Increasing chickpea and pigeonpea production through Intensive application of Integrated Pest Management

Project Proposal
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By

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			2010	2011	Co-operating centres
1	Andhra Pradesh (1 district)	Anantpur	1	1	Dr Laxmi Reddy KVK, Reddipalli, Anantapur - 515701, Dist: Anantapur, Tel: 08554-257243 09989623825
2	Karnataka (1 District)	Gulbarga	7	7	Dr Suhas L Shetty Dr J B Gopali, ARS, Aland Rd, Gulbarga Dist., Pin 585101. (UAS, Raichur).08472-274120 09945582114
3	Madhya Pradesh (2 Districts)	Chindwara	1	1	Dr A K Bhowmick JNKVV, Jabalpur. (MP) 09424313301
		Narsingpur (KVK, Narsinghpur Jabalpur.	2	2	
4	Maharashtra (4 Districts)	Osmanabad	2	2	Dr N R Patange College of Agriculture, Kinhi Rd., Osmanabad. Pin - 413 601 02472-202150 09421755066
		Parbhani	2	2	Dr B B Bhosle MAU Parbhani 02452-228235 09423437894
		Aurangabad or Buldhana	1	1	Dr K R Kamle ARS, Badnapur 09421325575
		Nanded	1	1	Dr R C Lavekar Agri College Naigaon 02465-262800 09422171204
5	Uttar Pradesh (2 districts)	Banda	1	1	Dr S K Singh IIPR, Kalyanpur, Kanpur 09794769353
		Hamirpur	2	2	

Covered States	5
Covered Districts	10
Total Covered Area	20,000 ha

Coverage of area in terms of block (1 Unit=1000ha) under Chickpea IPM demonstration in different districts during (two) years (2010-2011).

S. No.	State	District	Year		
			2010	2011	Co-operating centres
1	Andhra Pradesh (1 district)	Anantpur	2	2	Dr Laxmi Reddy KVK, Reddipalli, Anantapur – 515701 Dist: Anantapur, Tel: 08554-257243 09989623825
2	Karnataka (1 District)	Gulbarga	5	5	Dr Suhas L Shetty Dr J B Gopali, ARS, Aland Rd, Gulberga Dist., Pin 585101. (UAS, Raichur).08472-274120 09945582114
3	Madhya Pradesh (1 Districts)	Narsingpur (KVK, Narsinghpur Jabalpur.	2	2	Dr A K Bhowmick JNKVV, Jabalpur. (MP) 09424313301
4	Maharashtra (3 Districts)	Osmanabad Parbhani Nanded	2 2 1	2 2 1	Dr N R Patange College of Agriculture, Kinhi Rd., Osmanabad. Pin - 413 601 02472-202150 09421755066 Dr B B Bhosle MAU Parbhani 02452-228235 09423437894 Dr R C Lavekar Agri College Naigaon 02465-262800 09422171204
5	Uttar Pradesh (2 districts)	Banda Hamirpur	1 1	1 1	Dr S K Singh IIPR, Kalyanpur, Kanpur 09794769353

Covered States	5	Covered Districts	8
Total Covered Area	16000 ha		

2. Introduction

India is the largest producer of pulses in the world with 25% share in the global production. While chick pea is the topper among pulses occupying 39% of pulse area, pigeon pea follows with 21% area share. The major pulse producing states are Maharashtra(20%), Madhya Pradesh (17%), Rajasthan (11%), Uttar Pradesh (11%) and Andhra Pradesh (11%) together accounting for 70% of the total production of 14.76 m.t from an area of 23.63m,ha (2007-08). In general, the pulse production is not keeping pace with the domestic requirements, hence has to import 1.5-2.8 m.t per year, and is a matter of concern. Keeping this in view, proposed programme covers the two important pulses crops *viz.,* chick pea and pigeon pea across different cropping systems and will take care of changing scenario emerging out of climatic changes as well as cropping pattern. Present proposal, which is based on holistic approach and changing ecosystem, will help in increasing production through reduction in pest infestation that would reduce the need for their import into our country.

2.1. Scenario of area, production and productivity

2.1.1 Pigeonpea is grown in an area of 4.3 m ha and production of 3.3 m tons in Asia. India has the largest area (3.6 m ha) under pigeonpea. Maturity duration varies from about 120days extra-early varieties to more than 260 days for long-duration varieties. Pigeonpea is an important constituent in the category of pulses among all Indians. Availability of 20-21% protein in pigeonpea supplements the energy rich cereal diet. From natural resource management perspective cultivation of pigeon pea improves the soil characteristics and fertility status (upto 200 kg N ha -1) ensuring better growth to succeeding crop by contributing about 40 kg ha $^{-1}$. Its stalks are sources of fuel and used for other socio-economic purposes in rural areas. Production levels of 1.7 million tonnes in 1950-51 increased to over 2.8 million tonnes in 2005-06 owing to the increase in acreage than the productivity *per se*. Consequently, per capita availability of pigeonpea has not been able to support the growing population. Pigeonpea varieties currently available has a potential to yield around 2.0 (short duration) to 3.5 (long duration) tonnes ha^{-1} . They are adapted to different agro-climatic intercropping niches, including low input conditions. The area increased from 3,33,000 ha in 1992-93 to 4,53,000 ha in 2006-08 in Andhra Pradesh, 1.01m.ha to 1.14 ha in Maharashtra and 4,72,000 to 6,24 000 ha in Karnataka mainly due to the increase in productivity in these states to the tune of 109%, 64% and 103%, respectively. Gujarat registered 27% increased yields of pigeon pea. The average experimental yield in national trials is around 1300 kg ha $^{-1}$, but the national average yield is only 753 kg ha $^{-1}$, indicating slow pace of transfer of technology and that 75-90% increase in productivity can be achieved through improved adoption of existing technology and varieties.

2.1.2. Chickpea (*Cicer arietinum*) is a key pulse crop being grown in 7.63 million ha with an annual production of 5.35 MT (GOI, records). Review indicates that chickpea is a resource poor farmers' crop and receives very less inputs in terms of bio-fertilizers and in terms of pesticides (Bio-& chemical pesticides) resulting in poor crop health succumbing to heavy pest infestations. During the period of 1991-93 to 2006-08, highest increase in productivity of chickpea has been recorded in Andhra Pradesh (124%) followed by Karnataka (63%), Maharashtra (53%) and Gujarat (40%). In Andhra Pradesh the area under chickpea has increased from 71000 ha in 1991-1993 to 517000ha in 2006-08 and productivity from 621 kg/ha to 1397kg/ha resulting in 16 times production increase. In Maharashtra the area increased from 566000ha in 1991-93 to 1.24 mha in

2006-08 with production from 288000 to 959000 tonnes. In Karnataka, the area increase was 2.7 times with a production increase of 4.4 times between 1991 and 2006.

3. Major constraints to production and productivity levels of pigeonpea and chickpea across the agro-ecological regions

Biotic stresses are one of the major constraints that limit the realization of the potential yields in pulses especially chick pea and pigeon pea.

3.1. Key pests of pigeonpea

Among insect pests gram pod borer (*Helicoverpa armigera*) and pod fly (*Melanagromyza obtusa*) cause severe damage and associated yield losses across pigeon pea growing regions of the country. Pod fly causing 2.5 to 86.8% of grain losses in different parts of the country was notable. The estimates of avoidable losses due to pod borer complex, mainly pod fly and *H.armigera* were 43.5 and 30.2%, respectively. Among diseases, *Fusarium* wilt (*Fusarium udum*) in Central and Southern states followed by sterility mosaic (virus transmitted by eriophyid mite *Aceria cajani*), and SMD and *Phytophthora* blight *(Phytophthora drechsleri f.sp.cajani)* diseases in the North east plain (Uttar Pradesh) cause substantial yield losses to the crop. Unchecked weeds also cause 21-97% yield loss in pigeon pea.

3.2 Key pests of chickpea

Wilt caused by *Fusarium oxysporum* f.sp.*ciceri* has been the widely occurring disease in chick pea in addition to *Helicoverpa armigera*, . In addition dry root rot stunt disease, *Aschochyta* blight, soft rot, cyst and reniform nematodes along with weeds also form the yield limiting stress factors.

4. Technologies available for increasing productivity of pigeonpea and chickpea

- Several cultural practices like field sanitation, soil solarisation through summer ploughing or using polythene sheets, green manuring reduce the wilt inoculums.
- Deep summer ploughing and removal of stubbles reduces the *Fusarium* population build up
- Host plant resistance is the best option for management of chicpea and pigeonpea diseases.

S.No.	Specific trait	Varieties of pigeonpea available
1	Resistance against wilt	Amar, Narendra Arhar, Asha BSMR 736, BSMR 853, JKM 7, Maruti , C11
2	Resistance against sterility mosaic disease (SMD)	Bahar, Amar, NDA 1, Asha, BSMR 736, BSMR 853, MA 3, Pusa 9, Co 5, MA 6, MAL 13
3	Resistance against wilt and SMD	Amar, Narendra Arhar, Asha BSMR 736, BSMR 853

4	Short duration	UPAS 120, PUSA 992, VLA1, Co 7, PAU 881
5	Suitable for Rabi planting	Sharad, Pusa 9

S.No.	Specific trait	Varieties of chickpea available
1	Resistance against *Fusarium* wilt	GNG 1581, GPF 2, DCP 92-3, KWR 108, JG 11, JG 315, JG 16, JG 74, Pusa 372
2	Resistance against *Achochyta* blight (AB)	Samrat, GNG 1581, PBG 5
3	Combined resistance against wilt and AB	GNG 1581
4	Tolerance against drought	RSG 888, Vijay
5	Delayed planting	PBG 1, Pusa 372, pant G 186, KPG 59, JG 14 (ICCV 92944)
6	Large seeds (Desi)	BG 256, Phule G5, Pusa 391, BGD 72, GNG 469, Co 4, Pusa 362, GC 2
7	Large seeds (Kabuli)	KAK 2, JKG 1, Shubra

- Soil application of sulphur @ 20kg/ha through SSP, gypsum or pyrite gives an yield advantage of 15-24% in pulses
- Seed dressing with *Trichoderma harzianum* & *T.viride* and Carbendazim +Thiram (1:3g/kg) contains wilt.
- Inoculation of seeds with biofertilisers such as *Rhizobium* culture @25g/kg of seeds and PSB 10-12 hours before sowing increases the yields by 11-21%
- Seed treatment with metalaxyl@ 3g/kg of seeds in blight prone areas is beneficial
- Ridge planting (60 cm spacing) of pigeon pea has been advocated for successful cultivation of pigeon pea in North East Plain Zone (**UP**, Bihar, Jharkhand, West Bengal) for ensuring better crop stand minimising the incidence of *Phytophthora*. Yield increases have been 17-20% in ridge over flat bed plantings.
- Intercropping chickpea with linseed and pigeon pea with sorghum is a well demonstrated technology against wilt in Maharashtra
- Foliar spray of urea (2%) increasing the photosynthetic activity leading to 13-20% increased yields in chick pea
- Against *H.armigera* , timely sowing to exploit host avoidance phenomenon, intercropping with sorghum, Use of trap crops like *Vicia sativa* and African giant marigold, use of NPV @ 450LE /ha, spraying NSKE @ 1.25l/ha, need based use of insecticides like 0.07% endosulfan or 0.04% fenvelarate are recommended.
- Against pod fly half dose each of Monocrotophos+NSKE or Endosulfan + HaNPV gave the maximum grain yield although sprays of Monocrotophos, NSKE and Dimethoate reduced pod damage.
- Sparying of Metasystox and Dimethoate @0.1% for control of mite the vector of SMD is recommended.

4.1. Yield gains (%) due to the improved technologies under FLDs across the country for chickpea & pigeon pea (2004-05 to 2008-09)

Component	% yield gain	
	Chickpea (mean of 3480 FLDs)	**Pigeon pea** (mean of 3773 FLDs)
Improved varieties	22.4	24.5
Rhizobium inoculation	13.4	13.5
Sulphur application (20kg/ha)	15.4	17.4
IPM	19.9	28.1
Weed management	-	30.0
Full package	24.9	34.6

Source: Proceedings of Brain storming Meeting on Issues and strategies for increasing Productivity and production of Pulses. 9-10 June, 2009, NASC, Pusa New Delhi-12. IIPR, Kanpur

5. Current scenario of pests, pest management options and needs

Off late (2002-07) *Helicoverpa* population, which use to be major production constraint has gone down due to disruption in generation by transgenic cotton. However 2008 crop season has witnessed intense comeback of *Helicoverpa* on chickpea and other pulses. Plant resistance (HPR) has played a crucial role in combating various plant diseases and presently represents as an important component of integrated pest management. In absence of high levels of host-plant resistance to *Helicoverpa* and its resistance towards a number of pesticides, there is urgent need of coupling with other IPM options for effective and economical crop management. Worldwide *Trichoderma* has been accepted as an important component as seed protectant resulting in availability of a good number of commercial preparations. Similarly HaNPV has been found as an effective tool for management of *Helicoverpa* in initial stages. Due to limitations in availability of neem seed for use as extract, neem oil is available in various formulations and serves as anti-feedant as well as repellant. Despite availabilities of technologies the coverage under IPM at present is estimated to be less than 4% of the total cultivable area in the country. There is need to integrate and interweave compatible plant protection strategies to achieve success of IPM in chickpea.

Success story of practical implementation of Integrated Pest Management technology in cotton based cropping system in Southern Maharashtra requiring only one spot application of pesticidal sprays (Chlorpyriphos, Spark, Match, Endosulfan, Cartap hydrochloride, Acephate, Ethofenprox, Karate, Curacron and Ethion) has paved the way for adopting similar approach in other parts of country. The IPM technology has not only brought down use of pesticides from 4 to 1 but has resulted in higher benefit ratio of 4.79 in comparison to 2.37 in conventional practices. Review of recommendations hosted on different State Govt., sites indicates gross deficiencies in terms of holistic approach, which need attention. Indonesia is well known example of success in the history of plant protection, wherein Govt withdrew the subsidies on pesticides and promoted ecological approach to manage rice pests. This has prevented the pesticides, which not only killed pests, but also beneficial organisms (such as parasitoids, predators, bees, earthworms and birds). It is worth mentioning that predators and parasitoids (*Campoletis chlorideae,*

Apenteles rufricus , *Bracon hebetor* and *Carcelia illota*)are capable of reducing 60% yield losses. The implementation of IPM programme and its success has served as a model for other countries.

NCIPM's efforts based on cotton based cropping system in rainfed areas has resulted in conservation of naturally occurring predators and egg parasitoids and utilization of local bio-diversity in a community approach. Modifications in habitat by introducing growing of coriander or linseed have enhanced natural defenders population along with niche to predators and modifying microclimate resulting in disease suppressive soils. Experience has not only enhanced natural defenders population but also helped on utilisation of locally available bio-diversity (neem as biopesticides) apart from extra remunerations and creating employment to rural youth.

6. OBJECTIVES:

- To develop "Nuclear Model Villages" in selective districts for demonstrating IPM modules in farmers' participatory mode to suit their cropping systems.
- Capacity building of technical assistants of different blocks, district/block level officers and farmers to enhance their capabilities towards healthy crop production through IPM strategies.
- To develop and carryout awareness campaigns through conventional (print) and electronic media, to reach areas not covered under this programme.
- To establish centralized "National Pest Reporting and Alert System" through networking of pulse growers, in addition to strengthening of pest diagnostic laboratory.

7. Detailed work plan

To develop "Nuclear Model Villages" in selective districts for demonstrating IPM modules in farmers participatory mode, to suit their cropping systems.

The area for demonstration of IPM will be based on criterion of selection of 0.4ha for every 100 ha in each of 11 states as identified on 26.02.10. Demonstration plots will be spread over the districts (table 1) to cover major pigeonpea growing regions. It will be able to give visibility of scientifically proven IPM strategies and its critical components. Under present proposal the IPM modules will be implemented in farmers' participatory mode over contiguous areas of a village that would serve as "Nuclear Model Villages" so to popularize area wide IPM concept. Farmers Field School (FFS) will be carried out in collaboration with local bodies (State Agricultural University) at different cropping stages. Focus will be on making farmers the better decision makers of their own fields. All crop production activities starting from field preparation to harvest will be under close supervision and guidance. In order to have visibility of the program, local and quality critical inputs, if available will be used.

Time to time feedback relating to socio economic adoption of IPM strategies will be reviewed and modified in consultation with local bodies.

Capacity building of technical assistants of different blocks, district/block level officers and farmers to enhance their capabilities towards healthy crop production through IPM strategies.

Technical Assistants engaged in entire A3P programme being implemented in all 11 states (covering 355 units) will be trained in collaborating universities/institutes in different aspects of crop production and protection. They will be trained in pest surveillance and pest recording. During the training period they will be equipped with all the necessary supporting literature and monitoring tools. State/block level officials will be provided with refresher course to make them acquainted with latest techniques in the field of plant protection at NCIPM. During the crop season they will be also taken to Model farms to see themselves working of IPM as holistic approach to crop production. Farmers will be trained under FFS and will be enriched with knowledge of "Good Agronomic Practices", based on location specific recommended practices. FFS will be carried out at vegetative as well as at flowering stages and farmers will be taught to differentiate between useful and harmful insects (*Helicoverpa* and *Autographa*) apart from stem, root, foliar, pod diseases (*Fusarium, Rhizoctonia, Sclerotium, Aschochyta, Botrytis, Alternaria, Stemphylium* etc.), and abnoxious weeds *(Chenopodium, Solanum, Anagallis, Vicia, Fumaria , Asphodelus , Convoloulus, Melilotus, Medicago, Avena* and *Cyperus).* This training will be carried out in collaboration with identified State Agricultural University (table 2). Apart from training, advice to the farmers in the adopted villages will be extended based on the real time surveillance based pest scenario.

To develop and carryout awareness campaigns through conventional (print) and electronic media, to reach areas not covered under this programme.

The popular semi technical and pictorial bulletins on crop health and associated pests with their management will be developed on regional basis through vernacular languages for distribution to farmers. The posters and pest calendars will be developed on the basis of crop phenology narrating the IPM activities.The short films showing the importance of IPM will be developed and screened in the IPM villages and distributed to self help, panchayat and local media groups. Farmers of each district will be taken to "Nuclear Model Villages" at peak crop stage.

To establish centralized "National Pest Reporting and Alert System" through networking of pulse growers, in addition to strengthening of pest diagnostic laboratory.

Roving as well as fixed plot survey will be carried out to monitor crop health in relation to pest and defender build up. Specific survey in the pest endemic areas will

be intensively carried out to keep track of pests (insect and disease out breaks), and data on population levels will be monitored on weekly basis to have real time database for use in automated reporting system. Data will be recorded in the standard format using standardized sampling and recording methods and will be transmitted to NCIPM website through user (Tech Asst & SRF) authenticated direct logging from Cyber Cafe. Data will be automatically analysed by the hosted database server and decision support system. Once analysed, pest advisory will be flashed on site and simultaneously reported to the concerned national and state level authorities through automatically generated email/ fax messages, and to farmers using mobile SMS message (fig 1).

Field surveys on pest problems during the growing season will provide both short term and long term benefits that are important to producers, and managers for making critical pest management decisions. In the long run, centralized database having uniformly recorded data along with weather parameters will serve as national repository for research managers to take decisions on crop insurance, crop failures and climate related disaster management.

Strengthening of laboratory would enhance the capabilities of identifying the strain variations among geographical populations of major pests using molecular approaches and to aid in the development of pest diagnostics. Study of the changing scenario of pests in relation to climate as well as cropping patterns would be quantified to formulate mitigating strategies for the future.

8. Likely output

- Pulse production will increase due to reduction in pest incidence/intensity and saved yields.
- The establishing and strengthening the critical IPM inputs producing units at SAU will strengthen and serve as source for quality critical IPM inputs.
- The farmers will be educated to become decision makers of their own fields and will not be carried away by pesticide dealers.
- Reduce dependence on chemical pesticides will result in savings in terms of money spent on it.
- IPM coverage will result in healthy environment for human being, for pest defenders as well as for restoring soil health, which in long run reduce dependence on chemical Nitrogenous fertilizers.
- A “National Pest Reporting and Alert System” will be in place to cater data need for disaster management group.
- Establishing and strengthening of quality control laboratory, critical IPM inputs producing units at SAU / KVK will serve as a local source of critical IPM inputs.
- Soil health will get improved– in terms of conservation of soil inhabiting beneficial flora and fauna

Table . 1. Proposed area (ha) of coverage under IPM demonstration in different districts

Pigeonpea (2010 to 2011)

S. No.	State	District	Area for Demonstration(ha)/Year	
			I	**II**
1	Andhra Pradesh	Anantpur	1000	1000
2	Karnataka	Gulbarga	7000	7000
3	Madhya Pradesh	Chindwara Narsimpur	1000 2000	1000 2000
4	Maharashtra	Osmanabad Parbhani Aurangabad/Buldana Nanded	2000 2000 1000 1000	2000 2000 1000 1000
5	Uttar Pradesh	Banda Hamirpur	1000 2000	1000 2000

Chickpea (2010 to 2011)

S. No.	State	District	Area for Demonstration (ha) / Year	
			I	II
1	Karnataka	Gulbarga	5000	5000
2	Andhra Pradesh	Anantpur	2000	2000
3	Madhya Pradesh	Narsimpur	2000	2000
4	Maharashtra	Osmanabad Parbhani Nanded	2000 2000 1000	2000 2000 1000
5	Uttar Pradesh	Banda Hamirpur	1000 1000	1000 1000

Table 2. Capacity building of Tech Asst and farmers empowerment

Activity	**Venue and NCIPM partners**
Training of Farmers	Collaborative Centre (KVK and SAU)
Tech Asst & Farmers Andhra Pradesh & Karnataka	 Krishi Vigyan Kendra, Aland Road, Gulbarga Dist., Pin-585101. (University of Agricultural

	Sciences, Raichur).
Madhya Pradesh & Chattishgarh,	Jawaharlal Nehru Krishi Viswavidyalaya, Jabalpur
Maharashtra & Gujarat	Marathwada Agricultural University, Parbhani
Uttar Pradesh , Bihar, Orissa Rajasthan & Jharkhand,	Indian Institute of Pulses Research, Kanpur
Refresher training to "Nodal persons" belonging to representative states.	NCIPM, LBS Building IARI Campus, New Delhi-12

Goals:

- To promote activities and outputs of area wide IPM being implemented by co-operating organizations.
- Introduce working of botanical and biological agents in fields and constraints encountered
- Guide crop protection projects by partner organizations for consistency with the SP-IPM position on the use of different IPM components and guiding principles for IPM; and assess inconsistencies and provide recommend corrective measures
- Assist to provide IPM solutions to production constraints resulting from change in cropping patterns and climate
- Assist State Govt staff to meet their obligations to conventions that are pertinent to IPM.

9. Technology gap and mitigation approach

Due to change in pesticide use pattern in cotton based cropping system there is shift in priority of *Helicoverpa* feeding habit and their nature of damage. *Helicoverpa*, which use to prefer cotton is not opting for other crops, which include chickpea. Unfortunately pulses (chickpea and pigeonpea) are their preferred crop. In absence of adequate genetic resistance crop managers has to rely on calendar based spray schedule. In Indian conditions pulses being marginal crop are often neglected and do not receive adequate plant protection coverage due to low benefit ratio. Increase in level of pest infestations on chickpea, requires more than one spray of chemical pesticides as curative option (Chlorpyriphos, Spark, Match, Endosulfan, Cartap hydrochloride, Acephate, Ethofenprox, Karate, Curacron and Ethion), which increases cost of production.

Successful implementation of IPM will lead to good crop health (grain to stover ratio), good crop stand by preventing seed and seedling decay, lesser pest infestations, retarding of development of pesticide resistance against commonly used insecticides, sustainable yield and improvement of soil chemistry. Vascular wilt and podborer are the main constraints in chick production because in epidemic conditions they are capable of causing 60% yield losses apart from making seeds vulnerable to post harvest insect pests and diseases.

9.1 Seed and seedling mortality

Seed dressing with appropriate (effective) dose of *Trichoderma* strain will lead to decrease in seedling as well as plant mortality caused by 3 distinct variants and 5 races of *Fusarium* and common nematodes, which are capable of causing 100% losses in the event of epidemics. This will also help in utilizing PGPR properties of *Trichoderma* as well as Pseudomonads in having good crop health and increasing earthworm population in soils apart from beneficial microflora.

9.2 Use of bio-pesticides

Use of locally available crude neem extracts (as repellant and antifeedant) as well as HaNPV alone or with adjuvants will cut down reliance on chemical pesticides for protection against podborer and other harmful insects. It will also help in prevention of resistance development against commonly used chemical pesticides. Provision of quality bio-components (*Rhizobium, Phosphate solubilizing Bacteria, Trichoderma* and *Pseudomonas* and HaNPV) from SAU, KVK, State Bio-Control Laboratory, industry and involvement of KVKs' in adoption of technologies in nucleus village village would ensure success of these approaches. This would not only reflect in conservation of natural enemies at various agroecosystems but also would cut down production costs with increase in yields as ultimate impact indicators apart from pesticide free drinking water, healthy farm workers and their economic status.

9.3 Action Plan

Based on local pest problems, location specific IPM strategies will be developed and implemented with the help of local authorities in farmer's collaborative mode. Use of sulfur (@20-30kg/ha) will help in increasing yield apart from imparting resistance against diseases and mites. Community approach will be adopted to implement the IPM strategies starting from field preparation to storage in the cluster of villages. One time seed will be replaced with recommended cultivars (with multiple pest resistance). Seed treatment with lead centres produced and screened strains of bio-fertilizers (Rhizobium and phosphate solubilising bacteria) and biopesticides will be ensured. Local educated unemployed youths will be trained as pest scouts to help in monitoring of pest population and calculating pest-defender population and farmers will be made decision makers of their own fields with the help of regular FFS. Importance of crop health monitoring will be emphasized and field standardised Indian formulation of *Helicoverpa* lures will be made available to them for monitoring and mass trapping of adult moth population of *Helicoverpa*. Pest data will be pooled at central place (Lead centre) and correlated with other parameters including weather. Based on field tested prediction models and real-time pest population quality IPM inputs will be made available in time for management of pests before their outbreaks. Farmers will be trained equipped and encouraged to set up units for processing of neem seed extracts, HaNPV and conservation of bio-agents .

The common facility of gram panchyat of these model villages will be equipped with basic infrastructure, and educational IPM tools (posters of Pests and defenders. Do and Donot of using chemical pesticides, correct use of different IPM tools). Few unemployed youths will be trained as ambassadors of IPM and will be provided with appropriate incentives to promote IPM among peers and adjoin village not covered under farm demonstration trials. The common facility will be used as site for organising regular FFS

and kisan melas for adjoining villages' folks to popularise and promote IPM activities (table 3, 4 and 5).

10. Approaches in Capacity building

- FFS will help farmers to work in field and identify problems and get their solutions.
- SMS and Extension workers Pulse will get an opportunity to update themselves and work with international scientists at ICRISAT to update their knowledge to manage problems of their areas.
- State level extension workers and farmers will be provided with refresher training courses. Group of educated youths from villages will be trained as pest scouts, who can be later on enrolled by pesticide industries.

Table 3. Stakeholders and their Responsibilities

S. No.	Organisation	Responsibility
1	NCIPM, New Delhi	• To coordinate and collaborate the development, validation and demonstration of IPM modules in the selected districts of 5 states • To develop the software for data reporting, analysis and issue advisory in consultation with state and national level authorities • To make available the pest monitoring kits and proformae/data sheets • To develop popular dissemination materials (resource material for both crops, pest calendar and extension folders • To coordinate the overall programme of pest monitoring • To carry out capacity building programme for State Govt Officials, Tech Asst and other resource personnels belonging to states covered under A3P programme. • To carry out impact analysis of IPM adoption and benefits in terms of economic and environment in collaboration with other agencies
2	State Agriculture Department and State Agricultural Universities	• Top monitor the pest scouts and monitors for quality records of pest data • To train the field staff by the senior staff of the department • To train the farmers on IPM modules by the field staff • To popularize the IPM modules through posters / leaflets , etc. • To alert the farmers based on pest monitoring in case of alarming situations • To get feedback for future anticipatory research for developing IPM components

Details of operation has been given in ANNEXE-III

Fig. 1. Scheme of pest surveillance and alert system

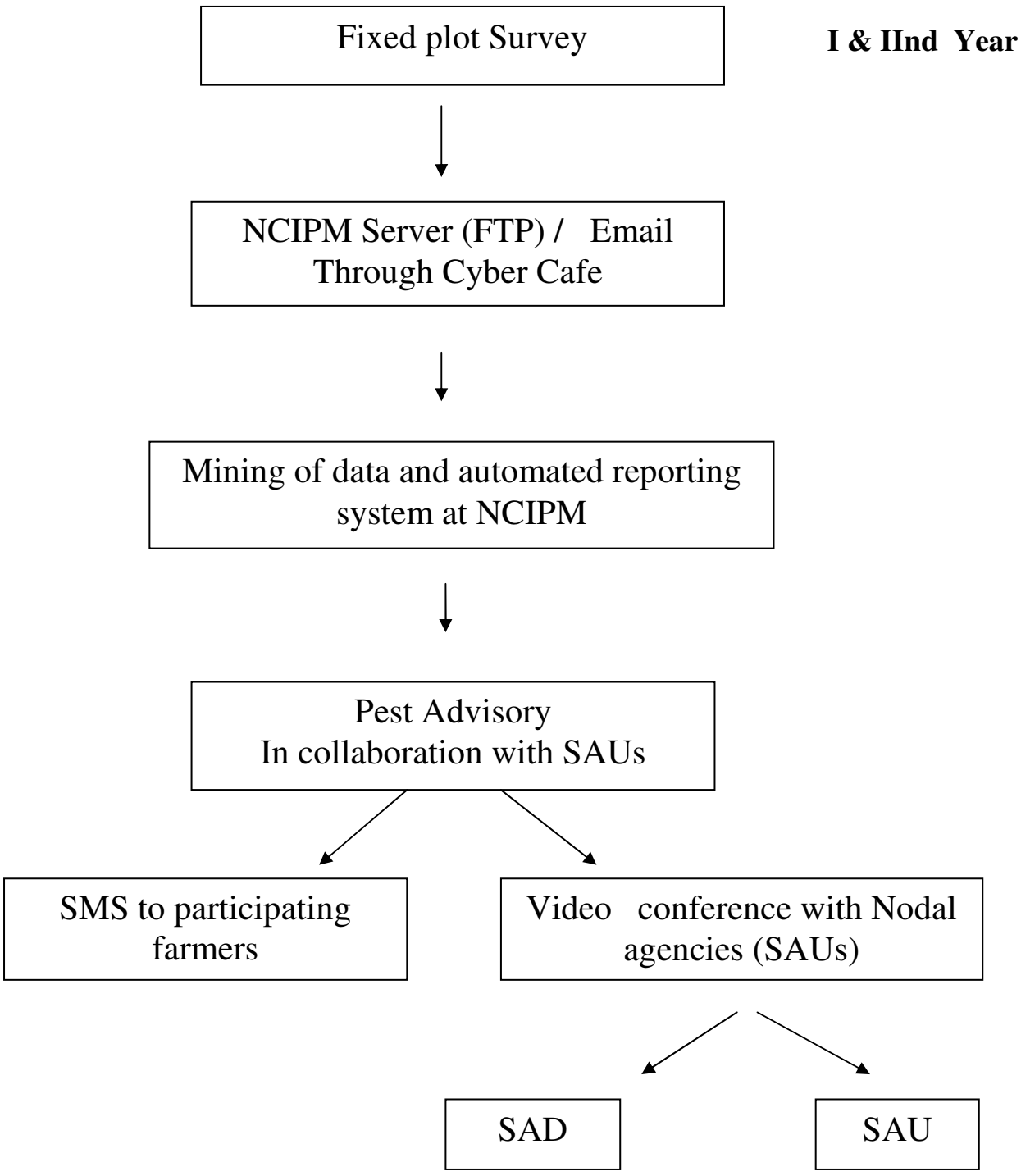

Table 4. Details of the Co-operators

Activity	NCIPM partners
Farmers Field School (FFS)	Collaborative Centre (SAU and KVK)
Training of Tech Asst and other state Govt Extension workers	
Andhra Pradesh	**Dr Laxmi Reddy**, I/C Station KVK, Reddipalli, Anantapur – 515701 [Acharya NG Ranga Agricultural University (APAU), Hyderabad]
Karnataka	**Dr Suhash L Shetty**, (Pr Entomologist) ARS, (University of Agricultural Sciences, Dharwad). Aland Road, Gulbarga Dist., Pin-585101.
Madhya Pradesh	**Dr. A. K. Bhowmick** (Pr Entomologist) Department of Plant Breeding & Genetics, Jawaharlal Nehru Krishi vishwa Vidyalaya Jabalpur – 482 004
Maharashtra	**Dr K R Kamle.** I/C Station Agril. Research Station**,** Badnapur Dist. Jalna 431 202. **Dr B B Bhosle,** HOD (Ent), Marathwada Agricultural University), Parbhani
Uttar Pradesh	**Dr S K Singh,** PS (Ext) IIPR, Kalyanpur, Kanpur (UP)

Table. 5. Tentative cost estimate (Rs) of different IPM components (including bio-fertilizers) for Pigeonpea.

S. No.	Inputs	Rate of application	Cost of IPM Components	Cost of IPM per ha	Ist Year	II Year	
1	Integrated Nutrient Management (INM). Gypsum	250kg/ha	Rs 4.80	1200	24000000.00	24000000.00	
2	Micronutrient (ZnSo4, Borax, Ferrous sulphate, micronutrient mixture	25kg/ha	Rs 40.00	1000	20000000.00	20000000.00	
3	Rhizobium + PSB	500gm/ha	Rs 60/kg	60	1200000.00	1200000.00	
4	Trichoderma	10gm/kg (1.5kg)	Rs 100/kg	150	3000000.00	3000000.00	
5	Spray of Urea (2 spray)	20gm/1000 ml (2%) at flowering and 15 days after Ist spray	Rs 10/kg	240	4800000.00	4800000.00	
6	Pheromone traps	5No /ha	Rs 15/-	75	1500000.00	1500000.00	
7	Lures (podborer)	15No/ha	Rs 10/-	150	3000000.00	3000000.00	
8	Bird Perches	20/ha	Local resources	0	0.00	0.00	
9	HaNPV	500 ml/ha	Rs 1700/lt	850	17000000.00	17000000.00	
10	Neem oil (5000 ppm)	2ml/ltr	Rs.400/-	240	4800000.00	4800000.00	
11	Insecticides	Endo sulfan 1ltr/ha + Emectin for management of epidemic situation	Rs 750	750	15000000.00	15000000.00	
		Dimethoate or any other 1lt/ha	Rs.500	500	10000000.00	10000000.00	
			Total	5215	104300000.00	104300000.00	
Grand Total						**208600000.00**	

Total covered area (ha) over two years under demonstration cum validation	**20000**

Coverage under IPM Demonstration cum validation — I st Year = 20000ha; II nd Year = 20000 ha

	I yr	II Yr
Cost of INM	44000000.00	44000000.00
Cost of IPM	60300000.00	60300000.00

Table. 6. Tentative cost estimate (Rs) of different IPM components (including bio-fertilizers) for Chickpea .

S. No.	Inputs	Rate of application	Cost of IPM Components	Cost of IPM per ha	Ist Year	II Year
1	Integrated Nutrient Management (INM). Gypsum	250kg/ha	Rs 4.80	1200	19200000.00	19200000.00
2	Micronutrient (ZnSo4, Borax, Ferrous sulphate, micronutrient mixture	25kg/ha	Rs 40.00	1000	16000000.00	16000000.00
2	Rhizobium PSB	4kg/ha (for seed rate 75 kg/ha)	Rs 60/kg	240	3840000.00	3840000.00
3	Trichoderma	10gm/kg (75kg)	Rs 100/kg	56.25	900000.00	900000.00
5	Spray of Urea	20gm/1000 ml (2%)	Rs 10/kg	240	3840000.00	3840000.00
6	Pheromene traps	5 /ha	Rs 15/-	75	1200000.00	1200000.00
7	Lures (podborer)	10/ha	Rs 10/-	100	1600000.00	1600000.00
8	Bird Perches	20/ha	Local resources	0	0.00	0.00

9	HaNPV	250 LE/ha	Rs 1700/lt	425	6800000.00	6800000.00
10	Neem oil (5000 ppm)	2ml/ltr (2 sprays)	Rs.400/-	400	6400000.00	6400000.00
11	Insecticides (Endosulfa. + 3rd gen pesticide)	1 ltr/ha	Rs.250	500	8000000.00	8000000.00
			Total	4236.25	67780000.00	67780000.00
			Grand Total		**135560000.00**	
Total covered area (ha) over two years under validation cum demonstration						**16000**

Coverage under IPM Demonstration cum validation I st Year = 16000ha II nd Year = 16000ha

	I Yr	**II yr**
Cost of INM	35200000.00	35200000.00
Cost of IPM	32580000.00	32580000.00

Table. 7 . Details of assistance for IPM components for Pigeonpea + Chickpea under "Accelerated Pulses Development Programme" required for two years (2010-2012) of crop season.

S. No.	**Components**	**Implementing agency**	**Pattern of assistance**	**Cost estimates (Rs) Ist Year**	**Cost estimates (Rs) IInd Year**
A.					
1	Purchase of Breeder seed of pulses from ICAR	State Department of Agriculture/ NSC/SFCI/KRIBHCO/NAFED/IFFCO/State seed corporation	N/A	0.00	0.00
	Distribution assistance on certified seeds	State Department of Agriculture/ NSC/SFCI/KRIBHCO/NAFED/IFFCO/State seed corporation/Seed producing agencies in private and cooperative sectors.	N/A	Varieties are to be selected as per list given in the **Annexure-I**	
2	Integrated Nutrient Management (INM)	State Department of Agriculture or such agency as may be decided by Executive Committee of NFSM	Full	79200000.00	79200000.00

3	Integrated Pest Management (IPM) **(Chickpea (16000 ha)+ Pigeonpea (20000))** for 2 crop season	NCIPM in collaboration with collaborating centres	All critical inputs	92880000.00	92880000.00
4	Knap Sack Sprayers. (Manual and power operated)	N/A	N/A	0.00	0.00
5	Training of State Govt Officials. States=11. @ Rs 500/- per day per head (2 person from each state) Boarding & Lodging + Training material + Stationary + Local Transportation + Honorarium for lecture & supporting staff.	NCIPM	Full	122000.00	0.00
5	Training of Farmers will be based on FFS pattern. NCIPM in collaboration with Co-operating Centres will implement FFS (training of 100 farmers from each block twice in the crop season covering 1000 ha targeting 11 district . [37 x 100 x 150 x 2 = 1110000.00] training cost 150/per head per day + Farmers Mela during peak crop season	NCIPM in collaboration with Co-operating Centres at district level	Full	645000.00	645000.00
6	Training of Tech Asst . NCIPM in collaboration with Co-operating centers. State level training for trainers and extension workers. 355participants for 2 days @ Rs 300/per day of 2 days training. Training material + Honorarium + local transport .	- do -	Full	632500.00	632500.00
	Sub Total (A)			**173479500.00**	**173357500.00**

B	**Recurring**				
	(a) Tech Asst. (Consolidated Rs. 8000/-PM + 3000 as POL) 21 Nos	NCIPM + Collaborative agency	- do -	2772000.00	2772000.00
	(b) SRF at **State & district level + NCIPM** . (Rs.12000/-PM +30% HRA) (14 Nos)	- do -	- do -	2059200.00	2059200.00
	(c) **Res Associate at NCIPM** (Rs.18000/- PM + 30% HRA) (3 Nos)	- do -	- do -	842400.00	842400.00
	(d) Contractual help at State + District(Consolidated Rs 5000/-) (14 Nos)	- do -	- do -	660000.00	660000.00
	(e) Sensitization and Review meetings at NCIPM and at state level	- do -	- do -	200000.00	200000.00
	(f) Development and printing of Extension literature and "Resource Book/training manual" in regional languages for both crops (Hindi, Marathi, Telugu, Karnada & English) (6,00,000.00). Development of movies for promotion of IPM in Pigeonpea (2,00,000.00)	- do -	- do -	800000.00	300000.00
	(g) Printing of data record sheets (300000.00) + charges of cybercafe (@25/- for 38 weeks) for 355 Tech Asst	- do -	- do -	637250.00	337250.00
	(h) Travelling Allowances for NCIPM @ Rs.500000.00 per year	- do -	- do -	500000.00	500000.00
	(i) Travelling Allowances for Coperating centres + nodal centres @ Rs. 20000.00 per year	- do -	- do -	220000.00	220000.00
	(j) Hiring of vehicles at all co-operating centres + nodal office.	- do -	- do -	220000.00	220000.00

	(k) One time upgradation of biopesticide and biofertilizer units located in the University (ARS, Badnapur and ARS, Gulbarga).	- do -	- do -	450000.00	0.00
	(l) Miscellaneous Expenditure @ 20,000/- for all cooperators located at each state + district + 100000/- for NCIPM	- do -	- do -	320000.00	320000.00
	Sub Total (B)			**9680850.00**	**8430850.00**
C	**Non-recurring**				
	(a) Computer infrastructure (Latest desktop computer with internet connectivity and Web Cam and UPS) for Pest reporting system.@ Rs. 45000/-per unit for 13 (nodal + district centres).	NCIPM + Collaborative agency	- do -	495000.00	0.00
	(b) E-Note Book with modem card and Web Cam@ Rs. 32000/- for three units at NCIPM.	NCIPM	- do -	96000.00	0.00
	(c) Development of Relational database with SMS module. A decision making web based software for " National Pest Reporting and Alert System " with network of pulse growers and its maintainance. One server along with 2 desktop. (Out Sourcing)@ Rs.1000000/- for development and commisioning of real time database and reporting system.	NCIPM	- do -	1000000.00	0.00
	(d) Colour Laser Printer. @ Rs. 25000/- for one unit .	NCIPM	- do -	25000.00	0.00
	(e) Laser Printer.@ Rs. 15000/- (9Nos)	Collaborative centre	- do -	150000.00	0.00

	(f) Photocopier @ 0.5 Lakh	NCIPM	- do -	50000.00	0.00
	(g) Digital Camera. @ Rs.15000/- (13 units) + close up lens for Nikon-5000 (NCIPM)	NCIPM + Collaborative agency	- do -	210000.00	0.00
	(h) IPM kit. @ Rs. 700/- (370 units for all Tech Asst)	Collaborative agency	- do -	259000.00	0.00
	(i) PCR Kit (Machine)	NCIPM		500000.00	0.00
	(j) Dry Bath	- do -	- do -	50000.00	0.00
	(k) Horizontal Electrophoresis	- do -	- do -	150000.00	0.00
	(l) Centrifuge (High speed)	- do -	- do -	50000.00	0.00
	(m) Vortex mixture	- do -	- do -	10000.00	0.00
	(n) Split AC	- do	- do -	25000.00	0.00
	(0) Incubator Shaker (Refrigerated)	- do -	- do -	500000.00	0.00
	(p) Deep Freezer	- do -	- do -	75000.00	0.00
	(q) Microscope with photo micrographic attachment (plane-apo lenses)	- do -	- do -	700000.00	0.00
	(r) Glass wares and chemicals	- do -	- do -	200000.00	150000.00
	Sub Total (C)			**4545000.00**	**150000.00**
	Total (Total of A + B + C)			**187705350.00**	**181938350.00**
	Grand Total for two years				**369643700.00**

ANNEXE- I

State	Varieties (Chickpea)
Madhya Pradesh	Normal sown: **JG 130, BGD 72, JAKI 9218, JG 63, JG 16, Vijay** Late sown: **JG 14 (heat tol.), JG16** Kabuli: **JGK1, JGK 2, Shubra**
Maharashtra	Normal sown: **Vijay, Digvijay, Vishal, BGD 72, JG 16** Moisture stress: **Vijay** Kabuli: **JGK1, Subhra, BGD 128, Virat (K), KAK 2 (K)**
Rajasthan	Promotion of high yielding, short duration and drought tolerant varieties like **RSG 888, RSG 931, RSG 973**
Andhra Pradesh	Promotion of short duration and wilt resistant varieties like **JG 11, JAKI 9218, Vihar, KAK 2 and LBeG 7**
Karnataka	Promotion of short duration and wilt resistant varieties like **JG 11,BGD 103, KAK 2, JGK 1, BG1105 (K) etc**
Uttar Pradesh	Normal sown: **DCP 92-3, KWR 108, JG 16, KGD 1168, Vijay** Late sown: **PUSA 372, KPG 59, Pant G 186** Kabuli: **JGK 1, Shubhra (Bundelkhand tracts), PUSA 1003** (eastern UP)
Chhatisgarh	Promotion of high yielding and disease resistant varieties like **JG 130, Vishal** etc

ANNEXE- II

State	Varieties (Pigeonpea)
Maharashtra	ICPL 87, AKT 8811, BSMR 853, BSMR 736, Vipula
Karnataka	ICPL87119, ICP-8863, WRP-1, TS-3R
Uttar Pradesh	UPAS-120, Type-21, ICPl-151, ICPL-88039, Narendra Arhar-1, Amar, Azad, Type-7, Pusa-855