CAPP-3

Format for Application for Agri-CRP Projects

1. **Title of Platform**: Consortium Research Platform (CRP) on Conservation Agriculture (CA)

2. **Title of the Platform Project**: Development, refinement and validation of conservation agriculture (CA) in Vertisols of central India and quantifying impact of CA practices on soil and environment.

3. **Location**

Instituteôs Name:	ICAR- Indian Institute of Soil Science
Place:	Bhopal
District:	Bhopal
State:	Madhya Pradesh

4. **Project Principal Investigator:** Dr. K.M.Hati

5. **Co-Project Principal Investigators:** Drs. A.K. Viswakarma, J. Somasundaram, Sanjay Srivastava & Pramod Jha

7. **Objectives (in brief):**

- To identify best tillage, water and nutrient management practice under CA
- To quantify changes in soil quality parameters, nutrient dynamics, carbon sequestration and green house gas emissions under conservation agriculture
- Budgeting nutrient, water & energy use under CA

The objectives will be fulfilled through the subprojects give below:

Sub-project-1: Demonstration of Best-Bet Conservation Agriculture Practices on Farmers' Fields in Vertisols of Central India.

Objectives:

1. To evaluate conservation agriculture practices for crop productivity and profitability in farmerôs field.
2. To identify the best conservation agriculture practices.
3. To create awareness about conservation agriculture practices among farming community.

Co-PPI : Dr. A.K. Viswakarma

Collaborative Investigator (CI): Drs. RH Wanjari , R.K. Singh, KC Shinogi & AK Tripathi

Sub-project-2: Fine-tuning of Conservation Agricultural Practices for Vertisols of Central India

Objectives:

1. To identify and evaluate potential cropping systems and conservation tillage practices best suited for the Vertisols of central India
2. To formulate suitable weed management options for major cropping systems
3. Refinement and validation of component technologies of conservation agriculture.

Co-PPI : Dr. J Somasundaram
CI : Drs. K Ramesh, S. Ramana, B.P. Meena & Abhay Sirale

Sub-project-3: Development of Water and Nutrient Management Practices in Conservation Agriculture for Vertisols of Central India.

Objectives:

1. Studying root behavior and nutrient dynamics at different moisture regimes under CA
2. Quantifying water & nutrient use efficiencies, nutrient, water & energy budget under CA
3. Identifying the best water and nutrient management practices under CA

Co- PPI : Dr. S. Srivastava
CI : Drs. K.V. Ramana Rao, I Rashmi & N. K. Sinha

Sub-project-4: Impact of Conservation Agricultural Practices on Soil Health, Carbon Sequestration and Green House Gas Emissions in Different Production Systems

Objectives:

1. To quantify the changes in soil quality parameters (physical, chemical and biological) under CA
2. To study soil organic carbon dynamics, stabilization and stratification under CA
3. To quantify green house gases emissions under CA

Co-PPI : Dr. Pramod Jha
CI : Drs. B.L. Lakaria, M. Mohanty, J.K. Thakur & Kola Bharati

8. Practical/Scientific Utility:

- Residue management and quantification for a sustainable soil environment management.
- Potential cropping systems and conservation tillage practices best suited to the agro-ecological settings.
- Water productivity/savings would be evaluated.
- Energy input-output and benefit-cost economics would be assessed for different CA systems.

- Carbon sequestration and global warming potential under different CA systems would be quantified.
- Efficient nutrient management protocols/ strategies for CA would be developed.
- Weed dynamics would be evaluated and management options would be recommended for different CA systems.
- Key microbiological properties would be evaluated and soil health indicators would be identified.
- Development of optimum nutrient management practices under conservation agriculture suitable to different water management practices and soil moisture regimes.
- A resilient agriculture practice bringing substantial economic (low cost of agrochemicals and high productivity), environmental (reduced soil degradation, greenhouse gas emission and N leaching) as well as social benefits.
- Improved soil health for sustainable farming system.

9. Research work conducted

i. At sponsoring institutions:

A long-term tillage experiment on soybean-wheat system conducted at IISS, Bhopal showed that productivity of soybean and wheat did not differ significantly in conservation tillage systems compared to conventional tillage system indicating a sustainable benefit of no tillage system. Root length density of soybean at top 15 cm depth was higher in NT and RT than in MB and CT. An improvement in selected soil physical properties like soil water storage, bulk density, aggregate stability, penetration resistance and saturated hydraulic conductivity (Ks) were recorded in NT and RT than CT. Soil organic carbon (SOC) and also the aggregate associated carbon content at 0-15 cm depth were significantly higher in NT, and RT where wheat residues were left after harvest than that in CT system after ten years of cropping. It is concluded that no tillage and reduced tillage systems with management of residues and recommended rate of N for soybean-wheat system would be a suitable practice for sustainable production of soybean-wheat cropping system in Vertisols of central India (Hati et al., 2014). Another experiment conducted at the institute showed that the wheat residue incorporation or retention coupled with application of 28 kg N ha^{-1} through fertilizer or organic manures is more beneficial than burning in terms of enhanced crop productivity and soil fertility. Wheat residue incorporation resulted in 20ï 22% higher yields in soybean and 15-25% in wheat as compared to residue burning. Soil incorporation of wheat residue plus N supplementation through FYM at the rate of 28 kg N ha-1 (approx. 4 t FYM ha-1) along with 25 kg P ha-1 for rainfed soybean and 68 kg N + 30 kg P ha-1 for irrigated (1+ 2 irrigations) wheat was more effective and profitable. Soil carbon saturation and stabilization/measurement of green house gas emissions/soil quality and health monitoring were also studied.

ii. In other institution of the country:

Unlike, in the rest of the world, in India spread of CA technologies is taking place in the irrigated regions in the Indo-Gangetic plains where rice-wheat cropping system dominates.

CA systems have not been extensively tried or promoted in other major agro-ecoregions like rainfed semi-arid tropics, the arid regions or the mountain agro-ecosystems. Considering the severe problems of land degradation due to runoff induced soil erosion, rainfed areas particularly in arid and semi-arid regions require the practice of CA more than the irrigated areas in order to ensure a sustainable production (Venkateswarlu et al., 2009). In India, efforts to adopt and promote resource conservation technologies have been underway for more than a decade, but it is only in the past 6-8 years that technologies are finding acceptance by the farmers particularly in the Indo-Gangetic plains under the aegis of Rice-Wheat Consortium (Abrol and Sangar, 2006). A study undertaken for last five years in three major non-rice cropping systems, *viz*., cotton-wheat, pigeonpea-wheat and maize-wheat with suitable conservation agriculture (CA) practices (namely, zero-till permanent narrow bed (70 cm), broad bed (140 cm) and flat bed with both season crop residue) revealed that cotton-wheat system under zero-till permanent broad, flat and narrow beds is superior to pigeonpea-wheat and maize-wheat systems in terms of system productivity, net returns, and water & energy productivity than in conventional-till (CT) flat bed (Das et al., 2014). Significantly higher soil organic carbon (SOC) in the surface 0-5 cm layer was recorded under zero-till broad-bed with residue. This offers to be an important adaptation-led mitigation strategy to climate change. Similarly, a study carried out for five years towards replacing transplanted rice (TPR) with direct-seeded rice (DSR) through interventions of CA practices revealed that a system of ZT DSR with summer mungbean (SMB) residue retention - rice residue (RR) retention in ZTW ï wheat residue retention in ZT summer mungbean (SMB) results in comparable rice yield, but higher system productivity, net returns, B:C and system water productivity than that in TPR-CTW/ZTW system. This treatment results in an improvement in the SOC & total N in surface (0-5 cm) soil and a reduction in global warming potential (GWP) through reduction in methane emission from rice field (Bhatia et al., 2012). Persistent use of conventional tillage (CT) practice with extensive tillage and burning of crop residues had decreased soil organic matter content and labile soil carbon pools (Bhattacharya *et al.,* 2013; Das et al. 2013), deteriorated soil physical properties (Aggarwal *et al*., 1995, Mishra et al., 2015) as well as are capital- and energy-intensive, resulting in lower economic returns (Das et al., 2014). Contrarily, conservation agriculture has been reported to improve crop productivity, water-use efficiency and reduce global warming potential than conventional tillage practices, thus, enhances farm profitability (Bhatia et al., 2012; Das et al., 2014).

CA improves soil penetration ratio (SPR) and water stable aggregates; reduces mechanical impedance; increases infiltration, reduces erosion and increases WUE, provides a conducive root environment through enhanced root-moisture interaction, and decreases soil temperatures (Gathala *et al*., 2011, Saharawat *et al*., 2009). Overall CA has been reported to improve crop productivity, resource-use efficiency and reduce global warming potential than CT (Saharawat *et al*., 2011; Bhatia *et al*., 2014; Das *et al*., 2014). Conservation agriculture and conservation tillage practices improved soil aggregation, aggregate associated C and N (Bhattacharyya et al., 2013), soil microbial dynamics and overall soil health (Kukal et al., 2013); crop productivity (Jat et al., 2013), resource use efficiency over business as usual, enhances farm profitability (Saharawat et al., 2012).

iii. Other countries:

Conservation agriculture improves soil health (Zachmann *et al.*, 1987; Gan *et al.*, 2007), results in greater stratification of soil nutrients and higher availability of nutrients (Jones and Chen, 2007), immobilizes nutrients by increased microbial biomass (Jansson and Persson, 1982), increases total soil organic carbon, C and N mineralization (Fuentes *et al.*, 2009), increases macro-aggregation and aggregate associated C (Blanco-Canqui *et al*., 2006), improves soil penetration ratio (SPR) and water-stable aggregates (Wright and Hons, 2005; Gathala *et al*., 2011, Saharawat *et al*., 2009); reduces mechanical impedance (Sadras and Calvino, 2001); increases infiltration, reduces erosion and increases water use efficiency (Azooz and Arshad, 1996), provides a conducive root environment through enhanced root-moisture interaction (Derpsch, 2008), and decreases soil temperatures (Shaver *et al.,* 2002).

The overall objective of CA is to enhance the productivity and sustainability of farming systems as well as maintaining the soil health. Hence, the investigation should be focused, among other things, to the individual and interactive effects of conservation tillage practices, residue management, crop rotations, nutrient and water inputs on nutrient use efficiencies. Also, nutrient management practices in CA systems cannot be reduced to simple physical input-output model. While there is much new work that needs to be done to formulate nutrient management strategies in CA systems, all such strategies would need to ensure that soil health becomes the means of meeting crop nutrient needs in an optimum and cost-effective way within the prevailing ecological and socio-economic conditions.

10. Technical Programme:

Field experiments will be conducted both in farmers field and institute farm to evaluate cropping systems, conservation tillage practices, nutrient and weed management options under conservation agriculture most suitable for the Vertisols of the central India.

Items of Investigation:

(i) Assessment of the performance of proven CA practices under farmersô fields and fine tune these practices for large scale adoption.
(ii) Estimation of the influence of CA practices on crop productivity and soil properties under different cropping systems.
(iii) Crop growth parameters like biomass, LAI will be recorded at periodic intervals
(iv) Monitoring of the soil hydro-thermal regimes
(v) Quantification of residue addition in the component systems
(vi) Dynamics of the soil physical, chemical and biological properties under tillage and crop rotation regimes
(vii) Weed dynamics, weed shift and weed seed stratification
(viii) Yield and yield attributing parameters of the component crops
(ix) Energy budgeting, system productivity and profitability
(x) Soil fertility parameters during crop growth and after harvest of each crop

(xi) Nutrient and water uptake studies
(xii) Root characteristics and physiological parameters
(xiii) Nutrient, water, and energy budgeting under different systems of CA
(xiv) Biomass removal under different treatments
(xv) Computation of soil test based nutrient recommendations
(xvi) Development of customized formulation of nutrients
(xvii) Soil carbon storage and budgeting, green house gas emissions, soil quality

11. Facilities Available:

Equipments/instruments/ apparatus:

The institute laboratories are well equipped with ICP, GC, NIR, Spectrophotometer, N Distillation System, pH, EC meter, TOC analyzer, BOD, Environmental Shaker, Media Distributor, Centrifuge, **Wet Sieve Apparatus, Infiltrometer, Pressure Plate Apparatus, Penetrometer, Moisture meter** and other basic facilities. The institute Central Lab has Atomic Absorption Spectrophotometer, Flow Injection Auto Analyzer, UV- Visible Spectrophotometer and CHNS Analyzer.

Area of experimental fields (hectares):

The Institute developed its campus and experimental farm on a consolidated block of 50-hectare. Out of which 33 hectare of land is under cultivation with different field crops like soybean, wheat, mustard, chickpea, lentil, etc and horticultural crops like mango, guava, aonla, pomegranate etc. The farm has 4 water harvesting ponds which supply water for rabi season crops. Besides this 10 hectares agricultural field will be selected in progressive farmerôs field and participatory research will be conducted on those farmers field.

Laboratory: Four fully equipped laboratories, one referral lab and one central lab is available in the institute

Other facilities: (1) Training hostel
(2) Subject matter specialist
(3) Administrative and technical man power

12. Additional facilities required:

Equipment & apparatus:

1. Turbo Happy Seeder ï 3 nos.
2. Strip till seed drill - one
3. Sprayers - 4 Nos
4. Inclined Plate Planter with Herbicide Application Unit
5. Drip irrigation including overhead: one

6. Pump set: 3 HP: one
7. Microsprinkler: one
8. Storage tanks : 30000 L total capacity
9. Ventury fertigation: One

Area of land for Experimentation (hectares):
Laboratory: Already available
Office facilities: Already available

13. Duration: 2 years

14. Staff Requirements (Scientific, Technical etc.):

Designation of Post: NIL: Number of Post: NA: Scale of Pay: NA: Qualification Prescribed: NA
Designation of Post: Senior Research fellow (SRF)
Number of Post: 8

15. Estimation of Costs (2015-16):

Jr. Research Fellow:	NIL
Sr. Research Fellows:	Rs. 19.6 lakhs for eight SRFs
Research Associate:	NIL
Other Contractual Staff:	Rs. 5.4 lakhs

16. Recurring and Non-recurring contingencies: Rs. 55 lakhs (Details given below)

Recurring and Non-recurring contingencies	Year-I (2015-16)#
Capital	
Equipment/ Machinery/Apparatus/ Misc. items[@]	10.0
Revenue	
Contractual service (SRF 8 & other contractual services)	25.0
TA	2.0
Other recurring contingencies including institutional charges*	18.0
Total	**55.0**

***Institutional charges @10% of RC for lead institute and 5% of RC for cooperating institutes**
 # As per the new BE (2015-16). Original sanctioned total project budget is 63 crore.
@ Computer/Air Conditioner/Furniture as per absolute requirement of the project

17. Receipts anticipated: Produce obtained from the experimental fields

UNDERTAKING

18. Certified that:

i. The research work proposed in the **Platform Project on Conservation Agriculture** does not in any way duplicate the research work already done and being carried out elsewhere on the subject.
ii. The present scheme cannot be combined with any scheme financed by the Council, Central and State Governments, Universities or Private Institution of their own funds.
iii. Necessary financial provision for the platform project will be made in the Institution/ University/ State budget in anticipation of the sanction to the scheme by the council.
iv. We undertake to abide by the guidelines provided by the Council for the implementation of the Platform Project.

Principal Investigator **Signature**

Name: Dr. K.M. Hati

Certified that:

i. Project is in line with the approved mandate of the implanting institute.
ii. Platform Project Investigator/ Co-investigators are competent technically to undertake the project.
iii. Research work will not amount to duplication of efforts and In-house projects, handled by me will not suffer.
iv. Equipment and other infrastructure proposed under the project are either not available with the institute or the available facility cannot be extended to the project activities.
v. Basic facilities such as Telephone/ Fax/ photocopies/Generators etc. will be provided by the implementing agency. However, operational cost for these activities will be met from the institutional charges sanctioned under the scheme.
vi. The cost of equipment and other infrastructure requested for under the project is realistic and based on the prevailing market rates.
vii. Justifications and clear specifications for the equipment and other infrastructure asked for are reflected in the proposal.
viii. For collaborative projects with other institutions, the administrative/ financial/ technical issues related to implementation of the project shall be addressed between the two implementing agencies.

ix. The institutions has already furnished to the ICAR, full accounts and Utilization Certificates in respect of the grants received by it previously, as per the following details:

ICAR's amount	UC & Accounts furnished

Communication of Grant by the Institution and date of (Please indicate the Sanctioning Grant number and date of the communication with which ASAs, etc. are sent)

(1)_____(2)_____(3)

It is certified that the Institution has not received any grant from the ICAR previously.

Date: **Executive Authority of the Institution**