<u>CAPP-2</u>

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, Adaptation and refinement of location specific CA practices for enhancing productivity and profitability of irrigated eco-systems.

3. Location

Instituteøs Name: ICAR- Indian Institute of Farming Systems Research
Place: Modipuram Meerut
District: Meerut 250 110
State: Uttar Pradesh

4. Principal Investigator (PI)

Name: Dr. Mahendra Pal Singh Arya
Designation: Principal Scientist (Agronomy)
Date of Birth: 18 Dec. 1954
Experience: (Years): 35 years

5. Co-Principal Investigator (PI)

Name: Dr. Mohammad Shamim
Designation: Scientist (Agricultural Meteorology)
Date of Birth: 10th, November, 1975
Experience: (Years): Five Years
Number of Scheme handled: Two
Number of important research publications: Eleven

6. *Collaborative Investigator (s) (separate set for each): **Not Applicable**

Name:
Designation:
Date of Birth:
Experience:
Number of Scheme handled:
Number of important research publications:
Number of other Research Schemes (being carried out by PI):
Title of Scheme (s)
Name of the funding Agency:
Period from to Grant: Around Rs

7. *Objectives (in brief)

- To enhance nutrient use efficiency through cropping /farming systems approach
- To improve water conservation by irrigation management practices.
- To enhance energy conservation through land configuration and planting techniques
- To develop Decision Support System (DSS) under small and marginal farms

8. *Practical/Scientific Utility:

Conservation agriculture (CA) is a concept of resource saving agricultural crop production that strives to achieve acceptable profit together with high and sustained production level while concurrently conserving the environment (FAO).It is based on enhancing natural biological process above and below the ground. Conservation agriculture is characterized by three principals namely: (i) continuous minimum mechanical soil disturbance; (ii) permanent organic soil cover; (iii) diversified crop rotations in the case of annual crops and plant associations in case of perennial crops. (Detailed Information in Annexure A).

9. *Research work conducted: Annexure B

i. At sponsoring institutions
ii. In other institution of the country
iii. Other countries: Annexure IV

10. Technical Programme

Items of Investigation

- Standardization of irrigation schedule.
- Identification and evaluation of different cropping /farming systems.
- Studies on planting methods and land configuration.
- Development of Decision Support Systems and its validation

11. Facilities Available:

Equipments/instruments/ apparatus:

1. Farm Machineries e.g. Rice transplanter, combine, Roto till drill etc.
2. CHNS Analyzer
3. GCMS
4. Leaf Area Meter
5. SPAD
6. Temperature and Humidity Probe
7. CO_2 probe
8. Photosynthesis systems
9. Spectro-radiometer
10. Petty equipment

Area of experimental fields (hectares) Two Research Farm

Laboratory: Well-equipped Soil and Plant Physiology & Agromet-Lab

Other facilities: Irrigation Facility, Farm Machineries, Already developed IFS model, Conference halls etc.

12. Additional facilities required:

Equipment & apparatus:

(1) Water meters for measuring the irrigation water
(2) Laser land leveler
(3) Zero till drill machine
(4) Conoweeder
(5) Tensio meter
(6) Hot air oven

(7) Digital weighing balance
(8) Petty implements and tools
Area of land for Experimentation (hectares): One Hectare

13. Duration: Two Years
*Detailed information with regard to Sr. No. 6, 7, 8 and 9 may be furnished separately as supplementary annexure.

14. Staff Requirements (Scientific, Technical etc.)
15. Estimation of Costs:
    i) Sr. Research Fellows: 5
    ii) Other contractual services: As per requirement

16. Recurring and Non-recurring contingencies: Rs. 30 lakhs (details given below)

Recurring and Non-recurring contingencies	Year-I (2015-16)#
Capital	
Equipment/ Machinery	4.0
Revenue	
Contractual service (SRF 5 & other contractual services)	13.5
TA	1.5
Other recurring contingencies including institutional charges*	11.0
Total	**30.0**

***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.

Others

i. Receipts anticipated :Nil

UNDERTAKING

ii. Certified that:

i. The research work proposed in the Platform Project (Agri-CRP 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. Mahendra Pal Singh Arya

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
Rs. 6000000	-

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**

Annexure A

Conservation Agriculture

Conservation agriculture strives to develop a balanced co-existence between rural and urban societies, based on increased urban awareness of the environmental benefits and services provided by the rural sector. It works with the international and national market place to develop financial mechanisms to ensure that environmental benefits provided by CA are recognized by society at large, and benefits accrued to CA practitioners. A recent example is the marketing of carbon credits under the Kyoto Accord, but this is only the beginning. Many other opportunities for environmental payments will develop in the future, including the potential for farm products produced under a new ñconservation labelò. The rapid adoption of conservation technologies by large as well as small farmers in many areas of the world, often without government support, is clear evidence of the economic, environmental and social benefits that accrue from these practices. The principles of CA and the activities to be supported are described as follows:

- *Maintaining permanent soil cover and promoting minimal mechanical disturbance of soil through zero tillage systems, to ensure sufficient living and/or residual biomass to enhance soil and water conservation and control soil erosion.* In turn, this improves soil aggregation, improves soil biological activity and soil biodiversity, improves water quality, and increases soil carbon sequestration. Also, it enhances water infiltration, improves soil water use efficiency, and provides increased insurance against drought. Permanent soil cover is maintained during crop growth phases as well as during fallow periods, using cover crops and maintaining residues on the surface;
- *Promoting a healthy, living soil through crop rotations, cover crops, and the use of integrated pest management technologies.* These practices reduce requirements for pesticides and herbicides, control off-site pollution, and enhance biodiversity. The objective is to complement natural soil biodiversity and to create a healthy soil microenvironment that is naturally aerated, better able to receive, hold and supply plant available water, provides enhanced nutrient cycling, and better able to decompose and mitigate pollutants. Crop rotations and associations can be in the form of crop sequences, relay cropping, and mixed crops;
- *Promoting the application of fertilizers, pesticides, herbicides, and fungicides in balance with crop requirements.* This principle is based on feeding the soil rather than fertilizing the crop. The strategy is to reduce chemical pollution of the environment, improve water quality, and maintain the natural ecological integrity of the soil, while optimizing crop productivity and the economic returns;
- *Promoting precision placement of crop inputs to reduce input costs, optimize efficiency of operations, and prevent environmental damage.* This principle is based on treating the problems at the field location where they occur, rather than blanket treatment of the field, as with conventional systems. The benefits are increased economic and field operation efficiencies, improved environmental protection, and reduced (optimized) input costs. Precision is exercised at many levels: seed, fertilizer and spray placement; permanent wheel placement to stop random compaction; individual weed killing with spot-spraying rather than field spraying, etc. Global positioning systems are sometimes used to enhance precision, but farmer sensibility in problem diagnosis and precise placement of treatments is the principal basis. In small scale farming systems and horticultural systems, it also includes differential plantings on hills and ridges to optimize soil moisture and sunshine conditions;
- *Promoting legume fallows (including herbaceous and tree fallows where suitable), as well as promoting composting and the use of manures and other organic soil amendments.* This improves soil structure and biodiversity, and reduces the need for inorganic fertilizers;
- *Promoting agroforestry for fiber, fruit and medicinal purposes.* Agroforestry (trees on farms) provides many opportunities for value added production, particularly in tropical regions, but these technologies are also used as living contour hedges for erosion control, to conserve and enhance biodiversity, and to promote soil carbon sequestration.

FAO also defines CA with the following quantifying parameters

1. Minimum soil disturbance: the disturbed area must be less than 15 cm wide or 25 per cent of the cropped area (whichever is lower); no periodic tillage disturbs a great area than the aforementioned limit.

2. Soil cover: three categories are distinguished; between 30-60 per cent, 61-90 per cent and 91+ per cent ground cover, measured immediately after the planting operation; ground cover less than 30 per cent will not be considered conservation agriculture.

3. Crop rotation: the rotation should involve at least three different crops.

   Minimum tillage is necessary but it has to be combined with at least two complementary practices which are soil cover and diversified crop rotations. Only the combination of these techniques with their synergistic effect can lead to a sustainable, resource saving CA model

Tillage management practices with minimal soil disturbance and incorporation of crop residues decrease soil carbon losses through enhanced decomposition and reduced erosion. Systems that retain crop residues tend to increase soil carbon because these residues are the precursors of soil organic matter. For example, conservation tillage which leaves at least 30% of ground covered by crop residue mulch during seedbed preparation, increases soil organic carbon content when land is converted from conventional (plough-based) use.

Reduced tillage is another conservation tillage achieved by minimum disturbance of the soil in areas where seeds will be planted, either in rows or planting holes or small basins. Reduced tillage evolved in attempt to solve some disadvantages of NT systems, and improve root growth and penetration and water infiltration while maintaining surface mulch and slow down decomposition of organic residues. Reduce tillage can be achieved through:

Ripping is the most popularly advocated conservation tillage technology in tropical soils. Ripping is achieved by using a ripper that breaks clogs along the planting rows, leaving the spacing between rows undisturbed. The ripped area also acts as micro-catchment to collect rainfall water and increase infiltration. Ripping can be done by using tractors or oxen.

Small Planting basin is reduced tillage practices where the farm is cultivated in small fixed/permanent basins with 30-cm long and 20-cm deep, using narrow, deep and strong hand-hoes. The basins are cultivated at 70 cm spacing along the planting rows and 90 cm apart between rows to form rows of small basins. Seeding and fertilizer application is done in each basin. For maize 8, to 10 seeds are planted in a basin, while 10 to 20 seeds of beans are planted per basin. The basins are the only spot where soil is disturbed, hence helps to conserve soil and moisture. The basins also act as in situ rainwater harvesting and store water in the soil profile.

Increased nutrient uptake and N use efficiency across a wide range of rice growing environments with diverse climatic conditions were related to the effects of improved N management and balanced nutrition, an important impact of conservation agriculture. A major challenge is to simplify the approach for wider scale dissemination without sacrificing components that are crucial to its success. The underlying principles of SSNM need to be carefully identified and evaluated for each macronutrient. Approaches to further dissemination must be related to prevailing site-specific conditions.

Annexure B

Research Work Conducted

i. ***At sponsoring institutions:***

- ✓ Identification of bio-intensive, complementary cropping systems for high productivity and efficient resource use
- ✓ Resource conservation and sustaining high productivity through cropping system management and land configuration
- ✓ Long Term influence of Resource Conservation Technologies and crop Residue Management Practices on Crop Productivity, water requirement and soil health in Rice-Wheat cropping system.
- ✓ Long Term influence of Resource Conservation Technologies on Crop Productivity, weed management, water use and soil health in Rice-Wheat cropping system.
- ✓ Long Term influence of Resource Conservation Technologies on Crop Residue Management practices on crop productivity and soil health in Rice-Wheat cropping system
- ✓ Development of low-cost multi tillage, multi-crop planter for round grain cereals, legumes and pulses.
- ✓ Resource conservation modules for high yield realization for different cropping systems
- ✓ Studies on improvement of soil organic carbon pool in rice-wheat system under resource conservation technology
- ✓ Conservation agriculture based weed management practices in rice-wheat cropping system

II. ***In other Institution of the country (India)***

Conservation Agriculture is a concept for resource saving agricultural crop production to achieve sustained production and conserving the environment. Function of conservation agriculture is based on three key principles, viz. effective resource conservation, input optimization and optimum productivity of the farming system (Nagarajan et al., 2013). Certainly, the advancement in conservation agriculture is possible through genetic improvement in crops and varieties, which are suitable for better adaptation to different farming system environments. Besides, improved varieties and technologies can be assumed to improve productivity with an optimized input level. In the case of rice, resource conservation is possible with proper technological intervention. Water is the one of the most important factor, which governs the productivity of rice. In the concept of conservation agriculture, rice growing systems such as aerobic rice, direct seeded rice, system of rice cultivation and alternate wetting and drying could be used to conserve water. Several problems come to exist in rice growing environment under limited water such as pest, disease and weeds, which may reduce productivity.

Conservation agriculture helps in sequestering atmospheric carbon in soil-plant system through change in agricultural operations and management practices. Conservation tillage along with efficient management of inputs, viz. irrigation, fertilizer and pesticides facilitates carbon sequestration in soil-plant system. Land use change and conventional agricultural practices are major contributors to global annual emission of CO_2. Conservation agriculture and recommended management practices (RMPs) collectively are helpful to offset part of the emissions due to unscientific agricultural practices.

Based on average benefits of all conservation tillage systems, the carbon sequestration potential of adopting a conservation tillage system is about 0.15 t/ha (Lal 1997, b). Adoption of reduced tillage may also save fossil fuels at the rate of about 8 KgC/ha/year.

Zero tillage, strip till drill, bed planter and rotary till drill saved 60-85 per cent resources in rice ï wheat system (Singh, 2012). Zero tillage is conservation tillage achieved by no soil disturbance. Hence planting is done by no-till planter capable of placing seeds at appropriate depth in the soil and ensures adequate seed-soil contact required for germination. The advantage of NT is that it ensures surface soil cover by leaving residue on the surface, conserve soil moisture, and increase SOM in the top soil. However, NT in compacted soil hinders root development after seed germination especially during first years of no till, and reduced infiltration at early stages of NT. Weed pressure is also a problem in case the surface mulching is low in NT system. In the zero tillage or NT practices weed control depends solely on herbicides. The grain yields of rice were not significant with tillage. Zero-till wheat (Sah et al. 2013), however, produced significantly higher grain yield (2777 kg ha^{-1}) than permanent bed planting (2438 kgha-1) and conventional tillage (2499 kgha-1). It is not only on the part of saving energy but zero tillage helps in increasing cropping intensity thus improving carbon sink. As a successful example ICAR Research Complex for NEH Region, Meghalaya (ICAR report) introduced vegetable garden pea after rice using zero tillage technology in Nongthymmai village where farmers leave rice field fallow during rabi season mainly owing to lack of irrigation facilities.Efficient nutrient management of macronutrients increased yields of rice and wheat crops by 12 and 17% and profitability by 14 and 13%, respectively, in Northwest India (Khurana et al., 2008). Results suggest that further increases in yield can only be expected when farmers exploit the synergy that occurs when all aspects of crop, nutrient, and pest management are improved simultaneously.

III. **Other countries**

Historically, invention of cultivation implements such as mouldboard in the 11th century in Europe, followed by agricultural mechanization using tractors with multiple implements by early 1900 enable intensive cultivation in many agricultural soils in Europe and America. However, between 1931 and 1939, a dust bowl era took away precious top soil, which was made vulnerable by ploughing, was witnessed in the southern plain of US resulting in farm degradation and crop failure (Huggins and Reganold, 2008). Thus, the need to reduce intensive cultivation and ensure soil cover was realized as early as in 1940ös.The important practices of conservation of soil and water and improving rain/irrigation water have been summarized.

Conservation tillage is an important instrument that achieve minimum soil disturbance and leave organic residue on the surface of the soil to ensure at least 30% of surface soil cover (FAO, 1993). Conservation agriculture (CA) is a combination of wide range of tillage and cropping practices/technologies that aims at ensuring minimum soil disturbance, adequate soil cover, and mix or rotation of crops so as to reduce soil physical and chemical degradation (IIR and ACT, 2005). A combination of practices such as conservation tillage (reduced/minimum or zero tillage), mulching, intercropping, crop rotation are core in CA. Conservation agriculture hold great promise to break vicious cycle of poverty due low productivity and food insecurity caused by land degradation that makes the society vulnerable and hence poor. The entry point to break the cycle is through CAös positive impact on preventing/reducing land degradation to form a sustainable and viable production system that will improve livelihood of many rural communities in Africa. The CA core technologies/practices include:

The agricultural soil is usually disturbed by tilling or cultivating so as to loosen up the soil to enable easy root penetration and water infiltration for adequate crop growth. Other advantages of soil disturbance is discouraging weeds growth and reduce weed competition with crops at early stages of crop development. However, too much soil disturbance and inappropriate tillage methods has led to excessive removal of soil surface cover, destruction of soil structure and compaction, rapid losses of SOM and susceptibility to water and wind erosion during early stages of before full canopy cover.

Residue management is key to maintaining soil C in annual crops. Early estimates (Graham et al. 2007) suggested that, on average, about 55% of the stover produced by the U.S. corn crop could be harvested without risk of erosion were no-till management widely adopted. Erosion, however, is not the sole arbiter of soil C levelsð recent evidence (Wilhelm et al. 2007) suggests that only about a third of this amount can be harvested if soil C stocks are to be maintained. Removing even this amount, however, is likely to be insufficient to sequester additional C, so the fossil fuel offset credit of harvested residue must be carefully compared to the lost soil sequestration benefit, particularly if the prior system was accumulating soil C via no-till or set-aside management. Furthermore, the need to replace nutrients removed in residues, through increasing fertilizer additions, is an additional consideration.

Conservation tillage and no-tillage practices could provide higher C sequestration. It was found that a change from conventional tillage to no tillage could sequester from 0.43 to 0.71 Mg C haī 1 yearī 1 In an experiment conducted in Saskatchewan by Malhi and Lemke (2007), N_2O emissions were significantly lower from no-tillage (155 g N haī 1) than the conventional tillage (398 g N haī 1) treatments in the third year of the study. Rochette et al. (2008) summarized the effect of no tillage on N_2O emission and concluded that the net impact of the no-tillage on N_2O emission to be highly dependent on local environment (i.e. climate, soil type). In addition, the lower farm operation from no-tillage practices could further improve the net GHG. Although, in long term, the C sequestration return diminishes, CO_2 emissions are directly reduced since tillage fuel consumption is the greatest proportion of farming activity (Johnson et al. 2007) and Singh (2012) also reported a reduction of around 70 kg CO^2 emission by zero tillage over conventional sowing.

Integrating perennial trees/shrubs plants in agricultural lands both crop production and grazing has been documented to improve soil cover, and ensure green cover during off season. In so doing trees/shrubs in agricultural land helps to curb land degradation and conserve biodiversity to create a resilient land use that adapt and mitigate climate change (Kitalyi et al., 2011). This technology when integrated in crop land has to be done in such a way that light competition or shading effect between trees and crops is avoided. Thus, careful selection of trees with low shading effect and planting at the border of the farms preferably on the south-north borders is recommended. Trees can also be planted in areas of the farms that are highly vulnerable to soil degradation such as on steep slopes, soil bunds of terraces, and near water sources. Alley cropping can also be done, where trees are planted in alleys between crop fields.

Fertilizer trees capable of fixing atmospheric nitrogen and with multipurpose use such as Sesbaniasesban, Crotalaria grahamiana and Tephrosiavogelii are recommended and have been successful used in Kenya and Tanzania (Kitalyi et al., 2011). The World Agroforestry Center has developed four fertilizer trees options to improve soil fertility in the crop land. These fertilizer tree options includes fertilizer trees during fallow in rotations with cereal crops, intercropping fertilizer trees as coppiced fallow and cereals, intercropping shrubs in annual allay with cereals, and harvesting Gliricidia or Tithonia trees/shrubs leaves and apply them in crop land as mulch, green manure or compost (biomass transfer).

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