problems in hill regions should be undertaken.

ii. Sustainability of weeding *vis-a-vis* no weeding, and weeding only for fodder in hill region may be studied with proper reasoning.

iii. Regeneration of *Phalaris minor* after application of sulfosulfuron at certain growth stages may be studied.

iv. In the weed survey protocol, weed biomass in place of weed density may be considered.

v. Studies on root system of allelopathic rice variety which would be helpful in knowing the crop-weed interaction should be undertaken. Data on microbial and earthworm population may be recorded in all long-term experiments.

vi. OFTs must be conducted before passing on weed control recommendations to the farmers.

2.2 PAU, Ludhiana

i. Weed surveillance revealed that *Poa annua, Malva parviflora* and *Rumex spinosus* in wheat; *Coronopus didymus* in berseem; *Commelina benghalensis* and *Brachiaria reptans* in maize; and *Ipomoea* sp. and *B. reptans* in sugarcane; and *Leptochloa chinensis* and *Echinochloa colona* in rice were emerging as problematic weeds.

ii. Resistance in *P. minor* against alternate herbicides, viz. fenoxaprop, clodinafop and sulfosulfuron was increasing. Resistance has also been observed in *P. minor* against pinoxaden and mesosulfuron + iodosulfuron.

iii. Split application of glyphosate for three years eliminated *Sorghum halepense,* and suppressed *Cyperus rotundus* and *Cynodon dactylon*.

iv. In wheat + autumn sugarcane intercropping system, post-emergence sulfosulfuron at 0.025 kg/ha, mesosulfuron + iodosulfuron at 0.012 kg/ha, and metsulfuron at 0.005 kg/ha provided effective weed control.

v. Continuous use of recommended herbicides over the years in rice-wheat cropping system did not leave any residues in soil, grain and straw. The residues were also not influenced by presence of organic matter in soil.

vi. Ground water samples collected from different districts did not show residue of isoproturon, 2,4-D, sulfosulfuron and butachlor.

Comments of QRT

i. Calculation of economics of weed management treatments needs to be done more scientifically.

ii. Straw mulch may be tried for managing herbicide resistance.

iii. Studies on tools and implements for weed control need to be taken up in the project.

iv. In one of the field studies, it was found that *Parthenium* suppressed *Casssia sericea,* although *C. sericea* is widely used for suppressing *Parthenium* in road sides. The QRT observed that this may be an isolated case which must be confirmed by undertaking field experiments at different locations.

2.3 CCSHAU, Hisar

i. Infestation of broad-leaved weeds, *Malva parviflora* and *Rumex dentatus* was found increasing at an alarming rate every year in wheat, particularly in zero-till sown crop.

ii. *Phalaris minor* has developed resistance against clodinafop-propargyl in Kaithal, Karnal, Jind, Panipat and parts of Fatehbad, Ambala and Kurukshetra. Herbicides like fenoxaprop + metribuzin, UPH 110 and pinoxaden gave good control of clodinafop- and sulfosulfuron-resistant *Phalaris minor*.

iii. *Orobanche aegyptiaca* is becoming a very serious weed of mustard in south Haryana. Tomato crop was also found infested with this weed in Bhiwani and Mewat. Post-emergence application of glyphosate 25 and 50 g/ha at 30 and 55 days after sowing, respectively by using 375 liters of water/ha was found to provide 80-90% control of *Orobanche aegyptiaca* without any adverse effect on mustard. Addition of 1% $(NH_4)_2SO_4$ with glyphosate increased *Orobanche* control but also increased crop toxicity.

iv. *Chenopodium ambrosoides*, a new sp. with fast growth rate and high seed production capacity is fast emerging in non-cropped areas of Hisar, Jind, Rohtak, Bhiwani, Sonepat, Kaithal and Panipat.

v. In wheat, post-emergence application of pinoxaden at 40 g/ha *fb* carfentrazone at 25 g/ha ($(NH_4)_2SO_4$ 1%) proved effective in reducing density and biomass of weeds, and gave 92% control of grassy and 89% control of broad-leaved weeds without any phytotoxic effect on crop.

vi. In long-term herbicide trial, application of clodinafop and rotational use of herbicides (sulfosulfuron / clodinafop / fenoxaprop) provided effective control of *P. minor* and significantly increased grain yield of wheat. In rice, rotational use of herbicides (pretilachlor / anilophos / butachlor) provided effective control of *Echinochloa crusgalli,* and the grain yield in this treatment was at par with butachlor.

vii. In pearlmillet, application of atrazine provided excellent control of *T. portulacastrum, Digera arvensis* and *E. colona,* while in following chickpea, integration of one hoeing with pendimethalin or two mechanical weedings provided almost weed-free environment up to 60 DAS.

Comments of QRT

i. A post of Jr. Physiologist may be added to the Hissar centre.

ii. The problem of isoproturon resistance in *Phalaris minor* is prevalent in Haryana because of the selection pressure in *P. minor* due to continuous application of isoproturon over the years.

iii. The effect of temperature regimes in development of resistance in *P. minor* needs to be studied.

2.4 CSKHPKV, Palampur

i. Increasing dominance of *Brachiaria ramosa* and *Commellina benghalensis* In Kangra district; and *Brachiaria ramosa, Eragrostis tenella*, *Sorghum halepense, Ageratum conyzoides* and *Commelina benghalensis* in Una district was observed in upland *kharif* crops.

ii. Drum seeding of sprouted rice resulted in significantly higher grain yield of rice over direct-seeded broadcast method of sowing. Cyhalofop-butyl at 90 g/ha (20 DAS) resulted in significantly higher grain yield due to effective control of weeds.

iii. Continuous use of butachlor at 1.5 kg/ha fb 2,4-DEE with 75% N through fertilizer and 25% N through *Lantana* in rice and continuous or herbicide rotation in wheat resulted in significantly higher grain yield of transplanted rice. Continuous use of herbicide did not develop resistance in weeds.

iv. In wheat, carfentrazone at 25 g/ha or carfentrazone at 15 g/ha *fb* pinoxaden at 30 g/ha resulted in significantly higher grain yield by providing effective control of weeds.

v. Wheat varieties, 'HPW 147', 'VL 829', 'HS 240' and 'HS 420' showed weed suppression ability of 87.4, 51.1, 45.3 and 42.6% over 'PBW 343' at 120 days after sowing. In case of rice, 'Hassan Serai' and 'Kasturi' basmati of rice showed weed suppression ability of 38.0 and 33.6%, and 'HPR 2530' and 'HPR 1156' had a weed suppressability of 32.0 and 28.0%, respectively.

vi. In garlic bulbs, herbicide residues were detected with pendimethalin at 3.0 kg/ha (0.004 µg/g), oxyfluorfen 0.250 kg/ha (0.0015 µg/g), and oxyfluorfen 0.500 kg/ha (0.003 µg/g).

vii. Isoproturon residues were below detectable limit in soil and wheat grain samples collected from the fields of 10 farmers of the Kangra district who were using isoproturon for more than 10 years.

viii. In permanent herbicide trial, the uptake of available nutrients by rice was increased by herbicide rotation with cyhalofop-butyl over continuous use of butachlor.

Comments of QRT

i. Analysis of weed survey data in respect of weed shift should be compiled over the years / decades and inferences drawn.

ii. The invasive nature and quarantine importance of *Cynderella viallis* - a new weed reported needs to be confirmed.

Visit of QRT to RVSKVV, Gwalior from 11-13 October, 2011, and review of the work done by the coordinating centres, *viz*. RVSKVV, Gwalior; NDUAT, Faizabad; CSAUAT, Kanpur; and SKRAU, Bikaner.

2.5 RVSKVV, Gwalior

i. Incidence of *weedy rice* in cultivated rice; *Orobanche* and *Asphodelus tenuifolius* in mustard; *Phalaris minor* and *Avena ludoviciana* in wheat; *Euphorbia dracunculoides* in chickpea; and *Parthenium hysterophorus* in non-cropped as well as cropped areas was increasing.

ii. In pearlmillet-wheat sequence, minimum tillage in pearlmillet and conventional tillage in wheat proved better in terms of weed control and yield.

iii. Pre-emergence application of atrazine at 0.5 kg/ha + FYM at 10 t/ha or atrazine at 0.5 kg/ha PE + one hand weeding at 30 DAS or atrazine at 0.5 kg/ha PE proved effective for control of weeds in pearlmillet.

iv. Application of pinoxaden at 40 g/ha fb carfentazone at 25 g/ha + 1% ammonium sulphate surfactant as POE (one week after pinoxaden spray) in wheat was found effective for weed control.

v. Pendimethalin leached in soil up to 10 cm, chlorimuron-ethyl up to 20-25 cm, fenoxaprop-p-ethyl up to 30-35 cm, 2,4-D up to 30-40 cm and sulfosulfuron up to 50 cm.

vi. In farmers fields, application of isoproturon, 2,4-D and sulfosulfuron to wheat; atrazine to pearlmillet; and pendimethalin and oxydiargyl to mustard did not leave residue in post-harvest soil.

Comments of QRT

i. Continuity of information, irrespective of changes in Principal Investigator, should be maintained.

ii. The information generated under weed survey may be utilized for formulating future strategies of weed management. For assessing the impact of weed management technology, performance indicators for economic upliftment may be studied.

iii. QRT suggested re-checking the methodology for calculating economics. It was pointed out that the B:C ratio above 3.5 as reported in some cases was too high.

iv. Bioassay for studying herbicide residues may not be adequate. Appropriate laboratory facilities may be created to obtain meaningful results.

v. It was reported that Mexican beetle has not established in and around Gwalior. QRT suggested finding out the reasons for poor establishment of the beetles.

vi. The centre may strengthen its interaction with the farmers on need-based weed management, particularly to the marginal farmers.

2.6 SKRAU, Bikaner

i. *Phalaris minor* and *Avena ludoviciana* were the most common grassy weeds in Bikaner. *Orobanche* sp. occurred in *Brassica* with 8-10 shoots/m^2.

ii. In groundnut, post-emergence application of quizalofop-ethyl at 1000 ml/ha 20-25 days after sowing and mixing 1% urea gave maximum pod yield of groundnut.

iii. In wheat, post-emergence application of carfentrazone SG at 20 g/ha was found to be a suitable herbicide for controlling almost all seasonal broad-leaved weeds.

iv. In mothbean-wheat cropping system, pre-plant incorporation of fluchloralin at 0.75 kg/ha in mothbean, and metsulfuron-methyl at 4 g/ha (post-emerhence) in wheat produced significantly higher grain yield.

v. In mustard, application of neem cake at 200 kg/ha in furrows at sowing and pre-emergence pendimethalin at 0.5 kg/ha followed by hand weeding at 60 DAS suppressed all weeds including *Orobanche.*

vi. In lucerne, deep summer ploughing resulted in significantly higher green fodder yield. Pre-plant incorporation of imazethapyr at 75 g/ha was found effective in keeping down all seasonal weeds and *Cuscuta*.

vii. In pearlmillet-chickpea cropping system, pre-emergence application of atrazine at 0.75 kg/ha in pearlmillet, and pendimethalin at 0.75 kg/ha in chickpea followed by mechanical weeding were found effective.

viii. In chickpea, post-emergence application of imazethapyr at 50 g/ha produced significantly higher seed yield.

ix. In fennel, pre-plant incorporation of trifluralin at 0.75 kg/ha + one hand weeding produced higher seed yield.

x. In fenugreek, pre-planting incorporation of fluchloralin 0.5 kg/ha + one hand weeding 30 days after sowing produced significantly higher seed yield.

xi. In isabgol, pre-emergence application of isoproturon at 0.5 kg/ha produced significantly higher seed yield.

xii. In cumin, post-emergence application of imazethapyr at 50 g/ha produced significantly higher seed yield.

Comments of QRT

i. QRT desired that the PI should make efforts with the university authorities for filling up of the vacant post of Jr. Microbiologist.

ii. QRT urged the PI to follow the methodology / technical programme given by the PC unit.

2.7 CSAUAT, Kanpur

i. In direct-seeded rice, the lowest weed population and dry weight along with higher grain yield was obtained with cyhalofop-butyl + almix (90 g + 20 g/ha), followed by that with bispyribac (25 g/ha).

ii. In rice–wheat cropping system, higher yield of rice was recorded under conventional tillage. In wheat, lower density of grassy weed (*P. minor*) and its dry weight was observed under zero tillage compared with conventional tillage. Broad-leaved and perennial weeds (*M. alba and A. arvensis*) were found lower in conventional tillage.

iii. In sugarcane ratoon, atrazine at 1.5 kg/ha followed by hoeing at 60 and 90 days after planting resulted in satisfactory weed control and optimum millable cane yield.

iv. In long-term studies, the incidence of *Echinochloa colona* increased over years due to continuous use of butachlor.

v. In sugarcane-based intercropping system, blackgram was the best intercrop for weed control and higher cane yield.

vi. In saunf (aniseed), manual weeding twice at 20 and 40 days after sowing prevented weed competition and resulted in 4-fold increased seed yield over weedy.

vii. In wheat, sequential application of pinoxaden at 40 g/ha followed by carfentrazone at 25 g/ha proved to be the best for controlling grassy and broad-leaved weeds.

viii. In linseed, minimum dry weight and higher yield was obtained with application of pendimethalin at 0.5 kg/ha followed by hand weeding.

Comments of QRT

i. Poor control of *Echinochloa colona* with the use of butachlor needs to be studied under controlled conditions first for verifying resistance to butachlor, if any.

ii. Residue chemistry work needs improvement through training of the scientist involved particularly the chromatographic methods.

2.8 NDUAT, Faizabad

i. Weedy rice (*Oryza nivara, O. rufipogon and O. spontanea*) was observed in the lowlying rice fields, and the infestation was found very severe in the Chandauli district. During *rabi* season, in addition to the *P. minor*, population of *Polypogon monspliensis, Poa annuna, Rumex* spp., *Cirsium arvense* and *Lathyrus aphaca* was found increasing specially in the wheat fields.

ii. In direct-seeded rice, intercrop of *Sesbania* + pendimethalin at 1.0 kg fb 2,4-D at 0.5 kg/ha being at par with broadcasting of *Sesbania* + pendimethalin at 1.0 kg fb 2,4-D at 0.5 kg recorded significantly higher grain yield, low weed density and dry weight, which was at par with hand weeding twice.

iii. In wheat, sequential application of pinoxaden at 40 g/ha and carfentrazone at 25 g/ha with ammonium sulphate proved effective in reducing the density and biomass of weeds, and increasing the yield.

iv. For the control *Eichhornia crassipes,* glyphosate at 5-10 ml/l of water gave complete control and no regeneration was observed from 21-70 days after herbicide spray. There was no mortality of released fingerlings at both the concentrations.

v. Butachlor at 1.5 kg/ha as pre-emergence applied in rice did not leave any harmful level of its residue in the post-harvest soil. Oxadiargyl at 100-150 g/ha at 7 DAS also did not leave any harmful residue in soil at 15th day stage.

vi. Isoproturon at 1.0 kg + 2,4-D Na salt at 0.5 kg/ha applied as post-emergence in wheat did not leave any harmful toxic level of their residue in post-harvest soil.

Comments of QRT

i. Quality research papers in reputed journals should be published.

ii. It was suggested to study the effect of herbicides not only on fish mortality but on its reproductive systems also.

iii. Strengthening of residue chemistry laboratory with one GC was recommended.

iv. QRT asked the PI to popularize the cono weeder in Faizabad and adjoining areas.

v. The results on the remunerative potato-sugarcane intercropping may be validated at farmers' fields, and if found effective, these may be popularized.

Visit of QRT to UAS, Bengaluru during 28 Nov - 1 Dec, 2011, and review of the work done by coordinating centres, *viz*. UAS, Bengaluru; TNAU, Coimbatore; KAU, Thrissur and UAS, Dharwad.

2.9 KAU, Thrissur

i. Infestation of weedy rice and Chinese sprangletop *(Leptochloa chinensis)* was fast spreading in rice-growing areas. New weeds spreading in the aquatic areas and uplands were: *Alternanthera philoxeroides, Limnocharis flava,* and *Cabomba caroliniana.* In uplands *Alternanthera bettzickiana, Croton hirtus, Sesamum radiatum, Merremia vitifolia, Ipomoea cairica, and Wedelia calandulacea* were dominant.

ii. Least weed infestation was seen in transplanted rice, followed by SRI, wet seeding and drum-seeding techniques. Hand weeding was the most efficient, while at 30 day stage, chemical weed control was also equally effective.

iii. Zero tillage could be successfully practiced in rice. However, there was a shift towards perennial sedge, *Eleocharis*.

iv. In semi-dry rice, stale seedbed for 14 days with shallow hoeing on 7^{th} and 14^{th} day reduced the weed infestation. Raising cowpea as an intercrop for 30 days also reduced the weed problem.

v. For managing weedy rice in Kuttanad and Kolelands, apply glyphosate, reflood the field after 5 days, drain the field after 10 days, and broadcast pre-germinated rice seeds without any disturbance to the soil. Earheads of weedy rice which emerged earlier than rice could be destroyed by direct contact application of herbicides by using a wick applicator.

vi. In ginger, pre-emergence application of oxyfluorfen at 0.2 kg/ha and diuron at 1.0 kg/ha were effective in controlling weeds. Post-emergence application of glyphosate at 10 ml/litre before emergence of ginger shoots (about 30 days after planting) was also effective in controlling the early emerging weeds.

vii. In coconut, arecanut and rubber plantations, glyphosate at 8 ml/l was effective. Similarly, for control of *Costus sp.* in cocoa plantation, glyphosate at 12 ml/l and 2,4-D at 5 g/l were effective. The other problematic weeds could be controlled as follows: *Ipomoea carnea* (glyphosate at 15-20 ml/l), *Limnocharis flava (*2,4-D at 1.0 kg/ha or almix 20 g/ha at 20 DAS), and *Typha sp. (*glyphosate at 20 ml/l).

viii. Under long-term herbicide trial, continuous application of butachlor/ pretilachlor in rice for 10 years did not result in build-up of residues in soil, grain and straw. Application of FYM significantly improved the bioefficacy of butachlor and pretilachlor.

ix. When paraquat was applied over *Salvinia, Eichhornia* and *Alternanthera*, the residues persisted in water up to 20-30 days after spraying.

x. Herbicides 2,4-D, butachlor, pretilachlor moved through the soil columns, and the residues in the leachate at 60 cm depth were above the MRL prescribed for drinking water. Oxyfluorfen residues in the leachate were below the detectable level.

xi. More than 75% of butachlor, pretilachlor and 2,4-D applied to the rice soils was adsorbed by the soil within 2 hrs. Application of FYM improved the extent of adsorption.

xii. No change was observed in the fish gills due to 2,4-D, paraquat and glyphosate. In the liver, vacuolation of cytoplasm was seen in hepatic cells with all herbicide treatments. Application of 2,4-D resulted in necrotic changes. The muscle fibres showed loss of striations with glyphosate and 2,4-D. In the case of 2,4-D, fragmentation of muscle fibres was also seen. No loss of striations was observed with paraquat. Results indicated that application of 2,4-D caused greater impact on fish than paraquat and glyphosate.

xiii. Economic threshold for *Echinochloa glabrascens* in rice was worked out to be 8 plants/m^2. Rice varieties 'C3-2-49' and 'Jyothi' were most competitive with weeds.

xiv. Enhanced CO_2 level on C_3 weed species, viz. *Triumphetta rhomboidia, Ageratum conizoides, Urena lobata, Melochia corchorifolia* and *Synedrella nodiflora* showed significant increase in their growth parameters.

xv. Variation in the micronutrient content of *Dendrophthoe falcata* collected from 9 different host plants substantiated the effect of the host on the medicinal properties of the parasite. Aquatic weeds species, viz. *Eichhornia crassipes, Salvinia molesta and Ipomea aquatica* had higher concentration of Cu, Fe, Mg, Ca and Hg. *Justicia gendarussa* did not accumulate Hg.

xvi. For the control of *Loranthus* in fruit trees and plantation crops, application of ethrel at 20 ml/l was effective in providing temporary control. However, regrowth was seen in some of the host species. Padding with 2,4-D @ 0.8 g in 25 ml water at the site of regrowth was effective in completely eradicating the parasite. Salt padding during summer was also effective in the case of minor attack.

xvii. Staggered dormancy was found in the seeds of weedy rice.

Comments of QRT

i. Observations on *Tithonia* replacing *Lantana* in high altitudes need to be studied in scientific perspective.

ii. Evaluation of different species of cover crops in plantations, particularly in rubber was suggested.

iii. Micronutrient status of host trees infested with *Loranthus* may also be studied.

iv. Studies on effect of elevated CO_2 may be confined to the useful and important weed species only.

v. Residue analysis data should be statistically analyzed.

vi. Effect of herbicide on microbes may be taken up in collaboration with microbiologists.

2.10 TNAU, Coimbatore

i. New invasion of quarantine weed, *Solanum carolinense* (Horse nettle) was observed in many parts of Tamil Nadu, particularly under non-crop situations. The intensity of invasion was more in 8 districts.

ii. Under System of Rice Intensification (SRI), application of pyrazosulfuron-ethyl at 30 g/ha at 3 DAT and rotary or cono-weeder at 40 DAT resulted in better weed control, higher yield and net returns.

iii. In irrigated maize, pre-emergence application of atrazine at 0.5 kg/ha or oxyflurofen at 0.2 kg/ha on 3 DAS + twin wheel hoe weeding at 45 DAS was beneficial for higher grain yield and economic returns.

iv. In transplanted rice-rice cropping system, integration of weed control by butachlor at 0.75 kg/ha on 3 DAT + 2,4-DEE at 0.40 kg/ha at 15 DAT, or pretilachlor at 0.75 kg/ha on 3 DAT + 2,4-DEE at 0.40 kg/ha atn 15 DAT with 75% inorganic + 25% organic N recorded maximum yield.

v. Conventional tillage for maize and sunflower, with pre-emergence application of atrazine at 0.5 kg/ha for maize and pendimethalin at 1.0 kg/ha for sunflower followed by hand weeding at 45 DAS in both sunflower and maize resulted in higher yield and economic returns.

vi. In winter irrigated cotton, pre-emergence application of pendimethalin at 2.0 kg/ha or EPOE trifloxsulfuron at 10 g/ha at 15 DAS + hand weeding at 45 DAS provided effective control of late-emerged weeds, higher yield and economic returns.

vii. Pre-emergence application of pendimethalin at 1.0 kg/ha or pre-plant incorporation of fluchloralin at 1.0 kg/ha and plant hole application of neem cake 200 kg/ha resulted in reduction of *Orobanche* shoot population and higher tobacco leaf yield.

viii. For management of *Striga asiatica* in planted sugarcane, pre-emergence application of atrazine at 1.0 kg/ha on 3rd DAP + hand weeding at 45 DAP with an earthing-up on 60 DAP combined with POE 2,4-D Na salt at 5 g/l (0.5%) + urea at 20 g/l (2%) at 90 DAP + mulching with cane trash at 5 t/ha after final intercultivation on 120 DAP should be followed for higher productivity and profitability under red sandy loam soils.

ix. Continuous application of butachlor + 2,4-DEE in every season or rotational application of butachlor + 2,4-DEE during *kharif* and pretilachlor + 2,4-DEE during *rabi* did not show build-up of these herbicides in the post-harvest soil, grain and straw of the 20th rice crop.

x. No detectable residues were observed with atrazine in sugarcane and maize; pendimethalin in cotton and maize; metolachlor and alachlor in maize; metolachlor and pendimethalin in soybean; oxyfluorfen in onion, groundnut, rice, tea and potato; butachlor in fingermillet; and glyphosate, paraquat and 2,4-D in water bodies.

xi. Secondary metabolites of atrazine, viz. hydroxyatrazine in maize grown soil and ethofumesate, viz. oxy-ethofumesate and hydroxyl ethofumesate in sugarbeet grown soil were identified using GC-MS.

xii. Adsorption and desorption of metolachlor, alachlor and metamitron in different soil types was in order: peat soil > black soil > red soil.

Comments of QRT

i. QRT was of the opinion that herbicide should not be used in SRI.

ii. The work on weed control in horticultural crops was appreciated, and it was suggested to study the effect of herbicides on soil microbes.

iii. It was suggested to include stubble management as a treatment in tillage experiments. Effect on soil physical properties, soil microflora and economics should also be studied.

iv. Degradation of herbicides under organic and inorganic sources of soil nutrition needs to be studied in detail.

v. QRT suggested to screen different competitive crops for weed smothering, and cited the example of *Arachis pinnata* as cover crop in plantations. It was suggested to discontinue studies on glyphosate for control of water hyacinth in aquatic bodies.

vi. If the identity of *Solanum carolinense* has been confirmed in Tamil Nadu, Karnataka, and other states, then weed risk analysis should be done in collaboration with the Department of Plant Protection, Quarantine and Storage.

vii. Herbicide residues in food chain, water and their effect on water quality parameters need to be studied in detail.

2.11 UAS, Bengaluru

i. During survey, new weed species were noticed: *Solanum carolinense*, *Solanum sisymbrifolium* in waste land and near garbage areas; *Cenchrus biflorus* and *Trachys muricata* in pigeonpea; *Verbesina encelioides* in wasteland and road sides; *Polygala chinensis* in vegetables and grapes; *Ipomoea triloba* in sugarcane; and *Tithonia diversifolia* and *Anoda cristata* in maize and groundnut.

ii. In rice-rice cropping system, pretilachlor at 0.75 kg/ha at 3 DAP during *kharif* gave similar yield as two HWs at 20 and 45 DAP. During summer, use of butachlor at 1.25 kg/ha + almix at 4 g/ha at 3 DAP gave higher rice yield than one late hand weeding. The herbicides were cheaper (Rs. 762 - 1017/ha) as compared to one hand weeding (Rs. 4350/ha), and saved Rs. 3333 - 3624/ha for managing the weeds.

iii. In maize-groundnut cropping system, use of atrazine at 1.0 kg/ha as pre-emergence + integrating of one mechanical weeding at 3 weeks after sowing in maize, and pendimethalin at 1.0 kg/ha at 3 DAS gave in succeeding groundnut were found most economical for managing weeds and improving the yields.

iv. In long-term trial, use of butachlor at 0.75 kg + 2,4-D EE at 0.4 kg/ha during *kharif* fb pretilachlor at 0.75 kg/ha at 3 DAS during summer and hand weeding (during both the season) resulted in higher rice yield. Further, use of butachlor at 0.75 kg/ha at 3 DAP in fingermillet and pendimethalin at 1.0 kg/ha at 3 DAS in groundnut gave better weed control and higher yield.

v. For parasitic weed management of *Orobanche* in tomato, potato and brinjal, use of herbicides, viz. oxyfluorfen at 0.1 kg/ha, pendimethalin at 0.75 kg/ha and metribuzin at 0.5 kg/ha at 3 DAP delayed the emergence by 10-15 days, and lowered the *Orobanche*. Use of neem cake at 200 kg/ha in rows also lowered the population by 40%.

vi. In large-scale demonstrations, use of pyrazosulfuron-ethyl at 25 g/ha at 3 DAS and oxyfluorfen at 0.1 kg/ha at 3 DAS, in transplanted rice, pyrazosulfuron-ethyl at 25 g/ha at 3 DAS and butachlor at 1.25 kg/ha at 3 DAS, bensulfuron-methyl at 60 g/ha + pretilachlor at 600 g/ha at 3 DAP and pyrazosulfuron-ethyl at 25 g/ha at 3 DAS gave 21-25% higher yield of rice compared to two hand weedings.

vii. In direct-seeded rice, pretilachlor + safener at 0.75 kg/ha at 3 DAS (2.58 t/ha), cyhalofop-butyl at 90 g/ha + (chlorimuron-ethyl + metsulfuron-methyl) at 4 g/ha (2.64 t/ha), fenoxaprop at 60 g/ha + (chlorimuron-thyl + metsulfuron-methyl) at 4 g/ha at 25 DAS (2.71 t/ha), bispyribac-sodium at 25 g/ha at 20 DAS (2.62 t/ha) and fenoxaprop at 60 g/ha + ethoxysulfuron at 15 g/ha at 25 DAS (2.61 t/ha) gave similar yield as hand weeding (20 and 45 DAS, 3.15 t/ha) in addition to saving weeding cost by Rs. 2745 - 4900/ha.

viii. In long-term trial on tillage, adopting zero tillage (spraying of glyphosate to remove the existing weeds fb opening seed row using chisel) for sunflower in summer, and maize in *kharif* gave lower yields by 0.1-0.4 t/ha than conventional tillage. However, there was a saving of tillage cost by Rs 850 and Rs 700/ha in sunflower and maize, respectively.

ix. In a study on adjuvants for enhancing efficacy of glyphosate, it was found that addition of sucrose, jaggery and citric acid enhanced the drying period of droplet in *Oxalis latifolia* and *Digitaria marginata*, and jaggery in *Lagascea mollis.* Senescencing the plant material by spraying glyphosate (6 ml/lit) with jaggery (2%) for 24-48 h followed by glyphosate + jaggery spray appeared better in lowering tuber production of *Cyperus rotundus*. Tetrazolium chloride test for C*yperus rotundus* tuber viability suggested that all the tubers treated with glyphosate with or without jaggery were viable.

x. In an experiment to assess crop-weed toxicity of herbicide and recovery time, it was found that glyphosate maintained lower membrane leakage and higher RWC as compared to paraquat after 72 hours. Weeds like *Parthenium* showed 200% enhanced biomass, followed by *Echinochloa colona* (175%) and *Ageratum conyzoides* (155%) after 15 days of CO_2 enrichment, whereas reverse was the case with *Euphorbia sp*.

xi. *Ageratum conyzoides* and *Spilanthus acmella* appeared to respond to CO_2 concentrations more than maize.

xii. In long-term trial, residues of butachlor at 0.75 and 1.0 kg/ha in rice and fingermillet; pendimethalin at 1.0 and 2.0 kg/ha in groundnut; atrazine at 1.0 and 2.0 kg/ha were below detectable limits of 0.001 ppm in soil, straw, grains and underground water.

xiii. In aquatic ecosystem, glyphosate at 1.5-3.0 kg/ha, 2,4-D at 1.0-2.0 kg/ha and paraquat at 0.5-1.0 kg/ha were effective in controlling water hyacinth without affecting the fish mortality up to 35th day. The decaying water hyacinth affected dissolved oxygen content of water, and in turn on the fish mortality. The residues of paraquat were not observed after 15 days of application.

xiv. Composts or green manure of *Chromolaena odorata, Cassia uniflora* and *Parthenium* contained nutrients similar to FYM and green manure crops. Use of compost or green manure at 10 t/ha along with 75% recommended fertilizer in maize, transplanted and aerobic rice gave yield at par with 100% recommended fertilizer along with FYM at 10 t/ha.

xv. Release of *Zygogramma bicolorata* for management of *Parthenium* caused 40-75% and 35-65% damage in Hadonahally and Tubagere villages, respectively.

xvi. Weeds caused 10-50% loss of yields in rice, maize, sugarcane, fingermillet, groundnut, chickpea, pigeonpea, cotton and vegetables. Impact analysis showed that 60% farmers considered chemical weed management as promising in vegetables, rice, sugarcane and maize for lowering the cost of cultivation by Rs 2500-3000/ha as compared to conventional practice.

Comments of QRT

i. QRT appreciated the quality of slides and presentation by the centre.

ii. It was informed that problem of *Orobanche* is seen only in seed production fields of solanaceous crops and not in commercial fields. The main source of infestation may be from seeds. Similarly, 80% seed lot of lucerne from NSC was found infested by *Cuscuta*.

iii. QRT suggested identifying lead centres for working on parasitic weeds with additional posts and funds.

iv. Domestic quarantine like in Australia may be practiced in India also.

v. QRT recommended developing methodology for containing invasive weeds.

vi. QRT suggested relooking into the physiological studies being conducted at the centre more critically.

2.12 UAS, Dharwad

i. Application of atrazine at 2.0 kg/ha as pre-emergence on 3 DAS + 2,4-D at 1.25 kg/ha as post-emergence on 90 DAS + directed spray of glyphosate at 1.0 kg/ha at 150 DAS was found to be the best treatment for weed control and producing highest cane yield in sugarcane ratoon.

ii. In long-term trial on tillage in maize–chickpea cropping system, conventional tillage, and application of atrazine in maize and alachlor at 1.5 kg/ha in chickpea recorded the lowest weed emergence, dry weed weight and increased yield significantly.

iii. In groundnut-wheat cropping system, application of alachlor at 1.5 kg/ha or pretilachlor at 1.5 kg/ha in groundnut integrated with inter-cultivations was found effective for weed control and higher pod yield. In wheat, application of metsulfuron-methyl at 4 g/ha significantly reduced weed population and resulted in higher yield.

iv. Application of pendimethalin at 1.0 kg/ha PE as sand-mix reduced the density of *Cuscuta* in onion.

Comments of QRT

i. Presentation of data should be done properly.

ii. Microorganisms co-evolved with weeds could be utilized for weed control.

iii. Mechanism of *Parthenium* suppression by *Cassia* due to completion or allelopathic effect should be studied.

Visit of QRT to OUAT, Bhubabeswar from 10-12 Jan, 2012 and review of the work done by coordinating centres, *viz*. AAU, Jorhat; VB, Sriniketan; RAU, Pusa; BAU, Ranchi; IGKV, Raipur; and OUAT, Bhubaneswar.

2.13 AAU, Jorhat

i. *Dichanthium assimile,* a problematic grass in the tea gardens of Karimganj district of Assam, was found glyphosate resistant. A newly-introduced grassy weed, *Paspalum* sp. has created problem in the riverside villages along the Brahmaputra River in Lakhimpur and Dhemaji districts of Assam. *Alternanthera philoxeroides,* the problem

weed of deep water rice in Majuli extended its infestation to Dhemaji district. Problem weeds, *Xanthium indicum* and *Rumex nepalensis* dominated *rabi* vegetables in Lakhimpur district. *Sagitteria triflora* extended its distribution to Sivasagar district in aquatic situations.

ii. In direct-seeded rice - blackgram cropping sequence, the highest yield of rice and blackgram was recorded in conventional tillage. Application of pendimethalin at 1.5 kg/ha produced the highest seed yield of blackgram.

iii. In sugarcane + cowpea intercropping system, the highest cane yield was obtained with pendimethalin at 1.0 kg/ha.

iv. Application of pretilachlor at 0.75 kg/ha + safener was found to be best weed management practice in direct-seeded upland rice.

v. Under long-term herbicides trial, herbicide rotation reduced the population of *Cuphea balsamona* and *Monochoria vaginalis.* Application of butachlor + 2,4-D rotated with pretilachlor (100% NPK through chemical fertilizer) and butachlor + 2,4-D rotated with pretilachlor (25% nutrient through organic source) resulted in the highest yield in the rice-rice system.

vi. In rice-wheat cropping system, pretilachlor at 0.75 kg/ha in rice, and isoproturon at 0.75 kg/ha + 1% surfactant (tank mix) in wheat resulted in the highest yield.

vii. Application of metribuzin at 1.0 kg/ha + 4 HWs or metribuzin at 1.0 kg/ha + HWs or oxadiargyl at 1.5 kg/ha + HWs resulted in the highest flower yield in tuberose.

viii. Hand weeding twice at 20 and 40 DAP or application of oxyfluorofen at 15 g/ha + garden hoeing at 40 DAP resulted in the highest fruit yield of chilli.

ix. For the management of *Eichhornia crassipes,* paraquat application showed faster drying of the plants. Weed plants were completely killed by 15 days after spray. Regrowth of weeds up to 120 days of spray was not observed.

x. In upland direct-seeded rice, the residues of butachlor and pretilachlor in grain and straw, and in groundwater after harvest were below detectable level (10 ppb).

xi. Highest production of compost was obtained with *Chromolaena*, followed by *Ipomoea carnea* and *Eichhornia crassipes*. *Amyanthus diffringens* was found to be the slowest decomposer, while *Eudrilus eugeniae* was the best in terms of composting time required. The total P and K contents were significantly higher in *Ipomoea* compost.

Comments of QRT

i. OFTs should be conducted in minimum 1000 m^2 area per treatment.

ii. QRT suggested to prepare a map showing *Pathenium* infestation in the country.

iii. It was suggested to undertake DNA bar coding of important weed species in the country.

iv. Residue data on tea were not presented properly.

v. QRT appreciated the taxonomy work and recommended to provide adequate funds for taxonomy studies at the centre.

2.14 BAU, Ranchi

i. In direct-seeded rice, intercropping of *Sesbania* + pendimethalin at 1 kg/ha PE performed equally well as hand weeding at 30 and 45 DAS, recording maximum net returns (Rs 10,747) and B:C ratio (1.24).

ii. Conventional-conventional method of tillage was found similar to zero-conventional and conventional-zero under rice-wheat cropping sequence, resulting in significantly higher rice grain yield as compared to zero-zero tillage.

iii. Transplanting associated with application of pyrazosulfuron at 20 g/ha as pre-emergence + mechanical weeding by Dutch hoe at 40 DAS could be adopted for effective weed control and higher rice yield.

iv. In rice–wheat cropping system, application of butachlor at 1.5 kg PE + Almix at 4 g/ha PoE in preceding rice, and isoproturon at 1.0 kg PoE+ 2,4-D at 0.5 kg/ha PoE in following wheat recorded significantly higher grain yield.

v. Application of isoproturon at 1000 g + carfentrazone-ethyl at 15.0 g/ha or isoproturon at 875 g + carfentrozone-ethyl at 13 g/ha or isoproturon at 1.25 kg/ha PoE could be successfully be applied in wheat for weed control and higher productivity.

vi. Pre-plant incorporation of fluchloralin at 1.5 kg/ha or pre-emergence application of pendimethalin at 1.5 kg/ha could be practiced for higher productivity of wheat + razmash system.

Comments of QRT

i. Weedy rice is becoming a problem in Ranchi and adjoining areas.

ii. Availability of herbicides is very poor, and thus adoption of herbicide is very less. Farmers are following cultural methods to manage weeds.

iii. QRT opined that the centre's report is not having clarity and convincing results.

2.15 RAU, Pusa

i. During *kharif* season in rice, *Caesulia axillaris* emerged as the dominant weed species while during *rabi* weed shift was observed towards *Physalis minima, Phalaris minor, Solanum nigrum, Anagalis arvensis, Ocimum sanctum* and *Cirsium arvense*.

ii. In sugarcane, atrazine at 2.0 kg/ha as pre-emergence at 3 DAP + 2,4–D at 0.5 kg/ha as post-emergence at 75-95 DAP proved its superiority in terms of generating maximum net returns and B:C ratio.

iii. SRI along with cono weeder performed better than rest of the treatments. Transplanted rice performed better with use of pyrazosulfuron + mechanical weeding.

iv. In wheat, maximum reduction in weed count and weed dry weight were recorded with pinoxaden at 40 g/ha POE fb carfentrazone at 25 g/ha POE along with surfactant, which was comparable with pinoxaden at 35 g/ha POE fb carfentrazone at 20 g/ha POE along with surfactant POE.

v. In rice-chickpea cropping system, the lowest weed count and weed dry weight were observed under mechanical weeding twice in both crops. Butachlor at 1.5 kg/ha + 1 HW in rice, and application of pendimethalin at 0.75 kg/ha + one hand weeding in chickpea recorded the lowest weed count, weed dry weight and highest grain yield.

vi. In maize-lentil cropping system**,** minimum weed count and weed dry weight, and the highest grain yield were recorded under mechanical weeding twice comparable with atrazine at 0.75 kg/ha fb 2-4, D sodium salt at 0.5 kg/ha in maize.

vii. In coriander, zero tillage along with pendimethalin at 1 kg/ha pre-emergence recorded the highest net returns and B:C ratio.

Comments of QRT

i. QRT recommended that frequent shifting of scientists at Pusa centre should be avoided as this adversely affected the continuity and performance of the centre.

ii. Approved technical programme should be followed without any modifications.

2.16 V.B., Sriniketan

i. Weed shifts were noticed in several crops: *Echinochloa glabrescens* and *Cyperus iria* in *kharif* rice in place of *Echinochloa colonum* and *Cyperus difformis*; *Gnaphalium purpureum* and *Polygonum plebeium* in wheat and mustard in place of *Gnaphalium indicum*; *Cyperus rotundus* and *Croton bonplandianum* in summer vegetables in place of *Digitaria* and *Cynodon*. Infestation of *Phalaris, Avena* and *Lolium temulantum* has been detected in wheat Birbhum district. Rapid spread of weedy rice species, viz. *Oryza nivara, O. barthii, O. minuta, O. rufipogon* and grassy weed *Echinochloa glabrescens,* and *Setaria verticillata* has been observed in rice.

ii. In direct-seeded rice, the highest grain yield (3.84 t/ha), net returns (Rs. 22782 /ha) and B:C ratio (1.23) were obtained in rice when crop was sown after onset of monsoon integrated with butachlor + hand weeding.

iii. Highest rice grain yield (3.86 t/ha), net returns (Rs. 23453 /ha) and B:C ratio (1.28) were obtained in SRI system with pyrazosulfuron ethyl + mechanical weeding.

iv. Under long-term trial on tillage ystem, reduced tillage (RT) was beneficial in controlling weeds but conventional tillage recorded higher grain yield of rice. In yellow sarson, all tillage practices were at par in producing seed yield. In rice, the highest net returns were recorded in conventional tillage + butachlor (Rs. 31,003 /ha), and in yellow sarson, it was in zero tillage + isoproturon (Rs 17030 /ha).

v. In rice-mustard cropping system, there was complete disappearance of *Hydrolea,* decreasing tendency of *Fimbristylis,* increasing tendency of *Cynodon* and *Digitaria.* In rice, the highest grain yield (3.87 t/ha) in alternate use of butachlor / pretilachlor + organic manure + 2,4-D but highest net returns (Rs. 24,591/ha) and B:C ratio (1.48) were noticed in repeated use of butachlor + 2, 4-D + fertilizer. In yellow sarson, the highest seed yield (1.12 t/ha), net returns (Rs. 18,650 /ha) and B:C ratio (1.25) were observed in alternate use of isoproturon / pendimethalin + FYM.

vi. Studies on herbicidal resistance revealed that 96% inhibition of emergence was recorded with recommended dose of butachlor. No resistance has developed in *Echinochloa* where butachlor has been applied continuously during last 4-5 years.

Comments of QRT

i. QRT appreciated the presentation by the centre.

ii. It was suggested that objective of weed management is not to make the fields weed-free but to maintain them under threshold level.

iii. It was suggested to give more emphasis on weed smothering crop varieties.

2.17 IGKV, Raipur

i. In direct-seeded rice, pre-emergence application of pendimethalin at 1.0 kg/ha + one hand weeding, *Sesbania* + pendimethalin fb 2,4-D at 0.5 kg/ha as post-emergence and hand weeding twice at 30 and 45 DAS gave comparable yield of direct-seeded rice.

ii. Application of pretilachlor + safner at 650 g/ha fb *biasi* method of rice cultivation produced the maximum grain yield. In direct-seeded rice, significantly higher grain yield was recorded under post-monsoon sowing time, and with two HWs and butachlor at 1.5 kg/ha fb one HW.

iii. In long-term trial on tillage, tillage practices did not influence the performance of direct-seeded rice-wheat cropping system in terms of yield of individual crop. Benefit : cost ratio was higher under zero tillage than conventional for both the crops. Rice yield equivalence was higher where the combination of both the tillage practices was used as conventional *fb* zero tillage or vice-versa.

iv. In wheat, sulfosulfuron + metribuzin at 25 g + 105 g/ha resulted in significantly higher grain yield of wheat due to lowest weed dry matter production and weed control efficiency. Weed index was the highest under weedy check and ranged from 1.8-48.9%. Pinoxaden + carfentrazone at 50 + 20 g/ha and pinoxaden + metsulfuron at 50 g + 4 g/ha produced significantly higher grain yield of wheat.

v. For *Parthenium* management by *Zygogramma* beetles, it was observed that damage to the foliage of *Parthenium* was to the tune of 62.8%. The beetles migrated from the place of release to other *Parthenium* infested areas after 45 days of release.

Comments of QRT

i. It was suggested to find out the reasons for banning herbicide metribuzin in the state.

ii. Success stories on economic gains may be prepared for the Chhattisgarh.

2.18 OUAT, Bhubaneswar

i. In east and south-eastern coastal plain zone, weed density of *Celosia argentea* increased to the tune of 20-25% in crops like groundnut and pulses grown under upland situations. Gradual infestation of *Mikania micrantha* was observed in the plantation crops grown in the coastal region. *Parthenium hysterophorus* previously confined to roadside areas, has now encroached all major canal embankments in the coastal command areas. *Orobanche aegyptica* was observed in tomato and brinjal crops in tribal pockets of Keonjhar since last 2 years. A submerged and emergent weed *Phragmites kark*a (Nala grass) covering one-tenth area of the Chilka lake posed a serious problem in navigation and fishing.

ii. In direct-seeded rice, *Sesbania* + pendimethalin + 2.4.D resulted in not only higher grain yield (3.71 t/ha) by reducing the weed densities of *Echinochloa colona* but also lowered the cost of weeding (Rs 1800/ha) along with highest B:C ratio(1.55).

iii. In rice-rice cropping system, application of pretilachlor to *kharif* rice and butachlor + almix to *rabi* rice or pretilachlor in *kharif* and one HW in *rabi* produced the system grain yield of 8.72-8.76 t/ha, which was at par with farmers' practice in *kharif* (HWs at 25 and 45 DAP) and one HW (40 DAP).

iv. In direct-seeded rice, sowing before onset of monsoon with pre-emergence application of butachlor 1.5 kg/ha + 1 HW (30 DAS) recorded the highest grain yield (3.45 t/ha) and B:C ratio (2.11), followed by same herbicide treatment with sowing after monsoon (3.22 t/ha, B:C ratio 1.77).

v. In sugarcane ratoon, integration of metribuzin (2 DAP) with hand weeding (45 DAP) and 2,4-D Na salt (90 DAP) recorded the highest cane yield.

vi. Under long-term trial on tillage in rice-rice cropping system, zero-zero tillage with application of butachlor 1.5 kg/ha (2 DAP) recorded the highest B:C ratio (1.8) and system yield (9.1 t/ha). Zero-zero tillage methods recorded the higher weed index of 24.5%, followed by conventional-zero method (14.8%).

vii. In long-term herbicidal trial on rice-groundnut cropping system, the practice of two hand weedings with organic matter to *kharif* rice, and one hand weeding (25 DAS) + hoeing (50 DAS) to *rabi* groundnut produced the highest REY (11.26 t/ha) and B:C ratio (1.32).

viii. Deep ploughing in summer along with stale seedbed *fb* pendimethalin 0.5 kg/ha recorded the maximum grain yield in niger and *Cuscuta* control efficiency (53%). The highest B:C ratio (1.7) was obtained from summer ploughing + pendimethalin at 1.0 kg/ha as sand mix.

ix. Soil solarization reduced the density of *Orobanche* in brinjal by 28%, with yield increase by 6.7%. Although soil solarization + two hand weedings (30 and 50 DAP) resulted in the maximum yield of 35.7 t/ha with *Orobanche* control efficiency of 64.3%, these were at par with soil solarization + pendimethalin at 1.0 kg/ha at 3 DAP.

x. Residues of butachlor when applied at 1.0 kg/ha were recorded in soils of rice up to 45 days (0.024 ppm) and up to 60 days (0.02 ppm) at 2.0 kg/ha. However, the residues were below detectable level in post-harvest soils, grain and straw in both the doses. The residues of pretilachlor persisted up to 45 days (0.021 ppm) at 1.0 kg/ha and up to 60 days (0.027 ppm) at 2.0 kg/ha in transplanted rice. The residues of oxyfluorfen could be detected up to 15 cm depth in sandy clay loam soils irrespective of doses.

Comments of QRT

i. Research publications of the centre are not up to the mark.

ii. QRT suggested that long-term herbicide trial on rice-groundnut system be replicated, and glyphosate should not be sprayed uniformly in all the treatments.

iii. QRT appreciated the transfer of technology programme of the centre.

Visit of QRT to ANGRAU, Hyderabad during 01-02 Feb, 2012 and review of the work done by coordinating centres, *viz*. AAU, Anand; MAU, Parbhani; DBSKV, Dapoli; and ANGRAU, Hyderabad.

2.19 AAU, Anand

i. Infestations of *Phalaris minor* in wheat; *Cuscuta* in lucerne, fennel, cumin, citrus, pulses, mint and onion; Orobanche in tobacco, brinjal, potato, chilli, tomato, mustard and Ashwagandha; and *Loranthus* on mango, sapota, silver oak, paltaforum, bottle brush, and custard apple were recorded.

ii. Continuous use of fluchloralin or alternate use of metribuzin for weed management in potato was safe, and there was no adverse effect on soil health.

iii. Herbicide residues in different crops were analyzed including pendimethalin in groundnut, soybean and mustard; fluchloralin in potato, groundnut and mustard; and trifluralin in mustard and 2-4, D in wheat. Downward movement of herbicides was observed up to 7.5 cm.

iv. Microbial population in soil was significantly suppressed by recommended dose of herbicides, viz. pendimethalin and fluchloralin in greengram immediately after their application. However, the effect of herbicides was nullified 20 days after spraying. Application of FYM at 10 t/ha helped in building-up microbial population in soil under potato.

Comments of QRT

i. QRT appreciated the good presentation, including the herbicide residue studies.

ii. QRT suggested calculating economics not only for weed control but on total cost of cultivation.

iii. Efforts should be made to fill-up the post of Jr. Microbiologist at the earliest.

2.20 MAU, Parbhani

i. Soybean recorded the highest grain yield under CT - CT system. Two hand weedings resulted in significantly higher seed yield, which was at par with pre-emergence application of alachlor at 2.0 kg/ha. Succeeding crop of wheat produced significantly higher grain yield under tillage practices of bed-bed system. Pendimethalin at 1.0 kg/ha was found at par with 2 HWs.

ii. Considering the grain yield, field efficiency and economics of the treatments, the cycle hoe was found to be highly efficient for weeding in soybean.

iii. In sorghum-wheat cropping system, persistence of atrazine in soil by bio-assay method indicated that atrazine applied at 0.75 kg/ha and 0.50 kg/ha persisted in the soil up to 100 days and 80 days from the date of spraying, respectively. No detrimental effect of herbicide on soil micro-flora was observed.

Comments and recommendations

i. B:C ratio at FLD stage should be calculated. Cost of hand weeding in real terms need to be calculated. Weed-free treatment should be standardized.

ii. Observations on soil microflora at initial stage should be clearly defined. The data should be analyzed statistically. QRT observed that the results were not consistent over the years.

iii. QRT expressed concern over non-performance of the residue chemist. Even the agronomic experiments were not conducted and analyzed properly.

2.21 ANGRAU, Hyderabad

i. System of Rice Intensification with cono weeding twice recorded higher weed control efficiency, grain yield and B:C ratio. Transplanting with either pyrazosulfuron-ethyl fb mechanical cultivation or hand weeding also resulted in higher weed control efficiency.

ii. The highest grain yield of rice was obtained with hand weeding done at 20 and 40 DAP, which was significantly superior to post-emergence application of cyhalofop-butyl at 100 g/ha, and was on par with pre-emergence application of butachlor at 1.0 kg/ha.

iii. Conventional – conventional tillage (ridges and furrow system) coupled with application of atrazine at 1.0 kg/ha for maize in *kharif*, and hand weeding twice at 20 and 45 DAS for sunflower during *rabi* resulted in lower weed dry matter, and higher yields and total system productivity.

iv. In grapes, oryzalin as pre-emergence at 2.0 kg/ha in combination with glyphosate at 2.0 kg/ha was effective in controlling weeds and increasing yield.

v. In lucerne, imazethapyr at 100 g/ha as post-emergence or using pure seed of lucerne + hand weeding at 30 DAS resulted in efficient control of *Cuscuta* and other weeds, and higher green fodder yield. Residues of pendimethalin and imazethapyr were below detectable level in lucerne fodder.

vi. Studies on degradation of pretilachlor applied to rice revealed that residues of pretilachlor persisted up to 40 days when applied at recommended rate (1.0 kg/ha) and up to 60 days when applied at double the recommended dose (2.0 kg/ha). The half-life of pretilachlor varied from 11.9 days to 16.9 days at 1.0 kg/ha and 2.0 kg/ha, respectively.

vii. Paraquat residues were found up to 15-20 days after application and were below detectable limit at 30 days of application. Survival of the fish was not affected with paraquat or 2,4-D at recommended or double the recommended rate.

viii. Application of atrazine at 1.0 kg/ha or 0.75 kg/ha followed by mechanical weeding at 30 DAS to maize in *kharif* and two hand weedings at 20 and 45 DAS for groundnut during *rabi* resulted in significantly higher grain and pod yields, respectively.

ix. In long-term trial on tillage, CT - CT resulted in lower weed dry matter and higher maize grain yield. During *rabi*, in sunflower though the CT – CT was useful in obtaining lower weed dry matter but higher yield was obtained with zero-conventional tillage.

x. In long-term herbicide trial in rice-maize cropping system, hand weeding twice at 20 and 40 DAS to rice was essential for efficient weed control and higher yield. Similarly, atrazine at 1.0 kg/ha applied either pre-emergence or early post-emergence to *rabi* maize was found to be superior for efficient weed control and higher yield.

Comments of QRT

i. Statistical analysis of economics data should also be done.

ii. Minimum 4 replications are required in field experimentation.

iii. QRT suggested caution on herbicide recommendation in aquatic environments. Controlled release formulations may be developed for aquatic weed control.

iv. It was suggested to adopt methods for better recovery of residue studies.

v. Recommending a combination or mixture of herbicides should be done with caution.

vi. Farmers' practice should be well defined and can be taken as bench mark for comparison.

vii. QRT appreciated the good linkage of the ANGRAU centre with other extension agencies.

viii. Safety information especially for vegetable crops must be generated.

2.22 DBSKKV, Dapoli

i. *Cuscuta* was found to infest lablab bean, cowpea, gram and horse gram grown as zero-tilled dibbled crops after *kharif* rice at Chiplun and Khed areas of Ratnagiri.

ii. For effective and economical weed control in rice-rice cropping system, pre-emergence application of pretilachlor a 0.75 kg/ha to *kharif* rice after draining out the field followed by use of butachlor at 1.25 kg/ha + almix at 4 g/ha as pre-emergence 3 days after transplanting *rabi* rice should be followed.

iii. Under Konkan conditions, direct-seeded dibbled rice should be sown before onset of monsoon, and for effective weed management either hand weeding twice at 20 and 40 DAS or pre-emergence application of pretilachlor at 0.5 kg/ha with safener should be followed for obtaining higher yield and net returns.

iv. In *kharif* rice-*rabi* lablab bean cropping system, CT - CT system produced higher grain yield of *kharif* rice, followed by CT- ZT and ZT – CT systems. Zero-zero tillage system recorded the highest weed emergence, followed by conventional-zero system.

v. Pre-plant ploughing resulted in the lowest infestation of *Cuscuta* in *Lablab purpureus* grown after *kharif* rice. Stale seedbed followed by pendimethalin at 0.5 kg/ha pre-emergence was best for control of *Cuscuta*.

Comments of QRT

i. The centre should make efforts to solve the major weed problems of the region.

Critical analysis on achievements

i. The QRT observed that all the research projects at DWSR were focused towards addressing the mandate of the Directorate. There was fairly a good balance between basic, strategic and applied research. The work of different scientists was quite impressive by and large; however, it was felt that there is scope for bringing in inter-disciplinary approach for more efficient and purposeful research. At present, mostly the students at Masters' degree level are being trained at the Directorate. In future, special efforts may be made to attract doctoral and post-doctoral students.

ii. In the studies on the effect of herbicides on non-target species a greater level of inter-disciplinary approach involving soil scientists, microbiologists, entomologists, and pathologists is required. DWSR has initiated some studies; however, there is need to develop comprehensive protocol covering important non-target organisms like honey bees, P-solubilizers, rhizobia etc. While new molecules are being evaluated, systematic studies on effects on soil microbes and soil properties are lacking. The QRT felt that there has to be a well organized effort in developing cultural weed management practices.

iii. It was heartening to note that DWSR has developed a cost-effective technique for mass production of Mexican beetles, and these beetles were supplied to different AICRP-WC centres for release and establishment. The beetles were also distributed to KVKs, NGOs, and state departments. However, it was found that the beetle was not able to effectively kill the plants, and hence, there is an urgent need to consider the importation of more number of co-evolved natural enemies for classical biological control.

iv. An overall assessment revealed that there is greater scope for technology flow for validation to the AICRP centres from DWSR for on–farm multi-location testing. The impact of research on herbicide application is quite evident as seen by large-scale adoption by farmers across the country. Interaction with the farmers in different states indicated that they were quite happy with the weed management packages involving herbicides. However, more efforts are needed to undertake detailed socio-economic impact analysis over a large area.

v. It was also emphasized that strategic research in the area of management of weeds under the changing scenario of weed shift and alien invasive weeds and climate change should be addressed. It is important that strategic and anticipatory research be carried out in the area of management of potential quarantine weeds. Management of parasitic weeds like *Orobanche, Striga, Cuscuta and Loranthus* may be included in the priority areas of research.

vi. The DWSR had organized very intensive training programmes for the farmers, SMS of KVKs, scientists of AICRP-WC and ICAR institutes, officials of the state department of agriculture and horticulture, NGOs, and demonstrated the weed management technologies at farmer's fields.

C. THE REPORT

I. Brief History

A Coordinated Weed Control Scheme on wheat, rice and sugarcane was initiated as early as in 1952 in 11 States of the country by ICAR to monitor the weed flora, and also to find out the relative feasibility of economical weed control. Later, a number of Crop Research Institutes of ICAR and State Agricultural Universities were involved in weed control research. Different State Agricultural Universities also initiated the syllabus for weed management at under graduate and post-graduate level to teach and train students and researchers in weeds and their management.

In 1978 the Weed Research Programme was strengthened through All India Coordinated Research Programme on Weed Control by the ICAR in collaboration with the United States Department of Agriculture. Initially, six centres were started at different State Agricultural Universities (SAU) for a period of six years. Later seven more centres in II phase and nine more centres in III phase were added during 1982-83 and 1985-86, respectively for a period of five years each. The programme was continued with plan funds of ICAR. This project assisted farming community through the scientific technologies developed, which are effectively utilized for alleviating the yield losses due to weeds in field crops. The research programme tackled problems of weed management for which facilities were not available at different centres. In VII Plan, it was decided to establish a National Research Centre for basic as well as applied research in weed science in India. Accordingly, the National Research Centre for Weed Science (NRCWS) was approved during the middle of VII Five Year Plan with a total outlay of Rs 64 lakhs. Approval of Govt. of India for establishing NRCWS was conveyed vide DARE letter no. 13-13/85/AFC dtd. Nov. 14, 1986. The Centre actually came into existence on 22.04.1989, which was further upgraded to Directorate of Weed Science Research (DWSR) in January, 2009.

II. Mandate of DWSR and AICRP-WC

DWSR

The existing mandate of DWSR is as follows.

- To undertake basic, applied and strategic researches for developing efficient weed management strategies in different agro-ecological zones;
- To provide leadership and co-ordinate the network research with State Agricultural Universities for generating location-specific technologies for weed management in different crops, cropping and farming systems;
- To act as a repository of information in weed science;
- To act as a centre for training on research methodologies in the areas of weed science and weed management;
- To collaborate with national and international agencies in achieving the above mentioned goals; and
- To provide consultancy on matters related to weed science.

The QRT recommends the mandate of DWSR as follows:

"Development and promotion of sustainable weed management technologies for enhancing productivity and profitability of different crops and cropping systems including non-cropped area and aquatic bodies in diverse agro-ecological situations."

The different components of the existing mandate will form the core activities for fulfilling the mandate.

AICRP-WC

Mandate

- To conduct location-specific research for developing appropriate weed management technologies
- To demonstrate the weed management technologies through on-farm adoptive trials

The QRT feels that the existing mandate of AICRP-WC can be retained.

III. Priorities, Programmes and Projects

Research Proirities

DWSR

To meet the challenges in weed management, the DWSR had the following key research priorities:

i. Developing weed management technologies in different field and horticultural crops / cropping systems under varied ecosystems
ii. Herbicide evaluation and assessment of herbicide residues in different matrices
iii. Effects of climate change on crop-weed interaction and productivity.
iv. Development of bioherbicides
v. Research on parasitic weed management
vi. Management of Alien Invasive Weed Species
vii. Weed utilization
viii. Transfer of technology

Research progammes and projects

Research projects implemented during the review period were mainly aimed at generating information to evolve economical and environment friendly weed management strategies under following major themes:

Theme-I: Herbicide as a tool in weed management

The following projects were undertaken in this theme:

i. Testing of new herbicides
ii. Long-term effects of herbicides in cropping systems
iii. Studies on metribuzin phytotoxicity in pulse crops
iv. Influence of herbicides on soil micro-flora, soil fertility and productivity
v. Efficient weed management through herbicide use
vi. Studies on herbicide application techniques
vii. Herbicide residues in soil and food chain
viii. Impact of soil physical environment on pre-emergent herbicides
ix. Role of adjuvants on herbicide bio-efficacy
x. Studies herbicide residue in long-term herbicide trial in soybean-wheat cropping system
xi. Studies herbicide residue in long-term herbicide trial in rice-wheat cropping system
xii. Evaluation of herbicide toxicity on non-targeted organism under paddy cum fish culture
xiii. Evaluation of risk of ground-water contamination by the continuous use of herbicides
xiv. Establishment of techniques and protocol for the investigation on the role of leaf surface in the phototransformation of herbicides
xv. Investigation on phototransformation of SFS and PQF in aqueous phase and on soil surface
xvi. Studies on metirbuzin phytotoxicity in pulses.

Theme-II: Weed biology and eco-physiology

The following projects were undertaken in this theme:

i. Biology of major weeds
ii. Evaluation of methods of breaking weed seed dormancy
iii. Effect of elevated CO_2 on competitive interaction between wheat and *Phalaris minor*
iv. Weed flora shift in cropping systems
v. Weed herbarium and collection, conservation and utilization of weed biodiversity
vi. Effect of nutrient supply on crop-weed competition
vii. Studies on IPU resistance in *Phalaris minor*
viii. Germination, dormancy and ageing of weed seeds
ix. Physiological and biochemical basis for weed suppressing ability of different crop varieties.
x. Collection, conservation and multiplication of weed germplasm and documentation of weed seed identification character
xi. To study the effect of elevated CO_2 on weeds and competitive interaction between crops and weeds

Theme-III: Development and evaluation of integrated weed management techniques /practices

The following projects were undertaken in this theme:

i. Design, development and evaluation of mechanical weeding tool as a

component of integrated weed management techniques and practices
ii. Evaluation of manually-operated weeding tools suitable for uprooting of soil embedded weeds in soybean and chickpea
iii. Effect of tillage and weed control measures on weed dynamics in different cropping systems
iv. Integrated management of *Cuscuta* in berseem and lucerne
v. Effect of tillage and weed control measures on weed dynamics in rice based cropping systems
vi. Studies on effect of crop residue management on weeds in rice-wheat cropping system
vii. Herbicide-soil moisture interaction
viii. Weed management on horticultural crops
ix. Development of organic weed management in rice-wheat and soybean-wheat cropping system
x. Development of organic weed management in vegetable crops
xi. Detection of weeds through remote sensing techniques

Theme-IV: Bio-pesticides and biocontrol of weeds

The following projects were undertaen in this theme:

i. Herbicidal activity of plants and their constituents
ii. Survey, surveillance and impact evaluation of bio-agents and herbicides with other methods for integrated management of some important weeds
iii. Evaluation of bioagants and herbicides alone or in combination on water quality and fish mortality for integrated management of some aquatic weed
iv. Survey, identification and impact evaluation of new and existing insect bio-agents for biological control of important weeds in India
v. Collection, characterization and evaluation of plant pathogens for weed management
vi. Isolation and identification of root exudates of linseed and marigold and their growth inhibitory effect on few weeds
vii. Bio-herbicidal potential of allelochemicals from important plants
viii. Identification of weedy plants for phytoremediation of heavy metal contaminated sites
ix. Biological management of *E. crassipes* using potential aquatic fungal pathogens
x. Induction of systemic resistance against *Cuscuta* in chickpea
xi. Biology, host specificity and damage potential of bioagent on *Trianthema portulacastrum*

Theme-V: Weed Utilization

i. Preparation of vermi-compost from various weed species and evaluation of their nutrient status and seed viability

Theme-VI: Transfer of technology

i. Evaluation of improved weed control technologies on farmers' fields

AICRP-Weed Control

Research priorities

i. Weed survey and surveillance
ii. Effect of climate change on weeds
iii. Biological weed control
iv. Long-term impact of herbicides on weed seed bank, soil microbes, herbicide residues in cropping systems
v. Management of invasive/ parasitic/aquatic weeds
vi. Development of weed management technologies under moisture stress situations
vii. Management of alien invasive weed species specially introduced recently
viii. Mitigating the emerging threat of weedy rice in rice growing areas
ix. Testing of new herbicides
x. Up-scaling economical and eco-friendly weed management technologies in different crops and cropping systems under varied situations
xi. Transfer of technology and impact assessment

Network Projects

i. Weed survey and surveillance
ii. Weed management in crops and cropping systems
iii. Management of parasitic, aquatic, problematic and invasive weeds
iv. Herbicide residues, persistence, leaching behaviour and toxicity

The QRT suggests that the research programmes of the Directorate may be re-organized as follows:

I. Sustainable weed management strategies in diversified cropping systems

i. System-based approach to weed management, with emphasis on dryland / rainfed, hilly ecosystems, horticultural and plantation crops-based systems, and organic farming in high-value crops.
ii. Weed management and C-sequestration potential under long-term conservation agriculture systems.
iii. Improving efficiency of chemical weed control along with other production factors (soil type, moisture status, nutrient use, varieties, etc.)
iv. Standardization of spraying techniques, and mechanical tools including power weeders and sprayers
v. Use of remote sensing techniques for weed incidence / intensity studies, and development of spectral signatures of weeds in precision farming systems

vi. Development of herbicide tolerant transgenic elite rice varieties

II. Weed management under the regime of climate change and herbicide resistance

i. Effect of climate change on crop-weed interactions, herbicide efficacy, secondary metabolites, and bioagents

ii. Physiological and molecular basis of herbicide resistance development in weeds, and evaluation of herbicide tolerant crops

iii. Weed risk analysis and development of weed seed standards

III. Management of problem weeds in cropped and non-cropped areas

Identifying weeds of national / state importance, and studying their detailed ecology and management through biological, chemical and mechanical means

i. Parasitic weeds: *Orobanche, Striga* and *Cuscuta*

ii. Aquatic weeds: *Eichhornia, Alternanthera philoxeroides* and *Hydrilla*

iii. Crop weeds: *Phalaris, Echinochloa, Cyperus*, weedy rice

iv. Non-crop land weeds: *Parthenium, Lantana, Ageratum, Mikania, Chromolaena*

IV. Environmental impact of herbicides

i. Monitoring of herbicide residues in soil, water, plants, grain, straw/ fodder, and effects on non-target organisms on a long-term basis;

ii. Decontamination techniques for herbicides/ secondary metabolites contaminated soil and water

V. Transfer of technology and impact assessment

i. Large-scale demonstrations on integrated weed management on farmers' fields in disadvantaged / tribal areas, and impact analysis

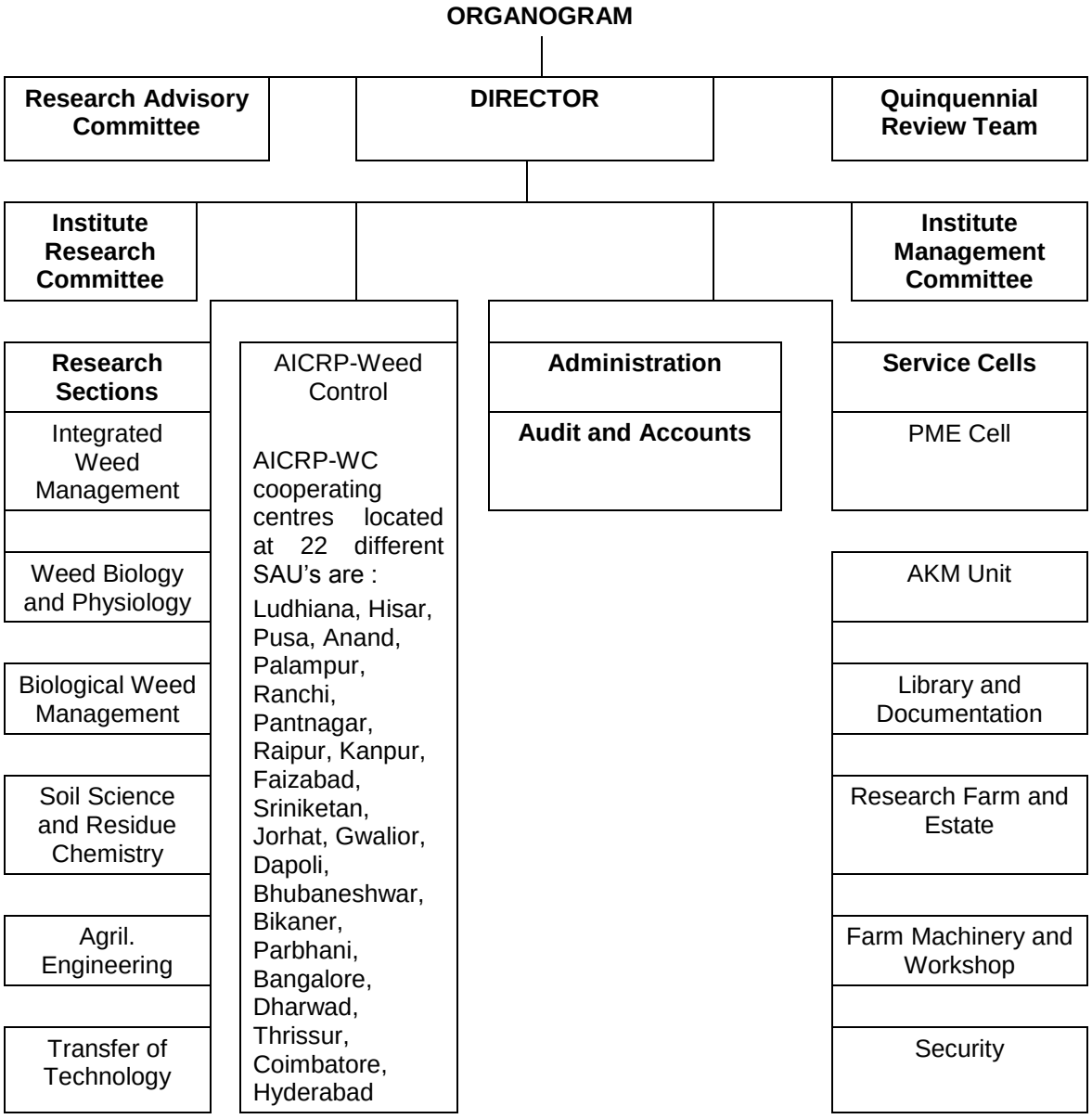
ii. Regular training programmes on advanced techniques in weed management to national and international participants (two courses each year)

The Directorate may identify suitable Programme Leaders keeping in view the competence and seniority, wherever necessary.

IV. Structure and Organization

DWSR

The DWSR is effectively organized as shown in the chart to fulfill its mandate



The QRT feels that the organogram should also indicate mandatory units and committees like women cell, IJSC, HYPM, PIMS, Bio-safety committee, ITMU, RFD.

Revised organogram is indicated below:

ORGANOGRAM

Research Advisory Committee | **DIRECTOR** | **Quinquennial Review Team**

Institute Research Council | **Institute Management Committee**

Research Sections	**AICRP-Weed Control**	**Administration**	**Service Cells**
Integrated Weed Management	22 Coordinating centres located at different SAUs are: Ludhiana, Hisar, Pusa, Anand, Palampur, Ranchi, Pantnagar, Raipur, Kanpur, Faizabad, Sriniketan, Jorhat, Gwalior, Dapoli, Bhubaneshwar, Bikaner, Parbhani, Bangalore, Dharwad, Thrissur, Coimbatore, Hyderabad	**Audit and Accounts**	PME Cell
Weed Biology and Physiology			HYPM
Biological Weed Management			PIMS
Soil Science and Residue Chemistry			ITMU
Agril. Engineering			RFD
Transfer of Technology			AKM Unit
			Research Farm and Estate
			Farm Machinery and Workshop
			Library and Documentation
			IJSC
			Women cell
			Bio-safety committee
			Security

Though the DWSR (previously NRCWS) was established in 1989, it shifted to new administrative-cum-laboratory building in 2001. Since then, the Directorate has been growing in a systematic manner, and efforts are being made to enrich the different laboratories with state-of-the-art sophisticated equipments.

Research farm: The Directorate has a well-developed and properly laid-out farm of 61.5 ha with adequate farm machines including four tractors, zero-till seed drill, FIRBS planter, and other farm implements. The farm has enough irrigation facilities both conventional and sprinkler type. Besides, it has a threshing yard, silos for storage purposes, and a field laboratory for initial processing of the bulk soil and plant samples. It also has an automatic weather station. The soil of the research farm is medium black (*Typic Haplustert*) and moderately alkaline.

In addition to these, the Directorate has facilities, such as net/poly houses to conduct pot culture experiments, controlled environment growth chambers, a quarantine insectory and containment facility, and quarantine net house for research on transgenics. Facilities like aquatic chambers are also available for conducting research on aquatic weeds.

Equipments and laboratories: The Directorate has well-equipped nine laboratories including Central lab. with modern scientific instruments like LC-MS/MS System, GC, HPLC, IRGA, AAS, universal research microscope with photographic attachment, stereo zoom research microscope, nitrogen auto analyzer, leaf area meter, UV-visible double beam spectrophotometer, high speed refrigerated centrifuge, HPLC grade water purification assembly, multi-probe soil moisture meter, chlorophyll meter, Line quantum sensor with data logger, Gel documentation unit, Lab-ware washer, Fluorescence meter, Root Length measuring system, Line quantum sensors with data-logger, Ice making machine, etc.

The Directorate has a big containment facility and two controlled environmental chambers to facilitate research under controlled conditions. Free Air CO_2 Enrichment (FACE) facility as well as three open-top chambers are there for studies on crop-weed competition under elevated CO_2 conditions. The research outcome of these facilities provides information about the possible impact of anticipating global warming on weed menace in crops.

The Directorate has a well-developed agricultural engineering workshop with facilities for fabrication, designing and development of weed control tools and implements. It has a pneumatic boat for survey and surveillance of aquatic flora and fauna. Quarantine insectory is also there to carry out the research using bioagents.

ARIS Cell (AKMU) and Library: The ARIS cell is well equipped with computers, VSAT and LAN facilities, colour xerox-cum-printer, and A-0 plotter. Specialized software like ARCInfo for GIS analysis, ERDAS Imagine for satellite image analysis and the routinely used software for data analysis are available. All the scientists are provided with internet facility. At present the library is having a total collection of 2702 books pertaining to weed science. It has modern facilities such as CAB-PEST and CAB-SAC CD-ROMs and Current Contents on Diskette (CCOD) on biological sciences. As on date, the library subscribes to 69 Indian and 20 foreign journals. DWSR library is also a member of Consortium for e-Resources in Agriculture (CeRA) under NAIP (ICAR). All the scientists have online access to more than 2000 e-journals in various fields of science.

Total Library Software system has also recently been installed for facilitating the library automation and information retrieval. Reprographic and documentation facilities have been created for the preparation of documents and reports.

Others: Modern facilities like conference/ committee halls equipped with LCD projector and public address system are available for holding scientific conferences, meetings and group discussions. In addition, a small museum is also developed for displaying various weeding implements collected from different places in India. The Directorate also has an information centre with exhibits depicting significant research results and the technologies developed. In addition the laboratories are also provided with uninterrupted power supply by a 33 KV generator set.

Organization of AICRP-WC

The AICRP-Weed Control was started under USDA Programme for a period of six years from April, 1978. The Phase-1 Centres remained for six years from April 1978 to March, 1984. The Phase-2 Centres effected from April, 1982 to March, 1987 for five years, while the Phase-3 started for four years from April, 1986 to March, 1990 under USDA finance. Four more centres were started in Phase-4. All these centres are now funded and supported by the ICAR as All India Coordinated Research Programme on Weed Control.

I Phase Centres (1978 onwards)

1. PAU, Ludhiana (Punjab)
2. JNKVV, Jabalpur *now at RVSKVV, Gwalior* (Madhya Pradesh)
3. UAS, Bangalore (Karnataka)
4. GBPUAT, Pantnagar (Uttarakhand)
5. CSKHPKV, Palampur (Himachal Pradesh)

II Phase Centres (1982 onwards)

1. TNAU, Coimbatore (Tamil Nadu)
2. MAU, Parbhani (Maharastra)
3. GAU, Anand (Gujarat)
4. AAU, Jorhat (Assam)
5. NDUA&T, Faizabad (Uttar Pradesh)

III Phase Centres (1986 onwards)

1. ANGRAU, Hyderabad (Andhra Pradesh)
2. CSAUAT, Kanpur (Uttar Pradesh)
3. CCSHAU, Hisar (Haryana)
4. OUA&T, Bhubaneswar (Orissa)
5. BAU, Ranchi (Jharkhand)
6. KAU, Thrissur (Kerala)
7. RAU, Pusa (Bihar)
8. Viswa-Bharti, Sriniketan (West Bengal)

IV Phase Centres (1995 onwards)

1. RAU, Bikaner (Rajasthan)
2. IGKVV, Raipur (Madhya Pradesh *now in Chhattisgarh*)
3. DrBSSKKV, Dapoli (Maharashtra)
4. UAS, Dharwad (Karnataka)

The AICRP-WC centres located at 22 State Agricultural Universities are working under the Directorate of Research of the University. The project is attached to the Department of Agronomy and Principal Investigator of the project is the leader of the centre.

Research

Individual AICRP-WC centres formulate location-specific research programmes, and these programmes are discussed in detail in Group Meeting and Biennial Workshop of the project along with the network experiments formulated by the project coordinating unit at DWSR. Detailed technical programmes are worked out for each network project, and the finalized programmes are implemented as per the recommendations of the project unit.

Teaching

All the scientists appointed in the project are directly linked with the under-graduate and post-graduate teaching programmes of their respective field of specialization. Scientists are also acting as research guides to M.Sc. and Ph.D students in their respective disciplines.

Extension

The centres are evaluating the recommended weed management practices under the programme of on-farm trials at various locations of the state. They also organise training programmes, participate in *kisan melas*, *kisan gosthis* and other related programmes organised by the SAUs, Govt. agencies and NGOs. Scientists also take part in different T.V. & radio programme related to weed management, and publish popular articles in news papers on weed related problems in their local languages. They also publish technical bulletin and other extension publication materials to cater to the farming communities of their respective state.

V. Management practices

DWSR

The research and administrative activities of DWSR are managed under the guidance of the Director. The Directorate has 6 research sections i.e. Integrated Weed Management, Weed Biology & Physiology, Biological Weed Management, Soil Science & Residue Chemistry, Agricultural Engineering, and Transfer of Technology. To facilitate research and other administrative functions of the Directorate, different service cells like Administration and Audit & Accounts, Technical Cell, ARIS Cell Library, Research Farm and Estate, Farm Machinery and Workshop, and Security are functioning. A separate AICRP-WC Co-coordinating unit is also functioning to assist the Director & Project Coordinator of the project.

Various committees like Institute Management Committee (IMC), Research Advisory Committee (RAC), Institute Research Council (IRC), and a number of local committees for carrying out day-to-day functioning and help in executing the various works of the Directorate. The Joint staff council is working since 1990. The Directorate has established a women cell to look after specific grievances of women employees of the Directorate. The details of meetings of important committees were given below.

Name of the committee	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Institute Research Council (IRC)	7-8 July, 2005	20-21 June, 2006	6-8 June, 2007	5-7 June, 2008	19-20 June, 2009	28-31 May, 2010	29-30 June, 1-12 July,2011
Research Advisory Committee (RAC)	19-20 January, 2006	22-23 February, 2007	19-20 February, 2008	-	25-26 June, 2009	24-25 May, 2010	7-8, April, 2011
Institute Management Committee (IMC)	21 October, 2005	31 October, 2006; 23 March 2007	15 October, 2008	15 April, 2009	15 Sep, 2009	-	-

AICRP-WC

The Project Cell initially attached to the Central Rice Research Institute, Cuttack was shifted to DWSR, Jabalpur during 1989. The technical control of the Project remains with the Assistant Director General (Agronomy), and is monitored by the Director (Project Coordinator) at its Headquarter at Jabalpur. However, the overall control remains with the Deputy Director General (NRM). The working of different centres is regularly supervised by the Director / Project Coordinator. The senior-most scientist appointed in the project acts as the Principal Investigator (PI) at the centre, and is responsible for coordinating the research and extension activities, providing the information and technologies to headquarters.

The Annual Group Meetings and Biennial Workshops are regularly organized to discuss technical programme of the year. The work done during the preceding year is reviewed, and modified technical programmes are finalized. The scientists at coordinating centres are appointed by the respective SAU and are fully under the administrative control of SAUs administration. The ICAR contribute 75% of the salaries to the scientists at all the centres along with travel and contingency grants. The respective universities contribute 25% of share. However, for the Shriniketan centre which is under the Central University, 100% contribution is made by the ICAR. The Universities provide all infrastructure facilities, such as building, laboratory, farm etc.

Details of Group Meetings and Biennial Workshops held during the QRT period

1.	Biennial Workshop	April 19-21, 2006	ANGRAU, Hyderabad
2.	Annual Group Meeting	May 8-9, 2007	NRCWS, Jabalpur
3.	XVIII Biennial Workshop	February 25-26, 2008	Rajendra Agricultural University, Campus- Bihar Veterinary College, Patna
4.	Annual Group Meeting	February 27-28, 2009	Rajasthan Agricultural University, Bikaner
5	XIX Biennial Workshop	February 23-24, 2010	IGKV, Raipur
6	Annual Group Meeting	28 Feb.-1 March, 2011	AAU, Anand

VI. Collaboration with SAUs and other research institutes

The Directorate collaborated with local institutions, viz. Jawaharlal Nehru Krishi Vishva Vidyalaya (JNKVV), Jabalpur; Rani Durgawati Vishwa Vidhyalaya (RDVV), Jabalpur; and Tropical Forest Research Institute (TFRI), Jabalpur in selected research areas.

At the National level, DWSR maintains effective linkages with its coordinating centres located in various State Agricultural Universities (SAUs) engaged in research and development of weed science. The Directorate is continuing the awareness campaigns against alien invasive weeds like *Parthenium*, water hyacinth, *Ipomoea* spp. etc. During these campaigns, the Directorate had effective collaboration with KVKs located in the different part of the country. This Directorate had effective linkages with ICAR institutes like CIAE, NBAII, PDFSR, NBSS-LUP and DRMR. DWSR had operated externally-funded projects by DBT, DST and ISRO, and implemented research projects sponsored by NAIP and DPPQ&S. There was an active linkage with several herbicide industries for bio-efficacy data generation. The Directorate was able to undertake two research projects funded by Monsanto India Ltd and Syngenta India Ltd. DWSR needs to develop collaboration outside the ICAR system including herbicide industry, and also with SAARC and international institutions.

VII. Linkages with clients/ end-users

The Directorate had close contacts with farmers of adjoining villages of Jabalpur Division, viz. Magamuha, Tagar, Mahangwa, Panagar, and Sehora. The Directorate derived benefits through interactions with farmer members of RAC. A large number of field demonstrations and on-farm trials besides various Kisan Melas/Gosthis, TV shows, radio talks etc. have been carried out to popularize the improved weed management technologies for cropped and non-cropped areas. The details of transfer of technology activities are as under:

'Parthenium Awareness Week' was organized throughout the country during 6-12 September in 2006 to 2012. About 5 lakh Mexican beetles were distributed throughout the country free of cost to SAUs, ICAR institutes, KVKs and other interesting agencies etc.

Extension activities for end users	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**
Field demonstrations							
Kharif	28	22	46	33	40	41	37
Rabi	30	38	43	45	43	40	45
Non-cropped situation	06	04	05	01	02	02	-
Training	02	01	02	02	03	02	02
Radio/TV talks	03	02	07	03	04	03	04
Kisan gosthis	01	01	01	01	02	02	01
Lecture on/off campus	12	15	15	20	18	21	18
Kisan Mela Organized	01	01	01	01	01	01	01
Participation in Kisan Mela/ Exhibition	01	02	01	02	02	02	01
Production of video films on weed management	-	-	-	-	01	03	-
Survey and socio-economic studies with	02	03	02	02	03	04	-

reference to weed management							
Extension folders	-	-	-	02	30	02	02
Extension articles in newspapers/ magazine	03	04	04	06	05	06	18
Awareness program/ campaigns on invasive weeds	01	01	01	01	01	01	01
Preparation of poster for exhibition	10	07	07	06	12	10	10
Success Stories	02	04	-	01	01	01	-

However, the Directorate needs to improve its activities under the following:

i. Involvement in Kisan Call Centre for the benefit of farming community
ii. Collaboration with KVKs for Front Line Demonstrations (FLDs)
iii. Yield gap analysis with particular reference to weed management practices.

Through the weed management packages developed and popularized by DWSR and AICRP-WC, yield advantage in the range of 30-40% in different crops in different agro-ecological zones has been reported. However, inefficient extension mechanism is the weakest link in transfer of technology. Convergence of efforts of different extension agencies e.g. DAC, NAABARD, CSO etc. at farmers' level is very much required.

VIII. Human, physical and financial resources

A.Human Resource

Staff position at DWSR during the QRT review period

Category	**Sanc-tioned**	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**
Scientific*	27	18	16	16	16	16	18	18
Technical	24	24	24	24	24	24	24	23
Administrative	11	10	10	10	10	10	09	09
Supporting	23	23	23	23	23	23	23	23
Total	**85**	**75**	**73**	**73**	**73**	**73**	**74**	**73**
* including one post of RMP								

a. Scientific positions

Sl.	Disciplines	Sanctioned posts				Filled posts				Vacant posts			
		S	SS	PS	Total	S	SS	PS	Total	S	SS	PS	Total
1	Farm Machinery	1	-	-	1	1	-	-	1	-	-	-	-
2	Agril. Extn.	-	1	-	1	-	1	-	1	-	-	-	-
3	Agril. Entomology	-	1	-	1	-	1	-	1	-	-	-	-
4	Organic Chemistry	1	1	1	3	1	1	-	2	-	-	1	1
5	Economic Botany	2	1	-	3	-	1	-	1	2	-	-	2
6	Plant Pathology	-	1	-	1	-	1	-	1	-	-	-	-
7	Plant Physiology	1	1	1	3	-	1	1	2	1	-	-	1
8	Agronomy	3	1	2	6	1	1	2	4	2	-	-	2
9	Soil chemistry	2	1	-	3	1	1	-	2	1	-	-	1
10	Agril. Economics	1	-	-	1	-	-	-	-	1	-	-	1
11	Microbiology	1	-	-	1	1	-	-	1	-	-	-	-
12	Agril. Statistics	1	-	-	1	1	-	-	1	-	-	-	-
13	Biotechnology	1	1	-	2	-	1	-	1	1	-	-	1
	Total	**14**	**9**	**4**	**27**	**06**	**09**	**03**	**18**	**08**	**-**	**01**	**09**

S-Scientist; SS-Sr. Scientist; PS-Pr. Scientist

Information on scientific, technical, administrative and supporting staff in different AICRP-WC centers

Staff position (Consolidated)

S. No.	Centre name	Scientific		Technical		Administrative		Supporting	
		S	**F**	**S**	**F**	**S**	**F**	**S**	**F**
1.	PAU, Ludhiana	4	3	3	3	1	-	2	2
2.	UAS, Bengaluru	4	4	3	2	1	1	2	2
3.	JNKVV, Gwalior	4	4	2	2	1	1	2	2
4.	GBPUAT, Pantnagar	4	4	3	1	1	1	2	2
5.	CSKHPKV, Palampur	4	4	3	3	1	1	2	2
6.	AAU, Jorhat	4	4	3	3	1	1	2	2
7.	MAU, Parbhani	4	4	3	3	1	1	2	1
8.	AAU, Anand	4	4	3	3	1	-	2	2
9.	TNAU, Coimbatore	4	4	3	3	1	1	2	2
10.	NDUA&T, Faizabad	4	4	2	2	1	1	2	2
11.	V.B., Sriniketan	3	3	2	2	1	1	1	1
12.	BAU, Ranchi	3	3	2	2	1	1	1	1
13.	CSAUAT, Kanpur	3	3	1	1	1	1	1	1
14.	KAU, Thrissur	3	3	2	2	1	1	1	-
15.	OUA&T, Bhubaneshwar	3	3	2	1	1	1	1	1
16.	ANGRAU, Hyderabad	3	3	1	1	1	-	1	1
17.	CCSHAU, Hissar	3	3	2	2	1	1	1	1
18.	RAU, Pusa	3	1	2	-	1	1	1	1
19.	DBSKKV, Dapoli	2	2	1	1	1	1	1	1
20.	IGKVV, Raipur	2	2	1	1	1	1	1	1
21.	UAS, Dharward	2	2	1	1	1	1	1	1
22.	RAU, Bikaner	2	1	1	1	1	-	1	1
Total		**72**	**68**	**46**	**40**	**22**	**18**	**32**	**30**

It was observed that about 33 per cent of the sanctioned posts of the scientists are lying vacant at the Directorate, which is of great concern. All the posts under technical and supporting cadre are in position. Presently, the post of AF&AO is lying vacant, which is not a healthy situation. The Directorate should take immediate step to get these positions filled-up by the ICAR.

The institute has to formulate a staff development plan to focus on the following key areas of research:

i. Development of protocol for weed risk analysis and identifying quarantine weeds
ii. Collection, conservation and utilization of weeds
iii. Controlled release formulation of herbicides
iv. Simulation modeling of crop-weed association

The Project Coordinator should take up the matter of filling vacant staff positions with university authorities.

Proposals for national and international training

(a) National Training

i. Developament of protocol for weed risk analysis and identifying quarantine weeds
ii. Collection, conservation and utilization of weeds
iii. Controlled release formulation of herbicides
iv. Simulation modeling of crop-weed association
v. Methodology for use of GPS

(b) International trainings (for two scientists each)

i. Herbicide residue analysis in food and agricultural product
ii. Biological control of weeds by insects and pathogens
iii. Herbicidal activity of plant constituents
iv. Herbicide resistance in weeds and crops
v. Weed risk analysis
vi. Biology and management of parasitic weeds
vii. Simulation modeling of crop-weed association
viii. Weed management and C-sequestration under conservation agriculture
ix. Remote sensing for spectral signatures of weeds
x. Climate changes effects on crop-weed associations
xi. Phytostabilization of farm agrochemicals
xii. Precision farming / farm machinery

B. Physical resources

Infrastructural and physical facilities developed during the QRT period

Works approved and completed for DWSR under XI Plan

i. Residential quarter (Type-V)

ii. Development of front area of office building

iii. Farm store

iv. Scooter stand

v. Water harvesting ponds (2)

vi. Boundary wall east side

vii. Tractor shed

viii. Covered threshing store

ix. Farm development

Equipments purchased at DWSR during the QRT Period

i. Leaf area meter

ii. Root length measuring system

iii. FACE facility

iv. Temperature gradient

v. GCMS-MS/LCMS

vi. UV-VIS-Spectrophotometer

vii. Line quantum sensors with data-logger [sensors (one each for above and below canopy) and one datalogger]

Details of equipments procured during XI Plan in AICRP-WC

Name of centre	Name of equipment	Unit cost (Rs. in lakh)	No. of centres	Total cost (Rs in lakhs)
PC Unit	**Office Furniture**	**-**	**-**	**3.49**
PAU, MAU, RAU(P), UAS(D), IGKVV	Autoclave	0.5	5	2.50
PAU, VB,CSKHPKV, UAS(B), KAU, RAU(P), IGKVV, UAS(D)	BOD Incubator	1	8	8.34
UAS(B), CSKHPKV, MAU, AAU(A), CSAUAT, KAU, OUAT, CCSHAU, RAU(P), DBSKKV, RAU(B)	Electronic balance	1	11	11.00
TNAU, PAU, RAU(P), UAS(D)	Laminor Air Flow	3	4	12.00
PAU, TNAU, RAU(P), IGKVV, UAS(D)	Microscope	1.5	5	7.50
MAU, AAU(A), NDUAT, CSAUAT, RAU(P)	Nitrogen Analyzer	3	5	15.00
PAU, GBPUAT, CSKHPKV, AAU(A), KAU, IGKV, RAU (B)	Oven	0.5	7	3.50
CSKHPKV, AAU(A), VB, CSAUAT, KAU, CCSHAU, RAU(P), IGKV	pH meter	0.3	8	2.50
AAU(J), JNKVV, GBPUAT, NDUAT, VB, KAU, PAU	Plant Canopy analyzer/Leaf area meter	3	7	22.00
PAU, MAU, UAS(D), TNAU	Spectrophotometer	3	4	12.00
All Centres	Computer with accessories	1.00	22	22.34
JNKVV, Gwalior	Deep freezer	1.00	1	1.00
CSKHPKV	Centrifuge	1.00	1	1.00
MAU, CSKHPKV	Distillation set	1.00	2	2.00
UAS (D), MAU, IGKV, RAU(P), NDUAT	Rotary evaporator	0.20	5	1.00
JNKV, CSKHPKV	Orbital Shaker	0.75	2	1.50
			Total	**128.67**

The QRT found that the Directorate had enough infrastructral facilities like research laboratories, farm, irrigation systems, water harvesting ponds, composting yard, net-house, workshop, equipments both scientific research and administration, library, information centre and phytoremedaition facilities. However, there is a need to provide an additional wing in the DWSR building, covered threshing floor, modern farm machineries, training hostel, guest house, mobile field laboratory, and Technology Park.

The Directorate had on need-base upgraded GC, HPLC, computers, replacement of vehicles, upgraded and modernized the laboratories and infrastructure, and promptly disposed off condemned articles, thereby ensuring efficient utilization of the laboratory space.

C. Financial resources

Budget and Expenditure Statement of DWSR (2005-06 to 2011-12)

Plan **(Rs lakh)**

Sl	Heads	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
A	**Recurring**							
1	Pay & allowances	13.00	13.73	16.00	76.00	34.72	30.00	30.00
2	TA	2.00	2.99	3.00	3.00	2.62	2.00	3.39
3	HRD	1.00	2.00	2.88	1.99	2.93	1.85	2.98
4	Research contingenies	114.76	34.99	123.12	123.80	93.92	49.76	15.00
5	Tribal Sub-plan	-	-	-	-	-	-	4.25
	Total (A)	130.76	53.71	145.00	204.79	134.19	83.61	55.62
B	**Non-Recurring**							
1	Equipments	38.69	2.87	24.54	72.72	155.01	14.35	9.84
2	Works	24.97	63.61	-	14.07	3.84	35.42	0.00
3	Library	5.54	1.29	14.45	8.33	6.87	6.00	1.33
4	Land	-	-	-	-	-	-	-
5	Vehicles	-	-	-	-	-	-	-
6	Livestock	-	-	-	-	-	-	-
7	Other (Specify)			-	-	-	-	-
	Total (B)	69.2	67.77	38.99	95.12	165.72	55.71	11.17
	Grand Total (A+B)	199.95	121.48	183.99	299.91	299.91	139.32	66.79

Non-Plan

Sl.	Heads	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
A	**Recurring**							
1	Establishment charges	125.73	135.10	144.68	189.41	342.45	334.44	389.37
2	OTA	0.05	0.10					
3	TA	1.60	1.01	1.98	2.29	1.47	1.98	2.97
4	Contingencies (Labour wages) including other charges	38.99	102.77	102.89	114.87	130.42	227.54	192.46
5	Matching grant	21.00						
	Sub-Total (A)			**249.55**	**305.60**	**474.24**	**563.96**	**584.80**
B	**Non-Recurring**							
1	Works							-
	a) Maintenance of office building	1.65	1.46	4.79	4.93	1.88	15.72	-
	b) Maintenance of residential building	1.00	1.49	3.78	2.95	2.42	2.34	-
	C) Petty works	-	-	3.72	0.89	0.94	0.99	-
	Sub-total (B)		-	12.29	8.77	5.24	19.05	-
	Total (A+B)	**189.97**	**241.83**	**261.84**	**315.97**	**479.62**	**583.01**	**584.80**

b. Budget and Expenditure Statement of AICRP-WC (2005-06 to 2011-12)

	Expenditure (Rs lakh)						
Head	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**
Pay	265.02	145.47	563.08	408.7	433.77	328.99	674.50
TA	5.51	5.51	13.16	12.23	11.64	13.14	14.00
Recurring contingencies	50.27	45.87	59.56	50.12	62.77	50.38	21.78
IT	5.50	4.40	10.23	13.76	11.05	7.37	7.57
TSP	-	-	-	-	-	-	36.42
VI Pay Commisson backlog	-	-	-	-	-	-	615.89
Equipments	6.70	-	3.49	125.18	-	-	-
Vehicle	30.00	-	-	-	-	-	-
Total	**363.00**	**201.25**	**649.52**	**609.99**	**519.23**	**399.88**	**1370.16**

The QRT examined the expenditure details of the Directorate during the XI plan period and observed the following:

DWSR

Considering the relative expenditure during the preceding years (2005-06 to 2011-12), it was observed that a reasonable allocation and its subsequent expenditure have been made, indicating efficient financial management. For example, the salary component was 38 per cent, contingencies 39 per cent, equipments 14 per cent and works 6 per cent of the total Plan and Non-Plan budget (Rs. 33.16 crores). It also indicates that the Directorate made a sound financial plan for the XI Plan period.

AICRP-WC

In contrast to the DWSR, it was observed that the salary component was 78 per cent in AICRP-WC, only 12 per cent for contingencies, and 6 per cent for equipments. The QRT feels concerned about the insufficient allocation of funds under recurring contingencies. Conducting different trials both in the laboratory and fields including farmer's fields, sufficient budget is required, and insufficient allocation is bound to affect the performance of the centres. The QRT strongly recommends that the recurring contingencies should be substantially increased. The allocation under TA also has to be increased to enable the scientists to conduct the mandated field experiments and demonstrations.

The QRT observed that there was a fair amount of delegation of responsibilities at the Directorate. The action taken and compliance of recommendations made by the IRC and RAC was examined, and it was found that most of the recommendations have been implemented.

With reference to AICRP-WC, the QRT has observed the following:

i. Growth of manpower and cooperating centres

   a. There has been some improvement in filling-up of vacant posts at the centres. Out of 72 posts of the scientists, 68 were filled.

   b. It was heartening to note that 5 voluntary centres have been added to the AICRP-WC.

ii. Evaluation of achievements of AICRP-WC

a. The QRT found the achievements to be relevant to the national programme.

b. There were several multi-location experiments in a coordinating manner.

c. It was observed that in none of the experiments, secondary data on the impact of herbicide application on pests, diseases and the natural enemies were generated. Therefore, the Coordinator should take this point into account in future experiments.

iii. There appears to be reasonable amount of exchange of scientific information amongst the centres.

iv. Inter-institutional and inter-disciplinary linkages should be strengthened.

v. Strategic plans were in place for solving the problems of the herbicide resistance in *Phalaris minor* and weed shift in rice-wheat cropping system.

vi. In the context of globalization and increased threat due to alien invasive weed species, it is crucial that the international linkages are established.

vii. Information on technology base is in place. However, there is need to update the base in the context of international developments.

viii. Encouragement by the Project Coordinator to centres: It was found that the centres received adequate recognition in the form of awards for best annual report and best performing centre at the time of biennial workshop which facilitated healthy competition amongst the centres.

ix. Quality of recommendations: The recommendations of group meeting / workshop were found to be appropriate. However, there is scope for more serious compliance on part of centres.

x. The work on herbicide resistance in *Phalaris minor* was innovative in developing management strategies. Majority of research efforts were on evaluation of herbicides; however, the AICRP could develop contingency plan with reference to emerging weeds consequent to weed shift.

xi. In addition to mandatory experiments, the QRT found individual initiative in the following centres:

a. AAU, Jorhat: The work on taxanomy of weeds was a new initiative, and developed high quality documentation on ‘Keys for weed seed identification’.

b. The scientists at OUAT, Bhubaneswar and VB, Sriniketan took special interest in transfer of technology programme for a large number of farmers.

IX. Planning for the future

One of the breakthroughs in agricultural research that is now visible across the country is an unambiguous impact of herbicides in economic management of weeds in farmers’ fields. This situation is a result of 5 decades of research on weed management done jointly by the ICAR-SAU combine. The NARES should utilise this opportunity and turn it into a workable Mission Mode Programme in XII Five Year Plan. Reasons for the above forward thinking are obvious:

- A wealth of highly valuable research data are available with resulting useful economic technology ready to use.
- Farmers are convinced and ready to use the improved weed management technology developed by agricultural scientists.
- A number of these recently-evolved herbicides are more effective, economical and safe to use. Low-dose, high-potency herbicides are revolutionizing the achievements of herbicide industry. However, timely availability and appropriate application methodology of these herbicides needs to be ensured for greater adoption on the farmers' fields.

Following facts that emerged during the nation-wide exercise conducted by the QRT during 2011-12 are worth considering while formulating any policy programme for weed management at national level:

- Sharp rise in manual labour cost and their non-availability in rural India has made manual weeding in crop fields unaffordable. Labourers in many parts of the country are not available even at Rs. 300 a day.
- This along with efficient, effective and much safer herbicides available in the market has encouraged farmers all over the country to use herbicides for managing weeds at economic level.
- Scarcity of labour in rural progressive areas has compelled farmers to use mechanical transplanter in place of manual planting of rice. This resulted in better crop stand and an advantageous crop-weed competition compared to wide and irregularly spaced contract manual transplanting. While manual transplanting costs about Rs 2,500 per acre, mechanical cost is half at Rs. 1200 per acre only.
- Because of the efficient and high-potency herbicides, the volume to be used per unit area will decline, but increasing number of farmers are opting herbicides for weed management.
- Weeds are to be recognised as a foremost pest not only in damaging crops but also for harbouring insect-pests and crop diseases. Some of the weeds like *Parthenium* work as a medium in causing human diseases and discomfort. In addition, weeds compete with crop plants for plant nutrients, water and light.
- Herbicide-tolerant crops are an important component of eco-friendly management of weeds combined with conservation agriculture. Crop species engineered for tolerance to eco-friendly herbicides appeared on the scene in 1995. Since then, HTCs have become an important part of global transgenic (GM) crop cultivation. Out of 160 million ha of GM crops cultivated in 2011, HT crops (maize, soybean cotton, canola, sugarbeet) occupied 60% of the area. Development of HT crops, especially, cereals such as rice and wheat, are extremely important in current scenario where availability of manpower has become very difficult. In addition, practice of no-tillage agriculture, SRI mode of cultivation and eco-friendly weed management should go hand in hand to conserve natural resources, particularly water and nutrients. Herbicide tolerant crop varieties need to be evolved for different agro-climatic regions in the country. This will require a reformed plant breading policy and the plant breeders will have to be convinced to work on this on priority basis.
- Research on management of herbicide resistance needs to be expedited by properly trained lab and field scientists at DWSR and SAUs.
- Climate change and its impact on weed management research should be given priority.

- For a systematic work of weed management, it is necessary to start 'Weed Seed Banks' at the DWSR and AICRP-WC centres.
- Increased attention on weed management is needed in drier and rainfed areas to save precious and scarce soil water.
- Emphasis is required on social aspects like women role in weed management, safety measures at all levels, and human and animal health concerns.
- Weed management research should be an integral part of overall integrated crop management research and not a separate entity.
- Work should be initiated on biodegradable herbicides and sustainable management of weeds in field and horticultural crops.
- Problem weeds like *Orobanche, Cuscuta, Parthenium* and few others need a special attention.
- Research work on utilization of weeds for medicines and other organic driven chemicals needs to be initiated.
- Special care is required to monitor the quality of field research, where at times simple research norms like standard statistical procedures, fertility gradients in field, normal crop stand and keeping of 'standard check' or 'control' treatments are ignored. This also includes maintenance of field data records and timely recording of data. Regular training of scientists can help improve the situation.
- A workshop on proper presentation of research reports will be useful.

In view of the above considerations, there is an urgent need to identify and prioritize the research programmes on weed management.

The current research programme is fragmented with large number of research projects. In order to bring clear output and outcome through inter-disciplinary approach, it is recommended that DWSR may reorient its research activities by developing a few meaningful research programmes with involvement of relevant disciplines with necessary sub-projects. The following major research programmes are suggested for implementation:

I. Sustainable weed management strategies in diversified cropping systems

i. System-based approach to weed management, with emphasis on dryland / rainfed, hilly ecosystems, horticultural and plantation crops-based systems, and organic farming in high-value crops.

ii. Weed management and C-sequestration potential under long-term conservation agriculture systems.

iii. Improving efficiency of chemical weed control along with other production factors (soil type, moisture status, nutrient use, varieties, etc.)

iv. Standardization of spraying techniques, and mechanical tools including power weeders and sprayers

v. Use of remote sensing techniques for weed incidence / intensity studies, and development of spectral signatures of weeds in precision farming systems

vi. Development of herbicide-tolerant transgenic elite rice varieties

II. Weed management under the regime of climate change and herbicide resistance

i. Effect of climate change on crop-weed interactions, herbicide efficacy, secondary metabolites, and bioagents

ii. Physiological and molecular basis of herbicide resistance development in weeds, and evaluation of herbicide-tolerant crops

iii. Weed risk analysis and development of weed seed standards

III. Management of problem weeds in cropped and non-cropped areas

Identifying weeds of national / state importance, and studying their detailed ecology and management through biological, chemical and mechanical means

i. Parasitic weeds: *Orobanche, Striga* and *Cuscuta*

ii. Aquatic weeds: *Eichhornia*, *Alternanthera philoxeroides* and *Hydrilla*

iii. Crop weeds: *Phalaris*, *Echinochloa*, *Cyperus*, weedy rice

iv. Non-crop land weeds: *Parthenium*, *Lantana*, *Ageratum*, *Mikania*, *Chromolaena*

IV. Environmental impact of herbicides

i. Monitoring of herbicide residues in soil, water, plants, grain, straw/ fodder, and effects on non-target organisms on a long-term basis;

ii. Decontamination techniques for herbicides/ secondary metabolites contaminated soil and water

V. Transfer of technology and impact assessment

i. Large-scale demonstrations on integrated weed management on farmers' fields in disadvantaged / tribal areas, and impact analysis

ii. Regular training programmes on advanced techniques in weed management

D. OVERALL ASSESSMENT

DWSR

QRT found that DWSR has really grown during the past 6 years in terms of aquisition of infrastructure, well-focused research efforts leading to useful research output (basic and applied), and coordination of weed management research in the country.Therefore, the QRT rates its performance as 'very good'.

Keeping in view the necessity to enhance the performance of the Directorate to a higher level to meet the emerging needs of weed management in the country, the QRT has finalized the recommendations as given in section E.

AICRP-Weed Control

The QRT reviewed the work done by AICRP-WC centres and rated their performance based on research output, impact, timely utilization of funds and submission of different reports and queries from the HQ. The rating given below has also taken into the consideration the comments of QRT on the research achievements as mentioned in the pages 6-32.

Rating	AICRP-WC Coordinating Centres
A (Very Good)	PAU, Ludhiana; CCSHAU, Hisar; CSHPKV, Palampur; GBPUAT, Pantnagar; TNAU,Coimbatore; UAS Bengaluru; AAU Anand; ANGRAU, Hyderabad
B (Good)	KAU, Thrissur; NDUAT, Faizabad; AAU Jorhat; VB, Sriniketan; OUAT, Bhubaneswar; IGKV, Raipur; RAU, Pusa
C (Average)	RVSKV, Gwalior; DBSKV, Dapoli; BAU, Ranchi
D (Below Average)	RAU, Bikaner; CSAUAT, Kanpur; MAU, Parbhani; UAS, Dharwad

It is recommended that the centre at RAU, Bikaner may be shifted to MPUAT, Udaipur since the performance of the centre has been assessed as 'below average' by the present QRT. The new centre will focus on weed management in different agro-ecological zones of Rajasthan. Similarly, the performance of the centre at CSAUAT, Kanpur has also been poor consistently for the last 10 years, during the present as well as the previous QRT. It is recommended that this centre may be shifted to CAU, Pasighat with the mandate to develop weed management technologies in hill ecosystems of NEH region. These two centres (Bikaner and Kanpur) have not responded positively inspite of repeated alerts.

The present QRT has found the performance of the centre at UAS, Dharwad to be 'Below average'; and hence, it is recommended that it can be shifted to UAS, Raichur.The centre at MAU, Parbhani (MH) with four scientists also deserves closure being 'Below average'; and hence, it is recommended that this may be closed and staff redeployed as follows:

i. New centre to be created at PDKV, Akola (MH) with two scientists (Agronomist and Jr. microbiologist) and two technical staff.

ii. Strengthening existing centres at Hisar and Hyderabad, with one Jr. Microbiologist at each centre.

E. CONSOLIDATED RECOMMENDATIONS OF QRT

Major recommendations of QRT after reviewing the work done by DWSR and AICRP-Weed Control during 2006- March, 2012 are as follows:

DWSR

Administrative

1. All vacant posts under scientific, administration and finance categories need to be filled immediately for smooth functioning.

Research

1. Reorganization of the research projects into programme mode with multi-disciplinary approach. In these programmes, there should be greater emphasis on stakeholder's participation from beginning to the end. The proposed programmes are as follows:

    i. Sustainable weed management strategies in diversified cropping systems
    ii. Weed management under the regime of climate change and herbicide resistance
    iii. Management of problem weeds in crop and non-cropped areas
    iv. Environmental impact of herbicides
    v. Transfer of technology and impact assessment

2. DWSR needs to lay emphasis on basic and strategic research on weed management taking into consideration the weed shift in the context of climate change. Some potential areas are:
    i. Development of weed competitive crop plants
    ii. Development of cost-effective and biodegradable organic herbicides (Corn gluten based organic weed killers, vinegar–based herbicides like Burnout II etc.). Products suitable for organic farming would be useful.
    iii. Long-term studies on the safety of chemical herbicides on non-target species. Study the metabolic and environmental transformation products, terminal residues (including bound and conjugated residues), human and environment toxicology of transformation products and allied aspects.
    iv. Weed utilization to improve the livelihood of farmers. Profiles of major weeds in terms of nutrient (for human, animal and plant), medicinal, manurial (including green manure), toxicological, pest harboring ability, efficacy as mulch, biofuel production capacity and efficiency and other beneficial uses may be developed to identify the domains where these plants can find remunerative outlets. This will help in improving the livelihood of farming community of small and marginal farmers.
    v. Workout the biochemical basis of resistance/ cross resistance in *Phalaris minor* to herbicides;
    vi. Impact of climate change on the weed shift and degradation of herbicides in different matrices
    vii. Studies on weed molecular biology relating to characterization of weedy rice.

viii. Anticipatory action for management of potential invasive weeds including weed risk analysis may be taken up for timely action.

ix. Development of precise application technology for new generation ultra low-dose high potency herbicides.

x. A review of work on submerged and aquatic weeds is required for strategical planning. Last five years work on this subject has not yielded desired results.

3. To promote eco-friendly weed management, there is a need to develop a balanced research programme focusing on sustainable chemical and non-chemical management practices. Cultural, biological and mechanical methods of weed control need to be incorporated in developing weed management strategies. To strengthen this, IWM models for crops and cropping systems region-wise need to be developed.

4. A proper strategy for the management of weeds in various aquatic bodies adopting eco-friendly approaches is essential. For alien invasives, co-evolved biological control agents may be considered. For management of *Mikania micrantha, the* rust sp. *Puccinia spegazinnii* with broader genetic base should be considered. Similarly for *Parthenium*, the seed weevil and other agents like *Carmenta* moth may be imported. *Heteropsylla spinulosa* may be imported for the management of *Mimosa diplostricha*. For quarantine requirement, the state-of-the-art facility at NBAII may be utilized. Cost-effective mechanical methods may also be developed coupled with weed biomass utilization.

5. A document outlining the state-of-art information on the effect of herbicide tolerant GM crops on the management of key weeds affecting the crop in reference needs to be developed.

6. It may be desirable that the Directorate/ Coordinator Cell develop a standard protocol for release of weed management practices to farmers rather than each centre following its own protocol. This will strengthen safer and more scientific weed management at the national level.

7. Weed management recommendations should be incorporated in all OFTs and FLDs in farmer's fields. Economic analysis of technologies should be worked out at OFT and FLD level.

8. Carefully identified up-scalable success stories on weed management technologies should be documented and appropriately disseminated. For example:

i. management of herbicide resistance in *Phalaris minor*

ii. post-emergence herbicides in direct-seeded rice, pulses

iii. integrated management of *Striga* in sugarcane

iv. developing and evaluating the efficiency of mechanical weeding tools like cycle wheel-hoe and power-operated weeding tools and implements particularly for reducing the human and animal drudgery should become a part of network programme at all the coordinating centres.

9. The research work at DWSR and AICRP-Weed Control needs to be prioritized. Projects of national importance with high perception should get priority. All basic research programmes should have direct relevance to solving the weed problems at farm level.

10. Transform the residue unit of DWSR into a duly Accredited National Referral Unit on herbicides with mandate to:
    i. develop, verify and modify analytical methods for uniform adoption by various laboratories
    ii. ensure accuracy and precision of analysis at various centres of AICRP
    iii. overview the results generated by various laboratories for their reliability
    iv. establish/ ensure compliance to MRLs on edible crops and commodities
    v. develop guidelines on herbicide safety in environment, and
    vi. develop decontamination technologies in different substrates.

    For this purpose, it must be adequately staffed, equipped and provided with requisite infrastructure in a time-bound schedule. To ensure that capability to handle the upgraded facilities, if not existing, is developed over time, linkage with the nearby chemistry strongholds on mutually beneficial terms is suggested.

11. Monitoring of residues in different matrices (environment, food, feed, fibre etc.) needs to be planned meticulously. These results need to be made available to public for safety through appropriate authority.

12. While investigating the effect of climate change on weed shift, sight may not be lost of the possible effect of climate change on the fate of herbicides in environment. It is of particular significance when the residue data generated on a chemical several years back is relied upon in decision making.

13. There is a need to establish weed management data repository and develop effective Management Information System (MIS) at DWSR. A systematic compilation, retrieval and utilization cross country multi-year data of technology generating system is a pre-requisite for future strategy.

14. QRT observed that information on impact of weed management technologies is scanty. Impact assessment needs to be undertaken by using suitable indicators and the analytical tools at district/ block levels through competent independent agencies. Socio-economic impact of weed management technologies needs to be properly analyzed and such information can be disseminated.

15. Scientists should be encouraged to publish quality research papers in reputed journals.

Infrastructure

1 DWSR should utilize the KVK platform for disseminating weed management technology.

2 Provision for a training hostel may be made in XII plan.

Collaboration and linkages

1. In view of increased risk due to alien invasive weeds from neighboring countries, effective linkages for management should be established with institutions of other countries and international organizations involved in weed management research.

2. DWSR should become a partner with IARI and other national laboratories in development of new indigenous herbicide molecules.

3. QRT observed that there is a need to strengthen the collaboration with different stakeholder agencies like other AICRPs, SAUs, KVKs, ICAR institutes, State Department of Agriculture, DAC (GOI), herbicide industry and Civil Society Organizations (CSOs) for effective dissemination and adoption of weed management technologies. A suitable mechanism should be in place for ensuring feedback on the collaborative agencies for making technology transfer.

4. Innovative institutional framework may be created for effective scale-up strategy. The feed-back and farmer-scientist-policy maker interface for technology refinement and up-gradation are needed. The pathway of technology roll-out in collaboration with stakeholders may be appropriately identified and adapted across various agro-ecological systems and diverse socio-economic set up.

Human Resource Development (HRD)

1. Capacity building of scientists in new emerging areas like climate change, herbicide resistance, conservation agricultural practices, crop modeling, precision farming, GIS, bioinformatics, MIS should be undertaken.

2. DWSR may take up students research guidance activity in approved institutions.

AICRP-Weed Control

Administrative

1. Centre-wise recommendations of the QRT must be communicated to different centres of AICRP on weeds after approval by the Council without any delay.

2. The scientific and other posts lying vacant at centres should be filled without further delay.

3. Frequent shifting of scientists in the AICRP should be stopped as this adversely affects the continuity and performance of the centre.

4. A post of Jr. Agronomist (Weed Science) may be included at all the coordinating centres.

5. The recurring contingency may be enhanced from Rs 80,000 to Rs 2.5 lakhs/scientist/year. Financial discipline by coordinating centres has to be followed.

6. Adequate contingency for hiring vehicles may be proposed in the XII Plan EFC proposal.

Research and related issues

1. Based on surveillance data, each coordinating centre may identify at least five emerging weeds which are likely to become major problem in the next five years and work out their management strategies.

2. Greater emphasis may be laid on weed management in plantations, orchards, vegetables, floriculture and other horticultural crops at the relevant centres.

3. IWM packages need to be spelt out clearly for different crops and cropping systems region-wise.

4. It has been observed that most of the results of experiments on persistence, environmental distribution and contamination, safety and allied aspects relating to herbicides are interpreted based on qualitative data generated by bioassay method. It is, therefore, recommended that centres which are already equipped with Gas Liquid Chromatograph (GLC) or High Performance Liquid Chromatograph (HPLC) (Category 1, *Annexure-III*) should be strengthened by providing GC-MS/ LC-MS, either as independent units or MS units compatible with the existing Chromatographs. The centres lacking GC/ LC at present (Category-2 *Annexure-III*) be provided these equipments.

5. Coordinating centres must not deviate from the methodology / technical programme approved by the PC unit.

6. Analysis of weed survey data in respect to weed shift should be compiled over the years/ decades and inferences drawn by the coordinating centres.

7. In states with higher tribal population and hill regions like North Eastern Hills region, Chhattisgarh, Odisha, Jharkhand, Himachal Pradesh and Uttarakhand, weed management has all together a different social dimension. Weeding is mostly done for fodder purposes in these regions. Besides studying the economics of weeding, social factors for weeding and characterization of weed problems may also be taken up. Sustainability of weeding *vis-a-vis* no weeding, and weeding only for fodder in tribal and hill region may be studied with proper reasoning.The role of weed management practices on biodiversity of flora and fauna may also be studied.

8. OFTs / FLDs must be conducted before passing on weed management recommendations to farmers. Technology demonstrations should be based on validated results coming out of OFTs and FLDs.

9. Participatory research for developing weed management technologies should be adopted.

10. The details of the farmers' practices as mentioned in technical programme need to be specified.

11. Awareness amongst the farmers needs to be created for utilizing ICTs.

12. The committee has suggested impact analysis of weed management technologies released to the farmers (format given *in Annexure-V*). The same should be followed by AICRP-WC centres.

13. Scientists should publish research papers only in NAAS rated journals.

Collaboration and linkages

1. Scientists of the coordinating centres should collaborate with relevant disciplines like entomology, pathology, economics, agricultural engineering and others within the SAUs / NARS, which is found lacking.

Human Resource Development

1. Capacity building of scientists in new emerging areas like climate change, herbicide resistance, conservation agricultural practices, residue analysis, GIS should be undertaken on a periodic basis.

F. LIST OF ANNEXURES

Annexure- I

Meeting with stakeholders

1. On 6th Sep 2011 QRT visited Padariya village around 12 km from DWSR at Jabalpur and interacted with farmers regarding the problem of weeds, their management, availability of inputs, and role of DWSR etc. Farmers narrated their problems like labour unavailability due to higher wages in NAREGA, higher cost of herbicides, infestation of *Echinochloa colona* in DSR, *Phalaris minor* in wheat etc., and appreciated the role of DWSR for advice on weed management in their crops.

2. The QRT on 21-09-2011 visited farmer's fields near Pantnagar, Uttarakhand and a *Kishan Goshti* wherein a large number of farmers, agricultural department officials, pesticide dealers were present. The progressive farmers of the area were very much aware of the losses caused due to weeds and were applying latest herbicides in their crops. However, they reported poor efficacy of some of the herbicide formulations.

3. On 11-10-2011 the QRT visited a village Birgawan-Bhitarwar near Gwalior and participated in farmer-scientist/ State Agriculture Department officials' interaction. The farmers demanded regular visits of weed management specialist and release of Mexican beetles in their area.

4. The QRT visited the farmers' fields on 29-12-2011 in Mandya district in Karnataka and appreciated the use of mechanical transplanters by rice farmers which facilitated effective weed management. *Echinochloa glabrescence* was the major weed; however, it is being fed to cattle. Farmers were using londax @ 4 kg/ac in rice for weed control. Farmers informed that herbicide use per acre costs Rs 1000 in comparison to Rs 3000 being spent on manual weeding.

   QRT visited National Bureau of Agriculturally important Insects (NBAII) at Bengaluru, and saw the biological control unit for management of papaya mealy bug. While interacting with Director, it was suggested to work out more collaborative programmes with DWSR.

   A meeting with herbicide industry personnel was held on 01-12-2011 at UAS, Bengaluru, wherein leading herbicide companies i.e. Bayer, FMC, Indofil, Syngenta, Monsanto etc. participated. The QRT viewed that herbicide industry and ICAR need to work as equal partners in research and development of new herbicides. A serious partenership is required among ICAR institutes, SAUs and herbicide industry. The Chairman urged the herbicide industry to play a more proactive role in research and development to meet the challenges under changing weed scenario. Emphasis was also given on appropriate spray techniques at farmers' fields. Safety aspects of herbicide application, developing protective clothing suiting to Indian climate were also discussed.

   Agricultural officers from state department urged for more training to extension officers and farmers on herbicide use.

   QRT also visited Monsanto Research Centre and interacted with the Director. QRT was informed about the new HTCs in cotton, soybean and maize under pipeline.

5. An interactive meet with farmers, district agricultural officers, ICAR institutes was held at OUAT, Bhubaneswar on 11-01-2012. DAO, Angul informed that subsidy is being given on herbicides from govt. outlets. QRT was informed that large-scale use under Hirakud command area is taking place.

   Two farmers also spoke in the meeting and narrated their experience on use and benefits of oxyfluorfen in groundnut.

   QRT appreciated the efforts of Bhubaneswar and Sriniketan centres in extension work through effective linkages with other departments.

   A visit to farmers' fields at Mangalpur in Puri district, Odisha was made where a group of farmers, DAO, KVK officials, herbicide industry representatives interacted with the QRT. The problem of weeds being transported through irrigation water was reported. Sprayers were available on hire and also on subsidy, but safety measures were not being followed by the farmers.

6. An interactive meet of farmers, officials from KVK, herbicide industry, DAATT Centres was held on 02-02-2012 at Hyderabad. It was informed that ANGRAU is coordinating with KVK and DAATT centres for transfer of technology. On the issue of spurious herbicides, it was informed that the problem in the state is only 5-10%. Farmers informed that at present cultivation without herbicides is not possible. Site for *Orobanche* infestation in tomato, demonstration on management of weeds in drum-seeded rice were also shown to the QRT.

Annexure-II

Directorate of Weed Science Research
Jabalpur

Proceedings of the XXI Meeting of Institute Management Committee (IMC) held on 30th June, 2012 at DWSR, Jabalpur

The following were present:

1. Dr. A.R. Sharma, Director, DWSR & Chairman
2. Dr. A.K Vyas, Head, Division of Agronomy, IARI, New Delhi & Member
3. Er. S.S. Shrimali, Senior Scientist, CSWCRTI, Dehradun & Member
4. Dr. S.D. Upadhyay, Professor & Head, Department of Forestry, JNKVV, Jabalpur & Member
5. Dr. K.K. Barman, Senior Scientist, DWSR & Member
6. Sh. Wajyoddin, Administrative Officer, DWSR & Member Secretary

7. Dr. S.C. Modgal, Chairman, QRT, DWSR and AICRP-WC, Special Invitee
8. Sh. Prashant Kumar, Senior FAO, CIAE, Bhopal & Special Invitee
9. Dr. Anil Dixit, Principal Scientist and I/C Asstt. FAO, DWSR, & Special Invitee
10. Dr. R.P. Dubey, Senior Scientist and I/C AICRP-WC, DWSR & Special Invitee

Besides the above, the following Programme Leaders of the research programmes at DWSR, Jabalpur also attended the forenoon sessions:

1. Dr. V.P. Singh, Principal Scientist (Agronomy), and Leader of Programme 1
2. Dr. D.K. Pandey, Principal Scientist (Plant Physiology) and Leader of Programme 2
3. Dr. Shobha Sondhia, Senior Scientist (Residue Chemistry) and Leader of Programme 3
4. Dr. Sushilkumar, Principal Scientist (Entomology) and Leader of Programme 4
5. Dr. P.K. Singh, Principal Scientist (Agricultural Extension) and Leader of Programme 5

Dr. J.C. Dagar Asstt. Director General (Agronomy & Agroforestry), ICAR; Dr. Prem Kishore, Chief Editor, Crop Care Ltd.; and Dr. Dev Raj Arya, Technology Development Head, Monsonto India Ltd. were not present in the meeting due to their other preoccupations.

At the outset, Mr. Wajyoddin, Administrative Officer, DWSR and Member Secretary, IMC welcomed the Chairman QRT, Chairman IMC, and members and special invitees for the IMC meeting. Thereafter, Dr. A.R. Sharma, Director, DWSR & Chairman IMC apprised the participants of the agenda items for this meeting. He informed that this meeting was being held after a gap of nearly three years, and this was the first meeting of the newly-constituted IMC. He made a brief presentation on the DWSR – historical background, mandate, infrastructure, staff strength, research projects undertaken and new research programmes. He also informed that Dr. Sushilkumar, Principal Scientist (Entomology) has bagged the prestigious Swami Sahajanand Saraswati Outstanding Extension Scientist Award of the ICAR for the year 2011. All the participants in the meeting appreciated the contributions made by Dr. Sushilkumar and congratulated him for the recognition conferred on him as well as on the Directorate.

1

The agenda items were taken-up as follows:

(A) Action Taken Report on recommendations of XX IMC meeting

Dr. Anil Dixit, Principal Scientist, DWSR and Incharge Asstt. FAO presented the Action Taken Report (ATR) on the recommendations of the XX IMC meeting held on 15.9.2009. It was mentioned that the Council granted approval to the procurement of LCMS as decided in the meeting, but did not approve other proposals. It was informed that CPWD has not undertaken the work on road construction at the DWSR farm, although an amount of Rs. 25 lakhs was deposited in 2009-10. It was suggested that the matter may be taken up with the higher officials of the CPWD, and the possibility of undertaking the work through other public sector undertakings or private agencies may also be explored. It was decided that the matter be pursued vigorously as enough time has elapsed since the money was deposited.

(B) Presentation of QRT report

Dr. S.C. Modgal, Chairman, QRT and special invitee to the IMC meeting informed that the QRT has undertaken an exhaustive exercise to review the functioning of the DWSR and AICRP-WC centers during the period from 2006-2011. He mentioned that the draft of the QRT report has been prepared with inputs from all concerned, and appreciated the contributions made by other members of the team, viz. Dr. B.S. Parmar, Dr. R.J. Rabindra, Dr. B.C. Barah and Dr. M.K. Porwal. He also praised the work done by Dr. R.P. Dubey as Member Secretary of the QRT. Dr. Dubey presented the major highlights of the activities undertaken by the QRT over the last one year, including the consolidated recommendations under administrative, research, infrastructure, collaboration and linkages, and human resource development in respect of DWSR and AICRP-WC.

The members appreciated the efforts made by the QRT and the comprehensive recommendations made all aspects. Chairman, IMC informed that he also participated in the last two meetings of the QRT, and many recommendations of the QRT including reorganization of the research projects into programme mode, multi-disciplinary research projects, collaboration with other institutions, transfer of technology, students guidance etc. have already been implemented. Similarly, many recommendations for the AICRP-WC centers have also been considered while formulating the network technical programme for 2012-13, and communicated to the AICRP-WC centers. Recently, a two-day training programme on weed management was undertaken at Zonal Project Directorate, Jabalpur involving scientists and Subject Matter Specialists of the KVKs of three states, viz. Madhya Pradesh, Orissa and Chhattisgarh.

The Chairman, QRT suggested that weed problems of tribal areas and biodiversity aspects should also be considered in the QRT report. It was suggested that a mechanism for effective implementation of recommendations on weed management emanating from AICRP-WC centers and DWSR should be taken up with help of state government. Dr. R.P. Dubey mentioned that such a mechanism already exists and the scientists of the AICRP-WC centers regularly participate in the meetings with State Department of Agriculture. However, such collaborations should be further expanded and strengthened. Most members were of the opinion that the extension machinery under the state government was not functioning efficiently for dissemination of technologies. Chairman, IMC informed about the steps taken by the DWSR for dissemination of weed management technologies from the current season.

After thorough discussion, the QRT report was adopted by the IMC.

(C) Presentation of salient research achievements and future research programmes

Five Programme Leaders, viz. Dr. V.P. Singh, Dr. D.K. Pandey, Dr. Shobha Sondhia, Dr. Sushilkumar and Dr. P.K. Singh presented the salient research achievements of 2011-12, and the newly-identified

major research programme as per the recommendations of QRT, SMD meetings at the ICAR and inhouse discussions at DWSR. The IMC appreciated the efforts made by the DWSR scientists for generating quality output, and formulating focused research programmes for the XI Plan.

In the afternoon sessions, the members of the IMC and special invitees discussed the various issues as per the agenda, and decisions were taken as follows:

(D) Budget allocation and Utilization

Details of budget allocation and utilization under Plan and Non-Plan of DWSR and AICRP-WC centers for the years 2009-10, 2010-11 and 2011-12 were presented before the IMC. The members appreciated the effective utilization of funds under different heads.

(E) Outstanding Audit Paras

The outstanding audit paras for the years 2003-04, 2004-05, and for 2010-11 were presented before the IMC. The issues were discussed in detail, and it was informed that the audit paras for the years 2003-04 and 2004-05 were under consideration of the Council. Similarly, most of the audit paras for the year 2010-11 are also being examined through a special inquiry committee constituted by the Council. It was decided that the observations of the External Audit must be complied with, and the explanations submitted by the former Director, DWSR may be submitted to the Audit for information and further necessary action.

(F) Review of status of approved and proposed works to be undertaken

It was informed that several works approved in the XI Plan EFC could not be taken up during the plan period. Out of these, the following works were identified and presented before the IMC for undertaking during the year 2012-13:

Particulars of works (as mentioned in XI Plan EFC)	Approved amount (Rs. in lakhs) (As per XI Plan EFC)	Preliminary estimate as per CPWD (Rs. in lakhs)	Current tentative cost (Rs. in lakhs)
1. Side wing of office building	150.0	426.18	500.00
2. Development of area adjoining Director's residence (boundary wall, garden, water body etc.)	15.00	-	20.00
3. Residential quarters (Type II (2 nos.) and Type III (2 nos.), and remaining work of type V quarter	62.00	74.21	120.00
4. Farm development (making of bunds, RCC roads with 9.5 km long including electrification)	30.00	-	60.00
Total			**700.00**

The IMC considered and examined each item of work critically. The proposed works as mentioned above were recommended along with the current tentative cost for execution during 2012-13.

(G) Proposal for procurement of equipments / farm implements

It was informed that several equipments approved during the XI Plan could not be procured during the plan period. Out of these, the following equipments were identified and proposed for procurement during 2012-13. It was pointed out that a tractor of 25-30 HP was approved in the XI Plan EFC, but now a tractor of higher capacity (55-60 HP) was required for use with Laser Leveller and Front loader.

Equipment	Number	Approved amoint as per XI Plan EFC (Rs. In lakhs)	Current tentative cost (Rs. In lakhs)
1. Tractor 55-60 HP capacity (instead of 25-30 HP)	1	3.00	7.00
2. Laser leveller	1	2.50	5.00
3. Tractor front loader	1	2.80	5.00
4. Osmometer	1	2.00	3.00
5. Multi-parameter water purifier	1	3.50	9.00
Total		**13.80**	**29.00**

The IMC examined the requirement of each equipments and recommended that the above equipments mentioned in order of priority should be procured.

(b) New equipments proposed to be procured during 2012-13

Chairman IMC informed that as per the decision taken in SMD meetings at ICAR, the experimental farms of the Institute should be mechanized and modernized. Accordingly, latest farm machinery should be procured for reducing the cost of cultivation and improving efficiency. The following equipments were proposed for procurement during 2012-13:

Equipment	Justification	Approx. cost Rs. in lakhs)
1.Farm implements		
i. Multi-crop zero-till planter	For sowing of different crops under no-till conditions in unprepared field after crop harvest	0.60
ii. Happy Seeder	For sowing of crops under zero-till after combine harvest in residue retention condition	1.30
iii. Roto-till seed drill	For minimum tillage and sowing of crops in a single operation so as to reduced cultivation cost	1.30
iv. Disc bund former	For making bunds in the field to reduce manpower requirement	0.30
v. Trailed type disk harrow	For thorough land preparation before sowing in heavy-textured soils and incorporation of residues	1.30
vi. Seed-cum-fertilizer drill	For sowing of crops under conventional tillage conditions	0.60
vii. Power weeders (2)	For carrying out mechanical weeding in wide row crops and inter-row areas of the experimental plots	1.60
viii. Drip irrigation unit	For efficient water and weed management in horticultural plantations of mango and citrus orchard	1.00

2. Refrigerator (frost free, separate side by side door chambers, open door alarm, exterior LED display, with standard warranty and voltage stabilizer	For storing sensitive chemicals, keep buffers use in molecular studies, and to have chemicals at set temperatures	1.00
3. Rotary vacuum evaporator	For sample preparation in herbicide analysis and natural products including botanicals and microbial metabolic analysis	2.00
Total		**11.00**

The IMC examined the requirement of each equipment and opined that these items are absolutely necessary for mechanizing of farm operations and meeting the essential requirements in the laboratory. Accordingly, these equipments, mentioned in order of priority, were recommended for procurement during 2012-13.

(c) New equipments for AICRP-WC centers

The request received from AICRP-WC centers, viz. AAU, Jorhat and DBSKKV, Dapoli for procurement / replacement of the following minor equipments was placed before the IMC for consideration:

AICRP-WC centre	Equipment	Justification	Approx. cost (Rs. in lakhs)
1. AAU, Jorhat	Replacement of UPS batteries	Urgently required for the instrument	0.50
2. DBSKVV, Dapoli	i. Vacuum pump	For initiating microbiological studies	0.15
	ii. Refrigerator		0.15
	iii. Hot plate magnetic stirrer		0.10
Total			**0.90**

In view of the urgent requirement of these centres and petty nature of the items, the IMC recommended their procurement in the current financial year.

In the end, the Chairman, IMC expressed satisfaction over the outcome of the meeting, and mentioned that several administrative, financial and research related issues have been thoroughly discussed in the meeting. He emphasized that the IMC meetings will now be held at regular intervals as per the guidelines, and expressed the hope that all members will be present in the subsequent meetings. It was essential to fill the post of Administrative Officer (likely to fall vacant following voluntary retirement of Mr. Wajyoddin in a few months) and Asstt. Finance & Accounts Officer for better administration and financial management of the Directorate.

The meeting ended with vote of tanks to the Chairman, members of IMC and special invitees for their participation and valuable contributions in the meeting.

Member Secretary **Chairman**

Annexure - III

Category of AICRP-WC centres for herbicde residue research at AICRP-WC

Category 1.

1. GB Pant University of Agriculture and Technology, Pant Nagar, Uttarakhand
2. Punjab Agricultural University, Ludhiana, Punjab
3. Ch. Charan Singh Haryana Agricultural University, Hisar, Haryana
4. CCS HP Krishi Vishva Vidyalya, Palampur, H.P.
5. Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu
6. Kerala Agricultural University, Thrissur, Kerala
7. University of Agricultural Sciences, Hebbal, Bengaluru, Karnataka
8. Assam Agricultural University, Jorhat, Assam
9. Anand Agricultural University, Anand, Gujarat
10. Acharya NG Ranga Agricultural University, Hyderabad, A.P.

Category 2.

1. RVSKVV, Gwalior, M.P.
2. SK Rajasthan Agricultural University, Bikaner, Rajasthan
3. Narendra Dev University of Agriculture and Technology, Faizabad, U.P.
4. CSAUAT, Kanpur, U.P.
5. RAU, Pusa, Bihar
6. BAU, Ranchi, Jharkhand
7. Visva Bharati, Shantiniketan, West Bengal
8. Indira Gandhi Krishi Visvavidayalya, Raipur, Chhatisgarh
9. Orissa University of Agriculture and Technology, Bhuvaneswar, Orissa
10. MAU, Parbhani, Maharashtra
11. DBSKVV, Dapoli, Maharashtra
12. UAS, Dharwad, Karnatka

Annexure- IV

Preliminary results of a survey of research impact on weed science (Among DWSR and AICRP-WC centres)

A quick questionnaire based survey was conducted under the auspices of the Quinquennial Review process of the DWSR 2011-12. The questionnaire was sent to DWSR scientists, AICRP scientists in all the 22 centres (Table 1.). The objective was to gather relevant science based information on weed science research and impact during past five years. After repeated persuasion, some responses were obtained. The responses were analysed and few observations made. The information sought could have been more accurate, e.g. the information are sought on research output/publications by the scientists during past five years and the NAAS rated journal papers. In several cases, information provided pertains to entire life time, NAAS rated journal list is not comprehensive.

On the whole, there are nearly 72 scientists involved in the project on weed science research. Some of the centres performed satisfactorily. Data of twenty-four scientists who worked at the DWSR Jabalpur was considered. In rest of the collaborating centres, number of researcher varies from one to five. Quite a good amount of funds / resources (nearly Rs 3510.53 lakh) are generated from various projects both internal and external sources. Large number of papers (999, perhaps the entire period covering both project period and past period of the scientists) has been published by the scientists, which include both referred journals and NAAS rated journals. Although information on NAAS rated journals was not clear, yet it was estimated that about 45 per cent of them were in NAAS rated journals. If the information is correct, then the publication effort is good. The number of publications as means of research communication calculated on per scientist basis, varied from institution to institution ranging from zero to 18 in DWSR. Therefore, publication effort in the project is required to be enhanced.

The scientists are involved in research in a number of areas (Table 2). In fact, research efforts are on-going in as many as 30-40 important areas, which is good sign.

Following observations are made:

i. We feel that an effective management information system (MIS) needs to be developed at the DWSR. In view of enormous research efforts undertaken by the Directorate, a systematic compilation of the information about technology and practices would be useful for future strategy.

ii. The technology on weed management requires proper effort in dissemination and adoption by the target areas and farmers. This particular aspect has not been considered seriously. Because the socialisation of technology is indispensible in improving food and livelihood security. There is need for adequate efforts to improve capacity building of the stakeholders including scientist, extension system, policy makers, and of farmers at large.

iii. The process also demands technology refinement and upscaling strategy for wider impact to the society.

iv. Ultimately, it is essential to know what are requirements and preparedness of the technology to go out, adapted to various agro-ecological situations and adopted under diverse socio-economic set-up.

Some of the above areas may be taken on experimental or on comprehensive pilot basis in representative areas/ crops/ regions. We strongly feel that DWSR and its team have knowledge capability and resources (both human and physical) to undertake more socially beneficial research through proper inclusion approach.

Table 1: R&D achievement and involvement of scientists in weed science Research

Organization	Number of scientists	Project fund (Rs lakhs)	Average years of experience	Total research papers	Res papers / year	NAAS rated papers	Per scientist/ year
AAU, Anand	4	116.4	22.8	57		44	2
DWSR, Jabalpur	20	2563.8	16.4	404	25	295	18
GBPAUT, Pantnagar	4	251.9	13.8	114	8	82	6
KAU, Thrissur	3	27.3	26.7	54	2	6	0
NDAUT, Faizabad	4	0.6	18.3	13	1		
TNAU, Coimbatore	4	527.5	13.3	23	2	15	1
DBSKV, Dapoli	3	23.0		45		15	
AAU, Jorhat	6		22.3	104	5	1	0
RVSKV, Gwalior	4		27.2	151	6		
MAU, Parbhani	2		10.5	6	1		
RAU, Bikaner	1		31.0	28	1		
Total	**55**	**3510.53**		**999**		**458**	

Table 2: Broad areas of research by institutions based on projects undertaken

GBPAUT, Pantnagar	i.	Weed control, fertility management, organic farming, weed science & management
	ii.	Plant tissue culture/ molecular physiology, weed biology/herbicide, physiology/crop-weed competition
	iii.	Weed management in sugarcane, rice, wheat, millets
NDAUT, Faizabad	iv.	Herbicides and their residual effect in the soil.
	v.	Weed control and weed management technologies in field crops
	vi.	Teaching and KVK training
AAU, Anand	vii.	Herbicide testing, screening and development of new technology related to WM
	viii.	Herbicide residue research
	ix.	Weed biology, physiology, weed survey and extension activity (weed management)
TNAU, Coimbatore	x.	Weed management and herbicide agronomy
	xi.	Farming system, weed management & herbicide agronomy
	xii.	Agricultural production and marketing, impact analysis and yield loss assessment
	xiii.	Soil fertility, herbicide residue
MAU, Parbhani	xiv.	Weed management, rice, millets, and dominant cropping systems
	xv.	Soil microflora, effects of herbicides and green manuring on soil microflora and its associated parameters
	xvi.	Use of POE herbicides in field crops
	xvii.	Residue studies of herbicides
	xviii.	Effect of herbicides on microbial activity in soil, biological weed management
DWSR, Jabalpur	xix.	Non-chemical apporaches for weed control, weed control in non- crop situation etc.
	xx.	Integrated weed management particularly through cultural practices in dominant cropping systems, vegetable crops
	xxi.	Phytoremediation of heavy metals by weeds, waste water fisheries utilizing weeds
	xxii.	Various aspects of herbicides and herbicides residues. Screening of herbicides residues and phytotoxicity
	xxiii.	Evaluation of persistence and dissipation of herbicides in different soil, herbicide residues in soil, crop produce at different stages, food grains, vegetables, fodder crops, water and fishes
	xxiv.	Development of methods for herbicides residues and secondary metabolites in environmental samples
	xxv.	Effect of herbicides on non target organisms such as soil microbes, earthworms, beneficial insects and fishes and succeeding crop, herbicides residue management techniques

	xxvi.	Isolation of biomolecules, development of bioherbicides and allelopathy, fate of herbicides under changing climatic conditions, phytoremediation of herbicide contaminated soil
	xxvii.	Development of various models for herbicide leaching, risk of ground water contamination by herbicides
	xxviii.	Evaluation of root exudates for herbicidal properties, evaluated various plants species for bioassay, etc
	xxix.	Pesticide residue analysis, photochemical degradation of pesticides, Alternative synthesis of insecticides and raw materials,
	xxx.	Photo and microbial degradation of herbicides, botanical herbicide
	xxxi.	Nutrient management, green manuring and crop residue management; weed utilization for phytoremediation of heavy metal contaminated sites
	xxxii.	Impurity profile of pesticides, bioefficacy of bio-molecules and biopesticides on farmers' field and plantation.
	xxxiii.	Transgenic technology and basic studies on weed interactions
	xxxiv.	Plant protection machninery, mechanical weeding Tools and machninery, spray application techniques and machniery
	xxxv.	Development of suitable agro technology in difficult terrains of Himalayas, development of integrated weed management in rice-based cropping system
	xxxvi.	Weed biology and ecology, impact of climate change on weeds, weed seed dormancy and quarantine weeds
	xxxvii.	Allelopathy, seed dormancy, seed germination, herbicidal potential/ inhibitory activity of plant secondary metabolites, aquatic weeds, weed physiology, etc.
	xxxviii.	Biological control based integrated weed management, utilization of weeds
	xxxix.	Environmental impact of weed management technologies, herbicide persistence
	xl.	Herbicide as a tool for weed management

Annexure-V

Proforma for Impact Analysis

Questions for the Project leaders

I) Name of project, PI and location:

II) List of technology developed

1.

2

……

III) The technology is directed towards following:

1. Input saving
2. Yield improvement
3. Sustainability natural resource
4. Employment generation
5. Equity Improvement
6. Minimization of losses
7. Feed back at research system

1) Input saving

List of the inputs	Cost of inputs	Percent of input saving or cost saving in Rs.	Lag period of technology adoption	Probability of adoption (rate of adoption)	For which crop in this technology
1 2 3 4					

2) Yield improvement

a) For which crop(s) name…
b) Expected year of relating of technology
c) Expected adoption rate
d) % of area in which the tech can be adopted
e) Expected yield gain

f) Expected no. of years the benefit will cease (expected life of the benefit)

g) Maximum level adoption of technology in %.

3) Sustainability natural resource

Sustainability issues towards

a) H_2O management / health

b) Soil management / health

Benefits of each of above

i. Yield improvement
ii. Adoption employment
iii. Material / input cost of technology developed which will be adopted.

4) Employment generation

No. of days the employment increase as a unit of technology developed.

5) Industrialization:

Interface of technology with industry (how it will improve the industrialization)

6) Equity

Interface of technology with equity

7) Minimization of losses

How much will be the saving in losses (%)
Improvement in quality (% improvement)

8) Feedback to the research system

i. Towards strengthening extension system
ii. Towards improving sustainability
iii. Towards increase in improvement in research
iv. Returns to investment to research

Impact assessment indicators

- Efficiency
- Food security
- Sustainability
- Employment generation
- Institutional capacity

Efficiency indicators	• Total farm productivity • Total farm income • Technical efficiency • Income per unit output • Price per unit output
Food security and health	• Fish consumption • Food security of household • Animal protein consumption • Nutritional status • Poverty reduction
Employment	• Employment opportunity generated • Equity
Sustainability indicators	• Diversity • Farmers perception • Fertility of natural resources • Total Factor Productivity (TFP) growth • Real cost of production

Impact indicators at farm level

i. Increase in average yield
ii. Increase in net income
iii. Decline in unit cost of production
iv. Enhance employment and labor productivity
v. Price premium due to quality
vi. Increase of quality seed demand
vii. Household food and nutritional security
viii. Gender related issues

Regional level indicators

i. Food production
ii. Food security
iii. Employment issues
iv. Equity issues
v. Poverty
vi. Trade
vii. Inter-sectoral linkages
viii. Sustainability of natural resources

Cost and benefits stream

– Stream of cost

  - Research
  - Extension
- Stream of benefits
  - With and without improved carp strains
  - Before and after improved carp strains

Factors influence the research benefits

- R&D lags
- Seed policy
- Dissemination strategy
- Research risk
- Uncertainty
- Government policy

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
KRISHI ANUSANDHAN BHAWAN-II
PUSA NEW DELHI -12

F.No.14-9/2010-IA.II Dated 29th March, 2011

OFFICE ORDER

The Director General, ICAR has been pleased to constitute a Quinquennial Review Team (QRT) in respect of Directorate of Weed Science Research, Jabalpur as well as DWSR Centres to review the work done by the Institute as well as DWSR Centres for the period of 2006-2010. The Composition of the QRT is given below:-

I. COMPOSITION

1. **Dr. S.C. Mudgal**, Ex-VC, GBPUA&T : Chairman
   6, Rajdeep Enclave, Phase-II,
   100 Feet Road, Dayal Bagh, sureshmodgal@yahoo.in 09319975599
   Agra-282005 (UP)
2. **Dr. M.K. Porwal**, Ex-Prof.& Head of Agronomy : Member
   1 K27, Shanti Nagar, Sector-5, Hiran Magri,
   Udaipur-313002 (Raj.) mkporwal2010@yahoo.co.in
3. **Dr. B.C. Barah**, : Member
   LD-168, S.P. Apartment,
   Pitam Pura, New Delhi-110088
4. **Dr. P. Ananda Kumar,** Project Director : Member
   NRC for Biotechnology, IARI, Pusa, N.Delhi-12
5. **Dr. P.K. Pathak**, Ex-Prof. & Head (Entomology), : Member
   GBPUA&T, Pantnagar, 20, Teacher Colony,
   Jhadua-457661, Madhya Pradesh
6. **Dr. R.K. Gupta**, Residue Chemist, : Member
   HIG-103, Avas Vikas Colony,
   Scheme No.1, Kalyanpur,
   Kanpur-208017 (UP)
7. **Dr. R.K. Dubey,** Sr. Scientist, : Secretary
   Directorate of Weed Science Research, as Member
   Jabalpur (MP)

II. Procedure given in the revised guidelines for the QRT issued by the Council vide F.N.5-1/2009-Plng. Dated 15th July, 2009 may be adhered to.

III. QRT shall review the work of DWSR, Jabalpur as well as DWSR Centres keeping in view the guidelines given in the aforesaid circular and submit the report within the time schedule given at Annexure-II.

IPA Copy to Dr. Dubey

आवती संख्या 211
05 APR 2011
रा.ख.अ.नि.स. केन्द्र, जबलपुर

Contd. from pre-page:-

The Director of the Institute will provide necessary stenographic, technical and administrative assistance, etc. to the QRT members for the efficient functioning of the team and preparation of the report. The TA of the non-official members of the QRT for attending its meeting will be paid by the Institute in accordance with the relevant rules of the Council.

(N.K.JINDAL)
Under Secretary (NRM)

Copy to:

1. Chairman , QRT (copy of the QRT guidelines)
2. All members and Secretary, QRT
3. Director, DWSR, Jabalpur
4. PPS to DDG (NRM)
5. ADG (AF & Agro.), ICAR
6. F&AO, DWSR, Jabalpur
7. Director (Finance), ICAR
8. ADG (PI&M), ICAR
9. Guard file/Spare copies

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
KRISHI ANUSANDHAN BHAWAN-II
PUSA NEW DELHI -12

F.No.14-9/2010-IA II

Dated 16 September, 2011

OFFICE ORDER

The Director General, ICAR has been pleased to constitute a Quinquennial Review Team (QRT) in respect of Directorate of Weed Science Research, Jabalpur as well as DWSR Centres to review the work done by the Institute as well as DWSR Centres for the period of 2006-2010. This revised Composition of the QRT is in supersession of earlier office order of even number dated 29th March, 2011:-

I. **COMPOSITION**

1. **Dr. S.C. Mudgal**, Ex-VC, GBPUA&T, 6, Rajdeep Enclave, Phase-II, 100 Feet Road, Dayal Bagh, Agra-282005 (UP) : Chairman
2. **Dr. M.K. Porwal**, Ex-Prof.& Head of Agronomy, 1 K27, Shanti Nagar, Sector-5, Hiran Magri, Udaipur-313002 (Raj.) : Member
3. **Dr. B.C. Barah**, LD-168, S.P. Apartment, Pitam Pura, New Delhi-110088 : Member
4. **Dr. P. Ananda Kumar**, Project Director, NRC for Biotechnology, IARI, Pusa, N.Delhi-12 : Member
5. **Dr. R.J. Rabindra**, No.1, Parthasarthy Street, Chennai (Tamil Nadu) : Member
6. **Dr. B.S. Parmar**, 337, Mandakini Enclave, Alaknanda, New Delhi-110019 : Secretary as Member
7. **Dr. R.K. Dubey**, Sr. Scientist, Directorate of Weed Science Research, Jabalpur (MP)

II. Procedure given in the revised guidelines for the QRT issued by the Council vide F.N.5-1/2009-Plng. Dated 15th July, 2009 may be adhered to.

III. QRT shall review the work of DWSR, Jabalpur as well as DWSR Centres keeping in view the guidelines given in the aforesaid circular and submit the report within the time schedule given at Annexure-II.

: 2 :

Contd. from pre-page:-

The Director of the Institute will provide necessary stenographic, technical and administrative assistance, etc. to the QRT members for the efficient functioning of the team and preparation of the report. The TA of the non-official members of the QRT for attending its meeting will be paid by the Institute in accordance with the relevant rules of the Council.

(N.K.JINDAL)
Under Secretary (NRM)

Copy to:

1. Chairman , QRT (copy of the QRT guidelines)
2. All members and Secretary, QRT
3. Director, DWSR, Jabalpur
4. PPS to DDG (NRM)
5. ADG (AF & Agro.), ICAR
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7. Director (Finance), ICAR
8. ADG (PI&M), ICAR
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INDIAN COUNCIL OF AGRICULTURAL RESEARCH
KRISHI ANUSANDHAN BHAVAN II
PUSA NEW DELHI 110012

F. No. 14-9/2010-I.A.II

Dated 29th August, 2012

To
Dr. Suresh C. Modgal,
Chairman, QRT (DWSR, Jabalpur)
6, Rajdeep Enclave, Phase –II
100 Feet Road, Dayalbag
Agra – 282005, U.P.

Subject: Review of DWSR and AICRP-Weed Control by the QRT – Regarding.

Sir,

I am directed to refer to your letter dated 03.08.2012 on the subject cited above and to convey the approval of the Secretary, DARE & DG, ICAR for submission of Quinquennial Review Team (QRT) in respect of DWSR, Jabalpur for the period from **2006 –March 2012.**

Yours faithfully,

(Rajinder Kumar)
Under Secretary (NRM)

Copy to : Director, DWSR, Jabalpur for information.

(Rajinder Kumar)
Under Secretary (NRM)