PROJECT PREPARATION TECHNICAL ASSISTANCE

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FEASIBILITY REPORT

for the

Karnataka Integrated and Sustainable Water Resources Management Investment Program

VOLUME 2: ANNEXES

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Prepared for the State Government of Karnataka and the Asian Development Bank

By

DHV BV, The Netherlands in association with DHV India Pvt. Ltd.

Abbreviations

AC-IWRM	Advanced Center for Integrated Water Resource Management
AIBP	Accelerated Irrigation Benefit Program
CADA	Command Area Development Authority
CDTA	Capacity Development Technical Assistance
CMO	Central Mechanical Organisation of WRD
DPR	Detailed Project Report
EA	Executing Agency
EARF	Environmental assessment and Review framework
EIRR	Economic internal rate of return
EMMP	Environmental management and mitigation plan
FIRR	Financial internal rate of return
FY	Fiscal Year (April 1 – March 31)
GAP	Gender Action Plan
GOI	Government of India
GSDP	Gross State Domestic Product
IA	Implementing Agency
ICB	International competitive bidding
IEE	Initial environmental examination
IP	Indigenous people
IRBM	Integrated River Basin Plan
IWRM	Integrated water resources management
KERC	Karnataka Engineering Research Center
KISWRMIP	Karnataka Integrated and Sustainable Water Resources Management Investment Program
KNNL	Karnataka Neeravari Nigam Limited
KUIDFC	Karnataka Urban Infrastructure Finance Corporation
KUWSDB	Karnataka Urban Water and Sewerage Drainage Board
LWMP	Land and Water Management Plan
MCM	Million Cubic Metres
MFF	Multi-Tranche financing facility
MIS	Management information system
NCB	National competitive bidding
NGO	Non-government organization
O&M	Operation and maintenance
PIM	Participatory irrigation management
PMU	Project Management Unit
PPP	Public Private Partnership
RBO	River Basin Organization
RP	Resettlement Plan
SGOK	State Government of Karnataka
SPCB	State Pollution Control Board
TLBC	Tungabhadra Left Bank Canal
TMC	Thousand Million Cubic Feet (1 TMC = 28.317 MCM)
WALMI	Water and Land Management Institute of WRD
WRA	Water Regulatory Authority
WRD	Water Resources Department, Government of Karnataka
WRDO	Water Resources Department Organization, Government of Karnataka
WUCS	Water User Cooperative Societies

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ANNEX 1: DESIGN AND MONITORING FRAMEWORK

Draft Design and Monitoring Framework (DMF) TR – 1

Design Summary	Performance Targets/Indicators	Data Sources/ Reporting Mechanisms	Assumptions and Risks
Impact Enhanced access and security of water supply in the selected river basins in Karnataka	By 2016 • Enhanced and secure access to irrigation water increased by 2000 ha to 4,600 ha. • Increased incomes from irrigated agriculture of selected irrigation schemes by XX% and Rs XXX per household. • Minimum water quality and quantity targets are identified at key locations in the river basins	State and district statistics WRD/KNNL annual reports and scheme monitoring reports WRA annual reports CWC annual water yearbook Beneficiary surveys	**Assumptions** Net returns to agricultural enterprises remain positive
Outcome Improved water resources management in the selected river basins in Karnataka	By 2020 • Bulk water deliveries defined for major water users with operating plan including for drought conditions • Water allocation and hydrology (quantity and quality) monitoring system operated • Improved agricultural productivity of water by Rs XX/ m^3 • Canals operated and maintained to the satisfaction of WUCS • Beneficiary perception of service quality improved substantially	WRD/KNNL annual reports and scheme monitoring reports WRA annual reports Regular beneficiary perception surveys	**Assumptions** No natural calamities (eg. drought) beyond the design return period Continued political support to sustain and proceed with reforms
Outputs 1. AC-IWRM Strengthened to Support State and Basin level institutions and policies – State level policies reflect IWRM principals and requirements – Tungabhadra sub basin is managed consistent with IWRM principals – Information and knowledge management systems support the needs of river basin managers	AC – IWRM fully staffed and functioning as evidenced by the following indicators. • Draft state IWRM policy prepared and stakeholder consultation completed • Tungabhadra sub basin interim River Basin Organisation established and meeting regularly • Tungabhadra sub basin draft river basin plan endorsed by WRD • Water resource management model for Tungabhadra sub basin developed and used for river basin planning, management and operational advice	Project reports RBO meeting minutes WRA reports WRD/KNNL reports and minutes	**Assumptions** Continued political support to sustain and proceed with reforms AC-IWRM established with adequate resources
2. Management of Bhadra and Gondhi irrigation sub project is modernized – Infrastructure is modernized – Irrigation system management institutions strengthened	• 74.6 km of Gondhi Right Bank and 14.50 km of Gondhi Left Bank subproject main canal lined and 4,600 ha provided with Command Area Development works. • Flows at the measuring points	State and district level statistics WRD/KNNL annual reports and scheme monitoring reports WUCS reports Regular beneficiary surveys	**Assumptions** Continued political support for the reforms WUCS members are willing to adopt modern agriculture practices

Design Summary	Performance Targets/Indicators	Data Sources/ Reporting Mechanisms	Assumptions and Risks
– Irrigation system management is taking a volumetric water management approach – Information system are installed and data used for planning – WUCS are functional and managing minor and on-farm distribution networks: – WUCs receive water on volumetric basis – Farmers income and living conditions from irrigated agriculture increased	along the Gondhi and Bhadra canal are within 10% of design values at all times during the irrigation seasons • Telemetry installed and hydrological data is being recorded and used by water managers • 10 MOUs established (including 1 new WUCS) between WUCS and KNNL and system management handed over all WUCs • Farmer membership of WUCS on Gondhi system increases from 30% to 90% • 75% of farmers confirm receipt of their share of water • Water charges are volumetrically based and collections, increase from < 20% to 100% • WUCs receive the full government support from O & M • Asset management plans developed and updated annually by WUCS • Household income from irrigated agriculture increased from XX Rs. – XX Rs during Tranche 1.		Sufficient disciplines are applied to maintain orderly water distribution and fee payments No excessive droughts or floods beyond the design return period
3. Efficient Program Management Systems Operational	• PMU and SIO fully staffed with required expertise and made operational by month 3 • Project MIS established and reporting project implementation by month 6 • Project procurement plan prepared and implemented as per schedule • Financial disbursement happening as per project annual plans • Project Support Consultancy contracted and providing inputs as per ToR and schedule.	Project records and periodic reports Reports to and of supervision meetings Quarterly finance reports	**Assumptions** Timely staffing and mobilisation of PMU and SIO Resources and capacity available to build effective MIS Sound administrative practices developed and established
Activities with Milestones 1. Program Implementation 1.1. Inception Activities (by January 2014) – Preparation of inception report – Organization of an inception workshop, TA steering committee and work group meetings, and ADB inception mission 1.2. Implementation management (by January 2014) – Regular interactions with TA staff and work group members, and preparation of monthly activity summaries (by consultants) – Preparation of mid term progress report, organization of TA steering committee and advisory group meeting, fielding of ADB review mission – Organization of draft final workshop, TA steering committee, and advisory group meeting			**Inputs** ADB: $150 million Government: $75 million Beneficiaries: T.B.D.

AC-IWRM = Advanced Centre for Integrated Water Resources Management; ADB = Asian Development Bank; CWC = Central Water Commission; DSS = decision support system; IWRM = integrated water resources management; MLD = million litter per day; O&M = operation and maintenance; RBO = river basin organization; SIO = Sub-Project Implementation Office; TA = technical assistance; WRD/KNNL = Water Resources Department/ Karnataka Neeravari Nigam, Ltd.; WUCS = Water User Cooperative Society

Initial Environmental Evaluation, Gondhi Anicut

Karnataka Integrated and Sustainable Water Resources Management Investment Program

November, 2012

Prepared for the State Government of Karnataka and the Asian Development Bank

DHV BV, the Netherlands in association with DHV India Pvt. Ltd.

EXECUTIVE SUMMARY

1. The project is located in the Bhadrawati Taluk of Shivamogga District. Part of this district comes under the Western Ghats. Shivamogga also has a few sensitive areas such as the Bhadra Tiger Reserve. However, Bhadrawati Taluk does not fall in any of the wildlife reserve areas. From the available information and plans it unlikely that there will be any major adverse environmental impacts from the project. Considering the limited impact of the project, this project has been categorized as Category B project. Therefore, an IEE has been conducted for it.

2. There are also likely to be a number of positive impacts from project activities such as improved drainage resulting in better soil health, increased agricultural productivity and reduced habitat for certain disease vectors. There are discussed in greater detail in the impact assessment section.

3. Most adverse impacts are likely to be during the construction phase – when the canal lining and other structures (eg. outlet structures, bridge replacements, command area works, etc) are to be put in place, agricultural intensification taking place spontaneously and as part of the project design, the increased efficiency of water use and potentially a small expansion of agriculture. The major construction related activities of concern are the procurement of material, transport routes, and the various sites. These sites include quarries and borrow pits, material storage, labour camps and construction areas. The major concerns related to construction activities are (i) safety of the workers and local population, (ii) waste disposal, (iii) impact to local ecosystems due to degradation or destruction, (iv) reduced access to the local population dependent upon the sites, (v) long term degradation of sites such as erosion or waterlogging due to inadequate rehabilitation, (vi) damage to local infrastructure, and (vii) health risks from poor site management or safety and labour management such as waterborne diseases due to inadequate provision of sanitation facilities.

4. Tanks, currently linked to the canal system and which collect catchment runoff, overland flow from an upstream irrigation area and water from the canal system may be separated and then regulated to improve functioning and water management of the canal system. This will affect, to some extent, tank functions as ephemeral wetlands and result in longer term and less variable water levels. This could have some impact on the local ecosystem; however this is not likely to be a major concern.

5. Agricultural interventions and intensification is likely to result in higher use of agrichemicals[1]. This is expected to create greater toxicity to the environment impacting human health and the ecosystem adversely as these chemicals enter the environment. Furthermore, the disposal of agrichemical waste will also become an issue considering that at present there is no system for its disposal. While some waste is burnt or buried other, such as plastic containers are reused, entering the human food chain directly. Furthermore, any expansion of irrigated agriculture, although not planned may result in increased waterlogging, that may have an adverse impact on soil health and agriculture productivity. Increased waterlogging may also result in an increase in vector-borne diseases like malaria, or waterborne diseases due to existing low levels of sanitation.

6. Increased irrigation efficiency is another possible concern for the environment. While increased irrigation efficiency in some areas would result in reduced waterlogging, it may also result in reduced return flows to the river. This is likely to impact existing ecosystems and downstream users adversely.

7. Agricultural intensification and assured irrigation could result in increased hydraulic loading of soils not previously fully irrigated. This could result in waterlogging, increase the toxicity to the environment and may also create vector habitats.

1 Household survey and anecdotal experience indicates that the use of fertilisers is already high and exceeding recommendations levels. The project intervention is to reduce this to recommended levels.

However, most of these impacts are likely to be managed with appropriate interventions which are to be included in the project design, or in the case of construction related activities though appropriate contract clauses. The EMPs of all activities need to be monitored, as should the overall implementation of the project to ensure both appropriate implementation of the EMP and also inclusion of any unforeseen impacts during implementation.

8. In the case of construction related activities, good site management, consultative processes to ensure local populations are not adversely impacted, rehabilitation of sites, and safety measures at all sites are the major management actions required. Safety needs should not only include appropriate signage and warnings, but also safety equipment for workers and first aid in case of any accident until the injured are taken to appropriate medical centres.

9. To ensure agriculture interventions do not have an adverse impact on human or ecosystem health a good service to provide both information and support for farmers would be needed. This could include the better management, storage and disposal of agrichemical waste; Integrated Pest and Nutrition Management knowledge; and access to resources to prepare and implement identified farm management strategies including for the management of soil health (waterlogging, salinity, nutrition, organic matter, soil structure etc).

10. The maintenance of environmental flows and land use changes and patterns are likely to be beyond the immediate implementation actions of this project. Much of this can be more appropriately addressed in the overall IWRM framework of the KISWRMIP and the river basin management activities. Local land use changes and environmental risks – such as conversion of tanks that function as ephemeral wetlands into semi-permanent and more stable water retention structures, and other reclamation processes, may be reduced though the project's farm level education and communication process which would also address improved on-farm land, water and agriculture management. As well, guidelines for the operation of tanks that are integrated into the water distribution system would ensure increased multiple benefits (environment and socio-economic).

1. PROJECT DESCRIPTION

11. The Gondhi Anicut is built across river Bhadra, near Gondhi village which is 11.56 Km from Bhadravathy Town, Bhadravathy Taluk, Shivamogga District. It is situated at a latitude 13°46' N & longitude 75° 41' E. Gondhi anicut is located at 14.50 km downstream of Bhadra Reservoir. The construction of the anicut was started during 1916 and completed during 1926 with an estimated cost of Rs.16.00 lakhs. The Right bank canal was commissioned during 1926-27. The work of left bank canal started during 1951 and completed during 1953-54.

12. There are two main canals originating from Gondhi anicut both from Left Bank and Right Bank. Left bank canal is 14.5 km long with 20 DPOs for an atchkat of 212 Ha and full potential is created under this canal. The discharge required in the canal is 0.56 cumecs (20 cusecs). Right bank canal is 74.40 Km long with 16 distributaries and 130 DPOs to cater an atchkat of 4388 Ha. The Discharge required in the canal is 7.50 cumecs (265 cusecs) in unlined condition. The Gondhi Anicut canal system is unlined.

13. The GCA is 5060 Ha, CCA is 4600 Ha and sanctioned atchkat is 4465 Ha.

1.1 Canal Modernisation Activities

14. The following interventions are envisaged to upgrade the system and these and the following summary are described more fully in the main report and its attachments:

- Repairs to the Gondhi anicut and canal head works.
- Improvement of main canals and distributaries including provision of concrete canal lining to suit future water delivery requirements and upgrading of canal access roads. Lining may be a combination of slip formed channel and large precast units in order to minimize the duration of canal closures.
- Repair / replacement of all canal structures including bridges and crossings, drainage inlets and relieving weirs, pipe outlets and provision of new structures such as cross regulators where necessary to support the future operational objectives. Ramps into canals for laundry and animal drinking will be provided.
- Modification of current on-line storage (tanks) where feasible to become actively managed off-line storage and enhancement of existing off-line tanks for more pro-active management.
- Command area development works comprising lined channels, low pressure gravity-supplied pipe distribution where technically feasible and drainage where required.
- Provision of electronic flow measurement with telemetry at about 20 locations on the main canal and drainage system and flow measurement with recorders at all outlets.
- Capacity development of system operations staff and water users to enable them to effectively use the flow measurement system and provide a more efficient and equitable water distribution service more closely aligned with farmers' needs.
- Agricultural extension and on-farm water management training to equip the farmers with the skills to use water more efficiently.

15. It is also envisaged to develop managed conjunctive use of canal water, water stored in tanks and pumped groundwater and undertake small pilots of pressurised irrigation using gravity supply from the main canal with possible interlinking to existing drip irrigation that uses groundwater.

Construction Activities:

16. In summary, and in relation to environmental implications, the main construction activities are expected to involve:

- Clearance of vegetation along the canal rights of way to provide access and working space for the construction activities.
- Excavation where necessary within the existing canals. Suitable excavated material may be re-used within the construction works and unsuitable material (too silty) may be placed on fields to improve soil quality. The total excavation volume is estimated to be about 250,000m³.
- Filling of about 350,000m³ to restore the canal cross section and access track. Fill material will either be suitable material from the excavation or from borrow areas.
- Gravel surfacing of canal roads using material from suitable quarries or borrow areas.
- Concrete lining either using mechanised paving equipment, precast concrete units or hand-placed concrete. Concrete for paving equipment would be supplied by ready-mixed concrete but concrete for hand-placed lining will probably be mixed on site. Precast units would be stockpiled on site for a brief period before installation.
- Reconstruction of canal structures using reinforced concrete. Most structures will be cast in place although some works may use precast concrete. Rebuilding of larger structures may take a month or more and will probably follow after the lining works.
- Provision of either concrete field channels or pipes within the command area which will require temporary access over fields.

17. The logistics associated with the construction work include:

- Extensive movement of trucks carrying soil, gravel for roads and either ready-mixed concrete or materials for concrete. Potentially there could be about 100,000 round trip truck movements depending on the truck size.
- It is not currently envisaged that there will be work camps in the field as the construction sites are close to Bhadravati.
- The canals under modernisation do not pass through or immediately adjoin forest. The Gondhi Anicut and Gondhi left bank canal at the anicut is within 1 km of a minor forest (sandalwood plantation) and 6 km of a reserved forest (and wildlife reserve) on the left side of the Bhadra reservoir, with the Bhadra Left Bank canal and settlements in-between. The Gondhi Anicut and Right Bank Canal near the anicut are 2 km from a minor/State forest with settlements in between. It is 11 to 12 km from the Wildlife and Tiger Reserve with the Bhadra Right Bank canal and settlements in-between. Elsewhere the canal is more than 2.5 km from reserved forest with the Bhadra Right Bank canal and settlements in-between
- Modernisation works for each site will occur just the once and activity at any one location will only be for a few days in total. Passing traffic will increase for most of that closure period. Overall modernisation is expected to take place in 1 or 2 canal closure periods each year (mid May – mid July or December) when the canals are normally empty.

Improved In-scheme Storage

18. Gondhi irrigation system contains at least 20 tanks. Some of these are along the main canal and were formed where the canal cuts across small side valleys. Others are within the command area. One of these tanks, Koppa Dodakere, commands about 60ha and has gated outlets to enable active management of supply to its command area. The tanks along the main canal are on-line, which mean that their water levels fluctuate with the main canal. As such, they reduce the responsiveness of the system to flow changes. It is therefore recommended that tanks are modified to enable active management of the stored water. Once the tanks along the canals are modified so that they can be separated from the canal flows, they are likely to reduce in level and dry out more than they do currently in the dry

(Rabi) season and possible increase in storage in and immediately following the wet (Kharif) season.

Night Storage Reservoirs

19. The possibility of providing night storage reservoirs should be investigated. These would be located downstream of outlets so that, although water can flow continuously through the outlets, irrigation in the command area would be only undertaken in day-time, when water can be managed more efficiently, safely and wastage reduced. Such reservoirs, however, will require land which will need the support of the beneficiaries which may not be immediately forthcoming. If water becomes scarcer in future years then such reservoirs can only be incorporated if the downstream system has been designed for the increased flows resulting from 12-hour irrigation.

Command Area Development

20. To realise the overall objective of improved water use efficiency it is necessary to improve the entire distribution system between head works and the crops. This involves improving the distribution system in the command area and, if necessary, supporting measures such as land levelling and drainage. There is considerable potential to upgrade the command area distribution system in Gondhi. It is recommended that this distribution system includes piped distribution where feasible using uPVC or HDPE pipes. Final distribution of water from the fixed pipe outlets could be undertaken using flexible hose. A piped system will provide several benefits including: (i) negligible land take; (ii) negligible conveyance losses; (iii) reduced opportunity for water to be drawn from points between the agreed outlets; (iv) a clearly defined rotation system for sharing the use of the pipe outlets.

Gravity-Fed Pressure Irrigation

21. Part of the command area has slopes greater than 1% with land more than 10m below main canal level. This provides opportunity to mobilise sufficient pressure for micro sprinklers or drip irrigation with associated increase in water use efficiency. There may be potential for interlinking of the pressure supply from the canal system with the drip irrigation systems provided for some arecanut plantations to enable conservation of groundwater supplies for periods when insufficient surface water is available.

Reuse of Drainage Flows

22. At present the Gondhi main canals intercept drainage flows (both runoff from rainfall and excess flow from irrigation) from the Bhadra canal command areas. However, with better water management within the Bhadra system this source of water is expected to diminish. Within the Gondhi command area there is also potential to intercept runoff for re-use further downslope (the tanks within the command area probably do this) which raises the water use efficiency within the system. The existing situation needs to be mapped and further potential for water reuse identified.

Conjunctive Use

23. Opportunities should be identified for conjunctive use of surface water (canal supplies, water stored in tanks and pumping of surface water during canal closures) and groundwater, particularly to sustain perennial crops during canal closures. The potential groundwater storage and the likely abstraction should be estimated and compared with expected recharge from rainfall and irrigation percolation losses, while taking account of the tendency for groundwater to migrate downslope.

Flow Measurement

24. Improved flow measurement will provide information to support better operation of the irrigation system both in terms of day-to-day flow management and quantification of flow

volumes supplied. Main canal flow measurement will use electronic flow measurement devices with telemetry to enable real time data acquisition to guide system operation. Likely measurement points are at boundaries of WUCSs, at major inflows and possibly at selected command area outflow points. In addition, flow measurement using flumes with water level and flow volume recorders is proposed for all outlets so that water provided to each WUCS can be quantified.

Support to System Operation

25. Capacity building of the WUCSs is required to enable them to be sustainable and undertake operation and maintenance of the irrigation distribution system. Specific training of system operations staff will be provided to enable them to benefit from the flow measurement system to provide efficient and efficient operation with minimal wastage.

1.2 Agriculture Related Activities

26. The major agriculture related activities planned under the project are,

- Crop diversification including by introducing short duration and market value added crops such as vegetables, flower cultivation.
- Introduction and increase in the area under SRI Paddy cultivation which will increase yields and significantly reduce water use.
- 100% coverage of the area by soil testing, balanced fertilizers, use of micro nutrients and Integrated Pest Management. This should at least offset any increase in agrichemical use and it should reduce from the current levels. It should reduce the current applications of fertilisers which are said to exceed recommended levels.
- Adoption of rice (Kharif) following pulses (Rabi) cultivation
- Increase in area of crops under micro irrigation which will reduce water runoff and recharge of groundwater in the Rabi season
- Increase of area under horticultural crops with special focus on Arecanut, tissue cultured Banana
- Improved extension and training through WUCS to farmers to increase water saving, agricultural production, farmer profitability and environmental sustainability

1.3 Land and Water Use and the Environment Conditions

27. At the height of the irrigation season (Rabi), it is believed that, other than for urban water supply, little water is released into the rivers and all the inflows are diverted through the main canal off-takes for irrigation. As a result flows in rivers are extremely low for a considerable part of the year[2].

28. Currently water is supplied to the Gondhi system from the Gondhi Anicut. For the lower Gondhi canal beyond about chainage 45 km, irrigation water is received as tail water from the Bhadra system. Tailwater from the Gondhi system, as well as rainfall runoff from both, flows through to the Bhadra river. Return flows during the Rabi season are thought to be used further downstream by irrigation systems. Return flows are also considered to be a source of non point source pollution with elevated nutrients in particular for the river.

29. Once the project is implemented, the Gondhi DPR indicates that the current water irrigation supply water usage for the Gondhi system will be reduced by 0.5 TMC (14.12 Mm^3)[3]. The saved water will be transferred to new irrigation developments in the Upper Bhadra catchment. As a result of this and a major reduction of flows entering the Gondhi

2 CDTA Report (2010) Component 2: Sub-Basin Framework Plans for Efficient and Sustainable Water Resources Management. Integrated Water Resource Management and Sustainable Water Service Delivery in Karnataka (ADB TA No. 7418-Ind)

3 Modernisation of Left Bank Canal and Right Bank Canal of Gondhi Anicut in Bhadravati Taluk, Shimoga District. Detailed Project Report September 2012, 3G Consultants. p30.

system once the Bhadra system is being operated optimally, Tailwater, as well as non point source pollution leaving the Gondhi system and entering the Bhadra river is expected to be much reduced. Within the Gondhi area, the recharge of groundwater during the Rabi season should also be much reduced as the area of paddy is replaced with SRI rice and other annual and perennial crops.

30. The land in the command area is currently fully cropped based on satellite interpretation and so there is little likelihood that the area of irrigated land will expand especially given the planned reduction in the supply of water. A greater intensity of use is likely however and this is likely to involve greater use of agrichemicals although the use of N:P:K is said to already exceed recommended levels. An agricultural extension effort is to be implemented to reduce these inputs and to introduce IPM and INM.

2. POLICY AND LEGISLATIVE ARRANGEMENTS

31. There are a number of acts and rules of the State and National Government that may be of important to the project. While some of these could define activities to be done and location of the project, there are others that may be supported by project activities. This section discusses these regulations and their implications. As required for ADB activities the required actions under these legislations will need to be undertaken.

2.1 National and State Legislation

Environmental (Protection) Act, 1986, Environmental Impact Assessment Notification, 1994 with amendments and rules

32. This act vests power in the Central Government to take necessary action to protect the environment and in the prevention of environmental pollution. Under this act, standards for pollution and the discharge of effluents, as specified under the various pollution control acts are made. Under this act procedures and safeguards for handling hazardous substances are also laid down. All projects and activities are broadly categorized into two - Category A and Category B, based on the spatial extent of potential impacts and potential impacts on human health and natural and man made resources.

33. According to notification of 2006 under sub-rule (3) of rule 5 of the EPA, 1986, powers conferred by sub-section (1) and clause (v) of sub-section (2) of section 3 of the Environment (Protection) Act, 1986, read with clause (d) of sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986 construction of new projects or activities or the expansion or modernization of existing projects or activities listed in the Schedule to the notification entailing capacity addition with change in process and or technology will only be undertaken after the prior environmental clearance from the Central Government or as the case may be, by the State Level Environment Impact Assessment Authority.

34. The Schedule includes in 1(c) River valley projects, including irrigation projects. The table below gives details of what is mentioned under 1(c) of the Schedule.

		Category with threshold limit		Conditions if any
Project or Activity		**A**	**B**	
1(c)	River Valley projects	(i) ³ 50 MW hydroelectric power generation; (ii) ³ 10,000 ha. of culturable command area	(i) < 50 MW ³ 25 MW hydroelectric power generation; (ii) < 10,000 ha. of culturable command area	General Condition shall apply

35. Any project or activity specified in Category 'B' will be treated as category 'A/B', if located in whole or in part within 10 km from the boundary of: (i) Protected Areas notified under the Wild Life (Protection) Act, 1972, (ii) Critically Polluted areas as identified by the Central Pollution Control Board from time to time, (iii) Notified Eco-sensitive areas, and (iv) inter-State boundaries.

36. This project will therefore need to identify if there is a need to take environmental clearance for the project by the Government of India.

37. For any project that requires an environmental clearance under Government of India's EPA, 1986 there will be a need for an accredited consultant registered with the Ministry of Environment and Forests to undertake the EIA and obtain a clearance from it, as has been stated in the Office Memorandum: Accreditation of the EIA Consultants with Quality Council of India (QCI)/ National Accreditation Board of Education and Training (NABET) Dated 9th December, 2009 and available at the ministry's website.

The Biological Diversity Act, 2002

38. According to this act, where the Central Government has reasons to believe that an area rich in biological diversity, biological resources and their habitats is threatened by overuse, abuse or neglect, it could issue directives to the concerned State Government to take immediate ameliorative measures. The Central Government, as seen appropriate, integrates the conservation, promotion and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies. The State Government, under this act, can also declare areas of biological importance as heritage sites.

39. Based on this act's recommendations, the state has started to create Biodiversity Management Committees in Karnataka. The purpose of these committees is promoting conservation, sustainable use and documentation of biological diversity including preservation of habitats, conservation of landraces, folk varieties and cultivars, domesticated stocks and breeds of animals and micro-organism.

40. This project is close to the UNESCO MAB site – the Nilgiri Biosphere reserve, a tip of which is the Bhadra Wildlife Sanctuary, and other wildlife areas near the identified project area. Therefore, while implementing the planned activities there will be a need to consider possible biodiversity concerns, such as those relating to irrigated agriculture. Discussions with the State Biodiversity Board highlighted concerns of the change of the agri-ecosystems due to increased emphasis on high yielding variety crops and other more economically attractive crops, which may result in the areas agri-ecological landraces depleting. However, it is yet to be understood if there will be any impact, and the possible type of impact, on the Gram Panchayat (GP) level biodiversity committees and registers underway at present.

Karnataka Forest Act, 1963, Karnataka Forest Rules, 1969, Karnataka Preservation of Tree Act, 1976

41. The Karnataka Forest Act defines the use and management of Reserved Forests, District Forests, Village Forests and Private Forests, the control of forest products – both timber and other forest products. It also defines 'reserved trees' or trees that cannot be cut without permission from the Forest Department and the cutting of 'Government Trees' from private lands. According to the Tree Act the felling of any tree; even on private lands, requires permission from the appropriate authority for the area, as specified in the legislation. A few exceptions to the legislation have been given in chapter 5 of the document. The legislation also mentions that there is a need to plant trees of the same or different species in lieu of the felled trees, as directed by the Tree Officer.

42. Construction activities likely to result in the removal of some trees, whether to access identified intervention areas, create infrastructure or even use of wood as fuel wood by the construction labour or other uses are, based upon the provisions of this legislation required to obtain required permissions etc.

Karnataka Groundwater (Regulation for Protection of Sources of Drinking Water) Act, 1999

43. This bill defines the procedures for sinking of wells near public drinking water sources, declarations of watersheds as over exploited and the prohibition of sinking wells in such watersheds and the abstraction of water from wells in the watersheds.

44. Considering existing climate change predictions for the basin and the district there may be changes in the rainfall pattern. Also, there have been droughts in the area in the past. In such a scenario, there is may be additional temporary restrictions on the use of groundwater for all purposes other than drinking. This is may have an impact on any conjunctive water use plans developed for irrigated agriculture.

Karnataka Act No. 25 of 2011. The Karnataka Groundwater (Regulation and Control of Development and Management) Act 2011

45. This act further strengthens the Karnataka Groundwater (Regulation for Protection of Sources of Drinking Water) Act, 1999 as it brings a general legislation to control in-discriminatory exploitation of ground water especially in the notified areas in the State. This

act also provides for declaration of areas as drought hit, restriction and regulation of use of groundwater in notified areas and specifying minimum distance between irrigation bore wells.

46. Conjunctive water use plans would need to consider the provisions of this legislation and obtain required permissions while developing the plan.

Insecticide Act, 1968

47. This act provides a list of pesticides which are restricted or banned for use in India. There is a list of 34 pesticides and formulations banned for use in India. There are another seven withdrawn pesticide, eighteen refused registration and thirteen for restricted use in India.

48. Discussions in the field identified the use of pesticides restricted in India like endosulphan and monocrotophos. The major reason for this use is that they are considered extremely effective in comparison to other known formulations by the farmers. The project would therefore need to undertaken concentrated efforts to ensure that such formulations are not used and appropriate alternate pest management techniques are known, understood and implemented by the farmers.

Noise Pollution (Regulation and Control) Rules, 2000

49. This legislation defines the levels of noise permitted in each area, including from vehicular traffic, generators, construction activities and mechanical devices. This rule would be important especially during the construction period of the project. The ambient air quality standards under this rule are given in the table below. These levels need to be adhered to for all project activities.

Area Code	Category of Area/Zone	Limits in dB(A) Leq *	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

Air (Prevention and Control of Pollution) Act, 1981, its Rules and amendments

50. Under this Act, Boards (Central and State) for the prevention and control of air pollution have been set up to monitor and manage activities that would lead to air pollution in India, and to declare air pollution control areas. The act also sets ambient air quality standards for industrial, residential and ecologically sensitive areas.

51. This will be important during the construction phase, where there is likely to be use of diesel generators for provision of energy and other activities that may result in air pollution. Also, based upon the area where the project activities are underway, the standards, as defined by the Act are to be adhered to. These standards are given in the Annexure.

Water (Prevention and Control of Pollution) Act, 1974, its Rules and amendments

52. This law is to control and prevent water pollution. This legislation also defines discharge standards and permit needs for any effluent/wastewater discharged. It includes surface and ground water and marine discharges. The Act also discusses possible water pollution, prevention and control areas for the application of this act.

53. Presently the project does not envisage undertaking any activity that would result in effluent discharges and therefore permission under this act is not required. Nonetheless, at the construction phase of the project, there may be a need to look at possible discharge from various activities to ensure that discharges do not result in the change in the quality of water bodies, whether temporarily or permanently. Water quality standards for different uses have been defined by the Central Pollution Control Board, Government of India.

Manufacturing, Storage and Transportation of Hazardous Chemicals Rules, 1989 and Amendments

54. This Rule is for the management and transportation of hazardous chemicals and substances – that include toxic and flammable substances, their use, processing and storage. Schedule 1 to 4 of this rule describes what is categorized as hazardous, their quantities and levels of toxicity. These include a number of pesticides, and liquid and gaseous fuels. According to the rule, the agency needs to identify possible accidents and risk from the chemical during transport, storage or usage, ensure ways to avoid any hazard from taking place and in case of an accident, ensuring clean up and reporting of the accident to the appropriate authority. The rule also states that no industrial activity is to start until a safety report is filed to the concerned authority according to Schedule 8 of the rule. These must be followed and no changes in activities undertaken without updating of the report within another 90 days. Equally, any hazardous chemicals stored or transported need to be labelled as specified in the rules and an updated safety data sheet to be kept.

55. This could be relevant to the project as there could be certain chemicals and fuels likely to be stored for project needs. Some of these could be flammable or toxic. Prior to starting any activity the project would need to identify if there are any chemicals as identified in Schedule 3 of the project. If so, appropriate handling procedures and safety permits etc would need to be developed and submitted to the concerned authority.

Wetlands (Management and Conservation) Rules, 2010

56. This rule defines a wetland – which according to the rule is 'an area of marsh, fen, peat land or water; natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters and includes all inland waters such as lakes, reservoirs, tanks, backwaters, lagoons, creeks, estuaries and manmade wetlands and zones of direct influence of wetlands that is to say drainage areas or catchment areas of the wetlands as determined by the authority, but does not include main river channels, paddy fields and the coastal wetlands covered under the notification of the Government of India in the Ministry of Environment and Forests, S.O. 114 (E) dated 19 February, 1991 published in the Gazette of India Extraordinary, Section 3, Sub-Section (ii) of dated the 20th of February, 1991. The rules also identify various types of wetlands including those in UNESCO World Heritage sites, ecologically sensitive areas, below 2500 metres with an area of at least 500 ha, other notified wetlands or those identified by the Wetland Authority.

57. Activities not permitted in such areas are identified and include reclamation, setting up of new or expansion of existing industries, dumping of waste or discharge of effluents, any activity that adversely impacts the wetland ecosystem, amongst others.

58. Any activity that could have an adverse impact on wetlands in the project area must be carefully designed to ensure that they are according to this legislation.

Draft Guidelines for Integrated Water Resource Development and Management, 2010, Central Water Commission

59. The Guidelines mention the need to consider ecological needs of water and therefore the maintenance of appropriate minimum flows of rivers for ecological needs, aesthetics and other requirements. The guidelines go further and mention the need for catchment treatment, integrated watershed projects, restoration of ecological balance. No rules of thumb or calculations for assessing minimum flows are given in the guidelines.

60. The activities identified also include increased water use efficiencies. It is therefore suggested that the project consider the implications of the plan on environmental flows and if there is a need to suggest any changes. Any identified concerns would need to be

addressed through the project's IWRM activities. There are international guidelines4 that could be used for guidance on environmental flows for the river.

The Ancient Monuments and Archaeological Sites and Remains Act, 1958, The Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010 and their rules and amendments, and The Karnataka Ancient and Historical Monuments and Archaeological Sites and Remains Act, 1961

61. This act identifies limits of prohibited and regulated areas and the activities that can be carried out in them and the required permissions. According to this Act, areas within a 100 meters radius of notified monuments are prohibited and another 200 meters regulated. However, if required this area can be extended to protect the monuments and archaeological site. Any work in the prohibited area needs to be carried out by the archaeological officer and if work is carried out in a regulated area by persons other than the archaeological officer then there is a need for permission to undertake the work as defined in the regulation. Also, for any work in either the prohibited or regulated area permission is required to carry out any work. However, this Act also defines the sort of work that can be carried out within areas notified under this act. Furthermore, any construction, mining or other activity in the vicinity of a protected or regulated area would also need permission from the competent authority. These regulations prohibit cultivation within protected areas if it involves digging of more than 1 foot of soil.

62. While no protected monument has been identified in the project area, there could be chance findings. In the event of chance findings, as required under this Act the competent authority must be consulted and, as required, actions taken up.

63. Given below are the major Indian legislations that are applicable to this project along with the actions that would need to be undertaken for each of these regulations. These must be followed as a part of the environmental compliance activities for the Gondhi Anicut subproject at the time of construction or implementation, as required.

Table 1: GOI Legislative Environmental Compliance Requirements

Component	Applicable Legislation	Action Required
All irrigation project modernization activities	Environmental (Protection) Act, 1986	Requires environmental clearance – as discussed in the Schedule of the act
Any component where there is a need to acquire forest land or access any produce from forest produce Any trees cut by project activities	Karnataka Forest Act 1969, Wildlife Act, 1972 and Karnataka Preservation of Tree Act, 1976	Apply for permission and undertake any action as directed by the Forest Department Apply for permission and undertake any action as directed under this act – e.g. undertake compensatory plantation activities.
Any impact on biodiversity hotspots or sensitive areas due to project activities	Biodiversity Act, 2002	Consult with the Biodiversity Board to identify any sensitive areas and appropriate actions to minimize impact from project activities
For conjunctive water plans where groundwater is to be used	Karnataka Groundwater (Regulation for Protection of Source of Drinking Water) Act, 1999 and Karnataka Groundwater (regulation and Control of Development and Management) Act 2011	Taking permission for sinking of bore wells, ensuring minimum distance between irrigation wells and follow directions of legislation if area declared drought hit.
Especially during construction period	Noise Pollution (Regulation and Control) Rules, 2000	Ensure all activities adhere to the existing noise limits
Pollution due to vehicle and construction activities	Water (Prevention and Control of Pollution) Act, 1974	Ensure any activity undertaken is within the existing discharge standards, based upon the designated use of a water body.

4 Dyson, M., Bergkamp, G., Scanlon, J. (eds). Flow. The Essentials of Environmental Flows. IUCN,
Gland, Switzerland and Cambridge, UK. xiv + 118 pp.

At time of construction especially when there is likely to be use of diesel generators for energy and the various vehicles and machinery at the site and for transportation. Also at various quarry and other sites resulting in atmospheric dust	Air (Prevention and Control of Pollution) Act, 1981	Ensure that all activities comply with the existing air quality levels. Vehicles have required pollution under control certification from appropriate authorities
Waste dumping at construction or in the O&M phase	Wetland (Management and Conservation) Rules, 2010	Ensure compliance to the rules by ensuring identified waste disposal is in waterbodies and wetlands.

2.2 Asian Development Bank

64. From ADB's perspective there is the 2009 Safeguard Policy Framework. This Framework is a set of operational policies that seek to avoid, minimize, or mitigate adverse environmental impacts of development activities where ADB is involved. To ensure this, impacts of project activities on the environment are to be identified early in the project cycle so that appropriate mitigation and management actions are undertaken. This framework also states that the implementation of the identified safeguards is the responsibility of the client/borrower, while the ADB is to monitor compliance.

65. In the case of a MultiTranche Financing Facility (MFF), an Environmental Assessment and Review Framework (EARF) is also to be developed. The EARF will provide guidance to the assessments of the subprojects of subsequent Tranches.

66. The ADB has also developed categorisation of all projects according to the level and type of impacts and type of investments. ADB uses a classification system to reflect the significance of a project's potential environmental impacts. Projects can be categorised into four depending upon their impacts. Based upon this categorisation the Gondhi Anicut project has been categorised as Category B. This is defined as: *'A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An initial environmental examination is required'*.

3. INSTITUTIONAL ARRANGEMENTS AND SYSTEMS

67. The national and state level government agencies focusing on environmental management and regulation are given below. State level agencies function directly below their line national level agencies.

3.1 National Level

Ministry of Environment and Forests

68. The Ministry of Environment & Forests (MoEF) is the nodal agency in India for planning, promotion, co-ordination and overseeing the implementation of environmental and forestry programme. The principal activities undertaken by Ministry of Environment & Forests consist of conservation & survey of flora, fauna, forests and wildlife, prevention & control of pollution, afforestation & regeneration of degraded areas and protection of environment, in the framework of legislations.

69. It is located at the national level and has regional offices for various regions and works in coordination with the national office in order to undertake any work, clearances and other consultation related activities. This includes one for the South region for which the office is located in Bangalore. This ministry is also in charge of any forest related clearances as identified under the forest acts and to be undertaken by the central ministry.

Central Pollution Control Board

70. Central Pollution Control Board (CPCB) is the statutory organisation constituted in 1974. The board provides field information and technical services to MoEF. The Board also monitors and oversees the implementation of the Environmental Protection, Air and Water acts. The functions of the board are,

Advise the Central Government on any matter concerning prevention and control of water and air pollution and improvement of the quality of air
Plan and cause to be executed a nation-wide program for the prevention, control or abatement of water and air pollution
Co-ordinate the activities of the State Board and resolve disputes among them
Provide technical assistance and guidance to the State Boards, carry out and sponsor investigation and research relating to problems of water and air pollution, and for their prevention, control or abatement
Prepare manuals, codes and guidelines relating to treatment and disposal of sewage and trade effluents as well as for stack gas cleaning devices, stacks and ducts
Perform such other function as may be prescribed by the Government of India

3.2 State Level

Department of Ecology, Environment and Forests, SGOK

71. Department of Ecology, Environment and Forests (DoEF) is the apex body in the state of Karnataka with administrative control of environmental management in the state. The department through KSPCB administers the enforcement of various laws and regulations of Government of India. The department formulates environmental management and policy guide lines for Karnataka and grants clearances for projects under its purview.

72. The department is headed by a Principle Secretary to Government and Supported by Secretary (Ecology and Environment). The Secretary (Ecology and Environment) is supported by two Under Secretaries and a Director (Technical).

Karnataka State Pollution Control Board

73. KSPCB is the regulatory body in the state of Karnataka for enforcing various environmental legislations of the Government of India. While the regulatory powers are delegated to KSPCB from CPCB, the administrative control of the board rests with DoEF. More specifically, the functions of the board are listed below.

- Implementing the provisions of EPA 1986, Water and Air Acts

- Advise the State Government in respect of suitability of particular areas for industrial development
- Assess the quality of environment in terms of ambient air and water quality through monitoring
- Issue and enforce the consent orders issued for industrial pollution control
- Oversee, supervise and regulate water, air, solid, bio-medical and hazardous waste management in urban areas

74. The board is headed by a Chairperson who is supported by a Member Secretary and a Chief Environmental Officer. The Chief Environmental Officer is supported by Regional Environmental Officers and the District Environmental Officers in each of the district of the state. The Board has its Central Office in Bangalore. The enforcement of the Acts and Rules are being implemented through thirty three Regional Offices spread throughout the state. The Central laboratory of the Board is located in Bangalore. Regional laboratories have been set up along with Regional Offices.

75. Depending upon the needs of the project, for any clearances these agencies will need to be contacted as directed under the relevant acts discussed in the legislation section.

4. DESCRIPTION OF THE ENVIRONMENT

76. The whole of the Gondhi Anicut system is located in the Bhadravati Taluk of Shivamogga District. The Taluk headquarter is Bhadravathi town located on the banks of River. It is located at 130 52' North latitude and 75o 40' East longitudes. The town is located at a distance of 270 km from Bengaluru and 20 km from Shivamogga. The altitude of Bhadravathi town is 548.70 m above msl.

4.1 Physical Parameters

Weather Patterns

77. The climate is characterised by moderate summers and winters. The year can be divided into three distinct seasons. These are winter from October to February, summer from March to mid-May and the monsoons from mid-May to October. Humidity is at peak during months of July & minimum during month of April. The average wind velocity is 8 kmph, from the south – west direction. Temperature rises after March, April is the hottest month of the year with mean daily maximum temperature going up to 35.8 ºC. With the withdrawal of the monsoons, by the end of October, there is a sharp decrease in temperature. January is the coolest month of the year, with mean daily minimum temperature of 14.3 °C.

78. The mean summer temperature is 25°C - 37°C and the mean winter temperature is 20ºC - 30ºC. Total annual rainfall is about 993.1 mm. Maximum rainfall is received in months from May to October. More than 80% of rainfall is received during the winter season. The average number of rainy days from 1941 to 1999 was 68 rainy days annually, though in 2009 it was about 10 days more. As is seen from Table 2, Bhadrawati Taluk's rainfall is lower than the total of Shivamogga and rainfall has varied from around 580 mm in 2006 to 1400 in 2009 – nearly a three times difference.

Table 2: Rainfall

	Rainfall (mm)						Rainy Days	
Taluk/District	Normal Rainfall (1941-99)	2005	2006	2007	2008	2009	Normal (1941-99)	Actual 2009
Bhadravathi T.	887	774.2	580.2	1293	952.4	1427.4	68	79
Shivamogga D.	1,818.9	1,966.6	1,847	2,472.4	1,827.6	2,252.7	86	87

Source: - Shivamogga District Statistical Handbook 2009-10

Water Resources

Drainage and Surface Water

79. A number of rivers originate from Shivamogga District. These include Rivers Kali, Gangavathi, Sharavathi and Tadadi. The other major rivers which flow through the district are Tunga, Bhadra and Varada. The rivers Tunga and Bhadra meet at Koodli in Shivamogga District to form the Tungabhadra.

80. There are a number of water bodies both natural and manmade in Shivamogga district. This includes the famous Jog Falls and the Gopashetty Koppa, Sharavati and Gudavi Bird Sanctuary. However, within the project area there are no Ramsar sites and no water body of any major ecological significance has been identified.

81. Surface water is supplied to the project area from the Gondhi Anicut by two main canals one for the Left Bank (14.5 km long, 0.56 cumecs) and another for the Right Bank (74.4 km long, 7.50 cumecs). There are also many pumps that pump water directly into the project area from the Bhadra river.

82. The project area has a high slope and so surface drainage and rainfall runoff flows directly to the Bhadra river. Due to waterlogging, which was said to be significant (20-30% in some areas), there are small areas of sub-surface drainage.

Groundwater

83. In recent years the ground water table of Bhadravathi Taluk may have been rising and has gone up from 7.28 m in 2005 to 4.24 m in 2009. However, there seems to be no specific trend possible identified with certain years there being a sharp downward trend as is seen in the following table. There is very little groundwater usage for irrigation in the project area (household survey and field visits) and this is said to be due to the low yielding sediments. There would seem to be little scope for conjunctive water use plans. Groundwater is a significant source for household use

84. Future activity should look to create a register of groundwater pumps and usages (domestic and agriculture etc) in the project area (depth, volume, quality, seasonality, use of water, area irrigated, etc).

Table 3: Ground Water Level (in meters) 2008-09

Taluk/ District	2005	2006	2007	2008	2009
Bhadravathi T.	7.28	8.71	11.67	12.94	4.24
Shivamogga D.	7.35	7.09	7.20	7.46	5.90

Source: - Shivamogga District Statistical Handbook 2009-10

Water Utilisation

85. About 50% of irrigation supply at a District and Taluk level (and therefore including Taluks outside of the irrigation area boundaries) is from canals with local tanks providing another 33% of irrigation water. This is much higher than the district total, where canals only provide a quarter of the total irrigation needs and tanks 45%. Groundwater is the third highest source of irrigation in both the state and district providing 22 and 15 percent respectively. As can be seen, both surface and groundwater are being used for irrigation already. Furthermore, the tanks and water bodies seem to be an important source of irrigation water for both the district and Bhadrawati Taluk.

Table 4: Net Area Irrigated (hectare) 2008-09

Taluk/ District	Canals	Tanks	Wells	Bore wells	Lift Irrigation	Other sources	Total
Bhadravathi	12,745	8,354	399	2,517	1,323	0	25,338
Shivamogga D.	33,733	59,955	4,452	22,836	5,607	5,454	132,037

Source: - Shivamogga District Statistical Handbook 2009-10

86. Water supply in rural zones of Shivamogga indicates that out of 4,566 settlements 3,498 receive more than 55 lpcd (litres/capita/day) supply of water. Based upon the national criteria – of minimum 40 for rural areas, the table reflects that 84% of rural habitations have adequate water supply coverage. However, this data does not provide any information on quality and seasonality to accurately understand the quality of the service. Furthermore, discussions in the field show that people are also dependent upon the canal for provision of water for domestic needs. Canal water is used for washing, cleaning and various domestic purposes, other than drinking. In areas where drinking water is insufficient canal water also supplements the drinking water needs for the rural population. Equally, water from canals is also used by people for bathing of livestock and drinking.

Table 5: Status of Rural Water Supply in Karnataka State - 2003

	Water Consumption (Litres per Capita per Day, LPCD) No. of Settlements								
District	0-10	10-20	20-30	30-40	40-55	# <55 LPCD	% <55 LPCD	> 55 LPCD	Total
Shivamogga D.	4	301	297	288	178	1068	23.39	3498	4566

Source: - Rural Development and Panchayat Raj Department

87. At a project level, based on the results of the socio-economic survey and field visits irrigation water use is predominantly surface water provided from the canal but also by pumping from the Bhadra river. There is little pumping for groundwater for irrigation to low groundwater yields, however groundwater is an important source of water for domestic use.

Water Quality

88. An analysis of groundwater quality by the Department of Rural Development for 14 parameters was undertaken and identifies a number of water quality issues. Of these, some samples of Bhadrawati Taluk tested positive for total hardness, calcium hardness, chloride, sulphate, alkalinity and iron. According to the Karnataka State of the Environment (SOE) report some areas in Bhadrawati are also fluoride affected. The SOE further states that around 25% of household in Shivamogga district are affected by iron and fluoride in ground water. Also identified were problems of total coliform. The river at Bhadrawati is also classified as highly polluted according to the State Pollution Control Board, which is likely to be attributed to its industries such as the iron and steel industries.

89. Disposal of waste into canals is properly managed and they are used as waste receptacles. At times people go alongside them using them as sites for defecation and household waste is disposed of directly into the canal.

90. There is highly prolific aquatic weed growth in canals in the project area thought to be contributed to by nutrient rich runoff from the Bhadra irrigation area entering the canal system as well as from local pollution. This is likely to have adverse impacts on the health of the local population which uses the water for various domestic purposes.

91. Groundwater quality is not known however given the risks of high agri-chemical environment and pit latrines it is potentially a significant issue given its apparent importance for domestic use.

Land Resources

Topography

92. Shivamogga is a part of the Western Ghats and therefore the topography consists of planes interspersed with hills of moderate slopes. Bhadra River flows through the Taluk which is developed on both sides of the river. Bhadravathi town is at an altitude of 548.70 amsl. The total geographical area of the district is about 8,477 sq kms. It is the 9th largest district of the State.

Geology and Soil

93. The predominant geological formations of Bhadravthi which is a part of Shivamogga district are quaternary alluvium, Dharwar super group - ultra mafic complex, grewake, argoillite, quartz chlorite schist with ortho-quartzite, basal polymictconglomarate. The lower precambrian formations include Metabasalt with thin Ironstone. There also are Archaean formations of granite migmatites and granodioritic to tonolitic gneisses, amphibolites and pelitischists.

94. Soil is usually brown clay loamy soil, red soil, sandy soil, red sandy soil, yellowish loamy soil, lateritic soil, mixed soils & black cotton soils are predominant in the region, which favours growth of cotton, paddy & oil seeds. While loamy and sandy soils are better drained, areas with black cotton soil will require specific attention to ensure appropriate drainage to avoid waterlogging.

Land use patterns

95. The total land area in Bhadrawati Taluk is 69,101 ha or about 8% of the total district's land area. Of this 61% is under agriculture and 26% under forests. At the district level however the forest cover is higher, accounting for 32% of the total land area while agriculture accounts for 55% of the total. This higher forest cover at the district is because Shivamogga district includes part of the Western Ghats forests. Nonetheless, as is discussed later in this

section, degradation of forests is resulting in dense and closed forests now turning into open forests. For example, part of Shivamogga town has encroached upon the forest area and some of the outskirt areas of the town are presently being cleared of illegal settlers to start an afforestation programme and revive part of the forest area. Another 12% of the total land area in Bhadrawati Taluk is under pastures and 5% is fallow. Agriculture areas with more than one crop a year account for 18% of the total land area and 29% of the total area under agriculture. The area under trees and groves is a negligible at 66 ha and is less than 1% of the total land area, according to 2008 – 09 statistics. However, it is likely that these groves do not include the areca nut or coconut plantations, which are an important crop in the Taluk and district.

4.2 Ecological Resources

96. Shivamogga district has around 51% of its geographical area under various categories forest. Part of the Western Ghat forests is also in the district. Of the total area under forests only 4% is very dense forest with about a third as open forest, as is seen from Table. There is also an increasing area under open forests, with a decrease in dense forests. This is of concern not only as open forests are often very vulnerable for being taken over and encroached by settlers, but also this area is one of the sources of the water of the district/state's rivers.

Table 6: District- Forest Cover-2011

District	Geographical Area (GA)	Very Dense	Mod. Dense	Open Forest	Total	% of GA	Change	Scrub
Shivamogga D.	8,477	205	2,808	1,394	4,407	51.99	-1	23

Source: Forest Report, Forest Survey of India

97. The district's forests also provide many minor non-timber forest products, upon which a number of people are dependent for their livelihood. These include spices and medical herbs like Kairaraka, Soapnut, Alaekai and bay leaf. The forests also provide timber and include timber species like rosewood and teak.

98. Apart from a number of forest areas, the district also has Gudavi Bird Sanctuary, part of the Bhadra Tiger Reserve and the Shettihalli Wildlife Sanctuary. The project area does not fall in any of these sensitive areas. However, towards the tail end of the right bank canal near the confluence of rivers Bhadra and Tunga there is an elephant corridor. Also, it is understood that there are a number of wild animals in the forests surrounding the project areas and these may visit the project area.

4.3 Human Environment

99. The Gondhi Anicut system is located in the Bhadrawati Taluk of Shivamogga district. This Taluk has a total of 39 gram panchayats and 1 municipality.

Demography

100. The total population of Bhadravathi Taluk is 338,989 with population density of 491 per km², out of which 52.6% of population resides in the rural areas and 47.4% in urban areas. The sex ratio is 972 females per one thousand males which is higher than the national average.

Table 7: Some Demographic Statistics

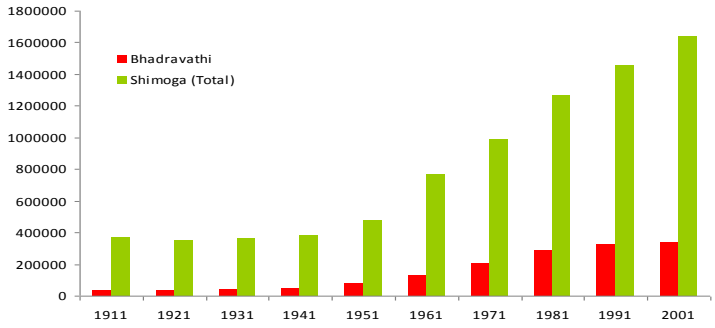
Taluk/District	Area (km²)	Total	Males	Females	Rural	Urban	Density	Sex Ratio
Bhadravathi T.	690	338,989	171,917	167,072	178,327	160,662	491	972
Shivamogga D.	8477	1,642,545	830,559	811,986	1,071,535	571,010	194*	978*

* Average, Source: - Shivamogga District Statistical Handbook 2009-10

101. The population growth in last ten decade shows rapid population growth from 1971-81 (41.6%), Figure. During 1991-2001 the annual growth rate was around 4.5%. However, the share of the district's population in Bhadrawati Taluk in 1911 was only about 10% in 1911 by 1981 it had become 23% of the district's total probably because of the introduction

of irrigaton. The 2001 census shows that presently Bhadrawati Taluk accounts for 20% of the district's total population. With a population growth rate at 4.5%, even if Bhadrawati Taluk's share of the district's population becomes stable at 20% or declines, it is still growing at a very high rate.

Figure 1: Population Growth Pattern Bhadrawati and Shimoga



102. There are a total number of 71,771 households in Bhadravati Taluk which is about 20% of the total of the district. Nearly equal numbers reside in rural and urban areas in the Taluk, while about 65% reside in rural areas at the district level. The average household size in rural areas is 5 compared to 4.5 in urban areas.

Table 8: Total Number of Households (2001 census)

Taluk / District	Rural Area	Urban Area	Total
Bhadravathi T.	36,253	35,518	71,771
Shivamogga D.	218,360	120,026	338,386

Education

103. Overall literacy rates in the rural parts of the Taluk are about 66% and urban 82%. The female literacy rate is lower in rural area (56%) compared to urban and district rates.

Table 9: Literacy Rate (2001 census)

	Rural			Urban		
Taluk/District	**Total**	**Males**	**Females**	**Total**	**Males**	**Female**
Bhadravathi T.	102,032 (66 %)	58,164 (74 %)	43,868 (57 %)	117,181 (82 %)	63,831 (88 %)	53,350 (75 %)
Shivamogga D.	647,632 (70 %)	367,227 (78 %)	280,405 (61 %)	421,302 (84 %)	226,663 (89 %)	194,639 (78 %)

Source: - Shivamogga District Statistical Handbook 2009-10

104. In terms of educational infrastructure, Bhadravathi has 356 primary schools with 40,859 students. There are 81 high schools, 21 pre-university colleges, 2 polytechnics and 4 colleges.

Health

105. The life expectancy at birth in Karnataka is slightly higher compared to the national average, with 2001 statistics indicating a life expectancy of 65.6 for males and 66.6 for females in Karnataka and 62.4 and 63.4 for females at the national level. Infant mortality rate in Karnataka compared to national average, is also lower than national averages with 2003 statistics putting the IMR rate in Karnataka at 52 and nationally at 60.

106. District level health statistics that monitor 20 identified diseases show that malaria, typhoid, hepatitis, dengue and swine flu incidences have been noted in the state in the first half of 2012 itself. Of the district's total, 21% of dengue, 9% of malaria, 23% of hepatitis and

15% of typhoid cases are from Bhadrawati. All cases reported are of men, which is likely as women may not have equal access to medical services. Therefore, it is likely that the total number of cases in both the district and the Taluk may be higher than reported. According to the Compendium of Best Practices in Rural Sanitation of the Water and Sanitation Programme, waterborne diseases in the district include cholera, amoebic dysentery, gastroenteritis, typhoid and jaundice, as is seen in the table below. For all of these there has been a downward trend which has been attributed to the success of the Total Sanitation Campaign in the district which aims at both increasing the use of toilets and improving solid waste management in rural areas.

Table 10: Shivamogga District Level Disease Burden for Selected Waterborne Diseases

Diseases	Affected in 2005-06	Affected in 2007-08	Affected in 2008-09	Affected in 2009-10
Cholera	417	165	130	59
Amoebic Dysentery	2,920	1,529	682	324
Gastroenteritis	764	414	196	97
Typhoid	334	209	117	73
Jaundice	208	110	74	42

Source: - Compendium of Best Practices in Rural Sanitation, WSP, 2011

107. In terms of medical facilities there are 12 hospitals and nursing homes totalling 468 beds in Bhadrawati. Another 10 primary centres with 60 beds and a community centre with 30 beds

Economic systems

Agriculture and Livestock

108. There is a general trend in Shivamogga district to convert single cropped areas to horticulture, agri-horticulture and agri-forestry systems. Depending upon monsoon and irrigation facilities, farmers may grow cash crops such as sugarcane and cotton. Kharif paddy lands and upland scrub may coexist. Arecanut plantations are becoming more popular in the district.

109. Major crops in the district include sugar cane, pulses, chillies, cardamom, pepper and betel nuts. Important cereals include paddy, ragi, jowar and maize. Non food crops grown include cotton, oil seed and coffee. The total area under cultivation for the Taluk is 39,782 ha and for the district 255,854 ha.

110. Understanding use of agrichemicals, their management and disposal is poor. The result is that organophospates like monochlotophos are not only used randomly, but their storage and disposal is poor. Furthermore, the poor understanding of soil nutrition and the lack of soil testing results in random application of fertilizers based upon what farmers consider is most appropriate. These, and low sanitation coverage has lead to the eutrophication of water bodies with them being covered by weeds like water hyacinths. Discussions in one of the villages suggested that the weed cover returns in the canal network within 3 months of desilting, reflecting the high levels of nutrition enrichment of the system.

111. Livestock are also kept in the area and there is an increasing preference for hybrid over local breeds, especially for cows. Of the total livestock 45% of the Taluk's livestock consists of cattle, about 25% buffalo and about 10% each for sheep and goat. Some people also rear poultry and ducks. In fact there have been some concerns from the State Biodiversity Board due to the increase in the introduction of hybrid species as most of these species are less drought resistant than native species.

Mining

112. Mining is not a major activity in Shivamogga district. There are a total of 6 mining leases in the district at present and the total working area of all the mining leases is 158.39 hectares. Limestone mining is carried out in Bandigudda village of Bhadrawati Taluk with the quarry being about 98 ha in size. Building stone quarry leases are situated in Moodalvitthalapur village near Holehonur and Kudligere village and Anthergange villages in Bhadravati Taluk over an extent of 11 hectares. Other mining activities in Shivamogga District include mining for building stones like granite and granite gneiss, sand and brick earth.

Industries

113. Bhadrawati town is an important industrial centre for the area with two big industries – the Visvesvaraya Iron and Steel Plan, and the Mysore Paper Mills. There are also a number of other factories in Bhadrawati. These include chemical and engineering industries – with a total of 29 factories in the Taluk, employing a little more than 8000 people. There are also a number of small scale industries, such as textile, wood, metal, chemical, electronic and electrical, paper and printing and leather. Many of these industries are highly polluting and contribute to the high pollution loads of River Bhadra.

Natural Resource Usage

114. Apart from the forest produce mentioned earlier, there are no other major natural resource products noted in the area. However, most people are dependent on firewood for fuel especially for cooking. Fishing for self consumption and the local market takes place in the many water bodies in the area.

Infrastructure

115. Bhadrawati Taluk has a total of 1,556 km of sealed roads which is about 15% of the district's total road network. Of these state and national highways account for about 25% of the total roads and another 10% are major districts roads of the district. At the Taluk level however state and national highways account for only 8% of the total Taluk roads and major district roads for about 15%. The majority of roads are village roads – accounting for about 65% of the total. However, many village roads are not all weather roads resulting in reduced access during the monsoons.

116. Bhadrawati is also connected by the railways with a total of 19 km of broad gauge railway tracks and 1 railway station in the Taluk.

Cultural heritage, archaeological sites and areas of significant beauty

117. Tourism is an important economic activity for Shivamogga District as there are a number of wildlife sanctuaries and other scenic places such as the Jog Falls. Part of the district is included in the hills of the Western Ghats.

118. There are also a number of temples such as the Lakshmi Narasimha Temple built by the Hoysalas in the 13th century is located in Bhadrawati town. Koodli is another important local pilgrimage area, 15 km from Bhadrawati town and is the confluence of Rivers Bhadra and Tunga.

4.4 Disasters

119. The major natural disasters identified in the state are floods and droughts, with the years 2004, 2007 and 2008 identified as those when the district had been impacted by floods. The years 2002, 2003 and 2007 have been drought affected. That apart, the District Disaster Management Plan identified in 2009 some possible hazards for the district. These are tabulated below. While this table identifies earthquakes as a possible risk, the National Disaster Management Authority, India, Shivamogga district, has Bhadrawati in Zone 2, or the low risk area earthquakes. Similarly cyclones are not expected to directly affect the district, though as the table indicates there is a possibility of indirect impact from cyclones.

Table11: Possible Hazards and their Impact in Shivamogga District

Type of Hazard	Period of occurrence	Potential impact	Vulnerable area
Floods	June – August	Loss of crops, damage to infrastructure, life, roads, houses and bridges	Along river courses, entire district
Heavy rainfall	June – August	Loss of crops	Entire district
Drought	January – May	Burning of crops, scarcity of drinking water, fodder, etc	Partly in Shivamogga
Earthquake	Anytime	Loss of life and damage to infrastructure	Entire district
Indirect cyclone affect	June – August	Heavy rain, loss of crop	Entire district

Source: - Disaster Management Plan - 2009-10, Shivamogga District

4.5 Climate Change Concerns

120. According to the 2012 Western Ghat Ecological Expert Panel report, the Western Ghats have been identified as landscapes of least resilience, making them very vulnerable to the impacts of climate change. This is of concern as many of the state's rivers including interstate rivers originate there. Part of Shivamogga lies in the Western Ghats and therefore would also be impacted by this assessment.

121. An analysis of the Karnataka Climate Change Action Plan, suggests a variability of rainfall in Shivamogga of be between 15% and 35% with an expected increase in rainfall between 10% and 20% in the district. However, there is expected to be a decrease in the SW monsoon precipitation and an increase in pre and post monsoon precipitation. The Tungabhadra basin districts of Chikmanglur, Shivamogga and Devangare are projected to have an increase in runoff between 0 – 25%, in both kharif and rabi season. There is also expected to be a decrease in the water yields in the Krishna basin overall, which will vary between 30 to 50% in most sub-basins.

122. There is also expected to be an increase in both the maximum and minimum temperature with the projected change for Shivamogga being 1.88 ºC on an average, which will be a change of 1.95 ºC in the minimum temperatures and 1.91 ºC in the maximum temperatures for 2021 to 2050, for A1B scenario. Climate change due to the expected temperature to have an adverse on irrigated rice productivity which could loose yield by up to 8% according to the scenario.

5. SCREENING OF POTENTIAL ENVIRONMENTAL IMPACTS

123. Below are the potential environmental impacts from planned project activities. The legend identifying the type of impact is given at the end of the matrix. This matrix identifies all possible impacts on the environment. However the management of these impacts is given separately in another section of this document.

Environmental Issue	Design Impact		Construction Impact		Operation Impact	
Physical Environment						
Water resources						
River system and environmental flows	(-, p, l)	Increased efficiencies in agriculture and better systems management with intensification of agriculture, that result in reduced environmental flows. Reduced availability of water for downstream uses.	(-, p, w)	Sand mining resulting in changing of river course and river scouring	(-, p, l)	Increased areas under irrigation outside of project area and intensification of irrigation in the project area resulting in reduced return flows to river, adversely impacting any environmental flows Where water reaches river/water bodies, but after being reused, higher level of agri-chemicals with agricultural intensification in increased toxics in river system and more aquatic weeds
Wetlands & local water bodies	(+/-, p, w/l)	Agriculture intensification may be at the cost of water bodies/wetlands. Also, with agriculture intensification there would be increased toxicity and eutrophication from greater use of agrichemicals and creation of waste Better agriculture practices may result in improved health of local water bodies More are under irrigated agriculture or inadequate drainage may result in increase in waterlogging Improved irrigation practices may reduce waterlogging in areas where practiced Changing some water bodies from ephemeral to perennial may change their characteristic	(-, p/t, w/l)	Dumping of waste in water bodies casing contamination Washing of vehicles and other activities leading to pollution of water bodies and wetlands	(+/-, p, w/l)	Dumping of agricultural waste agrichemical and their containers will degrade water bodies Additional and better maintained drainage resulting in waterlogging Improved on-farm management resulting in lowering agrichemical usage, contamination of water bodies Improved irrigation practices resulting in reduced waterlogging

Groundwater	(+/-, p, l)	Increased intensification of irrigation could lead to increased waterlogging and rise in water table Increased contamination of groundwater – due to waterlogging in areas of low sanitation coverage or high use of agri-chemicals contaminating aquifers potentially with health implications Agriculture expansion resulting in greater pumping of aquifer, lowering water table all though this seems unlikely Conjunctive water use plan not possible to implement due to existing legislation in drought period, resulting in crop failure Increased efficiency of agricultural water use, reducing unnecessary pumping of groundwater Reduced return flows in river resulting in lower recharge of connecting aquifers Improved irrigation practices may reduce waterlogging, improving aquifer quality	(-, p/t, l)	In areas where vehicles are kept, parked or at the quarry site, there may be spills of petroleum products – which could contaminate the groundwater Poorly managed sites or waste disposal resulting in waterlogging and a rise in the water table.	(+/-, p, l)	Poor drainage management leading to silting and choking, resulting in waterlogging and rising water table Poor agricultural practices – like excessive irrigation leading to rising water table and waterlogging Agri-chemicals leaching into aquifer causing contamination Improved agricultural practices resulting in lowering agri-chemical usage, improving aquifers health Improved irrigation practices may reduce, with positive impact on aquifer quality
Water quality	(+/-, p, w/l)	Inadequate drainage planning resulting in waterlogging – contaminating surface and ground water Agriculture intensification resulting in higher agri-chemical use and degradation of water quality Water and agricultural practices reduced return flows reducing non point source pollution (NPS) improving water quality Better on-farm practices improve water quality Improved irrigation practices reduce waterlogging and pollution	(-, p/t, l)	Construction activities – like sand mining in river bed would impact the river quality, resulting in localized turbidity to spill of grease and oil from heavy machinery and trucks excavating material Washing vehicles etc in river polluting them	(-, p, w/l)	Return flows, drainage into canal system (silt and water quality – agrichemicals) deteriorating water quality of both surface and ground water systems
Atmospheric Parameters						
Air			(-, t,l)	Vehicular pollution is likely as there will be many truck movements and it is noted that many of the vehicles – especially trucks, are old and poorly maintained Dust during excavation – at construction sites and sourcing of raw material such as aggregate, sand and murram, and transportation of these materials to construction site Diesel pump sets for provision of energy during construction – leading to air pollution		
Noise			(-, t,l)	During construction there is likely to be a relatively high level of noise at construction sites as well as from the large number of truck movements involved in importing fill. This would be heightened by the present quiet environment.		

Land resources						
Soil quality	(+/-, p, l)	Waterlogging takes place due to poor drainage planning Excessive application of water or cultivation of water intensive crops increases waterlogging and soil quality deteriorates Less water intensive crops are used, resulting in reduced water retention and waterlogging and improved soil health and reduced toxicity Reduced soil health due to soil salinisation from high water tables or toxicity due to agrichemical usage Poor on-farm practices resulting in reduced fertility and erosion Effective extension activities improve soil management and health and appropriate balance of micronutrients in the soil	(-, p/t, l)	Localized pollution due to oil and grease spill and waste. Labour camps, for some of the construction activities would create waste and pollution through poor management and poor disposal of waste Large volumes of fill will require borrow pits	(+/-, p, w/l)	Excessive use of agri-chemicals, poor soil and land management practices leading to soil exhaustion, toxicity and degradation, due to poor agricultural extension Effective agriculture extension improves soil quality
Erosion/ compaction	(+/-, p, l)	Improved soil management with improved agricultural extension systems resulting in better soil health and reduced erosion Inadequate agricultural extension resulting in intensive agriculture, poor soil management and erosion	(-, p/t, l)	From procurement sites for material – quarries etc, sheet and gully erosion possible Vehicular movement, construction sites and labour sites causing soil compaction and erosion	(+/-, p/t, l)	Agriculture intensification and poor farmland management without adequate attention to soil erosion control along waterways Better awareness due to agriculture extension resulting in reduced erosion along waterways
Salinity, alkalinity	(+/-, p, w/l)	Poor drainage or excessive water usage raises watertables and increases salinity and alkalinity Proper soil, water and drainage management would improve soil health			(+/-, p, w/ l)	Inadequate extension service resulting in poor irrigation and drainage practices Improved soil, irrigation and drainage management will ensure soil salinity and alkalinity is reduced

Natural and Biological environment						
Terrestrial						
Fauna	(+/-, p, w/l)	Expansion of area under agriculture may reduce bordering wildlife habitats and create animal-human conflict Alien species and habitat loss - Non-native and alien species planted by project plantation activities, displacing native species resulting in a loss of habitat although almost all command area land is already irrigated with little scope to expand. Increased animal – human conflict due to change in cropping like paddy resulting in raiding of fields by elephants, especially as there are a few elephant corridors (1 in particular) near the project area. Reduced toxicity in the environment with better on-farm management practices	(-, p/t, w/l)	Depending upon area for procurement of raw material, location of labour camp, transport routes and other activities disturbance to local avian and other species due to construction noise and human movement is possible. Introduction of alien species for plantation activities could result in loss of habitat Construction in areas with species migration, either at the time of the migration or because of change of habitat due to construction activity resulting in degraded habitat may result in disruption of local migratory patterns. While there are few identified migrations in the area there are some elephant corridors and the Common Crow butterfly local migration. Elephants may disrupt any construction activity in their way. Butterflies, on the other hand may not be able to use the same migration route affecting pollination of local species. Habitat loss due to cutting of trees and other vegetation and plantation of alien species as replacement or for fulfilling local fuel wood needs at the time of construction, which are not appropriate habitat for the local species such as *prosopis glandulosa*	(+/-, p, w/l)	Poor management of agriculture waste – especially agri-chemicals and their waste products, contaminates the area and impacts local or migratory species. Excess agri-chemicals in environment create toxicity and affect some of the species that are likely to either live there or migrate through the region (eg. important pollinating butterfly species). Change to the functioning of wetlands and local water bodies could result in loss or change to local habitats From given information, this is likely to be marginal. Reduced toxicity in the environment with better on-farm management practices
Flora	(+/-, p/t, w/l)	Some trees may be cut along with other vegetation, and possibly inappropriate alternate species planted, displacing native species and resulting in habitat loss. Alien plant species introduced competing with local species/landrace Intensification of area under irrigated agriculture, increase in HYV, monoculture and other crops and introduction of alien species with a corresponding potential loss of local agri-biodiversity Planting of non-native species in areas of local animal corridors resulting in damage to local forest habitats and of animal corridors	(-, p/t,w/l)	Impacts from clearance of vegetation are likely at different sites such as along canal banks and for storage of material Access to the quarries and borrow pits requiring clearance of vegetation. Fuel wood needs obtained from local forests would result in local damage to flora. Introduction of invasive plant and pest species from vehicles and work crews	(-, p, w/l)	Increased intensification of agriculture resulting in greater use of agri-chemicals damaging flora and assisting invasive species Increased areas under HYV, monoculture or other crops resulting in loss of local agri-biodiversity and landraces.

Aquatic						
Fauna	(+/-, p/t, w/l)	Reduced return flows from irrigated areas will reduce the small dry season flows. The reduced return flows on the other hand will reduce non point source pollution of the river. Increased agrichemicals usage resulting in degradation of the aquatic environment and toxicity for species Improved irrigation practices resulting in improved aquatic habitats for fish Improved irrigation, agriculture and on-farm practices resulting in improved aquatic habitats for fish Changing ephemeral waterbodies to perennial may impact the local fauna dependent upon it	(-, p/t, w/l)	Depending upon the area, there is a possibility of an increased turbidity or disturbance or degradation of the habitat. This could be due to sand quarrying, disposal of waste or washing of vehicles in the area, or even construction of structures in the aquatic system.	(+/-, p/t, w/l)	Agrichemical waste and increased toxicity of the local aquatic environment Reduced environmental flows due to agriculture intensification and reduced return flows resulting in decreased habitats Draining of wetlands and local waterbodies for expansion of agriculture resulting in loss of local habitats Improved irrigation, agriculture and on-farm practices resulting in improved aquatic habitats for fish
Flora	(+/-, p/t, w/l)	Depending on location of various activities and possible changes in river flows, aquatic flora may be impacted adversely. Increase in growth of aquatic weeds due to eutrophication of water Improved aquatic habitat with improved on-farm practices Changing ephemeral water bodies to perennial may impact the local flora dependent upon it	(-, p/t, w/l)	Depending upon the area, there is a possibility of an increased turbidity or disturbance or degradation of the habitat. This could be due to sand quarrying, disposal of waste or washing of vehicles in the area, or even construction of structures in the river system.	(+/-, p/t, l)	Agrichemical waste and increased toxicity and degradation of local aquatic habitat, and increase in aquatic weeds Improved aquatic habitat with improved on-farm practices
Sensitive areas	(?, t,l)	There are a number of notified sensitive areas such as the Bhadra Wildlife and Tiger Reserve, and a number of forests area in the vicinity of the project (the wildlife reserve is about 6 km away. However, there are many agricultural developments, roads and settlements before the forest areas and the Bhadra left and right bank before the Wildlife reserve Any project activities near these areas or in animal corridors could have an adverse impact on them.	(?, t,l)	Depending upon sourcing of material and transportation routes sensitive areas can be impacted due to noise, light, vibrations, and destruction of habitat. Material sourcing and transport routes will be at least 2-3 km away and there are other major roads between.	(?, t,l)	Agriculture and irrigation intensification and use of new species may have an impact on area of influence of sensitive area
Corridors, fly paths etc.	(-, p/t, w/l)	Change in land use, flora species changes, or other habitats resulting in disruption of corridors and flight paths. There are some elephant corridors which are likely to cross the command area of the project	(-, p/t, w/l)	Disruption and destruction of corridors Disruption of migration of species due to construction and other construction related activities – some local migration of common crow butterflies takes place, though it is not a large scale migration	(-, p/t, w/l)	Changing the functioning of wetlands and local water bodies may result in changed local habitats, Intensification of agriculture or other anthropogenic activities resulting in destruction of habitats

Economic and Infrastructure						
Agriculture	(+/-, p, l)	There is likely to be a positive impact on agriculture due to a move to higher value and more efficient crops. Improved agricultural practices – yield increased Improved livelihood opportunities in agriculture and better returns Possible loss of agri-biodiversity due to introduction of other species and HYVs	(-, t, l)	Lengthy canal closures during construction would reduce water availability and potentially cause loss of perennial crops or yield loss for several seasons There could be some disturbance accessing various sites such as construction and storage sites, vehicle parking area. Most of this is likely to be temporary, but poor management of sites may result in higher impacts	(+/-, p, l)	Improvement in yields and productivity with improved agriculture extension /agricultural practices, more reliable water supply, higher water use efficiency and reduced waterlogging.
Industries	(+/-,/t, l)	Competition in water use, ground water or pumping from rivers Impact from industries due to reduced water quality with more agrichemical usage Improved water quality due to improved on-farm management				
Mining and quarrying			(-, p/t, w/l)	Impact from quarries and mines due to reduced water availability and quality and change in aquifers or surface water systems		
Fisheries	(+/-, p, w/l)	Drainage of waterlogged areas which now have been reclaimed for fisheries, a programme encouraged by the state Fisheries Department. Improved on-farm practices result in better water quality and fisheries Expansion of area under agriculture result in loss of habitat or contamination by agrichemicals	(-, p/t, w/l)	Disturbance to local habitats during construction – such as sand mining from riverbeds. Waste dumping and washing and cleaning of vehicles, machinery etc in water bodies or near them	(+/-, p/t, w/l)	Changed functioning of water bodies (tanks) affect habitat and recruitment. Agrichemical and other waste dumping contaminating water bodies Improved on-farm practices resulting in better fisheries
Forestry	(-, p/t, l)	Vegetation clearance for structures Alien specie plantation and niche take over by species	(-, /t, l)	Vegetation clearance for access to construction sites, quarries etc Use of fire wood at sites and other construction activities		
Fodder and grazing lands	(+/-, p, l)	Intensification of agriculture may result in less areas for open grazing in fields More fodder crops and residues could be grown in the project area	(+/-, t, l)	Use of grazing areas for storage of construction material etc.	(+/-, p, l)	Less open land in fields for grazing More fodder crops and residues grown
Natural Resource usage and access	(+/-, p/t, l)	Reduced access as areas are used for other activities – compensatory plantation, used for procuring raw material such as murram Waterlogging reduced and improved agricultural practices	(-, t, l)	There could be some disturbance accessing various sites including construction, storage sites and vehicle parking		

WSS infrastructure	(+/-, p/t, l)	Many areas are dependent upon canal water for domestic, livestock and other uses. Lengthy canal closures would reduce water availability for them Contamination of groundwater due to waterlogging in new areas under agriculture or more water available, more intensive irrigation and inadequate drainage Contamination of groundwater due to agricultural intensification and extensive Improved groundwater quality due to better agricultural practices and reduced waterlogging Improved on-farm practices result in improved water quality	(-, p/t, l)	Damage to infrastructure at construction time –during sourcing of material or at various sites and facilities or during transport Lack of sanitation facilities for labour leading to contamination of existing resources Labour lack of sufficient water supplies leading to competition for existing resources Contamination of water sources due to construction activities – both at construction sites and in areas raw material is sourced from– impact availability of potable water.	(-, p, l/w)	Poor management of agriculture waste leading to pollution of groundwater reducing availability of potable water Contamination of groundwater used for stock and domestic purposes in areas where soak pits and septic tanks are used or due to poor storage of agrichemicals Increased usage of agrichemicals resulting in higher pollution loads in water bodies
Settlements		Unlikely to have any impact from project related activities	(-, t, l)	Frequent heavy vehicle traffic causing air (dust, exhaust fumes), noise, safety and traffic disruption issues. Disruptions and disturbance due to construction activities	(+, p, l)	Better and more reliable water supply
Navigation, roads and other transport infrastructure	(-, t, l)	Poor routing of traffic and heavy traffic loads will damage roads	(-, p/t, l)	During construction, there is likely to be higher traffic to and from the various sites – traffic disruptions, road damage Poorly identified borrow pits and river sand quarries could lead to a long term damage to both river based and land based infrastructure as landing sites may be disrupted and river courses could shift or lead to erosion downstream, undermining infrastructure on or next to the river Damage to infrastructure due to heavy transport vehicles	(+, p, l)	New bridges crossing canals will improve traffic flow
Energy	(-, t, l)	Lack of enough sites for fuels for machinery	(-, t, l)	Construction sites and intense traffic will require energy possibly causing conflict with the local population or destruction of local vegetation		
Waste	(-, p, l)	Agrichemical waste as more areas and more intense agriculture takes place Depending upon crops various waste products such as rice hulls, floriculture and horticulture require proper disposal Poor quality pipes used for irrigation/micro-irrigation requiring regular changing and waste dumping in the fields	(-, t, l)	Increased waste from silt, raw material procurement sites, construction sites Malfunctioning vehicles with on-site maintenance Waste from areas dug for infrastructure construction – such as old infrastructure.	(+/-, p/t, l)	Silt management – desilting, other waste, disposal sites Silt applied to fields as a manure Increased weeds rivers due to eutrophication resulting in increased need for disposal of weeds Reduced weed growth in canals due to reduced inflow of Bhadra tailwater reducing weed loads for disposal
Telecommunication			(-, t, l)	Possible damage to telecommunication lines during construction – near material procurement sites and during transportation. Though considering the rural setting, the possibilities are limited		

Social						
Population and livelihoods	(+, p, l)	Overall improvement in livelihood opportunities due to increased productivity and improved information on agriculture	(-, t, l)	Disturbance to local population due to construction activity		
Vector borne diseases	(+/-, p, l)	Due to reduced area of paddy rice and waterlogging reduced habitats for various vectors both due to reduced humidity and waterlogging. Number of vector diseases exist in the project districts and include malaria, dengue, chikungunya, Japanese encephalitis and filarial. Possible storage reservoirs put in place, increase vector habitats	(-, p/t, l)	Disruption of drainage, borrow pits and sand mining areas resulting in an increase in vector habitats	(+/-, p, l)	reduced area of paddy rice and waterlogging reduced habitats for various vectors both due to reduced humidity and waterlogging Additional storage reservoirs increase vector habitats
Water borne diseases	(-, p, l)	Waste management and increasing contamination of both surface and groundwater resulting in contamination of groundwater	(-, p/t, l)	May increase if waste management, sanitation and drainage systems for the labour camps are not adequately addressed	(+/-, p, l)	Improved drainage and better water supply through canal rather than overland flow Possible contamination of domestic groundwater supply
Nutrition and other health problems	(+/-,p/ t, l)	Agriculture expansion resulting in a higher agrichemicals usage and contamination of environment Sand mining destroying local fishing areas Increased nutrition with more pulses and other crops available	(-, p/t, l)	Accidents due to the proximity of the construction and transport sites to the residential area Accidents at the construction sites resulting in injury to the labour or local population.	(+/-, p/t, l)	Toxicity and other health risks due to use of agrichemicals without adequate protection Reuse of agrichemical packages for food and other storage purposes Burning of agrichemical plastic packaging Increased agri-industry waste disposal without adequate treatment and management Better food and nutritional supply
Archaeological, cultural sites, paleontological sites and aesthetics			(-,p/ t, l)	Any riverbed quarries will impact the aesthetics of the area, though the impact is expected to be low Quarries may have impact on forests if not properly selected. Quarries have an impact on local aesthetics Chance findings could exist and may be damaged if not cared for adequately		

Legend of Impacts

(-)	Adverse	(+)	Positive
(p)	Permanent	(t)	Temporary
(w)	Widespread	(l)	Localised

6. INSTITUTIONAL STRENGTHENING AND CAPACITY BUILDING

124. The project implementation is to be done through a PMU which will have an environment specialist as part of the team. This person is expected to have adequate knowledge on how to ensure the implementation of the EMP and also include any environmental concerns identified during the construction and implementation phase. However, to ensure that the PMU environment specialist and officials' in-charge of the system at KNNL understand ADB requirements and EMP needs basic training is needed.

125. Most project activities are geared towards improving agriculture and therefore directly working at the farm level. However, discussions in villages show that there is a lack of awareness on the management of land resources and use of agricultural inputs like fertilizers and pesticides. Therefore, the project will need to undertake capacity building of farmers to ensure that they purchase, store, use, and dispose of chemicals and their waste (eg. wrappings, containers, etc) appropriately.

126. It is also suggested that there is an awareness programme with the appropriate authorities – implementing field engineers and Superintending and Chief Engineers on ADB environment compliance requirements and the EMP so that they are aware of what is required in the project.

7. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

127. The consultative process for this subproject has identified a number of issues, such as the interest of 95% of villagers in the canal being lined mainly for livelihood and health related reasons. These include reduced waterlogging, improved and more efficient availability of irrigation water. This section discusses the relevant environment related issues which came up during the discussions.

128. **Agrichemical usage:** Discussions on the use of agrichemicals – both fertilisers and pesticides show that understanding of agrichemical usage is poor. Most information is either from their friends, family or neighbours or from agrichemical shops. Therefore in many cases it seems to be a hit and try process. Discussion with both farmers and agrichemical shops showed that the chemicals suggested for a specific pest do not always work and therefore another is tried until the appropriate one is found and the problem is solved. It was also noted that organophosphates are being used by the farmers, which is of concern both due to their impact on health and bio-diversity, and the poor understanding of dosage and disposal of unused agrichemicals and their waste.

129. **Management of agrichemicals:** Another issue identified was the poor understanding of agrichemical storage and management of the waste. Discussions show that there is no proper disposal of agrichemical waste. Therefore, waste such as empty containers and partly used chemicals are disposed in the village itself. This includes burning the waste containers, burning the chemicals, or reusing containers. Reuse includes for storage of food stuff.

130. Most people mention that agrichemicals are stored in the house, in places often easily accessed by all family members and also not necessarily separately in order to avoid contamination.

131. **Soil health:** Soil testing is not common in the area. The result is agrichemical usage is based on what the farmers consider to be appropriate. This inadequate information, according to the agricultural specialist of CADA has resulted in micro-nutrient deficiencies in some areas and apparently high application of N:P:K.

132. **Organic farming and IPNM:** At present organic farming is limited as the common understanding is that there is little value added and often crop productivity suffers. Therefore, most farmers prefer not to undertake organic farming. Equally, organic farming is only seen as the use of organic manures. The use of IPNM is not common in the area. Nonetheless, there are a few progressive farmers who experiment with vermi-compost, IPM and IPMN, though because of the common understanding that yields go down with use of organic manures these practices have not spread to many farmers.

133. Recently there has been an increase in the use of micronutrients. While the agrichemical shops identify these as ‘organic inputs’ farmers see these as fertilizers. This usage is however limited at present.

134. **Access to information on on-farm management:** Access to information on agrichemicals, their use and management is limited. Most information is from the shops that sell agrichemicals. The shop owners are informed mainly by the chemical companies who supply the various chemicals and tell them what to use and how. Discussions on the use of organic fertilizers or biocides among shopkeepers, shows their limited understanding on the subject. Shop keepers mainly see organic farming as the use of micronutrients.

135. Some farmers access government extension services – the Agriculture Department officials at the Hobli level. However, this is limited to only those who are living close to the area. The others mainly consult shopkeepers for any agrichemical information.

136. Management of soil health, soil testing and other farmland management activities are largely limited to existing knowledge of farmers and information from neighbours and relatives, as access to information is limited. While farmers understand that soil testing can

improve their soil health, they do not have sufficient information or access to appropriate systems to undertake soil testing activities.

137. **Water hyacinth management:** In some areas, farmers have mentioned the use of the water hyacinth as manure. This is confined to areas and periods when water hyacinth is easily available. Farmers understand that the use of water hyacinth improves productivity. Also, farmers seem to be happy to use this resource where available. Therefore, possibilities could be explored how the weed could be managed through farmer's participation. However, this cannot be assumed as a shift towards organic farming but just an available opportunity in selected areas.

138. **Canal water usage:** Discussions with villagers highlight that they use the canals for various purposes other than just for irrigation. They wash their clothes and animals with the water, animals also drink from the canal directly. Therefore, there is a need to consider these issues while designing any modernisation activities for the project.

8. ENVIRONMENTAL MANAGEMENT PLAN

139. Below is the EMP for the Gondhi Anicut project. This is based upon the findings of the impact assessment, a public consultative process, review of existing legislation and review of secondary information. All of these are given in earlier sections of this document.

Environmental Issue	Mitigation Action	Project Responsible Authorities
Project Design and Location		
Reduced environmental flows due to increased efficiency	Overall assessment of appropriate water needs for each sector, including environmental flows	AC-IWRM and River Basin Plans
Waterlogging or aquifer degradation due to project activities	Development of appropriate drainage structures and management measures, on-farm land management. Work with farmers to identify appropriate cropping patterns and agrichemical usage given existing soils and drainage conditions. Identify and manage quarries such that they cause minimum if any damage to surface and ground water systems, and ensure that during quarrying there is minimum if any damage to aquifers and surface water systems	PMU CAD and Institutions Cells WUCS and agricultural extension sub-project
Water quality degradation due to existing agricultural practices – agrichemicals and land management practices	Education to farmers on improved agricultural practices and use of agrichemicals, on-farm land management practices	PMU CAD and Institutions Cells WUCS and agricultural extension sub-project
Increased soil toxicity, reduction in soil quality, soil exhaustion and erosion	Education to farmers on improved agricultural practices, on-farm land management practices	PMU CAD and Institutions Cells WUCS and agricultural extension sub-project
Lowering groundwater table	Identify appropriate groundwater management and conjunctive use plans and local level regulation systems based upon local aquifer needs.	AC-IWRM's IWRM plans PMU CAD and Institutions Cells
Cutting of trees	Ensure design reduces need to cut trees For all trees cut/removed, plantation should be at the ratio of 3 planted for every 1 cut. All plantation activities should consist of appropriate species for the area to be planted, in consultation with the Forest Department and also after understanding the local ecological needs. Include in project budget. Need to include in the construction contractor's contract	PMU CAD and Institutions Cells
Reduction in habitat for local fauna and flora	Ensure all plantation activities are based upon the local fauna and flora needs, with no invasive species planted Identify possible animal corridors and identify possible actions to reduce conflict – such as scheduling any work in any corridors to minimise conflict. Minimise and manage grazing in ecological areas such as around tanks, along rivers and near any ecological forest areas. Ensure that alien species or those inappropriate for the area are not planted in any animal corridor or fly path area Identify appropriate local species for any firewood plantations All construction activities should be included in the construction contractor's contract clauses	PMU CAD and Institutions Cells
Human – animal conflict	Where possible identify appropriate cropping pattern, considering possible animal raid issues. Discuss with forest department Avoid any activity in animal corridors during migratory season and do not create any permanent structure to obstruct it.	PMU CAD and Institutions Cells

Environmental Issue	Mitigation Action	Project Responsible Authorities
Reduced fodder and grazing lands	Identify areas which are specifically for grazing in the area and through community management ensure that they are not encroached upon or overgrazed Identify appropriate agencies, such as the Animal Husbandry Department to help with improving fodder availability and reduction in open grazing. Implementation of locally identified issues through guidance form PMU	PMU CAD and Institutions Cells AC-IWRM's IWRM plan
Chance finding of an archeologically or culturally important site.	Clearly identify all required actions – that need to be included in construction consultant's contract	PMU Institutions Cells
Reduced aesthetics due to quarries on river bed, hills etc.	Rehabilitation of all sites must be undertaken once work is completed and plans developed well in advance of construction activities. Include rehabilitation requirements in the construction company contract to ensure it is taken up and appropriate budget should be made for the activity Avoid any quarrying work in an aesthetically important/significant place Ensure budget to rehabilitate sites are identified All construction related activities should be included in the construction consultant's contract as clauses, including material procurement.	PMU Irrigation and Institutions Cells.
Loss of local agri-biodiversity	Identify methods of preserving and cultivating local agricultural species and cultivars. Work towards breed improvement of local agricultural species and possible methods to improve income from the sale of produce of local agri-biodiversity	PMU Institutions Cell
Conflict with local fisheries	To the extent possible do not undertake any construction/quarrying activities in areas where local fish populations are important. In case unavoidable, identify methods to reduce impact after discussion with local population and also consider ways to compensate for loss Consider and include fish passage opportunities at anicuts	PMU Institutions Cell
Reduced access to water for domestic, livestock and other purposes from canal system due to design changes and increased water use efficiencies	Identify water needs for different users and in consultation with them develop appropriate design changes to ensure access to identified groups at required places	PMU Institutions Cell
Disruption of traffic routes – especially navigation due to sighting of infrastructure	Identify any landing and other sites along the planned infrastructure site. Where possible consider design changes to ensure there are no problems faced by the local population. Where not possible in consultation with the local population create alternate facilities.	PMU CAD and Institutions Cells
Increase in agricultural waste such as agrichemical waste	Undertake farm management education for farmers to ensure that they know how to dispose agrichemical waste in most appropriate way Explore with KVK's, Agriculture Department, local agrichemical shops and agrichemical companies possibilities of buy back system for agrichemical containers etc	PMU CAD and Institutions Cells WUCS and agricultural extension sub-project
Increase waste from fields due to micro-irrigation system	Educate farmers on best management of systems to be used, where to get good quality material that does not break down and spoil fast, its maintenance and proper disposal of waste	PMU Irrigation and Institutions Cells WUCS and agricultural extension sub-project
Increased vector habitats and diseases	Ensure adequate drainage needs are identified, designed and there maintenance is also identified If required, develop extra drainage plans for various structures to ensure	PMU CAD and Institutions Cells

Environmental Issue	Mitigation Action	Project Responsible Authorities
	there is no waterlogging	
Reduction in food supplements – fish and wild berries etc	Identify any use of lands where structure is planned, or fishing areas and consider how best to take into account people's needs Through an IWRM approach identify various needs of lands not presently occupied by agriculture and ensure that these uses are accounted for any land use and management plan developed for the area	PMU Institutions Cell
Increase in agri-industrial waste from local factories (eg. rice or sugar mills)	Review waste management processes and prepare better plans as required.	PMU Institutions Cell with State Pollution Control Board
Project Construction		
Sand mining and possible change in river course and river scouring	Identify appropriate areas for taking river sand, based upon existing regulations, but also ensuring that there is no excess sand taken. Rehabilitate land after work is finished to ensure least damage to area	Through appropriate contract clauses of construction agency under supervision of PMU Environmental specialist
Waterlogging from poor site planning and management	Ensure proper site planning takes place and site management is adequate – to be put into construction contractor's clauses	Contractor clauses of construction agency under supervision of PMU Environmental specialist
Erosion due to sand and murram mining and material procurement methods	Plan mining and procurement sites before starting work to keep in mind any erosion issues that may occur Rehabilitate site after finishing work, as appropriate	To be ensure by construction company through contract clauses from agency providing raw material , monitoring PMU environmental specialist
Disturbance to wildlife species due to construction and material procurement activities, including in fly paths and corridors	Discuss with local population before starting any construction activity to identify possible concerns to ensure minimum disturbance Only take up work in daytime In case of local animal movement or migrations, ensure that work does not take place when the migration is underway Do not create blockages by storage, labour camps etc in animal corridors Near sensitive areas ensure that work adheres to local regulations and also use least destructive methods, and rehabilitate area after finishing work	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU environmental and gender and social specialists
Occupational safety and construction hazards.	Provision of protective gear and safety equipment as required. Signage, site plan, lighting and restricted entry. Vaccination and preventive health measures as required, and first aid at site. Facilities for handling emergencies at site. Restricted access to hazardous materials. Personnel handling hazardous material properly trained, licensed and with sufficient experience. As needed have toilet and drinking water infrastructure, at construction sites.	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU environmental specialist
Pollution from construction activities	Proper storage and disposal of material, including hazardous material, to avoid contamination, spills and accidents. If there are no waste disposal systems in the area, the material should be sent to a pre-identified disposal site. No dumping in river/water bodies, or labour camps/temporary or material storage sites on river bed.	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU

Environmental Issue	Mitigation Action	Project Responsible Authorities
	Vehicles properly maintained and serviced – and not washed or serviced, at site. Proper waste storage and disposal. Sites restored after work completed. Avoid refuelling at project site. For refilling at site, demarcate site, ensure surface made impermeable. Ensure vehicles are properly maintained Ensure vehicles are covered when carrying raw material Reduce blasting and other similar activities that may create dust to the extent possible Use sprinklers etc to settle dust where needed	environmental specialist
Accidents and health concerns of local population	Ensure that all construction sites are cordoned off and only permitted people enter Ensure appropriate signage at construction, mining sites Ensure that where blasting takes place, such as at mines, timings are known and followed In case of accident ensure required first aid etc is given immediately	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU environmental specialist
Compaction of soil/soil erosion for access to various sites and quarries – such as metal quarries for aggregate, murram quarries and sand mining areas	Rehabilitate all sites after construction/quarrying activities are completed such as ploughing and plantation. Plan site prior to starting excavation activities, including slope stabilization, identify and develop appropriate slope aspect during excavation and contouring to ensure slope stability after earth borrowing activities are completed. Only clear vegetation that must be cleared As far as possible use already identified roads and routes to access various sites	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU environmental specialist
Impact on local fisheries and fish spawning and aquatic fauna.	Do not undertake any construction/ quarrying activity in rivers during the spawning period of the different fish species. Discuss with local population before starting any construction activity to ensure minimum disturbance	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU environmental specialist
Disturbance to local population.	Identify and enforce appropriate access routes, speed limits and timings with community. Identify appropriate material storage areas to ensure least possible disturbance. Consult with local population on hours of operation and any entry of private land Provide signage, demarcate and cordoning of areas to reduce access to construction site and to avoid accidents. Control traffic dust Ensure appropriate site drainage. Restore areas after work is over. Minimize transportation of material through heavily populated areas. Only use road worthy vehicles.	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU environmental specialist
Reduced access to sites for local population, construction sites or material procurement sites	Identify alternate routes for project construction activities where possible If not possible, in consultation with the local population identify appropriate alternatives for them and provide required facilities	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU

Environmental Issue	Mitigation Action	Project Responsible Authorities
		environmental specialist
Damage to infrastructure.	Vehicles to take pre-identified routes. Do not overload vehicles or use vehicle loads higher than transport infrastructure capacity or dimensions. Identify possible telecommunication lines or other structures over roads (eg. overpasses, tunnels) in the area prior to starting work to ensure that they are not damaged due to any construction work. If damage to infrastructure occurs, plan for any maintenance that might required.	To be ensured by construction company through contract clauses, monitoring PMU environmental specialist
Workers / labour camps and facilities.	Provide appropriate shelter and other facility for any labour brought from outside. Do not use hazardous materials like asbestos for construction of shelters or temporary housing. Ensure no conflict with local population due to labour camp. Provide sanitation and waste management faculties	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU environmental specialist
Conflict with labour camps on resources.	Select any labour camp sites to ensure least possible conflict with local population – e.g., at a distance from where population density is high. Ensure labour camps have required infrastructure like water supply, sanitation facilities and energy. Develop appropriate waste management system, and rehabilitate the site after construction is over Do not develop any construction site – material storage, labour camps etc without consultation with the local population. Where possible do not use grazing lands etc for labour and material storage	To be ensured by construction company through contract clauses both for work carried out by them, monitoring PMU environmental specialist
Chance findings – archaeological sites.	Stop all work that may be underway or planned in the area and discuss with District Commissioner for further action Ensure that the construction company and supervising consultants have an understanding of archaeological concerns in the area Ensure that any important archaeological area is well identified and demarcated and that required actions are specified in a detailed management and mitigation plan so that no damage takes place to it	To be ensured by construction company through contract clauses, monitoring PMU environmental specialist
Project Operation		
Increased agricultural waste in water and water bodies	Ensure through farmer's education that waste is not disposed in water bodies and appropriate waste disposal systems are found and used	PMU environmental specialist
Increased agrichemicals in surface and ground water systems, and reduced quality of return flows	Farmers education on proper use and management of agrichemicals, including their waste Ensuring a farmer-friendly method for disposal of agrichemical waste, as identified during project design	PMU Institutions and CAD Cells
Waterlogging and reduced drainage	Identify appropriate cleaning and maintenance of drainage system, including disposal of waste removed. Improved agriculture practices – understanding plant needs and use of irrigation water as required through improved understanding of the system Identify appropriate systems for the management of drains and disposal of silt Ensure there is a budget for the management of drains and the budget is spent on it	PMU CAD and Institutions Cells
Soil degradation due to poor on-farm management, intensive agriculture, soil	Identify appropriate soil management and soil testing systems and educate farmers on it. Ensure that farmers remember through repeated information sharing on good agriculture and soil management practices	PMU CAD and Institutions Cells

Environmental Issue	Mitigation Action	Project Responsible Authorities
exhaustion and soil toxicity due to chemical usage and lack of knowledge among farmers		
Change and degradation of wetlands due to waste dumping and expansion of agricultural lands	Identify important wetlands and monitor land use and condition Through the IWRM activities identify appropriate land management and conservation methods, and work with farmers to educate and ensure that wetlands are not degraded Work with farmers to identify appropriate land management and waste management systems at the village level	PMU Institutions Cells
Reduced and degradation of habitats for species – both aquatic and terrestrial species	Work through a community system to identify wetlands, other habitats and local environmental assets Work with local community to ensure that cultivation is not extended into areas environmental assets Educate community on management of soil and agrichemical usage Demarcate all areas though an IWRM plan for conservation and limitation of areas for agriculture.	PMU Institutions Cell AC-IWRM's IWRM plan
Increased aquatic weeds	Ensure appropriate drainage management to keep the canals and drains silt free and not allowing the disposal of any waste Work with farmers through farmer's education system to ensure appropriate application of agrichemicals, including fertilizers Educate farmers on proper soil management and testing	PMU Irrigation and Institutions Cell
O&M waste – spoils from drainage system and canals	Identify appropriate waste management system for drain cleaning Weeds can be used, in consultation with farmers, for manure. Therefore, if farmers are interested a system for their use and disposal on farmlands at the time that drains are cleaned should be undertaken.	PMU Irrigation and Institutions Cell
Increased toxicity in environment and for people with more agrichemical packages being reused	Farmer education on appropriate management of agrichemical packaging. Where possible consider a buy-back system for agrichemical packages by the agrichemical companies	PMU Institutions Cell
Non point source pollution of waterways	Work with and educate farmers on the best management of agrichemicals Consider options for improving quality of NPS runoff	PMU Institutions and CAD Cells AC-IWRM studies
Multi-objective use of tanks and off line storages	Consult with users, study existing and planned uses and consider options for best management of the tank areas recognising their multiple uses (eg. environment, irrigation water supply/control, weed collection, fishing, fringe grazing etc	PMU Institutions and Cell AC-IWRM IWRM plans

Monitoring Plan for Sub-Project

140. Prior to developing a monitoring plan there is a need to develop a baseline for some activities to help with the monitoring activities. The baseline is described below along with monitoring needs and responsibilities

Project Phase	Parameter	Frequency to monitor	Action	Responsible authority
Construction	Noise	Monthly before (baseline) and during construction period	Pre-construction baseline. Day time measurement since all activities are expected to be done in the day time If not possible to identify schedule – should be done for 3 different times: peak traffic, day quite hours and late	The actual measures should be available in the DPR for those areas where actions have been identified

Project Phase	Parameter	Frequency to monitor	Action	Responsible authority
			evening	
	Site for quarries and borrow pits	Before work baseline and end of work prior to making final payment for work to contractor.	Photographic baseline (pre-construction) for restoration of site after the construction activity is completed	Undertaken by the construction company or PMU, as appropriate. All records are to be with the PMU for future reference
	Removal of vegetative cover and trees	Prior to work starting and before making the final payment to the agency identified for undertaking all plantation activities.	Assessment to include cost in DPR Vegetative survey to identify type and amount of vegetation that needs to be replaced Tree surveys where trees are to be cut to estimate the amount that has to be replanted	Costs need to be included in the DPR too.
	Waste management at sites	At random at sites, but report compiled on a monthly basis from before construction commences.	Review if the waste management plan is in place and being followed properly.	The actual measures should be available in the DPR for those areas where actions have been identified
	Site management	Monthly for the duration of the work	To ensure that all required facilities are available – like safety equipment, workers sanitation facilities and domestic needs water for workers and their families etc. as defined in the EMP	To be identified as a list of actions and conditions in the construction contractor's contract.
	Site restoration	Once prior to work commencing and then before final payment of the construction company in-charge of the area	To ensure that restoration is undertaken appropriately. Photographic baseline to be maintained.	To be done by the contractor or the PMU with all records available with the PMU.
Project Operation	IPMN implementation	Six monthly	Review progress of knowledge and use of IPNM by farmers and access to required facilities.	Based upon the activities identified by the PMU CAD and institutional Cells and in the subproject documents

9. DETAILED PROJECT REPORT

141. The DPR for the Gondhi Project (September 2009) indicates that for the environment, ecology and forest aspects:

i. As there are no new constructions or alignments and no part of the canal that runs through forest areas, and that no approval is necessary therefore from the forest department.

ii. There is no cultural heritage site in the canal reaches so it not necessary to obtain such approvals.

iii. Since the project cost exceeds 50 Crores a proposal will be submitted to Ministry of Environment and Forest for clearance.

142. There are some additional considerations for the DPR and these include:

143. The Karnataka Forest Act 1963 and its Rules 1969 and the Karnataka Preservation of Tree Act, 1976 will need to be addressed to identify requirements in relation to any required clearances. For example, clearance of any tree will require defined permission and compensatory activities such as replacement by new plantings. Also, some trees are considered restricted trees under Karnataka's Forest Act and therefore procedures as identified for these trees must be followed.

144. According to the Environment Protection Act, 1986 and the EIA Notification 1994's recent amendment of 2006 the DPR will need to be submitted to the Karnataka state Department of Environment for a clearance and a no objection certificate that is included with the DPR unless the Department requires an EIA. While earlier projects above INR 50 crore required a clearance under the EIA notification, now all new and modernisation projects; regardless of cost, if in category A or B – as is described in section 2.1 of this Annex, will need to obtain a clearance from the Department or the Central Ministry and follow required procedures defined under this Act, its notifications and amendments.

145. Based on the above assessment and this IEE, the DPR should be amended to include identification of measures and where relevant budgetary allocations for:

i. Noise and dust control and monitoring,

ii. Specification of the location of sites for quarries (silt, sand and gravel etc);

iii. Removal and where relevant replacement of appropriate vegetation (especially trees),

iv. location of any elephant migration paths and the implications and mitigation measures including for project costs

v. Site and waste management,

vi. Site restoration,

vii. Project monitoring,

viii. Any EIA that might be required to fulfil the needs of the Environmental and Protection Act 1986 and it's 2006 notification procedures

10. CONCLUSION AND RECOMMENDATIONS

146. While there are sensitive areas in the District – Shivamogga, where this sub-project is located, none of them fall in the planned sub-project area. The planned activities of this modernisation sub-project are also unlikely to have an adverse impact on these sensitive areas. Nonetheless, as the site is near the Western Ghats, which are both ecologically important and sensitive, certain issues will have to be taken into account in project activities. In addition, there are a number of issues that will need to be managed in order to protect the environment of the project area and related areas.

147. The IEE has screened the range of potential environmental impacts, prepared a proposed Environmental Management Plan and sub-Project Monitoring Plan.

148. In addition to these plans there are a number of areas requiring further attention and these are:

- Appropriate mechanisms to improve on-farm soil and land management and to introduce IPNM and other mechanisms to ensure reduced use of agrichemicals need to be developed and implemented. It is expected that intensification of agriculture will be tend to increase agrichemical usage. Any expansion of agriculture, although not expected would also increase usage of agrichemicals.
- Discussion with forest officials is required to identify and pin point any elephant corridors that are in the planned project area. There is a need to ensure that there are no disturbances during their migratory period and that damage to infrastructure will not occur.
- The existence of elephant herds is likely to result in animal-human conflicts and the cultivation of rice and bananas may also result in elephants raiding fields although no more than in the pre-project case.
- Care also is needed to prevent the introduction of invasive alien plant species that may be transported by migrating animals to the Western Ghat forests.
- Another issue that would require serious consideration is environmental flows. The envisaged plan is to improve efficiencies of the system, save water for upstream consumption, which together will reduce return flows to the river. This is expected reduce water supply for the downstream environment and water users. This is something that should be considered in larger IWRM project.
- There is thought to be little scope for expansion of the irrigated area as the command area is now fully irrigated and on one side is bordered by the Bhadra river and on the other by the Bhadra command area. Internally there could be some minor scope however by encroaching upon tank areas which have some ecological value. It is suggested that local land use plans be developed in discussion with the local populations to protect any such important areas including along the river and waterways. This perhaps again is an area where the IWRM project could assist.
- The main area where there is a need for close monitoring is during the construction period – where issues of material procurement, site planning, management of any labour camps and labour needs, noise and dust control, disposal of waste, vegetation clearance, and the restoration of sites after the work is completed need to be ensured. These must be included in contractor contracts with adequate funds available for the activities to be undertaken properly.

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ANNEX 3: BHADRA ENVIRONMENT CONSIDERATIONS

1. Description of Subproject Activities

1. There are a few and very limited set of activities planned as a part of the Bhadra subproject. Activities planned are:

- Improved canal flow measurement that will provide information to support better operation of the irrigation system both in terms of day-to-day flow management and quantification of flow volumes supplied.
- Main canal flow measurement that will use electronic flow measurement devices with telemetry to enable real time data acquisition to guide system operation.
- Likely measurement of flows at the larger off-takes to distributaries and possibly at selected command area outflow points.
- There are no other engineering interventions or agriculture related activities planned in the Bhadra subproject.

2. Considering that this is the only activity planned and there would be very limited scope for impacts, the subproject is considered a Category C project. Therefore, no IEE or EIA is required for the project.

3. Any minor impacts could occur during the project construction/installation phase and to ensure that these are minimized this annex discusses possible areas of impact and their management.

2. Brief Area Description

4. The Bhadra subproject falls under the three districts of Shivamogga, Chikmangalur and Davangere, as noted in Table 1. There are a total of 8 taluks covered fully or partially by the Bhadra Reservoir Project between these three districts.

Table 1: District and Taluks of Bhadra subproject

Districts Covered	Taluka
Shivamogga	Shivamogga and Bhadravathi,
Chikmangalur	Tarikere,
Davangere	Davangere, Channagiri, Honnali, Harihara and Harapanahali,

5. Parts of Shivamogga and Chikamanglur districts also fall in the Western Ghats. While Shivamogga district has about 51% forest cover, Chikmanglur has a 30% forest cover and Devangere only 16%. Some of the ecologically sensitive areas in these project areas are Bhadra Wildlife Sanctuary, Kudermukh National Park, Gudavi Bird Sanctuary, and Shettihalli Wildlife Sanctuary. Apart from these sanctuaries and parks, there are also a number of other forest areas related this project. Some of the district area also falls under the recently declared UNESCO World Heritage site of the Western Ghats.

6. Discussion with various government officials noted that while the canal network does not pass through the parks or reserves, it does pass through and in places adjoin protected forest areas. The Bhadra Reservoir also adjoins the Bhadra Wildlife Sanctuary and Tiger Reserve. However, the present work will not include any work adjoining the National Park and Tiger Reserve or is expected to impact it.

7. The topography of the three districts though which the Bhadra canal network passes is varied. This consists of the hills of the Western Ghats followed by undulating land to the plains of Davangere. There are a number of rivers which originate from the area and are mainly from forests in the Western Ghat regions of Shivamogga and Chikmanglur. These are

Rivers Kali, Gangavathi, Sharavathi and Tadadi in Shivamogga and Bhadra and Tunga in Chikmanglur. The rivers Tunga and Bhadra meets at a place called Koodalgi in Shivamogga district to form Tungabhadra.

3. Project Impacts

1. In general this project is expected to have very few impacts, particularly as the canal has already been modernized and the proposed construction activities relate to equipment installation only. This section discusses possible impacts that may occur due to project activities.

Design Related Considerations

2. During design, the following impacts should be considered:

- For any cases where structures are located in forests or areas adjoining the forest, there could be disturbance of animals as a result of accessing sites for maintenance or for taking readings.
- Infrastructure may be damaged due to animal movement as it is understood that the canal is accessed for drinking water during the summers.

Construction Related Considerations

3. During construction/installation the following impacts should be considered:

- Although not anticipated, impacts from any possible sourcing of material such as from borrow pits or quarries, sand mining in the river, timber from the forest.
- In the event that camp sites are required during installation, waste including of camp sanitation.
- Safety of workers or the local population during installation operations
- Disturbance of wildlife, especially in areas near sensitive areas or during migration periods
- Disturbance of the local population near sites or material sourcing sites or during transportation of materials and equipment.

Operation Related Impacts

4. There could be waste due to O&M such as material and parts changing, painting etc.

4. Impact management

5. Details for possible management of impacts are given in the EARF EMP and should be referred to. This section however briefly suggests management actions.

Design Related

- Where possible, avoid siting the structures in sensitive areas like forests.
- Do not install any structure in an animal corridor
- Where no better location can be identified try to minimise disturbance
- Ensure design is such as to reduce possible access by animals to the flow measurement instrumentation. If needed, provide access to water for animals so as to make it safe when animals come to drink water in the area.
- Ensure design is such that animals, if they fall into the canal are not trapped by the equipment

Construction Related

- Develop appropriate worker safety and site safety plans and implement them

- Consult with the local population prior to starting work in an area and cordon off any site from the local population to minimum damage and accidents
- Identify appropriate waste storage sites and remove all waste from the sites
- Ensure all sites are rehabilitated once the work is over
- Ensure any borrow pits, sites, etc are rehabilitated once work is over according to the law.

O&M Related

- Ensure that there is a waste collection and disposal plan and that the maintenance staff know and follow it.

5. Conclusion and Recommendations

6. Impacts are expected to be very limited in nature and therefore are likely to have minimal to negligible adverse affect on the environment. The use of flow recording measures on the canal system is likely to reduce water wastage and therefore possibly reduce waterlogging as well as reduce demands on water sources such as river and ground water. Telemetric data collection and transfer also means that there will be no need to regularly visit the site. Site visits would only be needed for repair and maintenance.

7. However as for any activity, some impacts will occur and need to be managed with appropriate actions.

8. The main potential area of impact is during installation – and includes sourcing of any material, construction sites and labour camps and disturbance to the local population and animals. While disturbance to animals can be minimised by ensuring work is carried out at appropriate times, such as not during the migration of any species – such as butterflies like the Common Crow which are local migratory species for the area, disturbance to human species can be minimised though identification of appropriate sites for material storage and routes for transportation.

9. Any sourcing of material, disposal of waste, working in a sensitive area or cutting of trees, etc would require appropriate government permissions as identified in the project EARF's legislation section. Any work would need to be conducted according to government guidelines. All required permissions must be obtained prior to starting the work.

10. It is suggested, to the extent possible, not to undertake work in forest areas so as to create minimum disturbance to the forest. Also, site locations for the measuring devices should be located so as to create minimum disturbance to the local environment. For example the need for access to a site may require passage through a forest area which might disturb wildlife. Such access may require permissions.

11. The design and location of flow measurement devices need to ensure that they do not become or assist traps for wild animals that may fall into the canal while drinking water. Also they should be installed and protected to that they are not damaged by animals.

12. Post construction maintenance planning should identify possible waste collection and disposal and regular cleaning needs for all structures and ensure that there is no waste left in the area which could create habitats for various vectors.

ANNEX 4: GONDHI SUBPROJECT: BASE EIRR

EIRR Sensitivity Analysis

Change Variable		**EIRR**	**ENPV (12%)**	**Switching**	**Sensitivity**
	Change	(%)	(Rs million)	**Value** (%)	**Indicator**
BASE	**-**	***17.1***	**274.1**	**-**	**-**
Construction and CAD Costs Increased by	10%	*15.4*	197.6	*30*	1.00
Project Benefits Delayed by Years	2	*10.5*	-114.7	-	-
Project Life Reduced by Years	5	*16.6*	228.8	-	-
Incremental Benefits or Crop yields or Price (including saved water) Reduced by	10%	*13.7*	94.5	*15*	1.94
Gondhi Crop Production Costs Increased by	35%	*12.4*	22.3	*40*	0.78
Gondhi Crop Yield with Project Decreased by	10%	*4.0*	-434.6	-	7.67
Model Parameters		***80%***	**Reduce output and production costs without project to this % of original**		
CAD Included (enter 1 if included)	**1**				
Channel lining costs (enter % of channel **NOT** lined)	**0%**	Note 0% means 100% lined, etc. If channel lining costs are excluded, O&M costs for earth channels increase by 25% for unlined percentage			
Saved water value included (enter % of value net of delivery costs	**0%**	Note if 100% assumes NO delivery cost to water, if 50% half of water value absorbed by delivery costs etc. 0% means no water			

GONDHI SUBPROJECT: BASE EIRR

Project Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Item	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**	**2026 on**
Base Output (copy from model)	813,170,450	799,743,473	752,779,739	719,064,004	705,637,028	723,439,028	785,539,028	816,589,028	878,689,028	915,949,028	915,949,028	915,949,028	915,949,028	915,949,028
Base production costs (from model)	519,479,630	516,024,358	538,221,751	495,104,663	556,963,871	491,649,391	519,695,591	534,860,135	534,860,135	534,860,135	534,860,135	534,860,135	534,860,135	534,860,135
Without Project														
Output	813,170,450	639,794,778	602,223,791	575,251,203	564,509,622	578,751,222	628,431,222	653,271,222	702,951,222	732,759,222	732,759,222	732,759,222	732,759,222	732,759,222
Production Costs (including labour)	519,479,630	412,819,486	430,577,401	396,083,730	445,571,097	393,319,513	415,756,473	427,888,108	427,888,108	427,888,108	427,888,108	427,888,108	427,888,108	427,888,108
O&M without project (Rs 500/ha/year)	2,300,000	2,300,000	2,300,000	2,300,000	2,300,000	2,300,000	2,300,000	2,300,000	2,300,000	2,300,000	2,300,000	2,300,000	2,300,000	2,300,000
With Project														
WUA & PIM Support	0	4,050,000	4,050,000	4,050,000	4,050,000	0	0	0	0	0	0	0	0	0
Irrigation Infrastructure	260,000,000	346,400,000	260,000,000	0	0	0	0	0	0	0	0	0	0	0
CAD Works	0	0	37,600,000	37,600,000	37,600,000	0	0	0	0	0	0	0	0	0
Agriculture & Livelihoods	0	4,500,000	4,500,000	4,500,000	4,500,000	2,700,000	0	0	0	0	0	0	0	0
Project Management	2,200,000	2,200,000	2,200,000	2,200,000	0	0	0	0	0	0	0	0	0	0
Scheme Operation & Maintenance	2,300,000	2,300,000	2,300,000	3,330,000	3,330,000	3,330,000	3,330,000	3,330,000	3,330,000	3,330,000	3,330,000	3,330,000	3,330,000	3,330,000
Output	813,170,450	807,096,542	817,829,865	874,337,398	885,373,700	889,690,897	895,323,097	904,952,750	923,339,300	947,792,750	973,496,750	995,852,750	1,007,651,750	1,010,162,750
Production Costs (including labour)	519,479,630	526,520,973	537,162,943	533,970,575	521,893,155	519,311,771	520,037,304	516,687,177	513,732,540	517,992,980	522,829,612	523,801,350	523,801,350	523,801,350
Incremental Cost (Rs)	262,200,000	470,851,487	414,935,542	187,266,845	123,502,058	129,722,258	105,310,831	89,829,069	86,874,432	91,134,872	95,971,504	96,943,242	96,943,242	96,943,242
Incremental Benefits (Rs)	0	167,301,764	215,606,074	299,086,195	320,864,078	310,939,675	266,891,875	251,681,528	220,388,078	215,033,528	240,737,528	263,093,528	274,892,528	277,403,528
Saved Water Benefits (14 Mm^3 at Rs 21)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Economic Benefits (Rs)	-262,200,000	-303,549,723	-199,329,468	111,819,350	197,362,019	181,217,416	161,581,043	161,852,459	133,513,646	123,898,656	144,766,024	166,150,286	177,949,286	180,460,286
EIRR=	**17.06%**													
NPV@12% (Rs)	**274,089,630**													

ANNEX 5: FINANCIAL & ECONOMIC ANALYSIS: MARKETS AND PRICES

Asian Development Bank, TA-7954-INDIA

Karnataka Integrated & Sustainable Water Resources Management Investment Program

PPTA

FEASIBILITY STUDY SUPPLEMENTARY REPORT

Financial & Economic Analysis

Markets and Prices

DHV BV Consultants

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1 AGRICULTURAL PRODUCTION AND TRADE

1.1 Food Crops in Karnataka State

1. Table 1.1 summarises total production of the main food commodities in Karnataka. Production trends show a general increase for agricultural commodities, with current production around twice levels in 1980. Planted areas have hardly changed and yield rates have increased. This is due to increased irrigation, fertiliser application rates and adoption of HYV. Total cereal crop area is little changed, but rice (28 percent of 2011-12 cereal area) and maize (26 percent of 2011-12 cereal area) are of increasing importance, and coarse grains are declining. Pulse and oilseed areas are increasing slowly. The main pulses in Karnataka were grams. The main oilseed crops were groundnut, about half the oilseed area, sunflower (27% of area) and soya bean (15% of area), which account for 90 percent of production.

2. Assuming a cereal demand of 168kg per person per year, including seed, and a population of 61 million, Karnataka is more than self sufficient in grain crop production, requiring 10 million tonnes or 90% of production. Demand for pulses, assuming 14 kg/person/year, is below production, at about 0.9 million tonnes, 50% of total production. Oil seed production cannot meet demand for oils.

Table 1.1 Agricultural Production in Karnataka State 2011-12
(million tonne)

	2010-11	2011-12
Rice	4.3	3.9
Maize	4.4	4.2
Millets	1.9	1.7
Jowar (Sorghum)	1.5	1.3
Wheat	0.3	0.2
All Cereals	**12.4**	**11.2**
Pulses	1.6	1.2
Oilseeds	1.3	1.0
Arecanut	0.2	0.2
Sugarcane	38.0	na

Sources: Economic Survey of Karnataka 2011-12 (2011-12 provisional estimate)

1.2 Other Crops

3. Cotton is grown on 3 percent of the area, and produces about a million bales (0.2 million tonne). Irrigated cotton is discouraged as it has a high water demand, so is unlikely to be of importance in the project. Similar areas are under sugarcane (3.7 percent of area, about 25 million tonnes cane), coconut (3.4 percent of area, 2 to 3 million tonne), vegetables 2.4 percent and arecanut (betel palm) (1.5 percent of area, about 1 million tonne raw nut). Sugarcane, and arecanut are grown extensively on some subprojects.

1.3 Indian Production and Trade

4. India typically produces a little more cereal than is utilised, see Table 1.2, and exports about 2 to 5 percent of production, mostly as rice. Rice exports are again significant, after India temporarily banned rice exports in October 2007, 10 million tonnes may be exported in the next year. Wheat and other grain trading is usually small, but India is currently a net exporter of 4 percent of production. India imports pulses, oils and fats. India is the world's largest importer of edible oils, currently over 8 million tonnes a year.

Table 1.2 Indian Crop Production, Trade and Utilisation in 2011-12

(estimate) (million tonne)

	Production	Imports	Exports	Utilisation	End Stock
All Cereals	232.3	0.3	10.8	217.5	48.7
Wheat	86.9	0.2	2.0	84.6	19.0
Coarse Grains	42.1	0.1	2.5	38.8	22.9
Maize	21.6	0.1	2.5	18.4	8.0
Rice (milled equivalent)	103.4	0.1	4.0	91.6	21.5
Oil crops	37.3	0.2	0.7	-	-
Oils and Fats	-	8.7	0.5	18.6	-
Sugar (raw equivalent)	28.1	-	3.0	23.6	-

Source: FAO Food Outlook, May 2012

Notes: India banned rice exports in early 2008, and was a major exporter in 2011-12
Oils and fats from vegetable, animal and marine sources

5. India is a significant producer of grain crops, see Table 1.3, with about 10% of all cereals production, 22 percent of world rice production, and 12 percent of world wheat and sorghum production. International grain trade is minor, except for rice, of which India is a major exporter, with 12 percent of the world market. Despite a significant share of world oilseed production, in particular rape (mustard) seed, India imports oils and fats. Sugar is also a significant crop, with 19 percent of world production, and significant net exports.

Table 1.3 Indian Crop Production and Trade 2011

(percent of world total)

	World Production	World Trade
Cereals	*9.9*	*3.7*
Wheat	*12.4*	*1.5*
Sorghum	*12.5*	*0*
Maize	*2.5*	*2.6*
Rice	*21.5*	*11.6*
Sugar	*19.0*	

Source: FAO Food Outlook, May 2012

2 MARKET BACKGROUND AND PRICES

2.1 Fertilisers

6. India is the second largest producer and consumer of fertilisers in the world (after China) accounting for about 12 percent of world output. Installed capacity (2010) was 12 million tonne nitrogen and 6 million tonne phosphate in 56 major fertiliser plants, in public, co-operative and private sector ownership[5]. Little investment in new capacity is being made. Capacity for nitrogen meets demand using mainly local raw materials (production is being switched to natural gas), for phosphates is close to meeting demand using mainly imported raw materials and 28 per cent of direct fertiliser imports, and for potash relies on imported raw materials and, mostly, fertilisers. Annual consumption of fertilisers, in nutrient terms, has increased from almost nothing in 1950 to 28 million tonne in 2010-11, and has been critical in increased yields and production in India. Fertiliser utilisation is linked to irrigation and HYV crops.

7. World fertiliser prices are high, and are increasing over 2010 lows but are below 2008 peak prices. Prices of feed stocks, oil and power are under upwards pressure. In September 2012: urea was US$ 400/t; Triple Superphosphate (TSP) US$ 470/t[6]. Fertiliser prices at such high levels may well suppress utilisation by farmers with limited access to credit, but in India there are substantial, though rapidly falling, subsidies.

8. The Department of Agriculture & Cooperatives assesses fertiliser demand through half yearly input zonal conferences in consultation with the State Governments and the fertiliser industry. There appears to be little consultation with farmers. The Essential Commodities Act (ECA) Supply Plan and orders are issued under the Fertiliser Movement Control Order for urea (local and imported). The prices of urea are fixed by GOI, at the Maximum Retail Price (MRP).

9. The Karnataka Department of Agriculture allocates and manages the distribution of fertilisers to Districts and Taluks according to estimated crop requirements in each season. There is no private fertiliser wholesale market, as subsidies leave no margins. Black market fertiliser sales are reported as small, and exporting is minor. Fertiliser retail sales are undertaken through co-operatives and private traders, There are 275,000 fertiliser sale outlets in India, 77 per cent private businesses.

10. The Indian fertiliser industry has been state controlled for many years. Urea is under statutory price, movement and distribution control under the Essential Commodities Act, 1955.The new pricing scheme for urea units was introduced in 2003, and stage III, due to end 2010 has been extended. This pays variable subsidies, depending on plant type and age, whilst feedstock and fuel prices are passed on directly. P & K fertilizers were decontrolled in 1992, with maximum retail prices set at well below cost prices. Nutrient Based Subsidy Policy was implemented for P&K fertilisers from 2010. Imports of P&K fertilisers, including complex fertilizers, are now under Open General License, 38 per cent of the total fertiliser consumption are imports, increasing from 3.6 million tonne in 2000-01 to 21.7 million tonnes in 2010-11, mainly urea, DAP and MOP. This is due to under capacity and lack of local raw materials.

[5] Ministry Of Chemicals & Fertilizers, Department of Fertilizers, Annual Report 2010-11
[6] World Bank Commodity Price Data Sheet

Table 2.1 Consumption of Fertiliser Nutrients, India

('000 tonnes)

Year	Nitrogen (N)	Phosphate (P^2O^5)	Potash (K^2O)	Total	Kg/ ha
2007-08	14,419	5,515	2,636	22,570	116
2008-09	15,091	6,506	3,313	24,909	128
2009-10	15,580	7,274	3,632	26,486	136
2010-11	16,890	8,001	3,391	28,283	145

Source: Report of The Working Group on Fertilizer Industry for the Twelfth Plan (2012-13 to 2016-17) Government of India Ministry of Chemicals & Fertilizers Department of Fertilizers

11. India lacks potassic (K) resources and depends on entirely on imports. Phosphatic (P) fertilisers are supplied 90 percent by import of fertilisers or raw materials. Urea (N) is largely, 80 percent, met using indigenous resources, but use imported oil and LNG. Local production of fertilisers has not kept pace with demand due to limited raw materials (especially gas) and little new investment, due to poor profitability. Currently, about 5 million tonnes of rock phosphate and 1.2 million tonnes of sulphur are imported every year. The availability of rock phosphate from domestic sources is about 1.6 million tonnes. Domestic availability of sulphur is about a million tonne. A major portion of these raw materials is used by the fertiliser industry. During 2010-11, about 2 million tonnes of phosphoric acid was imported, 60 percent of requirements.

12. The use of fertilisers in Karnataka State has increased steadily from 153,000 tonne of nutrient in 1970, 1.2 million tonne in 2000 to over 2 million tonne in 2011-12, an average growth rate of 5 percent per year. The per hectare consumption in Karnataka is higher than India average, during 2010-11, it was 171 kg/ha compared to 145kg/ha for India. Over half the total is N, mainly as urea, Table 2.1, with a ratio of N2.6:P1.7:K1, where balanced use is taken as N4:P2:K1. Fertiliser consumption for P&K fell a little in 2011-12, due to rapid increases in farm prices, whilst price controlled N increased a little. Downwards consumption may continue, as prices rise.

Table 2.2 Karnataka State Fertiliser Consumption

('000 tonne nutrient)

Nutrient	2007-08	2008-09	2009-10	2010-11	2011-12	Annual Compound Growth (%)
N	790	864	963	1,016	1,030	5
P^2O^5	387	558	630	696	643	9
K^2O	330	409	466	398	337	-
Total	**1,507**	**1,832**	**2,058**	**2,110**	**2,010**	**5**
Kg/ha	121	148	166	171	165	

Source: Report of The Working Group on Fertilizer Industry for the Twelfth Plan (2012-13 to 2016-17) Government of India Ministry of Chemicals & Fertilizers Department of Fertilizers Department of Agriculture. Economic Survey of Karnataka 2011-12

13. Fertiliser prices based on the current MRP, and estimated from international prices are shown in Table 2.3. Prices in 2012 were increasing on world markets, and increasing rapidly at local retail rates, Table 2.3, for example DAP prices have increased 257% from 2009 to 2012, and are set to increase again in 2013. The MRP of urea was increased by 10% from Rs. 4830 to Rs. 5310 per tonne in 2010, and is likely to increase a further 10% in 2012. Obtaining fertilisers at the MRP was difficult, and farmers are reducing purchases, and switching to much cheaper urea, sold at highly subsidised prices. The implications of a rapidly increasing financial cost of fertiliser need to be considered in crop budget models, it is likely that historic increases in fertiliser use

will not be sustained in the medium term, in particular for P&K. The use of N as urea may increase, unless GOI rationalises the relative pricing (and reduces subsidy) by allowing urea prices to increase in line with import costs.

Table 2.3 Fertiliser Maximum Retail Price

(Rs/kg of product)

Product	2009	Rabi 2011-12	Kharif 2012
Urea 46% N		4.83	5.31
DAP 18%N 46%P	9.35	18.20	24.00
SSP 17%P		4.80	7.80
MOP 60%K	9.35	12.00	17.00

Sources: Press reports

14. Prices reported by the WB Commodity Price series were used, September 2012. The detail calculation of the estimated prices are shown in Section 4. Estimated prices are based on import parity for all fertilisers, and include the current Nutrient Based Fertiliser Subsidy of the GOI, which is around Rs 30 per kg of nutrient, about 50 percent of the real landed cost of nutrient, including import duty (at 10 percent) on the imported proportion of fertilisers, and bagging of bulk product for local distribution. Estimated prices are close to the MRP for all three main ingredients, except N from urea sold at very subsidised costs, around a third of the cost of imported N (mainly as DAP), after subsidy payment or a fifth of full import parity pricing. Most N sold is locally produced urea (currently about 70 percent, but falling), and the remainder imported as DAP and complex fertilisers which gives a average selling price of about Rs 20 per kg N at the farm gate. SSP is an inefficient fertiliser, with low nutrient content, and most P is supplied as DAP.

Table 2.4 Fertiliser MRP and Estimated Price, 2012

Type	Product	MRP retail Karnataka Kharif 2012 (Rs/kg)	Cost of Nutrient (Rs/kg)	Import Parity Price Nutrient at Farmgate (Rs/kg)	Price after Subsidy, Farmgate (Rs/kg)
N	Urea 46%	5.31	19	59	32
P (P_2O_5)	SSP 17%	7.80	46	71	38
K (K_2O)	MOP 60%	17.00	28	63	36

Sources: Press reports
World Bank Price Projections, September 2012

Notes: Estimated price for 2012, WB Pink Sheet Commodity Prices, September 2012
Estimated price of P was based on TSP, 46% nutrient.
TSP is not produced in India, most local sales of P are as DAP (60%)
Transport to the farm not included in MRP. Rs 2-4/kg nutrient.

15. Real fertiliser and commodity prices are expected to fall, in real terms, compared to 2012 values, according to World Bank projections[7], to around 60% of current values in real terms by 2025. This is NOT included in the economic analysis, to simplify the presentation. As both inputs and outputs are expected to reduce in real price the distortion should not be serious. Following recent reduction in fertiliser subsidy levels, current GOI policy appears to be to maintain current levels of subsidy for the indefinite future. This is subject to major political pressures to ease the burden on small farmers, serious budget pressures of rising subsidy costs, general policy movement to open markets, and the future demand for fertiliser at higher prices. These are not predictable, and it is likely that fertiliser price projections will prove inaccurate. The prices used in the analysis are shown in Table 2.5.

[7] Commodity Price Forecast, WB Development Prospects Group, Sept 2012

Table 2.5 Fertiliser Financial Farmgate Prices Used in Analysis, 2012 Values

(Rupees per kg nutrient)

Type	
N	19
P	46
K	28

Note: Weighted average price of N fertilisers, 70% Urea, 30 % imported fertilisers

2.2 Other Crop Inputs

16. Karnataka is an importer of seed and crop chemicals. A high proportion (60 to 70 percent) of the rice crop uses HYV. The rice seed replacement rate was about 43 percent in Karnataka in 2010-11. Seeds are supplied by Government agencies like Karnataka State Seeds Corporation (35% of total sales), National Seeds Corporation (4%) and Karnataka Co-Operative Oilseeds Growers Federation (5%) and private agencies (56%).

17. The cost of bought seed will be used in the crop budgets. HYV of hybrid maize require annual replacement to be effective, so crop budgets will assume all seed is purchased.

Table 2.6 Seed and Crop Chemical Prices

Item	Cost (Rs/kg or litre)
Rice (HYV)	36.00
Other seed (maize)	30.00
Pulse seed	99.00
Sugarcane set	1.25
Banana set	10.00
Arecanut seedling	15.00
Crop Chemicals	300.00
Bordeaux mixture	12.50

18. Typical prices were Rs 180 to Rs 300 per litre of crop chemical, for the most generally used chemicals. The crop budgets assume an average cost of Rs 300 per litre. Bordeaux mixture (a fungicide) is used on arecanut bunches, a low cost option.

2.3 Farm Labour

19. Unskilled farm labour was Rs 250 per day for men and about Rs 150 per day for women in late 2012. Assuming about 40% of the labour is by women (in particular transplanting, weeding and post harvest activities, an average wage rate of Rs 210 per day is used in the analysis. Rural wage rates have been rising at well over the rate of inflation for the last five years, typically at about 25% per year compound with inflation at about 8%, so wages have increase about fivefold whilst prices have gone up 1.6 times. Rural labour thus has two or three times the buying power of a decade ago. Farm costs are increasing, and this trend looks likely to continue as relatively well educated young people tend towards urban living and employment. Already it is reported that farmers are increasingly, and rapidly, adopting mechanised agriculture, with tractor ploughing and transport, seed drills and rice transplanters and combine harvesters. Whilst this trend is recognised it has not been included in the financial or economic analysis as the assumptions required would be “heroic”, but it is likely that farm employment will fall, and mechanisation will increase, possibly rapidly. It is even possible that the long term trend of declining farm size (due to inheritance) may reverse, as larger more efficient commercial units emerge.

20. Sharecropping is not very common, at least in the current sub projects. There are laws against land leasing in Karnataka. Share cropping is not included in the crop budget models.

2.4 Irrigation Fees and Maintenance

21. Karnataka irrigation fee rates are shown in Table 2.7. Fees range from Rs 150/ha to Rs 1000/ha, but the "typical" rate was Rs 500/ha, for Kharif rice. Irrigation Fees were collected by the Revenue Department and subsumed into general SGOK budgets. Irrigation fees, unlike all other inputs and outputs, have scarcely changed in the last decade, and are a tiny proportion of production costs, and about 30% of operating and establishment costs, and make no contribution to capital replacement.

Table 2.7 Irrigation Fee Rates for Major Crops, Karnataka 2006-12

Crop	Fee (Rs/ha)
Kharif	
Paddy	500
Semi dry crops	150
Rabi	
Paddy	500
Semi dry crops	150
Perennial Crops	
Sugarcane	1000
Arecanut	150

Sources:

2.5 Crop Insurance

22. Crop insurance is available for most crops. There are no recent data on the numbers insured available, but the claims history shows at least 20 percent have joined, a high rate that results from crop insurance being automatically, as a loan condition, included where farmers take out crop loans from cooperatives and commercial banks. Additional cover, up to 150% of average yield can be bought. Cover is also generally available at rates prescribed by Agriculture Insurance Company of India Ltd. (AIC): oilseeds 3.5%; other food crops 2.5%; wheat 1.5%. The premium for small and marginal farmers is subsidised by 10%, shared KSG & GOI.

23. The project should encourage crop insurance, especially where high input levels are being used, where a crop failure, can ruin a small farmer, and prevent further access to inputs.

2.6 Construction Materials and Fuel

24. India is a net importer of steel (rebar), petroleum products and cement, though most steel and cement products are produced in the country. The sub project construction costs will include fairly large proportion of steel and cement, whilst earthworks will be undertaken by heavy equipment.

25. Contract rebar prices in 2012 were Rs 45,000 per tonne, similar to an estimated international price of about Rs 51,000 ex depot Karnataka for imported steel bar at 2012 prices, see Table 4.6 in Section 4. Re-bar prices were US$ 640 per tonne FOB ex Japan in 2012.

26. Contract cement prices were about Rs 5,800 per tonne (as 50kg bags).

27. Diesel will be used during construction and for irrigation pumping and mechanised agriculture. The retail diesel price in Karnataka was Rs 51.24 per litre at the pump in 2012. Diesel is heavily subsidised in India, but there were no special agricultural concessions in operation.

28. Oil prices were US$100 a barrel in 2012. Crude oil accounts for about 72 percent of the cost of diesel (excluding tax), with refining costs of 20 percent and marketing costs

of about 8 percent, so the current oil spot price of US$ 100 per barrel (of 159 litres) equates to about Rs 70 per litre of diesel, using imported oil, implying a 30 percent diesel subsidy.

2.7 International Freight

29. Sea freight rates were low in 2012. The Baltic Dry Index was typically about 1,000 and reached a 25 year record low in early 2012 of 647, from an annual maximum of 1930 in December 2011. The overall maximum was almost 12,000 in early 2008. The November 2102 Baltic Dry Index was 965.

30. Panamax ship charter rates were around US$ 5,000 per day with higher spot prices. Bulk grain freight rates were around US$20 per tonne (USA Gulf to Europe), to US$ 50 per tonne (USA Gulf to Japan). Freight rates can be expected to increase as economies start to rally, and a Baltic Dry Index of over 2,000 is quite likely in the medium term. The freight rates used in the analysis are shown in Table 2.8

Table 2.8 International Freight Costs Used in Analysis

Route	US$ per tonne
Grain, steel, cement ex Asia	35
Grain ex Gulf ports USA	60
Crude oil, ex ME	35
Fertiliser, grain ex ME and Europe	50
Fertiliser, ex Vancouver	45

2.8 Major Crops

31. Agricultural commodity prices peaked in 2008, and have since fallen back. Demand for bio fuels (feedstock for ethanol or vegetable oils for diesel), and rising production costs due to high fuel and fertiliser costs tend to force prices up, but prices have reduced in volatility in the last year or so.

32. Minimum support prices (MSP) are set by SGOK , and should be the lowest price paid for public procurement. However public procurement is a small proportion of the total crop produced and marketed, (under 10 percent most years) so the MSP may not always be obtained by farmers selling at harvest times. Farmers sell through local markets and through traders, there are no marketing or transport restrictions.

33. There is a fairly close correlation of MSP and wholesale prices and MSP can be used for output pricing in the analysis, in the absence of better financial data.

34. Current national APMC wholesale market prices are available online from the Directorate of Marketing & Inspection on the AGMARKETNET (http: //agmarket.nic.in), by commodity and by State, by day or week. Typical November 2012 wholesale prices shown in Table 2.9. Costs of transport (say Rs 450 per tonne) and marketing (say 20 percent) need to be removed from these prices to obtain farm gate prices.

Table 2.9 Wholesale and Minimum Support Price
(Rupee per kg)

	2009-10	2010-11	2011-12	2012-13	Wholesale Nov 2012
Grains					
Paddy	9.50	10.00	10.80	12.50	15.00
Wheat	11.00	11.20	12.85	12.85	16.00
Maize	8.40	8.80	9.8	11.75	21.00
Jowar (sorghum)	8.40	8.80	9.80	15.00	15.00
Ragi (millet)	9.15	9.65	10.50	15.00	18.00
Pulses					
Pulses	17.60	21.00	28.00	29.00	
Oil Seed					
Mustard	18.30	18.50	25.00	25.00	
Groundnut (in shell)	21.00	23.00	27.00	37.00	54.00
Others					
Sugarcane	1.30	1.39	1.45	2.12	
Arecanut					140.00
Black pepper					400.00
Banana					30.00

Source: Agmarketnet, Directorate of Marketing & Inspection
Note: Sugar does not have a MSP, a FRP (fair and remunerative price) is published.

Cereals

35. World cereal markets were fairly steady in 2012, and stocks were high, after several years of good harvests. Prices are not likely to change quickly in the short term.

Rice

36. Rice trade is sensitive as a small proportion of production is marketed, most being consumed internally. India banned rice exports in October 2007, and has built up a substantial stock, which it needs to trade in order to release warehouse space. India is projected to be the largest rice exporter in 2013, overtaking Thailand, with 10 million tonnes traded. The local grain market is dominated by rice and rice will be the dominant produce for most sub projects, with a marketable surplus. Imports are unlikely to be substantial as there is a large import duty (80% in 2012)

37. The estimated export parity farm gate price for paddy was Rs 16.78 per kg in 2012, This compares to a MSP, at the farmgate, in Karnataka of Rs 12.50 per kg in 2012-13. It appears that domestic paddy rice prices currently lie below export (let alone import) parity levels as most rice is used domestically and only a small proportion is exported, even 10 million tonnes is only 10% of annual Indian production[8]. Trade rice prices were US$550 per tonne (FOB) in 2012, and appear to be trending upwards, but are not volatile.

38. It appears that financial paddy rice prices obtained by farmers are generally above the MSP level. Financial prices are likely to trend upwards to export parity on world prices in the medium term. A price for rice of Rs 14/kg was used in the model.

Other Grain Crops

39. Other grains were maize, millets and sorghum and a small amount of wheat. Other grain crop production is greater than rice accounting for about 66 percent of total grain crop production in Karnataka, mainly maize 38 percent, and sorghum plus millet 27 percent. MSP levels for sorghum and millets are similar to the rice price at Rs 15 per kg.

[8] The mid value of import and export parity has been used for recent World Bank irrigation projects.

Wheat is currently of little importance in the Karnataka grain production, less than 2 percent. Wheat is protected by tariff barriers, (100 percent duty), so preventing private imports. Current wheat stocks are high, after good harvests, and stocks are around 38 million tonnes. Exports are planned, to clear storage space, but this will require GOI subsidies to exporters, as the FOB price of Indian grain is around US$ 350 per tonne, compared to a world price of US$ 250 to 300 per tonne. The MSP for wheat has not be changed for 2012-13 (Rs 12.85/kg) but farmer prices are above this at Rs13.50 to 17.00/kg.

40. Price levels of other grains are not critical to most sub projects. Minor grain prices will be based on the MSP in 2012.

Table 2.10 Financial Farmgate Prices Used in Analysis
(Rupees per kg)

Type	2102
Rice (paddy)	14.00
Other Grain	14.00
Sunflower	37.00
Black Gram	43.00
Arecanut (wet)	15.00
Banana	4.00
Sugar cane	2.10

Pulses

41. Pulses are not traded internationally in large quantities, but are imported by India mainly as yellow pea from Canada. The MSP for pulses were Rs 29.00 per kg.

Oilseeds

42. Oilseed prices are high, as world production has reduced due to a shift from soybean to maize. Global demand is increasing, and there are also increasing demands for bio fuels and livestock feed cake. Prices are expected to remain high. India is the worlds largest importer of oils and fats.

43. The MSP for sunflower is Rs 37 per kg, and soya bean Rs 22 per kg in 2012-13. For farm gate prices allow for transport and handling to local markets of Rs 0.45 per kg. The import parity farm gate price for soya beans in 2012 was Rs 38 per kg. Import duties of 30 percent for oilseeds are not included as Government imports do not pay it.

Sugar[9]

44. India is the second largest producer of sugar in the world, after Brazil, and the largest consumer. Indian sugarcane area was 4.9 million hectares in 2010-11 and production 339 million tonnes. Karnataka had 421,000 ha of sugar and produced 38 million tonnes in 2010-11, about 11% of the national crop. Both area and production are fairly stable, with a compound growth rate of under 2%. Yield rates in Karnataka, 89 t/ha, are typical of the tropical region, where the crop has a 14 month rotation. Domestic and international prices of sugar are fairly closely correlated ($R^{2 =}$ 0.6) and follow the same trend. World sugar production is in surplus and world prices are declining, and India has surplus carry over stock of about 7 million tonnes.

45. The sugar industry was delicensed in 1998, entrepreneurs were free to set up new mills and increase their capacity and installed capacity has gone up substantially. Sugar mills are required to pay Fair and Remunerative Price (FRP) for sugarcane fixed

[9] The analysis of the sugar crop is drawn from: Price policy for sugarcane 2012-13. Commission for Agricultural Costs and Prices. Department of Agriculture & Co-operation, Delhi August 2011

by the Central Government and State Advised Price (SAP) announced by State Governments, provide free sugar for GOI programmes (2.8 million tonnes) and apply for export licences. These are in effect, producer taxes, and the system is not efficient, and may be abandoned in favour of market led mechanisms and international trade. Sugar producers do not receive the full FRP, and payments are delayed.

46. Recovery of sugar is about 10% of cane overall, molasses 5% and bagasse 30%. In north Karnataka sugar mills arrange harvesting and transportation of cane, based on crop maturity, and recovery rates are 11%. Higher wages are encouraging mechanised planting and harvesting. Production of ethanol (as a fuel) from sugar is not financially viable under current prices, but some power is generated from sugar waste products. Sugarcane producers in Karnataka have better returns than most of India, due to higher yields, and sugarcane is more profitable than wheat, paddy and cotton. As local sugar prices are directly linked to world price the sugar price used in the analysis is Rs 2.1 per kg cane projected FRP. Transport is included in crop budget.

Arecanut[10]

47. Karnataka is a significant arecanut (betel nut) producer, with about 46% of the total for India, and India produces about 55% of the world crop of about 0.9 million tonnes (processed nut). Kerala is the other major producer state in India, and Indonesia, Bangladesh and China are also major producers, with high productivity, especially in China. Arecanut contributes 8% to GSDP and quite large amounts of tax and import duty. Annual growth in demand is around 5%, and India area has increased from 250,000 ha in 1990 to 475,000 ha in 2011, production from 250,000 tonne to 490,000 tonne. Karnataka has had similar growth in 1991 to 2011, 70,000 ha to 180,000 ha and 95,000 tonne to 230,000 tonne. Demand is projected to increase at similar levels in future, and production will not meet demand, so imports of 80,000 tonne a year are expected in the medium future.

Table 2.11 Arecanut Area and Production 2010

	Area (ha)	Production (t)	Percent of World
Karnataka	180,000	230,000	*26*
India	475,000	490,000	*55*
World	**730,000**	**867,000**	***100***

48. India has been net importer of arecanut since 1995, and the import levels have increased over time, currently in the region of 30,000 to 70,000 tonne per year, typically around 40,000 tonne or around 8% of demand. The main source of imports is Indonesia, and imported nuts are cheaper than local nuts, tending to depress prices. Exports are less than 1,000 tonne.

49. Taxes are levied on local sales of about 5% (2 % VAT, 1.5% cess and 2% commission), but about half the crop evades the official market. Cooperative marketing is important, through Cocoa & Arecanut Marketing & Processing Co-operative, CAMPCO, and a number of smaller co-operatives, and taxes are paid on these sales. Farmer prices are higher, by 30 to 40%, for co-operative sales. Taxes on processed nuts are 30 to 80%, levied by a tax on packing machines, but about 70% of this tax is evaded. Import duties are 104%, but there is substantial cross border smuggling and 70% of duties are evaded.

50. Prices of arecanut are volatile, and have seen recent lows due to market gluts and imports. By products are leaf sheath and husk, around 5 t/ha, used as fuel, thatch and mulch. 50 per cent of the arecanut in Karnataka is processed into White Chali, the

10 Information on arecanut is taken from: Arecanut at the Crossroads, Dr TN Prakash Kammardi, Department of Agric. Econ. University of Agrucultural Sciences, Bangalore. 2012

rest into Red Boiled type. Prices of red boiled arecanut have been around Rs 150 per kg in recent years, after a peak of about Rs 190 /kg in 2006-7, when (cheaper) imports peaked. Most arecanut is sold on contract on the tree as wet nut, at about Rs 15/kg in 2012, and is harvested and processed by the buyer.

Table 2.12 Price of Red Boiled Type Arecanut, Karnataka

Season	Price (Rs/kg)
2006-07	186
2007-08	147
2008-09	110
2009-10	156
2010-11	140

51. Price support was operated in Karnataka from 2002, with a Minimum Support Price implemented through CAMPCO Ltd. It has now ceased, and only dealt with a small percentage of the crop.

2.9 Fruit and Vegetables

52. Comparisons with international trade prices for vegetables and fruit are possible, but tend to be misleading, due to the substantial differences in quality, grading and packaging. Field and transport damage are high. Seasonal availability is important, with low prices prevailing at harvest times (typically 50% of the mean), when most sales are made. Vegetable and fruit sales are based on local markets, and generally consumption is close to the point of production. Cold storage capacity is small compared to local production, and of minimal importance to the project. Using annual average prices is not relevant to growers, and for the analysis outputs are priced at the harvest time levels, which are usually the lowest.

53. Typical wholesale/local market prices are about 80 percent to 90 percent of retail prices. Farm gate prices are about 80 percent of wholesale/local market prices. These mark ups are reasonable when the costs of transport and marketing are included.

54. Vegetable prices for the analysis were based on harvest time wholesale prices brought back to farm gate, allowing Rs450 per tonne for transport and a 20 percent marketing margin.

2.10 Fodder and By Products

55. By-products, used as fodder, are a valuable part of output. Valuing fodders is difficult, but fodder prices have been increasing more rapidly than input prices, and the current price index is around 3 times values in 2005 (base year) whilst fertilisers are around 1.2 times. Sales values of fodders are usually high, especially if transport is required, but traded volumes are often very small, or used for high value added enterprises, such as fodder fed peri-urban milk production. Most fodder is used directly for the farmers own livestock production, as an intermediate output, and value added through livestock products, including animal draught. A proportion of the rice straw is consumed by grazing of aftermaths by nomadic sheep flocks and local cattle, in particular broken straw following combine harvesting. It is reported that farmers pay herders to graze their animals, in return for their manure. Fodder prices were very high in 2012, due to low availability after a poor monsoon.

56. Financial prices for fodder by products were estimated at levels that reflect the value to the producer, which are typically around half the marginal market price. The main by product is rice straw, which has a low nutrition content (unless treated), so valued at Rs 0.90/kg, as are wheat straw and oilseed residues. Pulse residues have better nutrient value, so have higher values. Residue yields are express as a factor of the main crop production, see Table 2.13

Table 2.13 Crop residue factors and price

Crop	Residue Factor	Price (Rs/kg)
Rice	1.5	0.90
Mustard, oil seeds	2.0	0.90
Pulses	2.0	1.50

Note: Residue factor is yield rate per kg of main crop

3 TARRIFS , TAXES AND SUBSIDIES

3.1 Local Taxes

57. In 2007 Karnataka State replaced Sales Tax (OST) with VAT. There are currently multiple rates of VAT- zero rate (exempted goods), 1 percent, 4 percent, a general rate of 12.5 percent, and 20 percent. These rates are uniform in all States in India, and applied uniformly to goods. Most essential commodities, such as food, are either exempt or taxed at 4 percent, such as steel and cement. Exempt goods include agricultural implements (manually operated or animal driven), books, periodicals, journals and fresh milk, sugar, textiles and tobacco leaf. VAT at 20 percent is applied to liquor and narcotics. If not otherwise specified goods are taxed at the general rate of 12.5 percent. The 2008 budget reduced VAT rates on a number of products. Small cars, buses and chassis were reduced to 12.5 percent. Other items were not relevant to the project. Paddy rice dealers are supposed to pay VAT on their sales turnover, but collection rates are probably low.

58. Under Sections 1(a) and (q) of the Karnataka Agricultural Income Tax Act of 1957, agricultural income tax is now applicable only to rent or revenue from plantation crops (coffee, tea, cardamom, orange, pepper, rubber and linaloe) grown on plantation land Other farmers are also liable to pay income tax, but Income taxes are progressive, with a zero rate up to Rs 150,000 per year, so will be paid by few farmers.

59. Central Sales Tax (CST) is still applied but is proving to be a hindrance in introducing VAT. CST was reduced to from 4 percent to 3 percent in April 2007, and reduced by 1 percent per year, to zero in 2010. CST for some items (Goods of Special Importance or Declared Goods), mainly major exports or imports[11], will be collected as part of excise duties. CST is currently 4% (recently reduced) for diesel and 25% for petrol. CST has been excluded from the financial and economic analysis, except where included in applicable VAT rates. VAT is charged at 5.5% for crop chemicals, vehicles, pumps, cement and steel.

60. Land cess is charged on all agricultural land, whether cropped or not, at Rs 250 per ha per year. It is paid by the landowner.

61. Entry tax is paid on items transported by road into Karnataka (formerly known as Octroi). There are three rates, 1 percent, 2 percent and a top rate of up to 12 percent (for vehicles, marble and air conditioners). The 2 percent rate of Entry Tax mainly applies to manufactured goods irrelevant to the project. The 1 percent rate applies to some agricultural products (pulses, spices, onion, potato) which need to be imported into Karnataka. Entry Tax is of minor importance and has not been included in the Financial & Economic analysis.

62. There are additional special taxes (luxury tax, profession tax, entertainment tax) not relevant to the project.

63. Construction contacts include 4.9% taxes. Construction contractors are paid by WRD for work net of the applicable taxes, these amounts are paid into revenue department, and credited against final tax returns by the contractor.

64. WUC are liable to income tax, but are operated as non-profit organisations, so no taxes are paid currently, and has been ignored in the analysis.

[11] cereals, hides and skins, jute, oil-seeds, pulses, sugar cotton and cotton products, man-made fabrics, wool fabrics, aviation turbine fuel, coal and coke, crude oil, iron and steel.

3.2 Import and Export Duties

65. Import duties for the major outputs and inputs for the project are shown in Table 3.2. Most locally produced agricultural products are under high levels of tariff protection, which prevents importation except by GOI agencies. Local price levels indicate that few, if any, imports pay the nominal duty, which are intended to stop private trade.

66. Following increasing imports of low cost arecanut in recent years an import duty of 108% was imposed in May 2012. This has increased local prices, and demand is unlikely to be met. There is considerable leakage of imports evading duty from neighbouring countries.

67. Fertilisers imports are generally charged at 10 percent, except for AS and mixed NPK types which are charged at 5 percent, presumably to try to increase the ratio of application of P+K to N.

68. Cement, construction and agricultural equipment and trucks are charged at 10 percent, steel at 10 percent (though all construction steel is locally produced), but cars and motorcycles at 100 percent, so locally produced types will be required. Diesel and crude oil have import duty of 2.5%.

69. Export duties for most project outputs are zero.

3.3 Agricultural Subsidies

Fertiliser

70. Fertiliser distribution is being liberalised, but quite slowly, planned decontrol measures are frequently deferred and there remains a substantial GOI interest in production, pricing and distribution. In 2010-11 urea is under price and partial movement control, 50 percent of installed manufacturing capacity was available on the open market, subject to a notified maximum retail price. The Department of Fertilizers manages movement, distribution and allocation of urea, based on requirement assessed by the Department of Agriculture & Co-operation (DAC) at State level. DAP and MOP may be imported freely. From 2008 a uniform freight subsidy regime for subsidised fertilisers was introduced, paid on receipt at the Districts or Blocks. Rail freight is paid and the road freight is based on average haulage distance for the District, 75 percent of transport is by rail. Farmers pay 25-40% of the actual cost of fertilizers.

71. Some States have levied VAT on fertiliser sales, and some raw materials attract Excise Duty, Central Sales tax, VAT, Electricity duty on power generation, Entry tax, Service tax, Education Cess etc. Taxes and duties paid by manufacturers cannot be passed on to the consumers. A Goods and Services Tax (GST) will be introduced in 2012, a dual levy by Central Government and State Governments.

Subsidy Total

72. The Government of India continues to provide a subsidy on fertilisers, reaching a peak of US$ 30 billion in 2008-9, which was not sustainable. Subsidy levels are falling but were still US$ 15 billion in 2010-11, 65 percent of which was for urea, Table 3.1. The fertiliser subsidy[12] is a significant cost to GOI, about 2 percent of GDP, and is increasing, with a compound annual growth rate of 15 percent, projected to double from Rs 84,844 crore (US$ 15 billion) 2010-11 to Rs 134,805 crore (US$ 25 billion) in 2016-17[13]. About 15 per cent of the increase in subsidy is due to increased consumption, 85 per cent due

[12] Fertiliser subsidy covers: urea, DAP, MOP, MAP, TSP, AS, SSP and complex fertilizers.
[13] 1 Crore =10,000,000. 1 Billion = 1,000,000,000

to the increased international fertiliser prices, and higher production costs for fuel and feedstock[14] prices which have risen sharply.

73. The New Pricing Policy (NPS) Stage III for urea units ended on 31st March, 2010 but has been extended till formulation of new policy. A system of direct transfer of fertiliser subsidy to farmers is planned, and is being implemented in stages, initially the payment will be made to sales outlets.

74. Nutrient Based Subsidy Policy (NBS) was introduced in 2010 for decontrolled P&K fertilizers. NBS is paid per kilogram of N, P, K & S, converted into subsidy per tonne for each subsidised fertiliser type. Department of Fertilizers allowances under the NBS during 2011-12 were: N 27.153 Rs/kg; P 32.338 Rs/kg; K 26.756 Rs/kg and S 1.677 Rs/kg. These are being substantially reduced in 2013, by 11.6 percent for N, 32.6 percent for P and 10.3 percent for K, whilst S is unchanged, according to press reports.

75. In 2012-13 the subsidies per tonne of nutrient were Rupee 14,350 for DAP, Rupee 10,030 for TSP and Rupee 14,400 for MOP. This is a substantial proportion of the retail price. Subsidy paid to importers and manufacturers on decontrolled fertilisers have been significantly reduced for 2013, for example: subsidy on DAP was reduced by 27% from Rs 19,763 per tonne to Rs 14,350 per tonne; subsidy on MOP was reduced by 10% from Rs 16,054 per tonne to Rs 14,440 per tonne.

Table 3.1 Fertiliser Subsidy, India

Year	US$ million	% on Urea
2006-07	6,967	73
2007-08	10,955	72
2008-09	30,009	60
2009-10	18,815	62
2010-11	14,789	65

Source: Ministry Of Chemicals & Fertilizers, Department of Fertilizers, Annual Report 2010-11

Farm Machinery

76. Machinery subsidies are available on a range of items, at 25 percent of purchase value, nominal, but with an upper limit, which is in line with current prices. The subsidy is administered by the Agriculture Department in Karnataka, and is available for power tillers, land-levellers, mowers, sowing and harvesting equipment. KSG stopped subsidy for tractors from 2011 due to misuse. This subsidy is small enough to be ignored in this analysis.

77. KSG provides 75 per cent subsidy for drip irrigation equipment, estimated cost is Rs 1,120, million (US$ 20 million) annually.

Fuel [15]

78. The petroleum sector is one of the most heavily subsidised energy sources in India. In June 2010, the Indian government deregulated the price of petrol. however, prices for diesel, kerosene and domestic LPG continue to be regulated. Subsidies totalled US$ 17.1 billion in 2010-11 and may reach US$ 34 billion in 2012, over 1% of GDP. Petrol is, more or less, de-controlled but still subject to GOI approval of price changes. Diesel accounts for over 40% of the subsidy going to transport (60%) and agriculture (20%), and the subsidy is around 40% of the diesel retail price, Rs 51.24 per

[14] Urea production uses gas, LNG, fuel oil, naphtha or coal for feedstock and fuel. Supplies are constraining.

[15] This review is based on: A Citizens' Guide to Energy Subsidies in India. Energy and Resources Institute & International Institute for Sustainable Development. Global Subsidies Initiative, 2012

litre in Karnataka (November 2012). GOI subsidies pay part of the costs, but oil companies and refiners also have to contribute significantly, around US$ 8 billion in 2010-11. Kerosene and liquid gas quotas are supplied to households at subsidised prices (at around a half of local market prices). Attempts to increase bottled gas prices in 2012 were reversed after political unrest. Cheap (domestic) kerosene and gas are diverted to commercial use and road transport (diluting diesel), perhaps 40%.

79. Agricultural electricity for irrigation pumping was free in Karnataka in 2012, for pumps up to 10hp. Agriculture uses a small and declining share of total power consumption, mostly for irrigation pumping. Power distributers lose substantial amounts, supported by State payments, and subsidies are 16% of sales. Power is effectively rationed by power cuts, only being made available for about 6 hours per day.

Output Prices

80. The MSP levels are currently below market price. In effect agricultural output prices are not subsidised.

Rural Credit

81. SGOK provides agricultural loans free of interest up to Rs 100,000 and at 3 percent interest for loans of up to Rs 300,000. It subsidises interest rates of lending institutions estimated at Rs 4,350 million (US$ 79 million) in 2011-12.

82. The GOI 2008 budget announced that all outstanding seasonal credit to 98 million small and marginal farmers (that is 82 percent of all farmers) would be waived, estimated as Rs 600,000 million (US$ 15,000 million) or Rs 6,000 per farmer. Debt write off has been provided on previous occasion, roughly every 10 years. This is an effective 10 percent subsidy. There are current (2012) proposals to cancel seasonal credit debts for small loans.

Water Costs

83. Irrigation Fees were collected by the Revenue Department and subsumed into general government budgets. Collection rates for irrigation fees were reported to be about 90 percent of the irrigated area. Water fees are well below the cost of maintenance and operations (around Rs 800/ha) and make no contribution to capital replacement, which would require fees of around Rs 2,500/ha. Water fees have not increased for a decade.

84. GOI policy assumes Rs 600 per ha per year for annual O&M cost to sustain the subproject infrastructure, comprising Rs 480 for works and Rs 120 for operational staff costs, these are nominal at 2004 prices. These fees should be paid to WUCs but are absorbed by WRD to finance establishment and operational costs. Most of the funds go to establishment costs.

3.3 Construction Subsidies

85. Construction equipment is freely traded, with a fairly low import duty of 10 percent. There appears to be no subsidies on construction equipment.

86. Cement and steel prices appear to be very close to international price levels, and there is no effective subsidy on these items.

Table 3.2 2012 Levels Of VAT, Import Duty, and Subsidy

Commodity	VAT or excise duty (percent)	Import Duty (percent)	Effective Subsidy (percent)
Crops			
Rice	*0*	*80*	*0*
Wheat	*0*	*100*	*0*
Other Grain	*0*	*0 to 80*	*0*
Oil Seeds	*0*	*30*	*0*
Pulses	*0*	*30*	*0*
Arecanut	*0*	*108*	*0*
Fertiliser			
N	*0*	*10*	*50 to 70*
P	*0*	*10*	*30*
K	*0*	*10*	*60*
Bought Seed	*0*	*0*	*3*
Crop Protection Materials	*5.5*	*10*	*0*
Irrigation Fees	*0*	*na*	*60*
Agricultural Equipment	*0*	*na*	*25*
Crop Insurance	*0*	*na*	*50*
Small Vehicles and motorcycles	*5.5*	*100*	*0*
Trucks, Tractors	*5.5*	*10*	*0*
Construction Equipment	*12.5*	*10*	*0*
Agricultural pumps	*5.5*	*10*	*0 to 25*
Diesel	*4.0*	*2.5*	*40*
Lubricant	*0*	*10*	*?*
Pumping Electricity	*0*	*na*	*100*
Rural credit	*0*	*na*	*25*
Cement	*5.5*	*10*	*0*
Steel bar	*5.5*	*10.0*	*0*

Source: www.cbec.gov.in; http://ctax.kar.in (mainly incomprehensible)

4 ECONOMIC VALUES

4.1 Background

87. Economic values convert financial prices, allowing for market distortions, import duties, local taxes and subsidies. For items traded internationally it is usual to estimate economic values using the world FOB price for exports, and CIF price for imports, with due allowance for the real costs of transport, handling, processing and so on, to or from the project, this is described as the world price numeraire.

88. Items that are not generally traded can be converted using individual CF, for example the shadow wage rate, or the Standard Conversion Factor (SCF), which is based on the net taxes, duties and subsidies in the economy as a whole. The SCF is generally not calculated for individual projects, and a typical value for India of 0.9 is adopted for this analysis.

89. Domestic prices in India for many key project items (notably rice, and most other crop outputs, fertilisers and fuel) were administered through Minimum Support Prices (MSP) and Maximum Retail Prices (MRP), so did not always reflect current world values, and conversion factors were estimated at 2012 prices, applied to the project lifetime. Conversion factors may well change in future, due to GOI policy and world price fluctuations, which are not predictable.

4.2 Grain Crops

Rice

90. Rice was a net export for India, and Karnataka, and priced at the FOB value, less transport and handling from the farmgate to the port, including milling. Economic prices were based on World Bank prices in late 2012 (pink sheets). Local handling costs were adjusted by the Standard Conversion Factor of 0.9. Estimated economic prices were almost identical to estimated financial prices, and the MSP, see Table 4.1.

Table 4.1 Economic Conversion Factor
2012 Rice Thailand 5% broken, FOB Bangkok, Export Parity

US$/t onne	550
Quality differential	0.9
Equivalent value of Indian product	495
Less: Freight and insurance cost to local Asian port	-35
Value at Indian port	460
Conversion to Indian Rupees (Rs)	
Exchange rate	55.00
Value at Indian port (Rs/t)	25,297
Less: Port handling charges, storage, and losses	-1,138
Less: Local transport dealer & processing costs (Rs1400/t)	-1,260
Value at local market/processor/mill	22,898
Less: Milling cost (R310/t)	-279
Equivalent price of paddy at mill	14,703
Less: Transport cost - farmgate to local market/mill (Rs120/t)	-108
Economic paddy price at farmgate, export parity (Rs/ton)	14,595
MSP at farmgate (less Rs 450 transport and marketing) (Rs/t)	12,050
Financial paddy price used in analysis (Rs/tonne)	14,000
Conversion Factor for rice on MSP	1.2
Conversion Factor for rice based on model price	1.0
Port handling charges, storage, and losses (%)	5%
Recovery rate at mill	65%
Standard conversion factor	0.90

Notes: Rice price from WB Commodity Price Data (pink sheet) later 2012 average
Port handling and losses at 5%, mill recovery 65%, SCF 0.9

91. 2013 MSP of rice in Karnataka was Rs 12.50 per kg for standard paddy. MSP levels are based on and linked closely to export values, and thus the economic price, which implies there is very little market distortion for rice. Adjusted MSP were used for the analysis, so the CF is based on this value. The estimated CF for rice was 0.9.

Wheat

92. Wheat is currently a major export, due to surplus stocks. Wheat was priced less transport and handling from the port to mill and milling costs, less costs from the farm gate. Economic prices were based on World Bank prices in late 2102. Local handling costs were adjusted by the Standard Conversion Factor of 0.9. Estimated economic prices were about equal to estimated export financial prices see Annex Table.

93. MSP for wheat in 2012-13 was Rs 12.85 per kg, and had not been increased. Farmers were getting higher prices than the MSP (Rs 13.50 to 17.00), which makes exports unprofitable. The CF for 2012 prices was 1.0, which is adopted for the analysis, see Table 4.2 and Annex Table.

94. Other grains, such as sorghum, millets and maize can be treated as substitute products for wheat, so can be adjusted using the CF for wheat.

Maize

95. Maize exports are likely to increase by 7% to three million tonnes during 2011-12 due to adequate local supplies and expected higher production. Demand from southeast Asia is likely to increase as Indian prices are US$50 lower than US corn, with less freight cost and US maize production declining and being diverted to feedstocks.

4.3 Other Crops

Pulses and Oilseeds

96. Pulses and oilseeds are imports to India, and increased project production will substitute for imports, so the border parity price is the CIF world price, landed at the project. Soya bean can be used for pricing. The estimated financial farmgate price of soya bean was considerably lower than local prices for soya or mustard, and a CF of 1.7 was used for the economic price.

Table 4.2 Economic Conversion Factor, Soya Bean, CIF Rotterdam, Import Parity, 2012

US$/tonne	599
Quality differential	1.00
Equivalent value of Indian product	599
Plus: Freight and insurance cost from Europe	35
Value at Indian port	634
Conversion to Indian Rupees (Rs)	
Exchange rate	55.00
Value at Indian port (Rs/t)	34,891
Plus: Port handling charges, storage, and losses	1,570
Plus: handling, transport costs and dealer costs (Rs1400/t))	1,260
Value at local market/processor/mill	37,721
Less: Transport cost - farmgate to local market/mill (Rs120/t)	-108
Economic price at farmgate (Rs/tonne)	37,613
MSP at farmgate (less Rs 450 transport and marketing) (Rs/t)	21,550
Conversion Factor for Soya beans on MSP	1.7
Port handling charges, storage, and losses (%)	5%
Standard conversion factor	0.90

Fruit and Vegetables

97. It is assumed that the local market reflects the true value of fruit and vegetables, allowing for quality and local marketing costs, and no crop specific conversion factor should be applied to these products. This includes arecanut, though there is some evidence that local prices are 20% or so above import parity levels. The SCF was used for analysis.

4.4 Fertilisers and Crop Inputs

98. Fertiliser values were based on imports to India, valued at the CIF price plus costs of transport and handling to the farm gate. World Bank late 2012 prices were used, which are near long term norms, but increasing. The calculation of economic prices values domestic value added at the SCF, and leaves out the Central Fertiliser Subsidy, taxes and duties. About 80 percent of the N used is from Urea, at Rs 19 per kg nutrient, giving a correction factor of 3.0.

99. The methodology for Urea was used for phosphates and potash. For these fertiliser types the estimated financial price based on world prices and the local MRP price were very close. For Phosphate a CF of 1.4 was estimated. for Potash a CF of 1.8 was estimated, see Annex 3 .

Table 4.3 Financial and Economic Cost of Urea, Import Parity, 2012 Prices

US$/t	400
Quality differential	1.0
Equivalent value of Indian product	400
Plus: Freight and insurance cost from Europe	35
Value ex-Indian port	435
Conversion to Indian Rupees (Rs)	
Exchange rate	55.00
Value at Indian port (Rs/ton)	23,947
Plus: Import Duty	0
Plus: Port charges	1,078
Plus: Internal handling and transport (Rs220/t)	198
Plus: Bagging (Rs 650/t)	585
Value ex factory	25,807
Plus: Transport to farmgate (Rs420/t)	378
Economic price at farmgate (fertiliser) (Rs/t)	26,185
Economic price at farmgate (nutrient) (Rs/kg)	56.92
Financial price (nutrient) (Rs/kg)	19.00
Conversion Factor for urea	3.0

100. Most seed was output retained by the farmer, which should be adjusted by the same CF as the relevant crop, most of these were close to unity. Bought seed was subsidised at about 25 percent. For simplicity the SCF was applied to seed.

101. Crop protection chemical prices were adjusted by a CF of 0.8[16], reflecting 10 percent import duty, 5 percent VAT and 75 percent domestic value added, adjusted at the SCF, see Table 4.5.

Table 4.4 Conversion Factor for Crop Protection Materials

Financial Price	Percent Tradable (@1.0)	Percent Domestic Value Added (@0.9)	Percent Tax (@0)	CF
100	*20*	*75*	*5*	0.8

Note: Taxes are 10% import duty on traded value of 20% and 5% VAT on sales, total 5%

4.5 Labour

102. Agriculture accounts for the majority of, though reducing, local employment. Farm labour costs have been increasing at 20 to 30% per year, well above inflation, and there a numerous reports of labour shortages and adoption of mechanised agriculture for key employment peaks (land preparation, planting and harvesting). Agricultural wage rates are likely to increase at similar rates in the future, and new entrants to the labour market will tend to seek urban employment. Historical shadow wage rates for unskilled labour (typically around 0.75) no longer appear appropriate, and labour costs are converted at the SCF of 0.9. This includes unskilled and skilled construction labour.

4.6 Power, Equipment, Transport and Mechanised Agriculture

Diesel

103. Diesel retail price in Karnataka was Rs 51 per litre in November 2012. Crude oil accounts for about 72 percent of the cost of diesel (excluding tax), with refining 20 percent and marketing costs about 8 percent. Based on current oil prices of US$ 100 per barrel local diesel financial price should be Rs 70 per litre, see Table 4.5, so there is a local subsidy of about 30 percent. Diesel financial prices were converted to economic prices using a conversion factor of 1.3, based on current pump prices.

[16] This is based on taking the full value of traded portion of the cost (imported materials and equipment for example), valuing the domestic value added at the SCF of 0.9, and removing local taxes. So a financial price for crop chemicals of 100 would have a CF of 0.89, based on 0.20 traded (at 100%), plus 0.75*0.9= 0.68 domestic value added, and 0.00 taxes.

Table 4.5 Diesel Price and Correction Factor, 2012 Prices

		FINANCIAL PRICE		ECONOMIC PRICE	
				Conversion	
		Factor	Value	Factor	Value
FOB Crude Oil, spot Middle East					
per barrel (159l)	US$		100	1	100
Plus Freight	US$		35	1	35
Plus Insurance	US$	0.25%	0.25	1	0.25
Plus Unloading	US$		1	0.9	0.9
CIF Port			**136.25**		**136.15**
Convert to Rs	Rs	55.00	7,494		7,488
Port charges	Rs	2.0%	150	0.9	135
Customs Duty	%	2.5%	187	0	0
Value Ex Port, per barrel	**Rs**		**7,831**		**7,623**
Crude cost per liter	Rs		49		48
Plus Refining cost (% of crude)	%	28%	14	0.9	12
Plus Retail Margin (% of crude)	%	11%	5	0.9	5
Cost per liter	**Rs**		**68**		**65**
Plus excise duty	Rs		2	0	0
Less Fuel Subsidy	%	30%	-21	0	0
Estimated Pump Price	**Rs**		**50**		**65**
Reported Pump Price	Rs		51		
Conversion Factor	**Estimated price**			**1.31**	
	Reported Price			**1.28**	

Assumes crude costs are 72% of total diesel cost, refining cost is 20% and retailing cost is 8%
Assumes 100% conversion of crude oil to saleable products with average value same as diesel.

Electricity

104. There are high non-technical losses on rural power, of about 60 percent (illegal connections and non-payment), which represent a transfer payment and can be ignored for economic analysis.

105. Typical international electricity generation costs are US Cents 5 to 7 per kWh. The economic cost of power in Karnataka, assuming technical (distribution) losses of 20 percent, was therefore between Rs 3.5 and Rs 4.8 per kWh, plus the costs of local distribution to the user, assumed at 25 percent, giving a delivered cost to the consumer of Rs 4.4 to Rs 6 per kWh. The financial price of rural electricity for agriculture was zero, mostly for pumping. The economic cost of power is assumed at Rs 5 per kWh.

Equipment, Transport and Mechanised Agriculture

106. Agricultural equipment attracts duty of 10%, and most is locally produced. These machines mainly use subsidised diesel, which typically accounts for around 50 percent of the ownership costs. The overall correction factor for mechanised operations is thus close to unity, and the SCF was used in the analysis. Animal power costs were converted at the SCF, as there were no traded goods nor taxes for this item.

4.7 Materials and Construction Conversion Factor

107. The main materials used in irrigation construction are cement, aggregates and steel. Steel price estimates are shown in Table 4.6, based on current international prices, with an estimated economic conversion factor of 1, so the SCF is adopted..

Table 4.6 Steel Reinforcing Bar Import Price in 2012 values

(Import parity per tonne)

Steel Re Bar ex Japan, November 2012	**FINANCIAL PRICE**	**ECONOMIC PRICE**

		Factor	Value	Conversion Factor	Value
FOB	US$		640	1	640
Plus Freight	US$		35	1	35
Plus Insurance	US$	0.25%	1.6	1	1.6
Plus Unloading	US$		7	0.9	6.3
CIF Port			**683.6**		**682.9**
Convert to Rupees	Rs	55.00	37,598	55.00	37,560
Port charges	Rs	2%	751.96	0.9	676.764
Customs Duty	%	10%	3,760	0	0
Value Ex Port			**42,110**		**38,236**
Local Transport (Rs 450/t)	Rs		450	0.8	360
Add local handling (Rs 100/t)	Rs		100	0.9	90
Retail margin	%	15%	6,316	0.9	5,685
VAT	%	4%	1,684	0	0
Estimated Retail price	**Rs**		**50,661**		**44,371**
Reported Price	Rs		45,000		
Conversion Factor	**Estimated price**			**0.88**	
	Reported Price			**0.99**	

108. Economic conversion factor for cement, based on the reported price, was 1.24, see Annex Table, implying there was little distortion in the local price. Given the limitations of accuracy of the calculation, as there is wide variation in FOB prices, some of which are below manufacturing cost, cement was valued at the SCF for the analysis.

109. Aggregates and other materials were not traded, and adjusted by the SCF.

110. Unskilled labour for construction was adjusted by the SCF of 0.9, as there evidence that labour is no longer in surplus in rural areas. Mechanical operations and transport used the SCF. Taxes were removed from economic value of construction. Contractors margin was taken to be the cost of management and supervision, adjusted by the SCF.

111. Individual conversion factors for each component of construction costs were applied to a typical percentage contents of irrigation scheme contracts in Table 4.7, giving an economic construction conversion factor (CCF), weighted by the percentage cost of each item in a typical sub-project of 0.8.

Table 4.7 Derivation of the Construction Conversion Factor

Item	Percent of Total Cost	Conversion Factor
Steel	22	0.90
Cement	17	0.90
Other Materials	10	0.90
Unskilled labour	14	0.90
Skilled labour	5	0.90
Transport & Plant	17	0.90
Taxes	5	0.00
Contractors Margin	10	0.90
Total	**100**	**0.85**

4.8 Other Items

112. Other un-traded items were corrected at the SCF.

4.9 Summary Of Economic Conversion Factors and Financial Prices

113. Conversion factors used to estimate the economic value of agricultural inputs and outputs, and the cost of construction materials equipment and labour are summarised in

Table 4.8. A detailed table of prices used and conversion factors is attached as Annex Table. Initial financial prices are shown in the table, but will be adjusted by price forecasts as detailed in the report.

Table 4.8 Summary of Conversion Factors and Financial Prices

Item	Conversion Factor	Financial Farmgate Price (Rs/kg)
SCF	0.9	-
Rice	1.0	14.00
Other Grains (maize)	1.1	14.00
Pulses (black gram)	0.9	43.00
Oil seeds (sunflower)	1.7	37.00
Fruit and Vegetables	0.9	
Fodder	0.9	0.9
Fertilisers		
N (as nutrient)	3.0	19.00
P (as nutrient)	1.4	46.00
K (as nutrient)	1.8	26.00
Seed	0.9	-
Agro-chemicals	0.8	300.00
Diesel	1.3	51.24
Electricity	Rs 5/kWh	0
Cement	0.9	5.8
Steel	0.9	45.00
Construction (CCF)	0.8	-
Labour (skilled)	0.9	-
Labour (unskilled)	0.9	210.00

Annex Table 1

WB Commodity Price Data

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COMMODITY PRICE DATA

Commodity	Unit	Annual averages Jan-Dec 2010	Annual averages Jan-Dec 2011	Annual averages Jan-Sep 2012	Quarterly averages Jul-Sep 2011	Quarterly averages Oct-Dec 2011	Quarterly averages Jan-Mar 2012	Quarterly averages Apr-Jun 2012	Quarterly averages Jul-Sep 2012	Monthly averages Jul 2012	Monthly averages Aug 2012	Monthly averages Sep 2012
Energy												
Coal, Australia	a/ $/mt	98.97	121.45	99.64	121.32	114.91	113.65	95.54	89.75	88.24	91.00	90.00
Coal, Colombia	$/mt	77.97	111.50	85.67	113.92	101.18	91.77	82.22	83.02	81.13	85.82	82.13
Coal, South Africa	$/mt	91.62	116.30	95.32	116.72	106.85	105.00	93.47	87.48	87.33	89.11	86.00
Crude oil, average	a/ $/bbl	79.04	104.01	106.04	103.07	103.16	112.52	102.83	102.77	96.75	105.27	106.28
Crude oil, Brent	a/ $/bbl	79.64	110.94	112.47	112.47	109.29	118.60	108.86	109.95	103.14	113.34	113.38
Crude oil, Dubai	a/ $/bbl	78.06	106.03	109.48	107.01	106.16	116.07	106.18	106.18	99.22	108.37	110.96
Crude oil, West Texas Int.	a/ $/bbl	79.43	95.05	96.17	89.73	94.03	102.88	93.44	92.17	87.90	94.11	94.51
Natural gas Index	a/ 2005=100	91.1	113.8	107.0	138.2	111.3	106.4	106.3	108.4	109.1	108.4	107.7
Natural gas, Europe	a/ $/mmbtu	8.29	10.52	11.39	10.88	11.42	11.51	11.52	11.13	11.13	11.18	11.08
Natural gas, US	a/ $/mmbtu	4.39	5.08	2.54	8.44	3.32	2.46	2.28	2.88	2.95	2.84	2.84
Natural gas LNG, Japan	a/ $/mmbtu	10.85	14.66	17.10	16.35	16.58	16.36	17.06	17.88	18.11	17.80	17.72
Non Energy												
Agriculture												
Beverages												
Cocoa	b/ ¢/kg	313.3	298.0	237.2	303.5	246.8	234.1	228.2	249.4	235.0	251.2	262.0
Coffee, arabica	b/ ¢/kg	432.0	597.6	429.1	597.7	536.2	486.9	400.4	400.0	419.9	385.4	394.6
Coffee, robusta	b/ ¢/kg	173.6	240.8	229.1	243.1	215.9	222.1	231.0	234.1	236.0	234.8	231.4
Tea, auctions (3) avg.	b/ ¢/kg	288.5	292.1	285.5	300.3	279.5	254.9	292.2	309.2	302.9	311.7	313.1
Tea, Colombo auctions	b/ ¢/kg	329.0	326.4	301.8	313.0	316.7	292.7	304.7	308.1	299.0	306.6	318.8
Tea, Kolkata auctions	b/ ¢/kg	280.5	277.9	270.4	312.8	256.4	205.3	289.9	316.1	311.0	320.4	316.9
Tea, Mombasa auctions	b/ ¢/kg	256.0	271.9	284.1	275.3	265.4	266.7	282.0	303.5	298.8	308.3	303.5
Food												
Fats and Oils												
Coconut oil	b/ $/mt	1,124	1,730	1,200	1,474	1,377	1,400	1,187	1,013	1,070	1,001	969
Copra	$/mt	750	1,157	799	991	917	933	793	672	714	656	645
Groundnuts	$/mt	1,284	2,086	2,425	2,234	2,646	2,800	2,617	1,858	2,175	1,850	1,550
Groundnut oil	b/ $/mt	1,404	1,988	n.a.	2,155	2,245	n.a.	n.a.	2,476	2,468	2,553	2,408
Palm oil	b/ $/mt	901	1,125	1,063	1,079	1,025	1,107	1,088	995	1,015	997	973
Palmkernel oil	$/mt	1,184	1,648	1,210	1,338	1,250	1,366	1,242	1,021	1,067	1,008	987
Soybean meal	b/ $/mt	378	398	504	399	357	392	488	631	601	644	649
Soybean oil	b/ $/mt	1,005	1,299	1,250	1,324	1,214	1,253	1,236	1,260	1,239	1,252	1,288
Soybeans	b/ $/mt	450	541	587	553	488	518	572	673	662	684	673
Grains												
Barley	b/ $/mt	158.4	207.2	236.7	210.4	210.9	215.6	235.0	259.5	249.0	266.8	262.5
Maize	b/ $/mt	185.9	291.7	292.2	302.1	269.3	277.7	270.2	328.6	333.1	332.0	320.8
Rice, Thailand, 5%	b/ $/mt	488.9	543.0	564.6	567.7	600.1	542.5	582.8	568.4	573.8	567.8	563.8
Rice, Thailand, 25%	$/mt	441.5	506.0	n.a.	532.0	570.0	534.0	n.a.	548	555.0	545	545
Rice,Thai, A.1	$/mt	383.7	458.6	526.4	476.2	527.6	520.4	545.4	513.3	518.8	509.0	512.0
Rice, Vietnam 5%	$/mt	429.2	513.6	433.1	544.8	551.2	436.9	428.7	433.8	409.3	436.4	455.7
Sorghum	$/mt	165.4	268.7	n.a.	287.5	261.8	269.6	235.8	n.a.	n.a.	n.a.	n.a.
Wheat, Canada	$/mt	312.4	439.6	n.a.	429.8	405.2	378.1	n.a.	n.a.	n.a.	n.a.	n.a.
Wheat, US, HRW	b/ $/mt	223.6	316.3	299.1	315.6	279.7	278.8	269.0	349.5	345.7	349.4	353.4
Wheat, US, SRW	$/mt	229.7	285.9	281.4	270.5	250.5	258.9	251.8	333.4	323.0	333.7	343.6
Other Food												
Bananas, Europe	$/mt	1,002	1,125	1,099	1,030	968	1,143	1,171	982	850	985	1,112
Bananas, US	b/ $/mt	868	968	997	953	951	1,052	979	960	965	951	965
Fishmeal	$/mt	1,688	1,537	1,486	1,426	1,336	1,300	1,481	1,677	1,658	1,697	1,677
Meat, beef	b/ ¢/kg	335.1	404.2	412.6	393.8	407.2	424.7	413.0	400.1	398.8	404.1	397.4
Meat, chicken	b/ ¢/kg	189.2	192.6	206.1	194.3	197.0	201.6	207.1	209.7	208.8	209.5	210.9
Meat, sheep	¢/kg	531.4	663.1	617.6	686.5	660.2	644.5	618.3	590.2	592.7	581.6	596.2
Oranges	b/ $/mt	1,033	891	870	1,038	824	771	844	995	1,015	970	1,001
Shrimp, Mexico	¢/kg	1,004	1,193	1,001	1,198	1,085	1,055	977	970	970	970	970
Sugar, EU	b/ ¢/kg	44.18	45.46	41.88	46.13	44.01	42.85	41.91	40.90	40.14	40.51	42.04
Sugar, US	b/ ¢/kg	79.25	83.92	67.93	86.72	82.09	75.66	66.63	61.50	63.23	63.36	57.90
Sugar, world	b/ ¢/kg	46.93	57.32	48.88	60.72	53.29	52.75	47.05	46.85	50.44	46.03	44.07
Raw Materials												
Timber												
Logs, Cameroon	$/cum	428.6	484.8	450.8	515.1	483.0	463.6	452.6	436.2	430.3	431.0	447.4
Logs, Malaysia	b/ $/cum	278.2	390.5	362.9	444.7	409.0	373.3	361.0	354.5	357.2	354.7	351.7
Plywood	¢/sheets	569.1	607.5	610.0	621.0	617.5	612.8	609.9	607.1	606.7	606.7	608.1
Sawnwood, Cameroon	$/cum	812.7	825.8	757.1	823.1	774.6	755.5	760.7	755.2	747.4	749.6	768.5
Sawnwood, Malaysia	b/ $/cum	848.3	939.4	877.0	965.2	911.8	882.9	883.8	864.3	857.9	856.7	878.2
Woodpulp	$/mt	866.8	899.6	767.7	930.5	834.6	781.1	786.8	735.1	752.0	733.4	720.0
Other Raw Materials												
Cotton A Index	b/ ¢/kg	228.3	332.9	202.0	259.4	228.4	221.5	198.9	185.6	185.1	186.1	185.5
Rubber, RSS3	b/ ¢/kg	365.4	482.3	347.1	465.3	360.6	385.3	359.1	297.0	307.8	279.3	303.8
Rubber, TSR20	¢/kg	338.1	451.9	324.7	456.5	358.7	368.8	330.1	275.0	289.3	259.5	276.3

COMMODITY PRICE DATA

Commodity	Unit	Annual averages Jan-Dec 2010	Jan-Dec 2011	Jan-Sep 2012	Quarterly averages Jul-Sep 2011	Oct-Dec 2011	Jan-Mar 2012	Apr-Jun 2012	Jul-Sep 2012	Monthly averages Jul 2012	Aug 2012	Sep 2012
Fertilizers												
DAP	b/ $/mt	500.7	618.9	542.3	650.8	605.7	516.6	545.2	565.0	563.1	559.0	573.0
Phosphate rock	b/ $/mt	123.0	184.9	186.2	197.5	201.3	195.8	179.4	183.3	180.0	185.0	185.0
Potassium chloride	b/ $/mt	331.9	435.3	468.6	471.3	473.0	479.8	461.3	464.8	462.5	467.5	464.3
TSP	b/ $/mt	381.9	538.3	465.3	558.3	564.2	440.4	470.4	485.0	485.0	485.0	485.0
Urea	b/ $/mt	288.6	421.0	412.9	485.4	437.3	387.3	470.0	381.3	384.5	374.9	384.5
Metals and Minerals												
Aluminum	b/ $/mt	2,173	2,401	2,030	2,399	2,094	2,179	1,982	1,929	1,876	1,845	2,064
Copper	b/ $/mt	7,535	8,828	7,979	8,984	7,514	8,318	7,889	7,729	7,584	7,516	8,088
Iron ore	$/dmt	145.9	167.8	131.0	175.9	140.8	141.8	139.6	111.6	127.9	107.5	99.5
Lead	b/ ¢/kg	214.8	240.1	201.9	245.5	199.2	209.1	197.9	198.7	188.1	190.1	217.8
Nickel	b/ $/mt	21,809	22,910	17,735	22,024	18,393	19,636	17,186	16,384	16,128	15,735	17,288
Tin	b/ ¢/kg	2,041	2,605	2,096	2,466	2,085	2,291	2,063	1,936	1,855	1,877	2,077
Zinc	b/ ¢/kg	216.1	219.4	195.0	222.4	190.4	202.5	193.2	189.2	184.8	181.8	201.0
Precious Metals												
Gold	$/toz	1,225	1,569	1,653	1,701	1,682	1,692	1,612	1,656	1,594	1,630	1,745
Platinum	$/toz	1,610	1,719	1,535	1,771	1,529	1,604	1,500	1,501	1,426	1,453	1,624
Silver	¢/toz	2,015	3,522	3,065	3,880	3,179	3,258	2,941	2,995	2,743	2,880	3,361
World Bank commodity price indices for low and middle income countries (2005 =100)												
Energy		144.7	188.9	189.2	190.0	186.6	200.8	183.7	183.2	173.6	187.3	188.8
Non Energy		173.9	209.9	191.1	212.3	188.8	192.9	189.3	191.0	191.9	189.1	192.1
Agriculture		170.4	209.0	194.9	209.7	190.7	192.6	191.6	200.6	201.1	200.3	200.3
Beverages		182.1	208.2	168.1	210.7	183.7	171.7	162.7	169.8	168.7	168.5	172.3
Food		169.6	210.1	212.0	212.7	197.6	203.6	206.9	225.3	225.7	226.5	223.8
Fats and Oils		184.5	222.7	232.9	220.4	202.5	216.9	231.1	250.6	247.1	253.2	251.5
Grains		171.8	238.5	239.3	245.4	229.3	226.8	227.1	264.0	265.4	265.6	261.1
Other Food		148.2	167.8	159.7	172.9	162.2	165.2	156.8	157.1	161.6	155.9	153.8
Raw Materials		166.3	206.7	167.3	201.9	177.8	176.5	169.3	156.1	157.8	153.0	157.5
Timber		130.5	153.5	143.1	162.4	152.2	144.9	143.7	140.7	140.2	139.8	142.0
Other Raw Materials		205.4	264.8	193.8	245.2	205.8	211.0	197.4	173.0	177.1	167.4	174.5
Fertilizers		187.2	267.0	262.3	290.9	284.2	260.1	270.0	256.9	255.8	256.7	258.1
Metals and Minerals c/		179.6	205.5	175.0	208.7	174.0	185.7	175.4	163.9	165.7	158.4	167.6
Base Metals d/		169.2	193.2	168.8	194.4	164.1	178.2	166.2	162.1	158.5	156.8	171.0
Precious Metals (NEW)		272.2	371.9	374.1	404.5	382.0	386.1	363.6	372.7	355.1	365.0	398.1

a/ Included in the energy index (2005=100) b/ Included in the non-energy index (2005=100)
c/ base metals plus iron ore d/ Includes aluminum, copper, lead, nickel, tin and zinc
$ = US dollar ¢ = US cent bbl = barrel cum = cubic meter dmt = dry metric ton dmtu = dry metric ton unit kg = kilogram
mmbtu = million British thermal units mt = metric ton toz = troy oz n.a. = not available n.q. = no quotation

Description of Price Series

Coal (Australia), thermal, f.o.b. piers, Newcastle/Port Kembla, 6,700 kcal/kg, 90 days forward delivery beginning year 2011; for period 2002-2010, 6,300 kcal/kg (11,340 btu/lb); prior to year 2002, 6,667 kcal/kg (12,000 btu/lb).
Coal (Colombia), thermal, f.o.b. Bolivar, 6,450 kcal/kg, (11,200 btu/lb) ; during years 2002-July 2005 11,600 btu/lb, less than .8% sulfur, 9% ash , 90 days forward delivery
Coal (South Africa), thermal, f.o.b. Richards Bay, 90 days forward delivery; 6,000 kcal/kg, during 2002-2005, 6,200 kcal/kg (11,200 btu/lb); during 1990-2001 6390 kcal/kg (11,500 btu/l
Crude oil, average price of Brent, Dubai and West Texas Intermediate, equally weighed.
Crude oil, U.K. Brent 38° API.
Crude oil, Dubai Fateh 32° API.
Crude oil, West Texas Intermediate (WTI) 40° API.
Natural Gas Index (Laspeyres), weights based on 5-year consumption volumes for Europe, US and Japan (LNG), updated every 5 years, except the 11-year period 1960-70.
Natural Gas (Europe), average import border price, including UK. As of April 2010 includes a spot price component. Between June 2000 - March 2010 excludes UK.
Natural Gas (U.S.), spot price at Henry Hub, Louisiana.
Natural gas LNG (Japan), import price, cif, recent two months' averages are estimates.

Cocoa (ICCO), International Cocoa Organization daily price, average of the first three positions on the terminal markets of New York and London, nearest three future trading months.
Coffee (ICO), International Coffee Organization indicator price, other mild Arabicas, average New York and Bremen/Hamburg markets, ex-dock.
Coffee (ICO), International Coffee Organization indicator price, Robustas, average New York and Le Havre/Marseilles markets, ex-dock.
Tea , average three auctions, arithmetic average of quotations at Kolkata, Colombo and Mombasa/Nairobi.
Tea (Colombo auctions), Sri Lankan origin, all tea, arithmetic average of weekly quotes.
Tea (Kolkata auctions), leaf, include excise duty, arithmetic average of weekly quotes.
Tea (Mombasa/Nairobi auctions), African origin, all tea, arithmetic average of weekly quotes.

Coconut oil (Philippines/Indonesia), bulk, c.i.f. Rotterdam.
Copra (Philippines/Indonesia), bulk, c.i.f. N.W. Europe.
Groundnuts (US), Runners 40/50, shelled basis, c.i.f. Rotterdam
Groundnut oil (any origin), c.i.f. Rotterdam.
Palm oil (Malaysia), 5% bulk, c.i.f. N. W. Europe.
Palmkernel Oil (Malaysia), c.i.f. Rotterdam.
Soybean meal (any origin), Argentine 45/46% extraction, c.i.f. Rotterdam beginning 1990; previously US 44%.
Soybean oil (Any origin), crude, f.o.b. ex-mill Netherlands.

COMMODITY PRICE DATA

		Annual averages			Quarterly averages					Monthly averages		
		Jan-Dec	Jan-Dec	Jan-Sep	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Jul	Aug	Sep
Commodity	Unit	2010	2011	2012	2011	2011	2012	2012	2012	2012	2012	2012

Soybeans (US), c.i.f. Rotterdam.

Barley (Canada), feed, Western No. 1, Winnipeg Commodity Exchange, spot, wholesale farmers' price.
Maize (US), no. 2, yellow, f.o.b. US Gulf ports.
Rice (Thailand), 5% broken, white rice (WR), milled, indicative price based on weekly surveys of export transactions, government standard, f.o.b. Bangkok.
Rice (Thailand), 25% broken, WR, milled indicative survey price, government standard, f.o.b. Bangkok.
Rice (Thailand), 100% broken, A.1 Super from 2006 onwards, government standard, f.o.b. Bangkok; prior to 2006, A1 Special, a slightly lower grade than A1 Super.
Rice (Vietnam), 5% broken, WR, milled, weekly indicative survey price, Minimum Export Price, f.o.b. Hanoi.
Sorghum (US), no. 2 milo yellow, f.o.b. Gulf ports.
Wheat (Canada), no. 1, Western Red Spring (CWRS), in store, St. Lawrence, export price.
Wheat (US), no. 1, hard red winter, ordinary protein, export price delivered at the US Gulf port for prompt or 30 days shipment.
Wheat (US), no. 2, soft red winter, export price delivered at the US Gulf port for prompt or 30 days shipment.

Bananas (Central & South America), major brands, free on truck (f.o.t.) Southern Europe, including duties; prior to October 2006, f.o.t. Hamburg.
Bananas (Central & South America), major brands, US import price, f.o.t. US Gulf ports.
Fishmeal (any origin), 64-65%, c&f Bremen, estimates based on wholesale price, beginning 2004; previously c&f Hamburg.
Meat, beef (Australia/New Zealand), chucks and cow forequarters, frozen boneless, 85% chemical lean, c.i.f. U.S. port (East Coast), ex-dock, beginning November 2002; previously cow forequarters.
Meat, chicken (US), broiler/fryer, whole birds, 2-1/2 to 3 pounds, USDA grade "A", ice-packed, Georgia Dock preliminary weighted average, wholesale.
Meat, sheep (New Zealand), frozen whole carcasses Prime Medium (PM) wholesale, Smithfield, London beginning January 2006; previously Prime Light (PL).
Oranges (Mediterranean exporters) navel, EEC indicative import price, c.i.f. Paris.
Shrimp , (Mexico), west coast, frozen, white, No. 1, shell-on, headless, 26 to 30 count per pound, wholesale price at New York.
Sugar (EU), European Union negotiated import price for raw unpackaged sugar from African, Caribbean and Pacific (ACP) under Lome Conventions, c.i.f. European ports.
Sugar (US), nearby futures contract, c.i.f.
Sugar (world), International Sugar Agreement (ISA) daily price, raw, f.o.b. and stowed at greater Caribbean ports.

Logs (West Africa), sapele, high quality (loyal and marchand), 80 centimeter or more, f.o.b. Douala, Cameroon beginning January 1996; previously of unspecified dimension.
Logs (Malaysia), meranti, Sarawak, sale price charged by importers, Tokyo beginning February 1993; previously average of Sabah and Sarawak weighted by Japanese import volumes.
Plywood (Africa and Southeast Asia), Lauan, 3-ply, extra, 91 cm x 182 cm x 4 mm, wholesale price, spot Tokyo.
Sawnwood (Cameroon), sapele, width 6 inches or more, length 6 feet or more, f.a.s. Cameroonian ports.
Sawnwood (Malaysia), dark red seraya/meranti, select and better quality, average 7 to 8 inches; length average 12 to 14 inches; thickness 1 to 2 inch(es); kiln dry, c. & f. UK ports, with 5% agents commission including premium for products of certified sustainable forest beginning January 2005; previously excluding the premium
Woodpulp (Sweden), softwood, sulphate, bleached, air-dry weight, c.i.f. North Sea ports.

Cotton (Cotton Outlook "CotlookA index"), middling 1-3/32 inch, traded in Far East, C/F beginning 2006; previously Northern Europe, c.i.f.
Rubber (Asia), RSS3 grade, Singapore Commodity Exchange Ltd (SICOM) nearby contract beginning 2004; during 2000 to 2003, Singapore RSS1; previously Malaysia RSS1.
Rubber (Asia), TSR 20, Technically Specified Rubber, SICOM nearby contract.

DAP (diammonium phosphate), standard size, bulk, spot, f.o.b. US Gulf.
Phosphate rock (Morocco), 70% BPL, contract, f.a.s. Casablanca.
Potassium chloride (muriate of potash), standard grade, spot, f.o.b. Vancouver.
TSP (triple superphosphate), bulk, spot, beginning October 2006, Tunisian origin, granular, fob; previously US origin, f.o.b. US Gulf.
Urea, (Black Sea), bulk, spot, f.o.b. Black Sea (primarily Yuzhnyy) beginning July 1991; for 1985-91 (June) f.o.b. Eastern Europe.

Aluminum (LME) London Metal Exchange, unalloyed primary ingots, high grade, minimum 99.7% purity, settlement price beginning 2005; previously cash price.
Copper (LME), grade A, minimum 99.9935% purity, cathodes and wire bar shapes, settlement price.
Iron ore (any origin) fines, spot price, c.f.r. China, 62% Fe beginning December 2008; previously 63.5%.
Lead (LME), refined, 99.97% purity, settlement price.
Nickel (LME), cathodes, minimum 99.8% purity, settlement price beginning 2005; previously cash price.
Tin (LME), refined, 99.85% purity, settlement price.
Zinc (LME), high grade, minimum 99.95% purity, settlement price beginning April 1990; previously special high grade, minimum 99.995%, cash prices .

Gold (UK), 99.5% fine, London afternoon fixing, average of daily rates.
Platinum (UK), 99.9% refined, London afternoon fixing
Silver (UK), 99.9% refined, London afternoon fixing; prior to July 1976 Handy & Harman. Grade prior to 1962 unrefined silver.

Sources include: Africa Tea Brokers Ltd Weekly Market Report, Bloomberg, Canadian Grain Commission, Canadian Wheat Board, Cotton Outlook, Coal Week International, Fertilizer International, Fertilizer Week, FRuiTROP, IHS McCloskey Coal Report, INFOFISH, INTERFEL Fel Actualités hebdo, International Cocoa Organization, International Coffee Organization, International Rubber Study Group, International Tea Committee, International Tropical Timber Organization, Internatonal Sugar Organization, ISTA Mielke GmbH Oil World, Japan Lumber Journal, Japan Metal Bulletin, Meat Trades Journal, MLA Meat & Livestock Weekly, Platts International Coal Report, Platts Metals Week, The Silver Institute, Singapore Commodity Exchange, Sopisco News, Sri Lanka Tea Board, Statistisches Bundesamt, US Department of Agriculture, US NOAA Fisheries Service, VALE and World Gas Intelligence.

http://www.worldbank.org/prospects/commodities
Development Prospects Group
World Bank
October 3, 2012

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Annex Table 2

Financial Prices for Traded Goods

India

Karnataka Integrated and Sustainable Water Resources Management Investment Programme

Financial Border Parity Price

ANNEX TABLE 2

Source WB Real Price forecast (real prices), Development Prospects Group 10/9/2012

Rice Thailand 5% broken, FOB Bangkok	per tonne
Export/Import substitute	**EXPORT**
Product location	Thailand
Quality of product	5%
	2012
US$/t (Constant 2012)	550
Quality differential	0.9
Equivalent value of Indian product	495
Less: Freight and insurance cost to local Asian port	35
Value at Indian port	**530**
Conversion to Indian Rupees (Rs)	
Exchange Rate	55.00
Value at Indian port (Rs/t)	29,147
Less: Port handling charges, storage, and losses	-1,457
Less: local transport and dealing costs (Rs 1400/t)	-1,400
Value at local market/processor/mill	26,344
Less: Milling cost (R310/t)	-310
Equivalent price of paddy at mill	16,922
Less: Transport cost - farmgate to local market/mill (Rs120/t)	-120
Financial paddy price at farmgate: Export Parity (Rs/tonne)	**16,802**
Import Parity (Rs/tonne)	**20,884**
Average Price (Rs/tonne)	**18,843**
Financial paddy price used in analysis (Rs/tonne)	**14,000**
MSP at farmgate (less Rs 450 transport and marketing) (Rs/t)	12,050
Port handling charges, storage, and losses (%)	5%
Recovery rate at mill	65%
Standard conversion factor	1.00

Urea bulk FOB Black Sea	per tonne
Export/Import substitute	**IMPORT**
Product location	E. Europe
Quality of product	46%
	2012
US$/t (Real 2012 prices)	400
Quality differential	1.0
Equivalent value of Indian product	400
Plus: Freight and insurance cost from Europe	35
Value ex-Indian port	**435**
Conversion to Indian Rupees (Rs)	
Exchange Rate	55.00
Value at Indian port (Rs/ton)	23,947
Plus: Import Duty	479
Plus: Port charges	1,197
Plus: Transport to farmgate (Rs 1500/t) includes bagging	1,500
Financial import parity price at farmgate (fertiliser) (Rs/t)	27,123
Financial import parity price at farmgate (nutrient) (Rs/kg)	58.96
Less: Central Fertiliser Subsidy	-27.12
Effective Farmgate Price (nutrient) (Rs/kg)	**31.84**
MRP of Urea, Rabi 2012 (nutrient 46%) (Rs/kg)	19.00
Port handling charges, storage, and losses (%)	5%
Standard conversion factor	1.00
Imported (%)	20%
Import Duty (%)	10.0%

Triple Super Phosphate (TSP) bulk granular FOB Tunisia	per tonne
Export/Import substitute	IMPORT
Product location	Mediterranean
Quality of product	46%
	2012
US$/t (Constant 2012)	470
Quality differential	1.00
Equivalent value of Indian product	470
Plus: Freight and insurance cost from Mediterranean	35
Value ex-Indian port	505
Conversion to Indian Rupees (Rs)	
Exchange rate	55.00
Value at Indian port (Rs/t)	27,794
Plus: Import Duty	1,554
Plus: Port charges	1,390
Plus: Internal handling and transport (Rs 220/t)	0
Plus: Bagging (Rs 650/t)	0
Value ex factory	30,737
Plus: Transport to farmgate (Rs 1800/t)	1,800
Financial import parity price at farmgate (fertiliser) (Rs/t)	32,537
Financial import parity price at farmgate (nutrient) (Rs/kg)	70.73
Less: Central Fertiliser Subsidy	-32.34
Effective Farmgate Price (nutrient) (Rs/kg)	38.39
MRP of SSP (17%P), Kharif 2012 (nutrient) (Rs/kg)	45.88
Port handling charges, storage, and losses (%)	5%
Standard conversion factor	1.00
Imported (%)	26%
Import Duty (%)	21.5%

Potash MOP bulk, standard FOB Vancouver	per tonne
Export/Import substitute	IMPORT
Product location	Vancouver
Quality of product	60%
	2012
US$/t (Constant 2012)	466
Quality differential	1.00
Equivalent value of Indian product	466
Plus: Freight and insurance cost from Vancouver	45
Value ex-Indian port	511
Conversion to Indian Rupees (Rs)	
Exchange rate	55.00
Value at Indian port (Rs/ton)	28,078
Plus: Import Duty	5,494
Plus: Port charges	1,404
Plus: Internal handling and transport (Rs 220/t)	220
Plus: Bagging (Rs 650/t)	650
Value ex importer	35,846
Plus: Transport to farmgate (Rs 420/t)	1,800
Financial import parity price at farmgate (fertiliser) (Rs/t)	37,646
Financial import parity price at farmgate (nutrient) (Rs/kg)	62.74
Less: Central Fertiliser Subsidy	-26.76
Effective Farmgate Price (nutrient) (Rs/kg)	35.98
MRP of MOP, Kharif 2012 (nutrient) (Rs/kg)	28.33
Port handling charges, storage, and losses (%)	5%
Standard conversion factor	1.00
Imported (%)	91%
Import Duty (%)	21.5%

Annex Table 3

Economic Price and Conversion Factor Tables for Traded Goods

India

Karnataka Integrated and Sustainable Water Resources Management Investment Programme

Economic Border Parity Price and Conversion Factors

ANNEX TABLE 3

Source WB Real Price forecast (real prices), Development Prospects Group 10/9/2012

Rice Thailand 5% broken, FOB Bangkok	per tonne
Export/Import substitute	**EXPORT**
Product location	Thailand
Quality of product	5%
	2012
US$/t	550
Quality differential	0.9
Equivalent value of Indian product	495
Less: Freight and insurance cost to local Asian port	-35
Value at Indian port	460
Conversion to Indian Rupees (Rs)	
Exchange rate	55.00
Value at Indian port (Rs/t)	25,297
Less: Port handling charges, storage, and losses	-1,138
Less: Local transport dealer & processing costs (Rs1400/t)	-1,260
Value at local market/processor/mill	22,898
Less: Milling cost (R310/t)	-279
` Equivalent price of paddy at mill	14,703
Less: Transport cost - farmgate to local market/mill (Rs120/t)	-108
Economic paddy price at farmgate, export parity (Rs/ton)	14,595
MSP at farmgate (less Rs 450 transport and marketing) (Rs/t)	12,050
Financial paddy price used in analysis (Rs/tonne)	14,000
Conversion Factor for rice on MSP	1.2
Conversion Factor for rice based on model price	1.0
Port handling charges, storage, and losses (%)	5%
Recovery rate at mill	65%
Standard conversion factor	0.90

Soya Bean, (US) cif Rotterdam	per tonne
Export/Import substitute	**IMPORT**
Product location	Europe
Quality of product	Dry grain
	2012
US$/t	599
Quality differential	1.00
Equivalent value of Indian product	599
Plus: Freight and insurance cost from Europe	35
Value at Indian port	634
Conversion to Indian Rupees (Rs)	
Exchange rate	55.00
Value at Indian port (Rs/t)	34,891
Plus: Port handling charges, storage, and losses	1,570
Plus: handling, transport costs and dealer costs (Rs1400/t))	1,260
Value at local market/processor/mill	37,721
Less: Transport cost - farmgate to local market/mill (Rs120/t)	-108
Economic price at farmgate (Rs/tonne)	37,613
MSP at farmgate (less Rs 450 transport and marketing) (Rs/t)	21,550
Conversion Factor for Soya beans on MSP	1.7
Port handling charges, storage, and losses (%)	5%
Standard conversion factor	0.90

Maize	per tonne
Export/Import substitute	**Export**
Product location	FOB, US
	Dry grain
	2012
US$/t (Constant 2007)	300
Quality differential	1.00
Equivalent value of Indian product	300
Plus: Freight and insurance cost from Gulf port	60
Value at Indian port	**360**
Conversion to Indian Rupees (Rs)	
Exchange rate	55.00
Value at Indian port (Rs/t)	19,800
Less: Port handling charges, storage, and losses	-891
Less: Local transport, dealer handling & processing (Rs1400/t)	-1,260
Value at local market/processor/mill	17,649
Less: Transport cost - farmgate to local market/mill (Rs120/t)	-63
Financial price at farmgate, Export Parity (Rs/tonne)	**17,586**
Wholesale market price for Maize (less 25% marketing and transport)	15,750
MSP at farmgate (less Rs 450 transport and marketing) (Rs/t)	11,300
Conversion Factor for maize based on model price	1.1
Conversion Factor for maize on MSP	1.4
Financial price used in analysis	14,000
Port handling charges, storage, and losses (%)	5%
Standard conversion factor	0.90

Urea bulk FOB Black Sea	per tonne
Export/Import substitute	**IMPORT**
Product location	E. Europe
Quality of product	46%
	2012
US$/t (Constant 2012)	400
Quality differential	1.0
Equivalent value of Indian product	400
Plus: Freight and insurance cost from Europe	35
Value ex-Indian port	435
Conversion to Indian Rupees (Rs)	
Exchange rate	55.00
Value at Indian port (Rs/ton)	23,947
Plus: Import Duty	0
Plus: Port charges	1,078
Plus: Internal handling and transport (Rs220/t)	198
Plus: Bagging (Rs 650/t)	585
Value ex factory	25,807
Plus: Transport to farmgate (Rs420/t)	378
Economic price at farmgate (fertiliser) (Rs/t)	26,185
Economic price at farmgate (nutrient) (Rs/kg)	56.92
Financial price at farmgate, after central subsidy (nutrient Rs/kg)	31.84
MRP of Urea, Rabi 2012 (nutrient 46%) (Rs/kg) (model price)	19.00
Conversion Factor for urea	3.0

Port handling charges, storage, and losses (%)	5%
Standard conversion factor	0.90

Triple Superphosphate (TSP) bulk granular FOB Tunisia	per tonne
Export/Import substitute	**IMPORT**
Product location	Mediterranean
Quality of product	46%
TSP bulk granular FOB Tunisia	**2102**
US$/t (2007=100)	470
Quality differential	1.00
Equivalent value of Indian product	470
Plus: Freight and insurance cost from Mediterranean	35
Value ex-Indian port	505
Conversion to Indian Rupees (Rs)	
Exchange rate	55.00
Value at Indian port (Rs/t)	27,794
Plus: Import Duty	0
Plus: Port charges	1,251
Plus: Internal handling and transport (Rs 220/t)	198
Plus: Bagging (Rs 650/t)	585
Value ex factory	29,827
Plus: Transport to farmgate (Rs 420/t)	378
Economic price at farmgate (fertiliser) (Rs/ton)	30,205
Economic price at farmgate (nutrient) (Rs/kg)	65.66
Financial price at farmgate, after central subsidy (nutrient Rs/kg)	38.39
MRP of SSP (17%P), Kharif 2012 (nutrient) (Rs/kg) (model price)	45.88
Conversion Factor for Phosphate	1.4
Port handling charges, storage, and losses (%)	5%
Standard conversion factor	0.90

Phosphate MOP bulk, standard FOB Vancouver	per tonne
Export/Import substitute	**IMPORT**
Product location	Vancouver
Quality of product	60%
	2012
US$/t (2007=100)	466
Quality differential	1.00
Equivalent value of Indian product	466
Plus: Freight and insurance cost from Vancouver	45
Value ex-Indian port	511
Conversion to Indian Rupees (Rs)	
Exchange rate	55.00
Value at Indian port (Rs/ton)	28,078
Plus: Import Duty	0
Plus: Port charges	1,264
Plus: Internal handling and transport (Rs220/t)	198
Less: Bagging (Rs 650/t)	585
Value ex importer	30,125
Plus: Transport to farmgate (Rs 420/t)	378
Economic price at farmgate (fertiliser) (Rs/t)	30,503
Economic price at farmgate (nutrient) (Rs/kg)	50.84
Financial price at farmgate, after central subsidy (nutrient Rs/kg)	35.98
MRP of MOP, Kharif 2012 (nutrient) (Rs/kg)	28.33
Conversion factor for KCL	1.8
Port handling charges, storage, and losses (%)	5%
Standard conversion factor	0.90

Construction Conversion Factor

Item	Percent of Total Cost	Conversion Factor
Steel	21	0.90
Cement	16	0.90
Other Materials	10	0.90
Unskilled labour	14	1.00
Skilled labour	5	1.00
Transport & Plant	16	0.90
Taxes	8	0.00
Contractors Margin	10	0.90
Total	**100**	**0.85**

Steel Re Bar ex Japan, November 2012		FINANCIAL PRICE		ECONOMIC PRICE	
		Factor	Value	Conversion Factor	Value
FOB	US$		640	1	640
Plus Freight	US$		35	1	35
Plus Insurance	US$	0.25%	1.6	1	1.6
Plus Unloading	US$		7	0.9	6.3
CIF Port			**683.6**		**682.9**
Convert to Rupees	Rs	55.00	37,598	55.00	37,560
Port charges	Rs	2%	751.96	0.9	676.764
Customs Duty	%	10%	3,760	0	0
Value Ex Port			**42,110**		**38,236**
Local Transport (Rs 450/t)	Rs		450	0.8	360
Add local handling (Rs 100/t)	Rs		100	0.9	90
Retail margin	%	15%	6,316	0.9	5,685
VAT	%	4%	1,684	0	0
Estimated Retail price	**Rs**		**50,661**		**44,371**
Reported Price	Rs		45,000		
Conversion Factor		**Estimated price**		**0.88**	
		Reported Price		**0.99**	

Cement

		FINANCIAL PRICE		ECONOMIC PRICE	
		Factor	**Value**	**Conversion Factor**	**Value**
FOB (Bulk)	US$		50	1	50
Plus Freight	US$		35	1	35
Plus Insurance	US$	0.25%	0	1	0
Plus Unloading	US$		7	0.9	6.3
CIF Port			**92.13**		**91.43**
Convert to Rupees	Rs	55.00	5,067		5,028
Port charges	Rs	2%	101	0.9	67
Customs Duty	%	10.00%	507	0	0
Value Ex Port			**5,675**		**5,095**
Add Local Transport	Rs		450	0.9	405
Add bagging cost	Rs		650	0.9	585
Add local handling (Rs 100/t)	Rs		100	0.9	90
Retail margin	%	15%	851	0.9	766
VAT	%	4%	227	0	0
Estimated Retail price	**Rs**		**7,953**		**6,941**
Reported Price	Rs		5,800		
Conversion Factor			**Estimated price**	**0.87**	
			Reported Price	**1.20**	

Diesel		FINANCIAL PRICE		ECONOMIC PRICE	
		Factor	Value	Conversion Factor	Value
FOB Crude Oil, spot Middle East					
per barrel (159l)	US$		100	1	100
Plus Freight	US$		35	1	35
Plus Insurance	US$	0.25%	0.25	1	0.25
Plus Unloading	US$		1	0.9	0.9
CIF Port			**136.25**		**136.15**
Convert to Rs	Rs	55.00	7,494		7,488
Port charges	Rs	2.0%	150	0.9	135
Customs Duty	%	2.5%	187	0	0
Value Ex Port, per barrel	**Rs**		**7,831**		**7,623**
Crude cost per litre	Rs		49		48
Plus Refining cost (% crude cost)	%	28%	14	0.9	12
Plus Retail Margin (% of crude cost)	%	11%	5	0.9	5
Cost per litre	**Rs**		**68**		**65**
Plus Excise Duty	Rs		2	0	0
Less Fuel Subsidy	%	30%	-21	0	0
Estimated Pump Price	**Rs**		**50**		**65**
Reported Pump Price	Rs		51		
Conversion Factor	**Estimated price**			**1.31**	
	Reported Price			**1.28**	

Annex Table 4

Prices used for Financial and Economic Analysis

India

KIWRMP Gondhi Subproject

(In Rupee)	Unit	Financial Price	Correction Factor	Economic Price
Outputs				
Sugarcane	kg	2.1	CF: 0.9	1.89
Arecanut (contract, on tree, wet)	kg	15	CF: 0.9	13.5
Paddy Rice	kg	14	CF: 1	14
Straw and Stalks	kg	0.9	CF: 0.9	0.81
Maize	kg	14	CF: 1.1	15.4
Sorghum (Jowar)	kg	14	CF: 0.9	12.6
Sunflower	kg	37	CF: 1.7	62.9
Black Gram	kg	43	CF: 0.9	38.7
Intercrop (banana)	kg	4	CF: 0.9	3.6
Inputs				
Arecanut seedling	each	15	CF: 0.9	13.5
Banana set	each	10	CF: 0.9	9
Sugarcane Seed	kg	1.25	CF: 0.9	1.125
Paddy Seed	kg	36	CF: 0.9	32.4
Other grain seed	kg	30	CF: 0.9	27
Pesticide	kg	300	CF: 0.8	240
Fungicide	kg	300	CF: 0.8	240
Herbicide	kg	300	CF: 0.8	240
Bordeaux mixture	kg	12.5	CF: 0.9	11.25
Manure	kg	2.5	CF: 0.9	2.25
Mud with transport	load	1,500	CF: 0.9	1,350
Animal Hire	animal day	300	CF: 0.9	270
Tractor Hire	hour	600	CF: 1.2	720
Land Levelling	hour	600	CF: 1.2	720
Contract transplant rice	ha	3,250	CF: 0.9	2,925
Combine Harvester /b	hour	2,000	CF: 1.2	2,400
Contract sugar harvest	Rupee	Value Basis	CF: 0.9	Value Basis
Irrigation Fee Sugarcane	ha	1,000	CF: 0.9	900
Irrigation Fee Garden	ha	150	CF: 0.9	135
Irrigation Fee Paddy	kg	500	CF: 0.9	450
Nitrogen	kg	19	CF: 3.0	57
Phosphorous	kg	46	CF: 1.4	64.4
Potassium	kg	26	CF: 1.8	46.8
Other costs	ha	5,000	CF: 0.9	4,500
Labour	person-day	210	CF: .9	189

ANNEX 6: CROP PHYSICAL AND FINANCIAL BUDGETS

	PRICES	(IN RUPEE)			FINANCIAL. PRICE		CORRECTION FACTOR		ECONOMIC PRICE
Outputs				**Unit**					
	Sugarcane /a			kg	2.1		CF: 0.9		1.89
	Arecanut (contract, on tree, wet)			kg	15		CF: 0.9		13.5
	Paddy Rice			kg	14		CF: 1		14
	Straw and Stalks			kg	0.9		CF: 0.9		0.81
	Maize			kg	14		CF: 1.1		15.4
	Sorghum (Jowar)			kg	14		CF: 0.9		12.6
	Sunflower			kg	37		CF: 1.7		62.9
	Black Gram			kg	43		CF: 0.9		38.7
	Intercrop (banana)			kg	4		CF: 0.9		3.6
Inputs									
	Seed								
		Arecanut seedling		each	15		CF: 0.9		13.5
		Banana set		each	10		CF: 0.9		9
		Sugarcane Seed		kg	1.25		CF: 0.9		1.125
		Paddy Seed		kg	36		CF: 0.9		32.4
		Other grain seed		kg	30		CF: 0.9		27
	Draught, Water, Fertiliser and Chemicals								
		Pesticide		kg	300		CF: 0.8		240
		Fungicide		kg	300		CF: 0.8		240
		Herbicide		kg	300		CF: 0.8		240
		Bordeaux mixture		kg	12.5		CF: 0.9		11.25
		Manure		kg	2.5		CF: 0.9		2.25
		Mud with transport		load	1,500		CF: 0.9		1,350
		Animal Hire		animal day	300		CF: 0.9		270
		Tractor Hire		hour	600		CF: 1.2		720
		Land Levelling		hour	600		CF: 1.2		720
		Contract transplant rice		ha	3,250		CF: 0.9		2,925
		Combine Harvester /b		hour	2,000		CF: 1.2		2,400
		Contract sugar harvest		Rupee	Value Basis		CF: 0.9		Value Basis
		Irrigation Fee Sugarcane		ha	1,000		CF: 0.9		900
		Irrigation Fee Garden		ha	150		CF: 0.9		135
		Irrigation Fee Paddy		kg	500		CF: 0.9		450
		Nitrogen		kg	19		CF: 3.0		57
		Phosphorous		kg	46		CF: 1.4		64.4
		Potassium		kg	26		CF: 1.8		46.8
		Other costs		ha	5,000		CF: 0.9		4,500
Labour				person-day	210		CF: .9		189
	May to July Labour			person-day	210		CF: .9		189
	Aug to Oct Labour			person-day	210		CF: .9		189
	Nov to Jan Labour			person-day	210		CF: .9		189
	Feb to April Labour			erson-day	210		CF: .9		189

SUGARCANE CROP MODEL						June - May							
YIELDS AND INPUTS						Existing	New Technology						
					Unit	1 to 25	1	2	3	4	5	6	7 to 25
	Yields				kg	85,000	85,000	85,833	88,333	92,500	96,667	99,167	100,000
	Operating												
		Inputs											
			Sugarcane Seed		kg	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
			Manure		kg	9,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
			Nitrogen		kg	300	350	350	350	350	350	350	350
			Phosphorous		kg	200	250	250	250	250	250	250	250
			Potassium		kg	140	170	170	170	170	170	170	170
			Herbicide		kg	-	0.5	0.5	0.5	0.5	0.5	0.5	0.5
			Pesticide		kg	1	1.7	1.7	1.7	1.7	1.7	1.7	1.7
			Fungicide		kg	3	3	3	3	3	3	3	3
			Irrigation fee		ha	1	1	1	1	1	1	1	1
			Animal Hire		day	17	20	20	20	20	20	20	20
			Tractor Hire		hour	40	50	50	50	50	50	50	50
			Contract harvest		Rupee	38,250	38,250	38,625	39,750	41,625	43,500	44,625	45,000
		Labor											
			Land Prep		pers-d	12	12	12	12	12	12	12	12
			Plant		pers-d	75	75	75	75	75	75	75	75
			Irrigate		pers-d	12	12	12	12	12	12	12	12
			Fertilise		pers-d	12	12	12	12	12	12	12	12
			Weed		pers-d	20	20	20	20	20	20	20	20
			Other		pers-d	4	4	4	4	4	4	4	4
			Other		pers-d	8	8	8	8	8	8	8	8
FINANCIAL BUDGET						Existing							
(In Rupee Per ha)						Technology				New Technology			
						1 to 25	1	2	3	4	5	6	7 to 25
		Revenue				178,500	178,500	180,249	185,499	194,250	203,001	208,251	210,000
		Input costs											
			Sugarcane Seed			6,250	6,250	6,250	6,250	6,250	6,250	6,250	6,250
			Manure			22,500	30,000	30,000	30,000	30,000	30,000	30,000	30,000
			Nitrogen			5,700	6,650	6,650	6,650	6,650	6,650	6,650	6,650
			Phosphorous			9,200	11,500	11,500	11,500	11,500	11,500	11,500	11,500
			Potassium			3,640	4,420	4,420	4,420	4,420	4,420	4,420	4,420
			Herbicide			-	150	150	150	150	150	150	150
			Pesticide			300	510	510	510	510	510	510	510
			Fungicide			900	900	900	900	900	900	900	900
			Irrig fee Sugarcane			1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
			Animal Hire			5,100	6,000	6,000	6,000	6,000	6,000	6,000	6,000
			Tractor Hire			24,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
			Contract sugar harv			38,250	38,250	38,625	39,750	41,625	43,500	44,625	45,000
		Sub-total Input costs				116,840	135,630	136,005	137,130	139,005	140,880	142,005	142,380
Income (Before Labor Costs)						61,660	42,870	44,244	48,369	55,245	62,121	66,246	67,620
		Labor costs											
			Land Prep			2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520
			Plant			15,750	15,750	15,750	15,750	15,750	15,750	15,750	15,750
			Irrigate			2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520
			Fertilise			2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520
			Weed			4,200	4,200	4,200	4,200	4,200	4,200	4,200	4,200
			Other			840	840	840	840	840	840	840	840
			Other			1,680	1,680	1,680	1,680	1,680	1,680	1,680	1,680
		Sub-total Labor costs				30,030	30,030	30,030	30,030	30,030	30,030	30,030	30,030
Income (After Labor Costs)						31,630	12,840	14,214	18,339	25,215	32,091	36,216	37,590

ARECANUT (ESTABLISHED) CROP MODEL						June - May			
YIELDS AND INPUTS						Existing			
(Per ha)						Technology		New Technology	
					Unit	1 to 25	1	2	3 to 25
	Yields				kg	15,000	15,000	16,500	18,000
	Operating								
		Inputs							
			Manure		kg	12,500	12,500	12,500	12,500
			Mud with transport		load	12.5	12.5	12.5	12.5
			Nitrogen		kg	170	170	170	170
			Phosphorous		kg	65	65	65	65
			Potassium		kg	210	210	210	210
			Irrigation Fee Garden		ha	1	1	1	1
			Bordeaux mixture		kg	1,000	1,000	1,000	1,000
			Tractor Hire		hour	15	15	15	15
		Labor							
			Irrigate		person-day	15	15	15	15
			Irrigate		person-day	15	15	15	15
			Fertilise		person-day	3	3	3	3
			Weed		person-day	15	15	15	15
			Other		person-day	10	10	10	10
			Other		person-day	10	10	10	10
Arecanut (established) Crop Model							June - May		
FINANCIAL BUDGET						Existing			
(In Rupee Per ha)						Technology		New Technology	
						1 to 25	1	2	3 to 25
		Revenue				225,000	225,000	247,500	270,000
		Input costs							
			Manure			31,250	31,250	31,250	31,250
			Mud with transport			18,750	18,750	18,750	18,750
			Nitrogen			3,230	3,230	3,230	3,230
			Phosphorous			2,990	2,990	2,990	2,990
			Potassium			5,460	5,460	5,460	5,460
			Irrigation Fee Garden			150	150	150	150
			Bordeaux mixture			12,500	12,500	12,500	12,500
			Tractor Hire			9,000	9,000	9,000	9,000
		Sub-total Input costs				83,330	83,330	83,330	83,330
		Income (Before Labor Costs)				141,670	141,670	164,170	186,670
		Labor costs							
			Irrigate			3,150	3,150	3,150	3,150
			Irrigate			3,150	3,150	3,150	3,150
			Fertilise			630	630	630	630
			Weed			3,150	3,150	3,150	3,150
			Other			2,100	2,100	2,100	2,100
			Other			2,100	2,100	2,100	2,100
		Sub-total Labor costs				14,280	14,280	14,280	14,280
		Income (After Labor Costs)				127,390	127,390	149,890	172,390

NEW ARECANUT CROP MODEL												
YIELDS AND INPUTS(Per ha)		Unit	1	2	3	4	5	6	7	8	9	10 to 25
Main Production												
	Arecanut (contract, on tree, wet)	kg	-	-	-	-	-	2,500	7,500	10,000	15,000	18,000
	Intercrop (banana)	kg	4,000	4,000	-	4,000	4,000	-	-	-	-	-
Investment												
	Land Levelling	hour	25	-	-	-	-	-	-	-	-	-
	Arecanut seedling	each	1,350.00	60	60	60	60	60	60	-	-	-
	Banana set	each	1,250.00	-	-	1,250.00	-	-	-	-	-	-
Operating												
	Inputs											
	Mud with transport	load	25	-	25	-	25	-	12.5	12.5	12.5	12.5
	Manure	kg	25,000	-	25,000	-	25,000	-	12,500	12,500	12,500	12,500
	Tractor Hire	hour	23	30	30	30	30	30	30	30	30	30
	Nitrogen	kg	230	170	-	170	-	170	-	85	85	85
	Phosphorous	kg	85	65	-	65	-	65	-	33	33	33
	Potassium	kg	210	150	-	150	-	150	-	75	75	75
	Irrig Fee Garden	ha	1	1	1	1	1	1	1	1	1	1
	Bordeaux mix	kg	-	-	-	-	-	-	500	1,000	1,000	1,000
	Labor											
	Irrigate	pers d	15	15	15	15	15	15	15	15	15	15
	Irrigate	pers d	15	15	15	15	15	15	15	15	15	15
	Pitting	pers d	80	-	-	-	-	-	-	-	-	-
	Apply mud, manure	pers d	13	-	13	-	13	-	7	7	7	7
	Fertilise	pers d	5	3	-	3	-	3	-	2	2	2
	Weed	pers d	15	15	15	15	15	15	15	15	15	15
	Other	pers d	10	10	10	10	10	10	10	10	10	10
	Other	pers d	10	10	10	10	10	10	10	10	10	10
FINANCIAL BUDGET(In Rupee Per ha)												
Revenue			1	2	3	4	5	6	7	8	9	10 to 25
	Arecanut (contract, on tree, wet)		-	-	-	-	-	37,500	112,500	150,000	225,000	270,000
	Intercrop (banana)		16,000	16,000	-	16,000	16,000	-	-	-	-	-
Sub-total Revenue			16,000	16,000	-	16,000	16,000	37,500	112,500	150,000	225,000	270,000
Input costs												
	Investment costs											
	Land Levelling		15,000	-	-	-	-	-	-	-	-	-
	Arecanut seedling		20,250	900	900	900	900	900	900	-	-	-
	Banana set		12,500	-	-	12,500	-	-	-	-	-	-
	Sub-total Investment Costs		47,750	900	900	13,400	900	900	900	-	-	-
	Operating Costs											
	Mud with transport		37,500	-	37,500	-	37,500	-	18,750	18,750	18,750	18,750
	Manure		62,500	-	62,500	-	62,500	-	31,250	31,250	31,250	31,250
	Tractor Hire (rotovate)		13,800	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000
	Nitrogen		4,370	3,230	-	3,230	-	3,230	-	1,615	1,615	1,615
	Phosphorous		3,910	2,990	-	2,990	-	2,990	-	1,518	1,518	1,518
	Potassium		5,460	3,900	-	3,900	-	3,900	-	1,950	1,950	1,950
	Irrigation Fee Garden		150	150	150	150	150	150	150	150	150	150
	Bordeaux mixture		-	-	-	-	-	-	6,250	12,500	12,500	12,500
	Sub-total Operating Costs		127,690	28,270	118,150	28,270	118,150	28,270	74,400	85,733	85,733	85,733
Sub-total Input costs			175,440	29,170	119,050	41,670	119,050	29,170	75,300	85,733	85,733	85,733
Income (Before Labor Costs)			-159,440	-13,170	-119,050	-25,670	-103,050	8,330	37,200	64,267	139,267	184,267
Labor costs												
	Irrigate		3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150
	Irrigate		3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150
	Pitting		16,800	-	-	-	-	-	-	-	-	-
	Apply mud & manure		2,730	-	2,730	-	2,730	-	1,470	1,470	1,470	1,470
	Fertilise		1,050	630	-	630	-	630	-	420	420	420
	Weed		3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150
	Other		2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100
	Other		2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100
Sub-total Labor costs			34,230	14,280	16,380	14,280	16,380	14,280	15,120	15,540	15,540	15,540
Income (After Labor Costs)			-193,670	-27,450	-135,430	-39,950	-119,430	-5,950	22,080	48,727	123,727	168,727

PADDY KHARIF CROP MODEL												
YIELDS AND INPUTS					Existing							
(Per ha)					Technology	New Technology						
				Unit	1 to 25	1	2	3	4	5	6	7 to 25
	Yields			kg	5,450	5,450	6,225	7,000	7,000	7,000	7,000	7,000
	By Products											
		Straw and Stalks		kg	8,175	8,175	9,338	10,500	10,500	10,500	10,500	10,500
	Operating											
		Inputs										
			Paddy Seed	kg	73	65	65	65	65	65	65	65
			Nitrogen	kg	130	130	133.3	136.7	140	143.3	146.7	150
			Phosphorous	kg	80	80	83.3	86.7	90	93.3	96.7	100
			Potassium	kg	70	70	73.3	76.7	80	83.3	86.7	90
			Pesticide	kg	4	5	5	5	5	5	5	5
			Fungicide	kg	10	12	12	12	12	12	12	12
			Herbicide	kg	-	0.3	0.3	0.3	0.3	0.3	0.3	0.3
			Contract transplant rice	ha	-	1	1	1	1	1	1	1
			Animal Hire	a. day	20	5	5	5	5	5	5	5
			Tractor Hire	hour	19	30	30	30	30	30	30	30
			Combine Harvester	hour	4	5	5	5	5	5	5	5
			Manure	kg	3,400	5,000	5,000	5,000	5,000	5,000	5,000	5,000
			Irrigation Fee Paddy	kg	1	1	1	1	1	1	1	1
		Labor										
			Land prep	pers d	15	10	10	10	10	10	10	10
			Transplant	pers d	48	48	48	48	48	48	48	48
			Weed	pers d	22	22	22	22	22	22	22	22
			Fertiliser	pers d	8	8	8	8	8	8	8	8
			Pesticide	pers d	12	12	12	12	12	12	12	12
PADDY KHARIF CROP MODEL					Existing							
FINANCIAL BUDGET(In Rupee Per ha)					Technology	New Technology						
					1 to 25	1	2	3	4	5	6	7 to 25
		Revenue										
		Main Production										
			Paddy Rice		76,300	76,300	87,150	98,000	98,000	98,000	98,000	98,000
		By Products										
			Straw and Stalks		7,358	7,358	8,404	9,450	9,450	9,450	9,450	9,450
		Sub-total Revenue			83,658	83,658	95,554	107,450	107,450	107,450	107,450	107,450
		Input costs										
			Paddy Seed		2,628	2,340	2,340	2,340	2,340	2,340	2,340	2,340
			Nitrogen		2,470	2,470	2,533	2,597	2,660	2,723	2,787	2,850
			Phosphorous		3,680	3,680	3,832	3,988	4,140	4,292	4,448	4,600
			Potassium		1,820	1,820	1,906	1,994	2,080	2,166	2,254	2,340
			Pesticide		1,200	1,500	1,500	1,500	1,500	1,500	1,500	1,500
			Fungicide		3,000	3,600	3,600	3,600	3,600	3,600	3,600	3,600
			Herbicide		-	75	75	75	75	75	75	75
			Contract transplant rice		-	3,250	3,250	3,250	3,250	3,250	3,250	3,250
			Animal Hire		6,000	1,500	1,500	1,500	1,500	1,500	1,500	1,500
			Tractor Hire		11,400	18,000	18,000	18,000	18,000	18,000	18,000	18,000
			Combine Harvester		8,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
			Manure		8,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500
			Irrigation Fee Paddy		500	500	500	500	500	500	500	500
		Sub-total Input costs			49,198	61,235	61,535	61,845	62,145	62,445	62,755	63,055
		Income (Before Labor Costs)			34,460	22,423	34,019	45,605	45,305	45,005	44,695	44,395
		Labor costs										
			Land prep		3,150	2,100	2,100	2,100	2,100	2,100	2,100	2,100
			Transplant		10,080	10,080	10,080	10,080	10,080	10,080	10,080	10,080
			Weed		4,620	4,620	4,620	4,620	4,620	4,620	4,620	4,620
			Fertiliser		1,680	1,680	1,680	1,680	1,680	1,680	1,680	1,680
			Pesticide		2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520
		Sub-total Labor costs			22,050	21,000	21,000	21,000	21,000	21,000	21,000	21,000
		Income (After Labor Costs)			12,410	1,423	13,019	24,605	24,305	24,005	23,695	23,395

OTHER KHARIF (MAIZE) CROP MODEL								
YIELDS AND INPUTS(Per ha)					Existing			
					Technology		New Technology	
				Unit	1 to 25	1	2	3 to 25
	Yields			kg	3,500	3,500	3,850	4,200
	Operating							
		Inputs						
			Other grain seed	kg	25	25	25	25
			Nitrogen	kg	100	100	100	100
			Phosphorous	kg	60	60	60	60
			Potassium	kg	20	20	20	20
			Fungicide	kg	1	1	1	1
			Tractor Hire	hour	5	5	5	5
			Irrigation Fee Garden	ha	1	1	1	1
		Labor						
			Land prep	pers d	10	10	10	10
			Pesticide	pers d	2	2	2	2
			Weed	pers d	7	7	7	7
			Irrigate	pers d	2	4	4	4
			Harvest	pers d	15	18	18	18
India								
KIWRMP Gondhi Subproject								
Other Kharif (Maize) Crop Model								
FINANCIAL BUDGET					Existing			
(In Rupee Per ha)					Technology		New Technology	
					1 to 25	1	2	3 to 25
		Revenue			49,000	49,000	53,900	58,800
		Input costs						
			Other grain seed		750	750	750	750
			Nitrogen		1,900	1,900	1,900	1,900
			Phosphorous		2,760	2,760	2,760	2,760
			Potassium		520	520	520	520
			Fungicide		300	300	300	300
			Tractor Hire		3,000	3,000	3,000	3,000
			Irrigation Fee Garden		150	150	150	150
		Sub-total Input costs			9,380	9,380	9,380	9,380
		Income (Before Labor Costs)			39,620	39,620	44,520	49,420
		Labor costs						
			Land prep		2,100	2,100	2,100	2,100
			Pesticide		420	420	420	420
			Weed		1,470	1,470	1,470	1,470
			Irrigate		420	840	840	840
			Harvest		3,150	3,780	3,780	3,780
		Sub-total Labor costs			7,560	8,610	8,610	8,610
		Income (After Labor Costs)			32,060	31,010	35,910	40,810

SRI PADDY KHARIF CROP MODEL

YIELDS AND INPUTS			New
(Per ha)			Technology
		Unit	1 to 25
Yields		kg	8,000
By Products			
Straw and Stalks		kg	12,000
Operating			
Inputs			
Paddy Seed		kg	30
Nitrogen		kg	150
Phosphorous		kg	100
Potassium		kg	70
Fungicide		kg	10
Contract transplant rice		ha	1
Animal Hire		animal day	5
Tractor Hire		hour	20
Combine Harvester		hour	5
Manure		kg	2,000
Irrigation Fee Paddy		kg	1
Labor			
Land prep		person-day	10
Transplant		person-day	48
Weed		person-day	22
Fertiliser		person-day	8
Pesticide		person-day	12
India			
KIWRMP Gondhi Subproject			
SRI Paddy Kharif Crop Model			
FINANCIAL BUDGET			New
(In Rupee Per ha) /a			Technology
			1 to 25
Revenue			
Main Production			
Paddy Rice			112,000
By Products			
Straw and Stalks			10,800
Sub-total Revenue			122,800
Input costs			
Paddy Seed			1,080
Nitrogen			2,850
Phosphorous			4,600
Potassium			1,820
Fungicide			3,000
Contract transplant rice			3,250
Animal Hire			1,500
Tractor Hire			12,000
Combine Harvester			10,000
Manure			5,000
Irrigation Fee Paddy			500
Sub-total Input costs			45,600
Income (Before Labor Costs)			77,200
Labor costs			
Land prep			2,100
Transplant			10,080
Weed			4,620
Fertiliser			1,680
Pesticide			2,520
Sub-total Labor costs			21,000
Income (After Labor Costs)			56,200

OTHER RABI (MAIZE) CROP MODEL									
YIELDS AND INPUTS						Existing			
(Per ha)						Technology		New Technology	
					Unit	1 to 25	1	2	3 to 25
	Yields				kg	3,500	3,500	3,850	4,200
	Operating								
		Inputs							
			Other grain seed		kg	25	25	25	25
			Nitrogen		kg	100	100	100	100
			Phosphorous		kg	60	60	60	60
			Potassium		kg	20	20	20	20
			Fungicide		kg	1	1	1	1
			Tractor Hire		hour	5	5	5	5
			Irrigation Fee Garden		ha	1	1	1	1
		Labor							
			Land prep		person-day	10	10	10	10
			Pesticide		person-day	2	2	2	2
			Weed		person-day	7	7	7	7
			Irrigate		person-day	2	4	4	4
			Harvest		person-day	15	18	18	18
India									
KIWRMP Gondhi Subproject									
Other Rabi (Maize) Crop Model									
FINANCIAL BUDGET						Existing			
(In Rupee Per ha)						Technology		New Technology	
						1 to 25	1	2	3 to 25
		Revenue				49,000	49,000	53,900	58,800
		Input costs							
			Other grain seed			750	750	750	750
			Nitrogen			1,900	1,900	1,900	1,900
			Phosphorous			2,760	2,760	2,760	2,760
			Potassium			520	520	520	520
			Fungicide			300	300	300	300
			Tractor Hire			3,000	3,000	3,000	3,000
			Irrigation Fee Garden			150	150	150	150
		Sub-total Input costs				9,380	9,380	9,380	9,380
		Income (Before Labor Costs)				39,620	39,620	44,520	49,420
		Labor costs							
			Land prep			2,100	2,100	2,100	2,100
			Pesticide			420	420	420	420
			Weed			1,470	1,470	1,470	1,470
			Irrigate			420	840	840	840
			Harvest			3,150	3,780	3,780	3,780
		Sub-total Labor costs				7,560	8,610	8,610	8,610
		Income (After Labor Costs)				32,060	31,010	35,910	40,810

PADDY RABI CROP MODEL												
YIELDS AND INPUTS			Existing									
(Per ha)			Technology						New Technology			
		Unit	1 to 25	1	2	3	4	5	6	7 to 25		
Yields		kg	5,500	5,500	6,050	6,600	6,600	6,600	6,600	6,600		
By Products												
Straw and Stalks		kg	8,250	8,250	9,075	9,900	9,900	9,900	9,900	9,900		
Operating												
Inputs												
Paddy Seed		kg	75	75	75	75	75	75	75	75		
Nitrogen		kg	175	175	177.5	180	182.5	185	187.5	190		
Phosphorous		kg	75	75	77.5	80	82.5	85	87.5	90		
Potassium		kg	75	75	77.5	80	82.5	85	87.5	90		
Pesticide		kg	14	14	14	14	14	14	14	14		
Herbicide		kg	4	4	4	4	4	4	4	4		
Contract transplant rice		ha	1	1	1	1	1	1	1	1		
Tractor Hire		hour	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5		
Combine Harvester		hour	4	5	5	5	5	5	5	5		
Irrigation Fee Paddy		kg	1	1	1	1	1	1	1	1		
Other costs		ha	1	1	1	1	1	1	1	1		
Labor												
Land prep		person-day	10	10	10	10	10	10	10	10		
Nursery & Transplant		person-day	10	10	10	10	10	10	10	10		
Weed		person-day	25	25	25	25	25	25	25	25		
Irrigate		person-day	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5		
Pesticide		person-day	5	5	5	5	5	5	5	5		
India												
KIWRMP Gondhi Subproject												
Paddy Rabi Crop Model							June - May					
FINANCIAL BUDGET			Existing									
(In Rupee Per ha)			Technology				New Technology					
			1 to 25	1	2	3	4	5	6	7 to 25		
Revenue												
Main Production												
Paddy Rice			77,000	77,000	84,700	92,400	92,400	92,400	92,400	92,400		
By Products												
Straw and Stalks			7,425	7,425	8,168	8,910	8,910	8,910	8,910	8,910		
Sub-total Revenue			84,425	84,425	92,868	101,310	101,310	101,310	101,310	101,310		
Input costs												
Paddy Seed			2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700		
Nitrogen			3,325	3,325	3,373	3,420	3,468	3,515	3,563	3,610		
Phosphorous			3,450	3,450	3,565	3,680	3,795	3,910	4,025	4,140		
Potassium			1,950	1,950	2,015	2,080	2,145	2,210	2,275	2,340		
Pesticide			4,200	4,200	4,200	4,200	4,200	4,200	4,200	4,200		
Herbicide			1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200		
Contract transplant rice			3,250	3,250	3,250	3,250	3,250	3,250	3,250	3,250		
Tractor Hire			4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500		
Combine Harvester			8,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000		
Irrigation Fee Paddy			500	500	500	500	500	500	500	500		
Other costs			5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000		
Sub-total Input costs			38,075	40,075	40,303	40,530	40,758	40,985	41,213	41,440		
Income (Before Labor Costs)			46,350	44,350	52,565	60,780	60,553	60,325	60,098	59,870		
Labor costs												
Land prep			2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100		
Nursery & Transplant			2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100		
Weed			5,250	5,250	5,250	5,250	5,250	5,250	5,250	5,250		
Irrigate			2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625		
Pesticide			1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050		
Sub-total Labor costs			13,125	13,125	13,125	13,125	13,125	13,125	13,125	13,125		
Income (After Labor Costs)			33,225	31,225	39,440	47,655	47,428	47,200	46,973	46,745		

SRI PADDY RABI CROP MODEL			New Technology
YIELDS AND INPUTS (Per ha)		Unit	1 to 25
Yields		kg	7,000
By Products			
Straw and Stalks		kg	8,400
Operating			
Inputs			
Paddy Seed		kg	30
Nitrogen		kg	80
Phosphorous		kg	40
Potassium		kg	40
Fungicide		kg	1
Herbicide		kg	1
Contract transplant rice		ha	1
Animal Hire		An. day	5
Tractor Hire		hour	10
Combine Harvester		hour	5
Manure		kg	1,500
Irrigation Fee Garden		ha	1
Labor			
Land prep		pers. d	14
Nursery		pers. d	10
Land prep		pers. d	12
Transplant		pers. d	45
Weed		pers. d	4
Chemicals		pers. d	15
SRI Paddy Rabi Crop Model			
FINANCIAL BUDGET(In Rupee Per ha)			New Technology
			1 to 25
Revenue			
Main Production			
Paddy Rice			98,000
By Products			
Straw and Stalks			7,560
Sub-total Revenue			105,560
Input costs			
Paddy Seed			1,080
Nitrogen			1,520
Phosphorous			1,840
Potassium			1,040
Fungicide			300
Herbicide			300
Contract transplant rice			3,250
Animal Hire			1,500
Tractor Hire			6,000
Combine Harvester			10,000
Manure			3,750
Irrigation Fee Garden			150
Sub-total Input costs			30,730
Income (Before Labor Costs)			74,830
Labor costs			
Land prep			2,940
Nursery			2,100
Land prep			2,520
Transplant			9,450
Weed			840
Chemicals			3,150
Sub-total Labor costs			21,000
Income (After Labor Costs)			53,830

SCHEME LEVEL AREA, HIGH NEW ARECANUT WITHOUT PROJECT CROP												
CROPPING PATTERNS												
(ha)					Without Project					With Project		
		1	2	3	4	5 to 25	1	2	3	4	5 to 25
Cropping Intensity	Percent	138.04	135.54	128.04	120.54	118.04	138.04	136.72	132.61	128.59	127.17
Cropping Pattern											
Existing Technology											
Arecanut (established)		2,300	2,300	2,300	2,300	2,300	2,300	2,013	1,150	288	-
New Arecanut		-	115	460	805	920	-	-	-	-	-
Sugarcane		550	550	550	550	550	550	481	275	69	-
Other Kharif (Maize)		350	306	175	44	-	350	306	175	44	-
Other Rabi (Maize)		750	656	375	94	-	750	656	375	94	-
Paddy Kharif		1,400	1,329	1,115	901	830	1,400	1,225	700	175	-
Paddy Rabi		1,000	979	915	851	830	1,000	875	500	125	-
Sub-total Existing Technology		6,350	6,235	5,890	5,545	5,430	6,350	5,556	3,175	795	-
New Technology											
Arecanut (established)		-	-	-	-	-	-	288	1,150	2,013	2,300
New Arecanut		-	-	-	-	-	-	63	250	438	500
Sugarcane		-	-	-	-	-	-	69	275	481	550
Other Kharif (Maize)		-	-	-	-	-	-	44	175	306	350
Other Rabi (Maize)		-	-	-	-	-	-	94	375	656	750
Paddy Kharif		-	-	-	-	-	-	56	225	394	450
Paddy Rabi		-	-	-	-	-	-	13	50	88	100
SRI Paddy Kharif		-	-	-	-	-	-	56	225	394	450
SRI Paddy Rabi		-	-	-	-	-	-	50	200	350	400
Sub-total New Technology		-	-	-	-	-	-	733	2,925	5,120	5,850
Total Cropped Area		6,350	6,235	5,890	5,545	5,430	6,350	6,289	6,100	5,915	5,850

SCHEME LEVEL AREA, HIGH NEW ARECANUT WITHOUT PROJECT CROP																									
ECONOMIC BUDGET	Without Project (INR ,000)										With Project (INR, 000)														
(AGGREGATED) (INR, ooo)	1	2	3	4	5	6	7	8	9	10 to 25	1	2	3	4	5	6	7	8	9	10	11	12	13	14 to 25
Main Production																								
Crops	797,218	784,401	739,282	707,411	694,595	712,397	774,497	805,547	867,647	904,907	797,218	791,796	804,236	862,076	873,649	877,966	883,598	893,228	911,615	936,068	961,772	984,128	995,927	998,438
By products	15,953	15,342	13,498	11,653	11,043	11,043	11,043	11,043	11,043	11,043	15,953	15,301	13,594	12,262	11,725	11,725	11,725	11,725	11,725	11,725	11,725	11,725	11,725	11,725
Gross Value Of Production	813,170	799,743	752,780	719,064	705,637	723,439	785,539	816,589	878,689	915,949	813,170	807,097	817,830	874,337	885,374	889,691	895,323	904,953	923,339	947,793	973,497	995,853	1,007,652	1,010,163
Production Cost																								
Investment Costs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Purchased Inputs	427,975	425,638	450,338	411,463	472,701	409,125	436,476	451,293	451,293	451,293	427,975	431,676	436,562	435,391	431,294	431,203	431,921	430,056	427,923	432,239	437,110	438,109	438,109	438,109
Labour	91,504	90,386	87,884	83,642	84,263	82,524	83,220	83,567	83,567	83,567	91,504	91,854	91,673	89,452	86,592	85,600	85,596	85,529	85,456	85,551	85,669	85,693	85,693	85,693
Sub-Total Production Cost	519,480	516,118	538,594	504,813	557,709	492,395	520,441	534,860	534,860	534,860	519,480	526,521	537,163	533,971	521,893	519,312	520,037	516,687	513,733	517,993	522,830	523,801	523,801	523,801
Cash Flow	293,691	283,626	214,185	214,251	147,928	231,044	265,098	281,729	343,829	381,089	293,691	280,576	280,667	340,367	363,481	370,379	375,286	388,266	409,607	429,800	450,667	472,051	483,850	486,361

SCHEME LEVEL AREA, HIGH NEW ARECANUT WITHOUT PROJECT CROP

		Without Project (INR)									
	Unit	1	2	3	4	5	6	7	8	9	10 to 25
PRODUCTION AND INPUTS (Detailed)		June - May									
Main Production											
Sugarcane	kg	46,750,000	46,750,000	46,750,000	46,750,000	46,750,000	46,750,000	46,750,000	46,750,000	46,750,000	46,750,000
Arecanut (contract, on tree, wet)	kg	34,500,000	34,500,000	34,500,000	34,500,000	34,500,000	36,800,000	41,400,000	43,700,000	48,300,000	51,060,000
Paddy Rice	kg	13,130,000	12,627,550	11,109,250	9,590,950	9,088,500	9,088,500	9,088,500	9,088,500	9,088,500	9,088,500
Maize	kg	3,850,000	3,367,000	1,925,000	483,000	-	-	-	-	-	-
Intercrop (banana)	kg	-	460,000	-	3,220,000	3,680,000	-	-	-	-	-
By Products											
Straw and Stalks	kg	19,695,000	18,941,325	16,663,875	14,386,425	13,632,750	13,632,750	13,632,750	13,632,750	13,632,750	13,632,750
Investment											
Arecanut seedling	each	-	6,900	27,600	48,300	55,200	55,200	55,200	-	-	-
Banana set	each	-	-	-	1,006,250	-	-	-	-	-	-
Land Levelling	hour	-	-	-	-	-	-	-	-	-	-
Operating											
Purchased Inputs											
Sugarcane Seed	kg	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000
Paddy Seed	kg	177,200	170,442	150,020	129,598	122,840	122,840	122,840	122,840	122,840	122,840
Other grain seed	kg	27,500	24,050	13,750	3,450	-	-	-	-	-	-
Pesticide	kg	20,150	19,572	17,820	16,068	15,490	15,490	15,490	15,490	15,490	15,490
Fungicide	kg	16,750	15,902	13,350	10,798	9,950	9,950	9,950	9,950	9,950	9,950
Herbicide	kg	4,000	3,916	3,660	3,404	3,320	3,320	3,320	3,320	3,320	3,320
Bordeaux mixture	kg	2,300,000	2,300,000	2,300,000	2,300,000	2,300,000	2,300,000	2,760,000	3,220,000	3,220,000	3,220,000
Manure	kg	38,460,000	38,218,600	48,991,000	36,763,400	59,522,000	36,522,000	48,022,000	48,022,000	48,022,000	48,022,000
Mud with transport	load	28,750	28,750	40,250	28,750	51,750	28,750	40,250	40,250	40,250	40,250
Animal Hire	animal day	37,350	35,930	31,650	27,370	25,950	25,950	25,950	25,950	25,950	25,950
Tractor Hire	hour	96,100	97,353.50	101,097.50	104,841.50	106,095	106,095	106,095	106,095	106,095	106,095
Contract transplant rice	ha	1,000	979	915	851	830	830	830	830	830	830
Combine Harvester	hour	9,600	9,232	8,120	7,008	6,640	6,640	6,640	6,640	6,640	6,640
Contract sugar harvest	Rupee	21,037,500	21,037,500	21,037,500	21,037,500	21,037,500	21,037,500	21,037,500	21,037,500	21,037,500	21,037,500
Irrigation fee Sugarcane	ha	550	550	550	550	550	550	550	550	550	550
Irrigation Fee Garden	ha	3,400	3,377	3,310	3,243	3,220	3,220	3,220	3,220	3,220	3,220
Irrigation Fee Paddy	kg	2,400	2,308	2,030	1,752	1,660	1,660	1,660	1,660	1,660	1,660
Nitrogen	kg	1,023,000	1,015,845	916,075	972,705	809,150	965,550	809,150	887,350	887,350	887,350
Phosphorous	kg	512,500	504,440	450,325	456,010	388,150	447,950	388,150	418,510	418,510	418,510
Potassium	kg	755,000	762,945	717,675	810,405	680,350	818,350	680,350	749,350	749,350	749,350
Other costs	ha	1,000	979	915	851	830	830	830	830	830	830
Labor											
May to July Labour	person-day	133,400	129,657	124,325	107,033	115,250	103,290	109,730	109,730	109,730	109,730
Aug to Oct Labour	person-day	128,700	125,975.50	117,717.50	109,459.50	106,735	106,735	106,735	106,735	106,735	106,735
Nov to Jan Labour	person-day	54,300	54,369	54,600	54,831	54,900	54,900	54,900	54,900	54,900	54,900
Feb to April Labour	person-day	167,750	168,233	168,350	171,227	168,950	171,710	168,950	170,790	170,790	170,790

SCHEME LEVEL AREA, HIGH NEW ARECANUT WITHOUT PROJECT CROP

PRODUCTION AND INPUTS (Detailed)			With Project (June – May) (NR,000)													
Main Production	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14 to 25
Sugarcane	kg	46,750,000	46,750,000	46,979,075	48,353,173	50,875,000	53,166,850	54,541,850	55,000,000	55,000,000	55,000,000	55,000,000	55,000,000	55,000,000	55,000,000
Arecanut	kg	34,500,000	34,515,000	36,225,000	40,554,000	41,400,000	41,400,000	41,557,500	42,340,000	43,902,500	45,780,000	47,684,000	49,340,000	50,214,000	50,400,000
Paddy Rice	kg	13,130,000	12,663,450	11,468,125	10,582,050	10,210,000	10,210,000	10,210,000	10,210,000	10,210,000	10,210,000	10,210,000	10,210,000	10,210,000	10,210,000
Maize	kg	3,850,000	3,850,000	4,042,500	4,523,400	4,620,000	4,620,000	4,620,000	4,620,000	4,620,000	4,620,000	4,620,000	4,620,000	4,620,000	4,620,000
Intercrop (banana)	kg	-	252,000	1,000,000	1,500,000	1,252,000	1,248,000	1,500,000	1,000,000	248,000	-	-	-	-	-
Straw and Stalks	kg	19,695,000	18,890,175	16,782,300	15,138,075	14,475,000	14,475,000	14,475,000	14,475,000	14,475,000	14,475,000	14,475,000	14,475,000	14,475,000	14,475,000
Investment															
Arecanut seedling	each	-	85,050	256,230	268,800	109,980	30,000	30,000	30,000	26,220	15,000	3,720	-	-	-
Banana set	each	-	78,750	233,750	235,000	156,250	233,750	235,000	77,500	-	-	-	-	-	-
Land Levelling	hour	-	1,575	4,675	4,700	1,550	-	-	-	-	-	-	-	-	-
Operating															
Purchased Inputs															
Sugarcane Seed	kg	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000	2,750,000
Paddy Seed	kg	177,200	162,845	119,725	76,680	62,250	62,250	62,250	62,250	62,250	62,250	62,250	62,250	62,250	62,250
Other grain seed	kg	27,500	27,500	27,500	27,500	27,500	27,500	27,500	27,500	27,500	27,500	27,500	27,500	27,500	27,500
Pesticide	kg	20,150	18,210.30	12,367.50	6,538.70	4,585	4,585	4,585	4,585	4,585	4,585	4,585	4,585	4,585	4,585
Fungicide	kg	16,750	16,282	14,900	13,518	13,050	13,050	13,050	13,050	13,050	13,050	13,050	13,050	13,050	13,050
Herbicide	kg	4,000	3,650.50	2,593.75	1,541	1,187.50	1,187.50	1,187.50	1,187.50	1,187.50	1,187.50	1,187.50	1,187.50	1,187.50	1,187.50
Bordeaux mixture	kg	2,300,000	2,301,000	2,300,000	2,301,000	2,300,000	2,300,000	2,300,000	2,331,500	2,456,500	2,644,000	2,769,000	2,800,000	2,800,000	2,800,000
Manure	kg	38,460,000	40,126,500	43,455,000	45,308,500	45,325,000	45,375,000	45,325,000	44,587,500	43,775,000	44,575,000	45,350,000	45,350,000	45,350,000	45,350,000
Mud with transport	load	28,750	30,337.50	33,425	35,037.50	34,975	35,025	34,975	34,237.50	33,425	34,225	35,000	35,000	35,000	35,000
Animal Hire	An. day	37,350	34,867	27,425	19,983	17,500	17,500	17,500	17,500	17,500	17,500	17,500	17,500	17,500	17,500
Tractor Hire	hour	96,100	97,389	101,616	106,771.50	109,316	109,750	109,750	109,750	109,750	109,750	109,750	109,750	109,750	109,750
Cont t'plant rice	ha	1,000	1,050	1,200	1,351	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400
Comb Harvester	hour	9,600	9,275	8,300	7,330	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
Cont sugar harv	Rupee	21,037,500	21,037,500	21,140,625	21,759,000	22,893,750	23,925,000	24,543,750	24,750,000	24,750,000	24,750,000	24,750,000	24,750,000	24,750,000	24,750,000
Irrig fee Sugarcane	ha	550	550	550	550	550	550	550	550	550	550	550	550	550	550
Irrig Fee Garden	ha	3,400	3,514	3,850	4,189	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300
Irrig Fee Paddy	kg	2,400	2,225	1,700	1,176	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Nitrogen	kg	1,023,000	1,018,440	1,000,587.50	966,674.80	931,180	918,315	920,435	921,830	916,815	911,290	916,730	922,000	922,000	922,000
Phosphorous	kg	512,500	511,050	505,857.50	495,724.80	484,335	480,670	482,580	484,185	482,299	480,280	482,454	484,500	484,500	484,500
Potassium	kg	755,000	759,700	769,587.50	764,634.80	740,920	729,335	731,415	732,850	728,425	723,550	728,350	733,000	733,000	733,000
Other costs	ha	1,000	888	550	213	100	100	100	100	100	100	100	100	100	100
Labor															
May to July Labour	p-d	133,400	133,130	126,291	108,882	92,597	87,663	87,637	87,285	86,956	87,466	87,900	87,900	87,900	87,900
Aug to Oct Labour	p-d	128,700	121,934	101,575	81,288.50	74,450	74,450	74,450	74,450	74,450	74,450	74,450	74,450	74,450	74,450
Nov to Jan Labour	p-d	54,300	59,310	74,250	89,235	94,200	94,200	94,200	94,200	94,200	94,200	94,200	94,200	94,200	94,200
Feb to April Labour	p-d	167,750	171,628	182,924	193,884	196,913	196,597	196,603	196,597	196,540	196,536	196,726	196,850	196,850	196,850

SCHEME LEVEL AREA, HIGH NEW ARECANUT WITH PROJECT CROP

Production And Inputs (Detailed)

		With Project (INR), June - May													
	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14 to 25
Main Production															
Sugarcane	kg	46750	46750	46979.075	48353.173	50875	53166.85	54541.9	55000	55000	55000	55000	55000	55000	55000
Arecanut (contract, on tree, wet)	kg	34500	34515	36225	40554	41400	41400	41557.5	42340	43903	45780	47684	49340	50214	50400
Paddy Rice	kg	13130	12663.45	11468.125	10582.05	10210	10210	10210	10210	10210	10210	10210	10210	10210	10210
Maize	kg	3850	3850	4042.5	4523.4	4620	4620	4620	4620	4620	4620	4620	4620	4620	4620
Intercrop (banana)	kg	-	252	1000	1500	1252	1248	1500	1000	248	-	-	-	-	-
By Products		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Straw and Stalks	kg	19695	18890.175	16782.3	15138.075	14475	14475	14475	14475	14475	14475	14475	14475	14475	14475
Investment		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arecanut seedling	each	-	85.05	256.23	268.8	109.98	30	30	30	26.22	15	3.72	-	-	-
Banana set	each	-	78.75	233.75	235	156.25	233.75	235	77.5	-	-	-	-	-	-
Land Levelling	hour	-	1.575	4.675	4.7	1.55	-	-	-	-	-	-	-	-	-
Operating		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Purchased Inputs		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sugarcane Seed	kg	2750	2750	2750	2750	2750	2750	2750	2750	2750	2750	2750	2750	2750	2750
Paddy Seed	kg	177.2	162.845	119.725	76.68	62.25	62.25	62.25	62.25	62.25	62.25	62.25	62.25	62.25	62.25
Other grain seed	kg	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5
Pesticide	kg	20.15	18.2103	12.3675	6.5387	4.585	4.585	4.585	4.585	4.585	4.585	4.585	4.585	4.585	4.585
Fungicide	kg	16.75	16.282	14.9	13.518	13.05	13.05	13.05	13.05	13.05	13.05	13.05	13.05	13.05	13.05
Herbicide	kg	4	3.6505	2.59375	1.541	1.1875	1.1875	1.1875	1.188	1.1875	1.1875	1.1875	1.1875	1.1875	1.1875
Bordeaux mixture	kg	2300	2301	2300	2301	2300	2300	2300	2332	2456.5	2644	2769	2800	2800	2800
Manure	kg	38460	40126.5	43455	45308.5	45325	45375	45325	44588	43775	44575	45350	45350	45350	45350
Mud with transport	load	28.75	30.3375	33.425	35.0375	34.975	35.025	34.975	34.24	33.425	34.225	35	35	35	35
Animal Hire	Anim d	37.35	34.867	27.425	19.983	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Tractor Hire	hour	96.1	97.389	101.616	106.7715	109.316	109.75	109.75	109.8	109.75	109.75	109.75	109.75	109.75	109.75
Contract transplant rice	ha	1	1.05	1.2	1.351	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Combine Harvester	hour	9.6	9.275	8.3	7.33	7	7	7	7	7	7	7	7	7	7
Contract sugar harvest	Rupee	21037.5	21037.5	21140.625	21759	22893.75	23925	24543.8	24750	24750	24750	24750	24750	24750	24750
Irrigation fee Sugarcane	ha	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
Irrigation Fee Garden	ha	3.4	3.514	3.85	4.189	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Irrigation Fee Paddy	kg	2.4	2.225	1.7	1.176	1	1	1	1	1	1	1	1	1	1
Nitrogen	kg	1023	1018.44	1000.5875	966.6748	931.18	918.315	920.435	921.8	916.82	911.29	916.73	922	922	922
Phosphorous	kg	512.5	511.05	505.8575	495.7248	484.335	480.67	482.58	484.2	482.3	480.28	482.454	484.5	484.5	484.5
Potassium	kg	755	759.7	769.5875	764.6348	740.92	729.335	731.415	732.9	728.43	723.55	728.35	733	733	733
Other costs	ha	1	0.888	0.55	0.213	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Labor		0	0	0	0	0	0	0	0	0	0	0	0	0	0
May to July Labour	Pers d	133.4	133.13	126.291	108.882	92.597	87.663	87.637	87.29	86.956	87.466	87.9	87.9	87.9	87.9
Aug to Oct Labour	Pers d	128.7	121.934	101.575	81.2885	74.45	74.45	74.45	74.45	74.45	74.45	74.45	74.45	74.45	74.45
Nov to Jan Labour	Pers d	54.3	59.31	74.25	89.235	94.2	94.2	94.2	94.2	94.2	94.2	94.2	94.2	94.2	94.2
Feb to April Labour	Pers d	167.75	171.628	182.924	193.884	196.913	196.597	196.603	196.6	196.54	196.536	196.726	196.85	196.85	196.85

ANNEX 7: CROP WATER REQUIREMENTS AND DESIGN DISCHARGE

1. REFERENCE EVAPOTRANSPIRATION

1. Reference evapotranspiration (ETo) is calculated from climate data using the FAO ETo calculator[17] or the FAO Cropwat program which use the Penman-Montieth formulae which was recommended to be adopted by an expert consultation in 1990. The method overcomes the few shortcomings of the previous FAO Penman method and provides values that are more consistent with actual crop water use data worldwide.

2. IRRIGATION EFFICIENCIES

2. The overall efficiency for an irrigation scheme is built up from the efficiencies of the separate steps in the water distribution and application process. The components normally used[18] are:

2.1 Conveyance Efficiency

3. Conveyance losses comprise seepage losses, operational (management) losses, for example due to mismatch between supply and demand, and evaporation losses. Of these the most significant are seepage and operational losses. Seepage losses are generally predictable and are dependent on canal type (ie lined / unlined), canal condition, soil type and canal fill. Operational losses can be low (ie less than 5%) with good canal management, or high (ie more than 20%) with poor management. Good canal management requires appropriate management institutions and farmer training/ awareness, but is only achieved if appropriate flow control and measurement infrastructure is provided. The term “conveyance” is often applied to the main canal system and an efficiency of 90% can be achieved for a canal with impermeable lining with diligent operation. In this context concrete does not constitute “impermeable” unless it is underlain by an impermeable membrane and any under-drainage is provided to valves that prevent seepage. The cut off statement in the DPR assumes seepage losses of 0.60m³/s/million m² (equivalent to 4.4% of the flow on the right main canal) which is low compared to 1.52 m³/s/million m² indicated as the norm for lined canals in Karnataka on Table 12.3 of *A Guideline for Estimating Irrigation Requirements*.

2.2 Distribution Efficiency

4. Distribution efficiency is applied to the distribution of water between main canal and field. 80% efficiency is considered to be the upper limit of the achievable because, in addition to the potential losses described for conveyance efficiency, excess supply of water to some fields to the detriment of others represents a loss. The expected distribution efficiency for an open channel system under careful operation is therefore 80%.

5. However, it is proposed to pilot, under the project, a gravity-supplied pipe distribution system for which a distribution efficiency of 90% is considered appropriate.

2.3 Application Efficiency

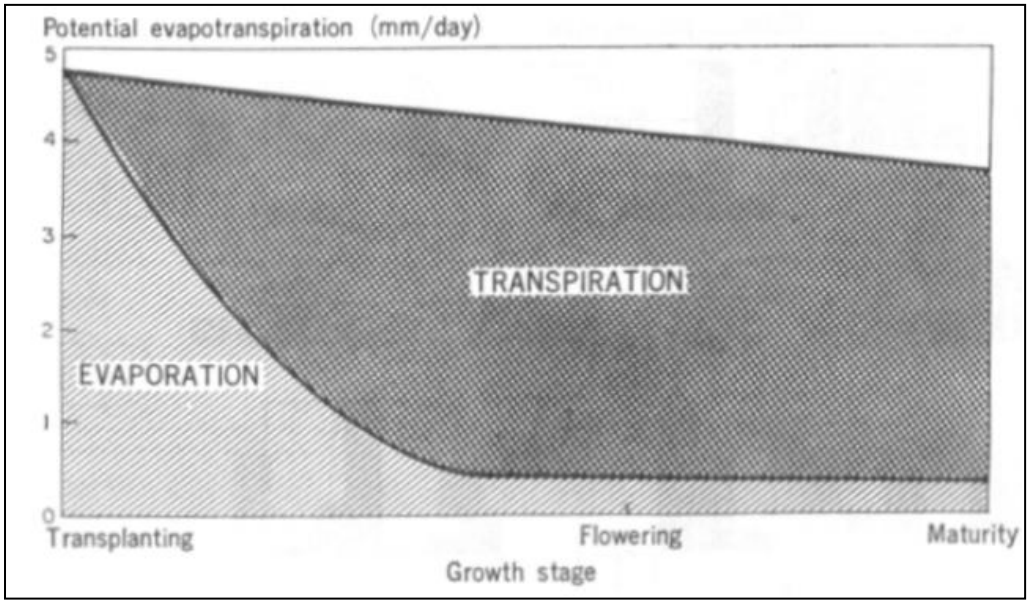
6. Application efficiency relates the water supplied to a field to the water used by the crop and takes account of runoff of excess water, percolation losses and evaporation from soil or open water. The application efficiency for surface irrigation typically ranges from 40% on sandy soils to 70% on clayey soils. However, because efficiencies are calculated based on crop water requirement but paddy is usually grown in flooded basins where the losses (principally percolation, evaporation from open water and run-off) are independent of the crop water requirement. A fixed daily percolation loss is normally used for the period when the field is flooded. However, and generally not included, is the high evaporation loss from

[17] http://www.fao.org/nr/water/eto.html

[18] http://content.alterra.wur.nl/Internet/webdocs/ilri-publicaties/publicaties/Pub19/pub19.pdf

open water which reduces as the crop canopy increases (see **Figure**1). This can be modelled making the crop coefficient high once the field is planted.

Figure 1: Evaporation / Evapotranspiration from a Paddy Field



From: A simple evapotranspiration model of a paddy field in tropical Asia. Shouichi Yoshida, International Rice Research Institute, Los Baños, Laguna, Philippines 1978

7. Application efficiency will depend on both irrigation type and soil conditions: For flooded paddy and for non-flooded crops. The following values are proposed[19]:

(i) For flooded paddy: 85% efficiency + separate percolation loss (4mm/day on black cotton clay and 6mm/day on red soils)

(ii) For non-flooded crops on black cotton clay: 75%

(iii) For non-flooded crops on red soils: 65%

(iv) Tree crops with basins: 70%

2.4 Overall Efficiency

8. The overall efficiency for three cropping conditions using canal distribution are:

(i) Flooded paddy 90% x 80% x 85% = 61.2% (+ percolation loss)

(ii) Non-flooded crops on black cotton soil = 90% x 80% x 75% = 54%

(iii) For non-flooded crops on red soils: = 90% x 80% x 65% = 46.8%

9. If a piped distribution below the outlet is used then the corresponding overall efficiencies become:

(i) Flooded paddy 90% x 90% x 85% = 68.9% (+ percolation loss)

(ii) Non-flooded crops on black cotton soil = 90% x 90% x 75% = 60.8%

(iii) For non-flooded crops on red soils: = 90% x 90% x 65% = 52.7%

10. This represents about a 6% improvement in the system efficiency provided by the piped system.

[19] Based on the Detailed Project Report of Modernisation of Canal system of Bhadra Reservoir Project 2007.

3. CROP WATER REQUIREMENTS

3.1 Agro-climatic data

11. In the absence of a representative time-series of local climatic data for use in calculation of the reference evapotranspiration, ETo, the values for the agro-climatic zone VII have been used. These values are compared in Table 1 with the nearest stations in the FAO CLIMWAT database.

Table1: Reference Evapotranspiration

	Agro-climatic Zone 7	Bellary	Chitradurga	Gadag
Altitude		449	733	650
	mm/day			
Jan	3.5	3.7	4.22	4.01
Feb	4.21	4.52	4.83	4.72
Mar	4.93	5.33	5.72	5.59
Apr	5.09	6.36	5.85	6.07
May	4.67	6.97	5.95	6.07
Jun	420	5.56	4.74	4.85
Jul	3.07	4.7	3.78	4.09
Aug	3.15	4.48	3.91	4.09
Sep	3.36	4.57	4.05	4.13
Oct	3.18	4.19	3.92	4.12
Nov	3.29	3.74	3.71	3.98
Dec	2.97	3.5	3.84	3.8

12. It can be seen that the values for agro-climatic zone 7 are lower than the reference stations but this is considered plausible because of Zone 7's proximity to the Western Ghats with higher cloud cover. However, it would be extremely beneficial to verify this using climatic data from the Bhadra-Shivamogga area because errors in assumed climate data result in corresponding errors in the computed water requirements.

13. Rainfall is calculated using the average of four nearby rainfall stations presented in the DPR and ranked to give a 75% dependable (ie excluding the 3 lowest values out of 11 data). While a succession of 75% dependable rainfall months is statistically less probable, below-average rainfall is usually accompanied by above-average sunshine and temperatures which will significantly increased evapotranspiration but is not built into the calculations.

3.2 Crop Factors

14. Crop water requirements are calculated using crop factors multiplied by the reference evapotranspiration, ETo. The crop factors used for most crops as given in the DPR are consistent with the FAO guidelines21 and are used for this analysis. However, requirements for two crops, arecanut and SRI paddy have been given further consideration as described below.

3.3 Arecanut

15. There are several specialist publications about arecanut which give estimated water requirements. One feature is that the water requirements increase over the first 5 years of growth as shown in Table 2. However, with the productive life of the trees extending to about

[20] Interpolated - data not given in reference

[21] Irrigation and Drainage Paper No. 56. http://www.fao.org/docrep/X0490E/X0490E00.htm

25 years, the full water requirement is assumed in the calculations. The normal planting density of arecanut is a 2.7m grid, representing 1370 trees per hectare. A water requirement of 40 litres per tree per day represents 54.89 m³/ha/day or 5.49 mm/day. This is assumed to be a gross application at about 70% application efficiency which represents a plausible crop coefficient of 0.82 if the ETo is 4.67mm/day. A constant crop coefficient of 0.80 is assumed for the calculation of water requirements.

16. Arecanut is vulnerable to yield reductions if stressed due to insufficient water. One reference[22] states:

"Arecanut cannot withstand drought for a long time. Being a perennial crop, once affected by water stress, it may require two-three years to regain the normal vigour and yield. The death of palms due to moisture stress is also not uncommon. Irrigation intervals of 5 and 10 days were found superior throughout the season."

Table 2 : Irrigation Requirements of Arecanut

Water Requirement of Arecanut (l/day/ palm) (spacing 2.7 m x 2.7 m)					
Months	I Year	II Year	III Year	IV Year	V Year onwards
July	6	8	11	14	18
August	7	10	14	18	22
September	8	12	17	20	25
October	9	13	18	23	28
November	9	12	17	20	28
December	10	13	18	24	30
January	9	12	17	24	27
February	10	14	20	26	30
March	12	16	22	28	34
April	12	16	22	28	34
May	14	18	24	30	40
June	10	14	20	26	32

Source: Arecanut Cultivation Under Micro Irrigation[23]

17. Arecanut also requires good drainage without waterlogging:

"Adequate drainage should also be provided during monsoon since the palms are unable to withstand water logging. Drainage channels should be 25 to 30 cm deeper than the bottom of the pits to drain the excess water from plot."[24]

3.4 SRI Paddy

18. SRI paddy comprises a package of practices for both cultivation and irrigation practice. A key difference from normal paddy is that the fields are not kept continuously flooded. The technique can provide both increased yields and reduced water requirements if

[22] http://srinidhifarm.com/tips_arecanut.php

[23] http://www.indg.in/agriculture/crop_production_techniques/arecanut-micro-irrigation.pdf

[24] http://www.inseda.org/Additional_material/CD_-_Agriculture_and_Environment_Education/59-Plantation Crops (PLCS)/Arecanut-237.doc

the full package of practices is implemented but can also increase yields but introduction of the agronomics practices alone. One reference[25] gives the following advice:

SRI does not require any purchases or credit, although its results are significantly enhanced by having access to and using implements that aerate the soil at the same time that that they control weeds.

> *Water Control: The main requirement for SRI success is a sufficient degree of water control, to be able to apply small amounts of water regularly and reliably, or to be able to flood the field and then drain it after a few days, being sure to be able to re-flood it after a few more days. In some places, farmers' access to water is too unreliable for them to be willing to operate with 'a minimum of water,' as Fr. de Laulanié recommended. Or they are cultivating where there is continuous inundation of fields from rainfall, such as in monsoon climates where there is poor general drainage. Or they may have low-lying fields and very heavy clay soils, so that it is difficult or impossible to evacuate the water and the fields are perpetually saturated. With saturated soil conditions (anaerobic or hypoxic), there will be less than the maximum benefit from SRI practices.*

19. Following from the preceding review of requirements, the main limitations for SRI use will be:

> *Water Supply and Control: While SRI reduces water requirements, no plants can grow without water. So some supply of reliable water is needed. Also, there should be some means of draining off excess water, so that soil remains mostly aerobic, with a good supply of oxygen. Where no water is available, SRI is not possible. Where there is no control over water supply, or no drainage facilities if water is abundant, SRI would not be recommended.*

20. The SRI irrigation practice provides two ways for reducing water consumption:

(i) Reduction in ponded water gives a corresponding reduction in the direct evaporation of water from the fields which is a substantial loss during the growth stage (see Figure 1) but reduces as the crop cover increases.

(ii) The soil being no longer permanently saturated then the percolation losses are much reduced.

21. It is reported that SRI alternative water management methods can reduce water consumption by 25-50% compared to continuously flooded paddy fields[26]. It is assumed for calculation of impact on crop water requirements that adoption of SRI at Gondhi would provide water savings at the lower end of this range. Experience elsewhere is that improvement in paddy water management can only be achieved by adoption by a group of adjacent farmers: One farmer will not be able to implement it if surrounding fields are flooded.

22. For the purposes of estimating scheme water requirements the differences in assumptions for crop water requirements between normal (flooded) and SRI paddy are summarised in Table 3.

[25] http://sri.ciifad.cornell.edu/aboutsri/FAQs.html#whatarethereequirements
[26] http://sri.ciifad.cornell.edu/aboutsri/FAQs.html#howdoessricompare

Table 3: Crop Water Requirements for Normal (flooded) and SRI Paddy

	Crop Coefficient (Kc)									Percolation loss (mm/day)	Application Efficiency
Period (half month)	I	II	III	IV	V	VI	VII	VII	VIII		
Flooded paddy	1.1	1.1	1.05	1.05	1.05	1.05	1.05	0.95	0.95	4	85%
SRI paddy	1.1	0.55	0.8	1	1.05	1.05	1.05	0.95	0.7	1	70%

Note: Growth period I is for the nursery (assumed to be 10% of the area)

23. It should be appreciated that while SRI water management can have a major impact on the gross water requirement of paddy, the only impact on the net requirement is the reduction in evaporation loss from open water. The other losses (percolation and runoff) are available for re-use elsewhere in the system.

24. The application efficiency of paddy appears high because the percolation loss from flooded fields (which is independent of the actual crop water requirement) is calculated separately. If the percolation loss for paddy is included in the application efficiency then, over the whole cropping season, the weighted application efficiencies for paddy would become:

- Flooded paddy : Kharif season 34%; Rabi season 50%
- SRI paddy : Kharif season 40%; Rabi season 57%

25. The higher apparent efficiencies in the rabi season are because the percolation loss is a lower proportion of the crop water requirement while the lower efficiency in the normal kharif season may not be a major concern if there is rainfall that would otherwise run off. However, it is a problem during any dry periods within the kharif season.

4. SCHEME WATER REQUIREMENTS

4.1 Method of Calculation

26. Scheme water requirements have been computed for a range of possible cropping options. The current cropping pattern was determined by assessment of the land use as shown on Google Earth[27] at over 500 points on a regular grid covering the gross command area. This evaluation is broadly in line with a household survey covering 100 households and both show a pronounced difference from the cropping pattern indicated by CADA. The main difference is in the area of arecanut which has expanded considerably in recent years (the smaller trees can be easily identified on the Google Earth imagery). The possible future cropping patterns consider two scenarios: (a) further expansion of arecanut at the expense of paddy; and (b) partial change of the paddy area to SRI paddy.

27. Water requirements are calculated separately for a unit area of each crop so that the results can be combined for different cropping patterns to be able to see their impact on flows and overall water requirements. The water requirements for different crops assume the cropping timetable given in Table 4.

Table 4: Assumed Crop Timetable

Crop name	Planting	Harvest
Arecanut (includes other tree crops)	Perennial crop	
Banana	Perennial crop	
Dry (non-paddy grains and pulses) kharif	July II*	November I
Dry (non-paddy grains and pulses) rabi	January I	April II
Paddy kharif	July II*	November II
Paddy kharif SRI	July II*	November II
Paddy rabi	Jan I	May I
Paddy rabi SRI	Jan I	May I
Sugarcane	Perennial crop	

[27] www.earth.google.com

*The start of the kharif cropping depends on the start of the monsoon season where rainfall both directly and indirectly provides the water. The timing of the rabi cropping is also influenced by this.

28. Rainfall is allowed for the calculation of net crop water requirements with the assumption that 70% of the dependable rainfall is effective. Rain can be ineffective for several reasons including (i) light rainfall can evaporate before reaching the root zone and (ii) rainfall on saturated soil or flooded fields can run off (this can mitigated for flooded paddy by deliberately keeping basins part full but is incompatible with the normal field-to-field irrigation practice).

29. Tables showing the unit water requirements for each crop are in Annex 7 and water consumption per unit area of crop is summarised in Table 5.

Table 5: Water Consumption per Hectare of Crop

Crop name	Diversion at headworks	Water consumed
	m³/ha	m³/ha
Arecanut (includes other tree crops)	14,491	7,303
Banana	22,119	11,148
Dry (non-paddy grains and pulses) kharif	3,490	1,634
Dry (non-paddy grains and pulses) rabi	8,604	4,646
Paddy kharif	18,328	6,131
Paddy kharif SRI	13,838	5,877
Paddy rabi	20,741	7,699
Paddy rabi SRI	16,628	7,310
Sugarcane	19,796	10,690

4.2 Scheme Water Requirement

30. Scheme water requirements have been calculated for 3 scenarios:

(i) The existing cropping pattern based on evaluation of satellite imagery but with the improved efficiencies anticipated under the project

(ii) A 500 ha increase in arecanut with corresponding decrease in paddy plus partial adoption of SRI paddy production and a reduction in the rabi paddy area

(iii) No increase in the current area of arecanut and the cultivation of semi-dry crops instead of paddy,

Table 6: Water Requirements for Selected Cropping Patterns

	Current Cropping Pattern			Future Cropping Pattern			No Paddy Cropping		
	Area	Peak Flow	Water Vol	Area	Peak Flow	Water Vol	Area	Peak Flow	Water Vol
Crop	ha	m³/s	Mm³	ha	m³/s	Mm³	ha	m³/s	Mm³
Arecanut	2,300	2.083	33.33	2,800	2.536	40.57	2,300	2.083	33.33
Semi-dry Kharif	350	0.239	1.22	350	0.239	1.22	1,750	1.193	6.11
Semi-dry Rabi	750	0.951	6.45	750	0.951	6.45	1,750	2.219	15.06
Paddy Kharif	1,400	3.011	21.01	450	0.968	6.75	0	0.000	0.00
Paddy Kharif SRI	0	0.000	0.00	450	0.767	4.46	0	0.000	0.00
Paddy Rabi	1,000	2.774	20.13	100	0.277	2.01	0	0.000	0.00
Paddy Rabi SRI	0	0.000	0.00	400	0.975	6.36	0	0.000	0.00
Sugarcane	550	0.668	10.89	550	0.668	10.89	550	0.668	10.89
Total area	6,350	5.801	87.36	5,850	4.896	72.11	6,350	4.971	59.70

31. It can be seen that the gross water requirement (at the headworks) is 87.4 Mm³ for current cropping pattern and reduces to 72.1 Mm³ for the assumed future cropping pattern. Cessation of paddy cultivation would reduce the gross water requirement to 59.7 Mm³. The net water requirements will be less than this because of return flows. These water

requirements exclude the demands of the perennial crops during the canal closure periods (assumed to be June and December). These demands would need to be satisfied by either stored surface water or groundwater or pumping from the river.

32. Table 6 also shows the maximum flows for each cropping scenario. The peak flows occur in the period January - March. The peak requirement for the current cropping pattern is about 5.8 m^3/s in early February while the peak requirement for the future scenarios is just below 5 m^3/s during March.

5. COMMAND AREA WATER BALANCE

33. Only about 50% of the water supplied to the area is directly consumed by the crops. The balance of the flow is either (i) evaporated from canals and fields; (ii) runs off to the drainage system or (iii) percolates to recharge groundwater.

34. Water other than the evaporation losses is available for reuse, either within the scheme or elsewhere in the river basin. An estimated water balance for the command area is presented in Table 7. The key components of this table are:

(i) Total diversion: The gross amount of water diverted at the anicut.

(ii) Crop water consumption: The evapotranspiration requirements of the crops within the 4,600 CCA.

(iii) Water for non-irrigated land: Allowance for evapotranspiration from land not directly irrigated from the canal system (eg trees and other vegetation, crops indirectly irrigated from drainage water or ground water). Satellite imagery shows extensive vegetation cover.

(iv) Allow for other evaporation: An estimate of the evaporative losses from canals, fields and bare soil

(v) Closure water requirement: The water needed for the perennial crops during the periods when the canals are closed.

(vi) Return flow: The water which runs off from the scheme, either directly or through groundwater transfer. It is the inflow (i) less the other consumptive uses ((ii) to (v).

(vii) Scheme water consumption: This is the sum of uses (ii) to (v).

Table 7: Command Area Water Balance

	Current Cropping		Future Pattern		Reduced Water	
	Mm^3	TMC	Mm^3	TMC	Mm^3	TMC
Total diversion =	87.361	3.085	72.109	2.546	59.702	2.108
Crop water consumption	44.030	1.555	36.343	1.283	30.090	1.063
Assume water for non-irrigated land =	10.000	0.353	10.000	0.353	10.000	0.353
Allow for other evaporation	7.500	0.265	7.500	0.265	7.500	0.265
Closure water requirement	5.679	0.201	6.609	0.233	5.679	0.201
Return flow =	20.152	0.712	11.657	0.412	6.433	0.227
Scheme area water consumption =	67.209	2.373	60.451	2.135	53.269	1.881
Saving from current cropping pattern			6.757	0.239	13.940	0.492

35. It can be seen that the return flow is around 23% of the inflow for the current cropping pattern but anticipated future changes to cropping patterns with lower gross demands will result in reduced return flows between 10% and 15% as a result of other consumptive demands for water, which remain constant, using a larger proportion of the reduced irrigation losses.

36. The above calculation does not, however, take rainfall into account except where it is used to meet crop water requirements. Rainfall above that amount would supplement the return flows.

6. CONJUNCTIVE USE

37. Conjunctive use, utilising pumped groundwater or surface water stored within the project area, can improve project water use efficiency by reusing water that would otherwise return to the wider system. Conjunctive use can also reduce the peak demand on the canal system by temporarily using supplementary supplies from other sources and also provides a reserve supply during system closures.

38. The closure water requirement listed in Table 7**Error! Reference source not found.** would have to come from conjunctive sources. The value in that table is based on the demand requirement. There is currently, however, insufficient data to indicate that amount of water can be supplied.

7. CONCLUSIONS

39. This analysis indicates a design flow of about 5.5 m^3/s is required for the current cropping pattern, dropping to about 5 m^3/s if anticipated further increases in arecanut production and/ or transition of paddy production to SRI occur. This flow is significantly in excess of the design discharge of 4.15 m^3/s proposed in the DPR and would necessitate excessive encroachment on the freeboard.

40. The analysis, however, does not take account of any return flows from the Bhadra system which drain into the Gondhi area. While these flows are expected to substantially reduce, it is unlikely that they will cease completely while irrigation occurs. However, such return flows are variable. They will tend to be excessive when rainfall occurs and insufficient at times of high demand such as during land preparation.

41. Optimisation of irrigation efficiency and agricultural production in Gondhi also depends on improving the reliability of irrigation supply so that farmers do not tend to over-irrigate because they do not know when water will next be available. This will require more proactive management of river releases from Bhadra dam to supplement river flows as needed to ensure that the required flows are available for diversion at Gondhi anicut.

ANNEX 8: GONDHI IRRIGATION SYSTEM: USE OF PRECAST CONCRETE

1 INTRODUCTION

1. Precast concrete is being used to an increasing extent in the construction industry and is facilitated by the expanding availability of suitable lifting equipment. Precasting is particularly attractive where there many identical units to be produced.

2. It is anticipated that implementation of the modernisation of the Gondhi irrigation system without significantly affecting agricultural activities will be challenging due to the relatively short closure periods that are likely to be acceptable to the farmers, who are accustomed to maintenance closures not exceeding one month.

3. Use of precast concrete is one option for minimising closure periods through advance manufacture of concrete units while reducing the contractors' resource peaks, which represent an additional cost. It is also easier to monitor and control the quality of precast concrete.

2 PRECAST CANAL LINING

4. Proposals for the Gondhi irrigation system include lining of the following small canals with less than 1.2m bed width that have been proposed for hand-placed lining.

- 26km of right main canal
- 14.5km of left main canal
- 34km of distributaries (small canals serving two to four outlets)

5. The use of precast concrete for these canals would increase the speed of construction and avoid the quality and durability problems that frequently occur with hand-placed concrete.

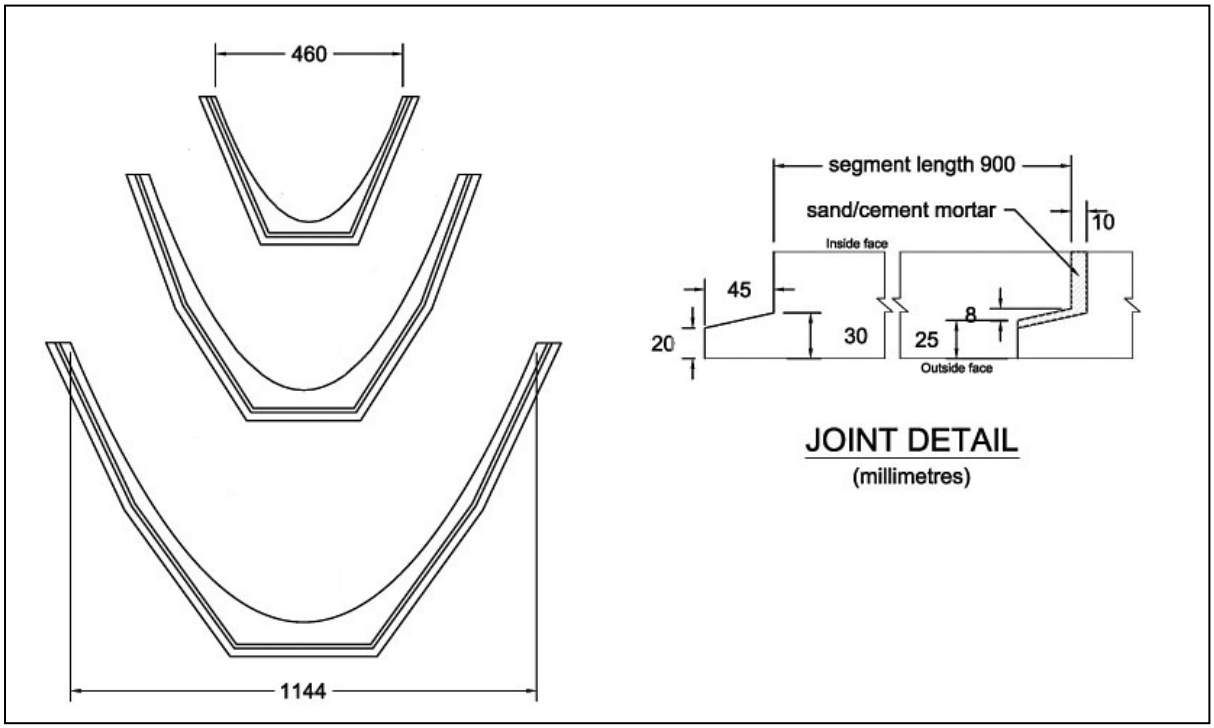
6. Precast concrete canal lining has been previously used in India. One form of construction has been the use of small panels which can be lifted by one or two people. However, this type of construction has been vulnerable to vandalism with the slabs removed for other uses. The other form of construction is complete precast units for smaller canals with parabolic sections preferred for better structural efficiency[28]. This design was used in Banavasi in Karnataka.

Figure 1: Concrete Canal Lining

Missing precast slab	Precast parabolic canal

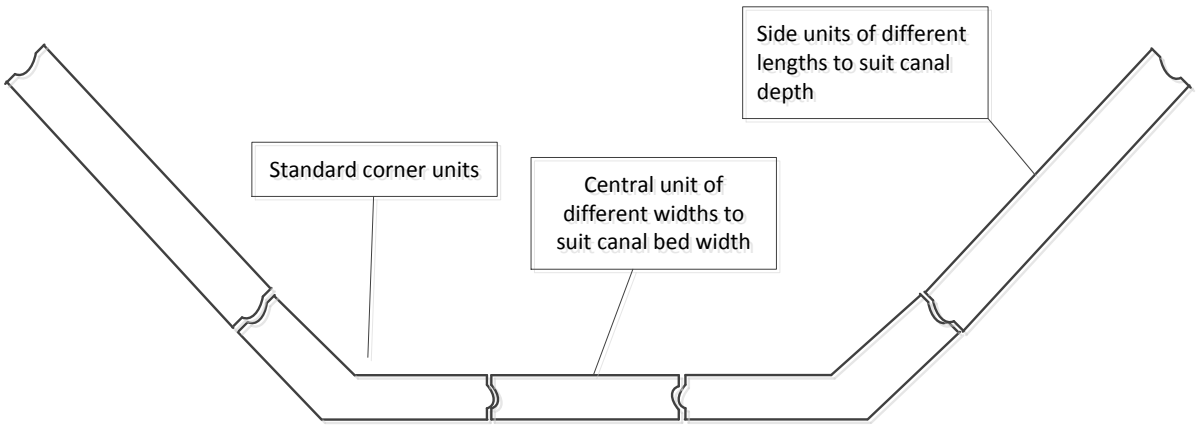
[28] Search http://www.adrianlaycock.com/pictures/thumbnails.php for "precast" for many examples

Figure 2: Construction Details for Parabolic Channel[29]



7. Weight and structural considerations indicated that precast lining for larger canals is best constructed of segments. These can be designed as standard interlocking components that can be placed in different configurations to create channels of different sizes as shown in Figure 3.

Figure 3 : Indicative Interlocking Precast Lining



8. The likely thickness of the units is 75mm to 100mm. If a unit is 100mm thick, 1m long and 0.6m wide then the weight will be about 150 kg. This will be difficult to remove without equipment. In additional, to improve the overall integrity, the panels are interlocking and a cast-in-place capping beam can be provided along the top of each side.

9. Water-tightness can be enabled by either (i) placing compressive filler in the joints as the panels are assembled or (ii) placing the precast units on an impermeable membrane. If

[29] Adapted from http://www.adrianlaycock.com/pictures/displayimage.php?album=search&cat=0&pos=9

pressure relief valves are needed to prevent uplift during sudden drawdown, then these can be placed, after assembly, in holes that are built into the precast units.

10. A further advantage of precast lining using interlocking segments is that the flexibility provides the ability to tolerate modest ground movements without damage. This can simplify construction costs and logistics by avoiding the need for as higher standard of earthworks as is required for lining that is cast in-situ. Mortaring of the joints is therefore not recommended.

11. The disadvantages of precast concrete lining include (i) the need for specialist knowledge, skills and equipment for the mass production of precast units; (ii) the risk of damage during transportation, handling and placement; (iii) increased leakage through the additional joints compared to cast in place lining.

3 PRECAST STRUCTURES

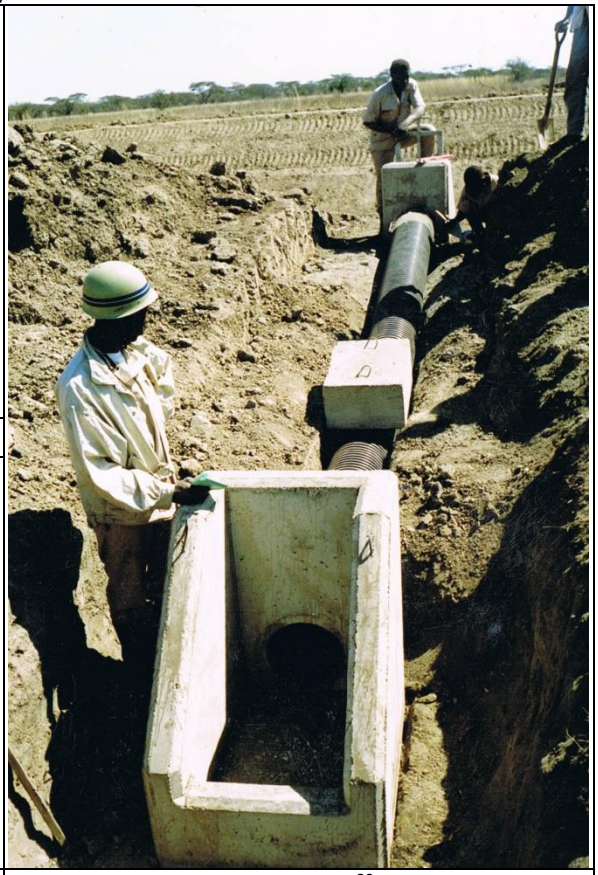
12. Construction in-situ of even a simple irrigation structure can take several weeks. If structures, or structure components, can be precast then the construction period can be shortened. Also, as with lining, it is easier to control the quality of precast concrete than for concrete placed in the field.

13. Constraints on the use of precasting are (i) the need for a significant number of structures of the same or similar size so moulds can be reused with little or no modification; (ii) the structure, or component, is a weight which can be lifted with available equipment and (iii) the shape of the unit is structurally robust.

Figure 4: Precast Structures for Kapunga Rice Project, Tanzania

The casting yard - gate guides were included

Structure after installation



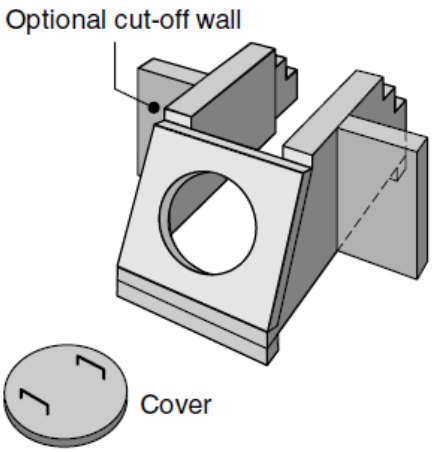
Installation of inlet, pipe[30] and outlet

14. The most numerous type of structure proposed for the works in Gondhi is the outlets with over 100 in total. This provides considerable scope for standardisation. The likely form

[30] Pipes were twin-wall plastic for ease of construction and jointing

of the structure is precast inlets and outlets joined by pipes. For speed of installation, quality of jointing and minimal leakage the use of heavy duty plastic pipes should be considered as part of the precasting work.

Figure 5: Examples of Precast Inlets and Outlets

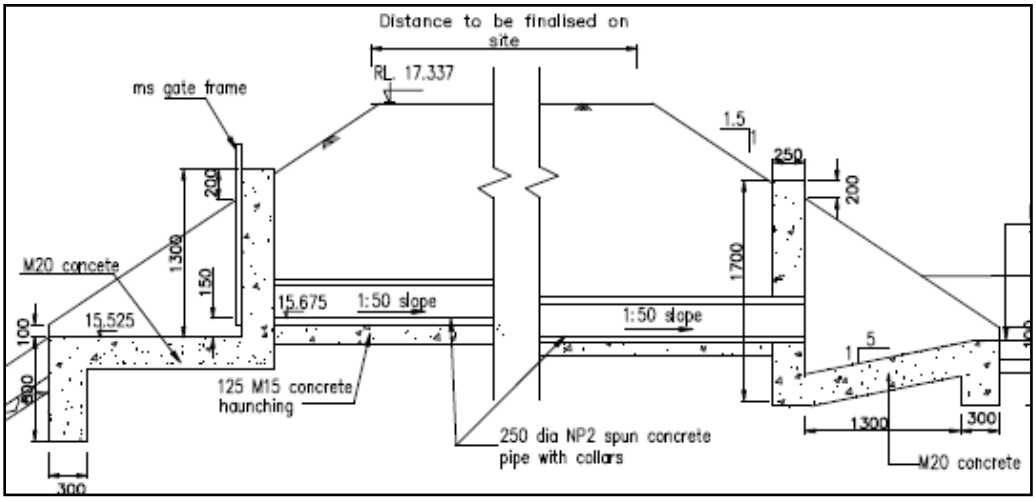


Precast inlet unit[31]

Precast outlet unit[32]

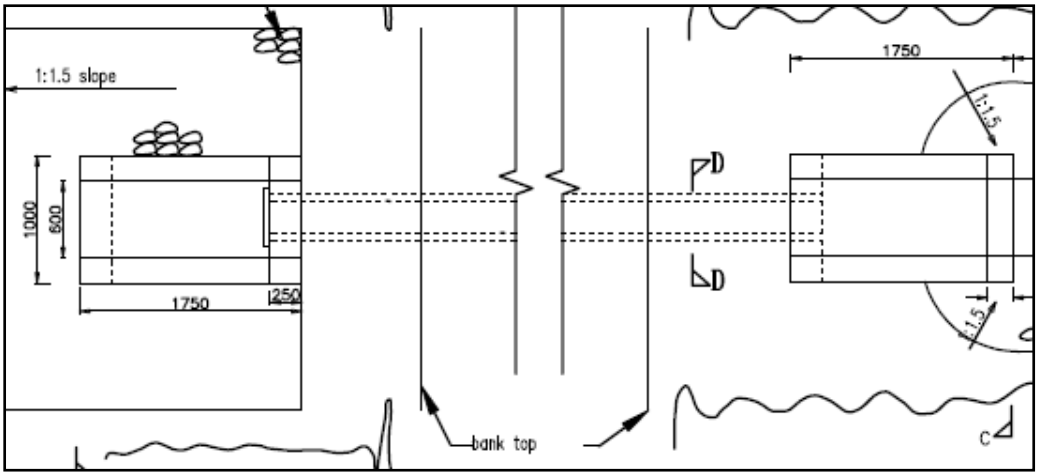
15. Detailed design of suitable precast units will require consideration of suitability for precasting (usually undertaken upside-down for this type of unit) and handling.

Figure 6: Outlet Design Suitable for Modification for Precasting



[31] From: http://www.lboro.ac.uk/well/resources/technical-briefs/42-small-scale-irrigation-design.pdf

[32] From: http://www.lekoprecast.com/products/inlet-outlet/



16. The outline design presented in Figure 6[33] may be suitable for adaptation for pre-casting. The inlet and outlet are both box-shaped for improved strength.

17. Partial precasting of other structures should also be considered, particularly for beams or deck slabs of the various canal crossings for which the supporting props of a cast in-situ need to be removed before a canal can be re-opened.

18. It may be appropriate to prepare indicative designs that are suitable for indicating the type of structure and estimation of cost while leaving the contractor to develop the details. Reinforcement requirements and concrete strength will be governed by fabrication and handling considerations rather than the ultimate requirements once in place.

4 CONSTRUCTION REQUIREMENTS

19. A key requirement for precast concrete is high strength (50N/mm² is recommended) to reduce the risk of breakage in handling. This can be achieved by careful attention to quality during production with a low water content mix, use of vibration (preferably a vibrating table) and proper curing. The use of high strength concrete can avoid the need for reinforcement of the precast units.

20. Production of pre-cast units requires specialist knowledge, skills and equipment (including suitable vibration equipment and, ideally, steam curing for high early strength). Moulds have to be designed and specially fabricated to enable units to be cast and the moulds dismantled without damage, either to themselves or the concrete units. These skills are becoming increasingly available as precast concrete becomes more widespread in different construction sectors.

21. Precast units also require careful handling to avoid damage. It is normal practice to use specially made lifting cradles (to make sure that lifting avoids putting bending loads on the units) with lifting points cast into the precast units.

22. The contractors who are familiar with construction and modernisation of irrigation systems may not have the required expertise in precast concrete and would therefore need to associate with a specialist subcontractor. A requirement to demonstrate experience in precast concrete will need to be written into the bidding documents.

[33] Prepared for the ADB-funded Orissa Integrated Irrigated Agriculture and Water Management Improvement Project

ANNEX 9: CONSTRUCTION SCHEDULE

1. SCOPE OF CONSTRUCTION WORKS

1. The anticipated scope of modernisation works for the Gondhi irrigation system includes:

- Repairs to the Gondhi anicut and canal headworks
- Concrete lining of 74.7km of right main canal, 14.5km of left main canal and 34km of distributaries (small canals serving two to four outlets) and upgrading of canal access roads
- Reconstruction of canal structures including:
  - 12 head sluices for distributaries and 206 outlets
  - 102 cart bridges and 52 pipe culverts
  - 61 drainage inlets
  - 31 relieving weirs and 8 escape sluices
  - 9 main canal drops and 107 distributary drops
  - 89 washing points and cattle ramps
  - Repairs to 3 aqueducts
- Modification of current on-line storage where feasible to become actively managed off-line storage and enhancement of existing off-line tanks for more pro-active management.
- Command area development works over 4,600ha comprising lined channels, low pressure gravity-supplied pipe distribution where technically feasible and drainage where required.
- Provision of electronic flow measurement with telemetry at about 20 locations on the main canal and drainage system and flow measurement with recorders at all outlets.

2. CONSTRUCTION PLANNING

2. It is envisaged that the Gondhi modernisation works will be completed within the 3 year duration of Tranche 1 of the proposed ADB-funded project. Completion all the proposed construction works within this period will be a logistical challenge although it is planned that the works will be at an advanced stage of bidding when the project commences.

3. A further constraint on the implementation of modernisation activities is the avoidance of adverse impacts on agricultural production in an area where more than half of the land is under perennial crops (mainly arecanut and sugarcane). Detailed planning of a feasible implementation schedule should be undertaken before bidding of the works is commenced. Otherwise overruns in both temporary closures and the overall implementation are likely to occur.

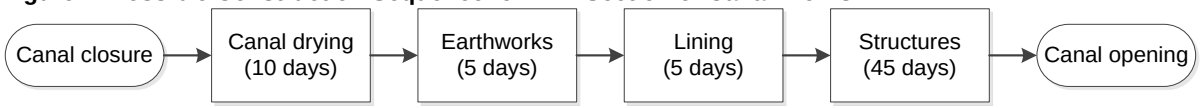
4. Considerations include:

Activity Sequencing and Durations

5. Some construction activities have to be undertaken in sequence. For example, canal lining depends on completion of canal earthworks which depends on the site drying out to be suitable for construction activities.

6. Where slipform lining equipment is used, work on canal structures may be delayed until after the equipment has passed through. Otherwise the lining work is disrupted while the machinery is moved around the structure. An indicative sequence is shown on Figure 1. This aspect needs consideration in the construction scheduling.

Figure 1: Possible Construction Sequence for 1km Section of Canal Works



Canal Closures

7. The timing and duration of temporary closures need to be acceptable to the farmers for minimal impact on agriculture. Normal operation practice is to have closures of up to one month in December and June but these may be shorter if limited work is to be carried out. However, one month is a short period to undertake any construction works given the time required for the channels to dry out. Based on the above analysis, a two month closure duration is likely to be the minimum for productive construction work but is likely to affect crop yields unless farmers have alternative water sources. The most likely timing for a closure is after the rabi season. There is likelihood of some rain in the April-June period although sufficient rainfall to meet crop needs is likely to be disruptive to the progress of construction works.

8. It may be appropriate to provide alternative temporary supplies of irrigation water, such as pumping from the river, if this enables a longer construction period for the modernisation works.

Site Access

9. The canal access road is generally single track. Two small vehicles may be able to pass but trucks will not be able to pass. This will create logistical problems unless one-way traffic movement can be implemented. This may be feasible in many areas utilising the connecting roads between the canal and the road running through the middle of the project area.

Resourcing

10. Subject to the constraint of a minimum duration of sequential activities, the time required to complete the work will depend on the resources used. If, for example, a slipform machine can lay 200m lining per day then 6km can be placed in 30 days or, pro-rata, 4 machines can complete 24km in 30 days. However, this output can be subject to various constraints including (i) down time due to equipment problems; (ii) down time due to changes in channel section; (iii) down time due to adverse weather; and (iv) down time due to moving equipment around structures. Consequently, the overall productivity can be much lower than the potential. Application of more resources will reduce the overall time required but resource peaks tend to add to the cost.

Advance Preparations

11. Construction work can progress more rapidly during a closure if all feasible advance preparations have been made. This include: (a) mobilisation of all required equipment and manpower; (b) stockpiling of materials, ideally close to the work sites; and (c) pre-assembly of components where feasible. Pre-assembly can include pre-casting of concrete units where these will simplify the construction logistics. Precasting of units for bridge deck slabs, for example, will substantially reduce the time between completion of abutments and completion of bridges because the time for hardening of concrete in the deck slabs cast in place is avoided. Refer to a separate note on the use of precast concrete for suggestions.

12. Advance works should also include identification and improvement of access routes including, where feasible, temporary passing places along the canal roads.

3. IMPLEMENTATION SCHEDULE

13. If construction takes place over 30 months then it is likely that the working period will encompass two longer closures (assumed as two months) and two shorter closures (assumed to be one month). Activities during closure periods needs to be focused on specific sections with the objective of completing all work within a section during a closure to avoid the risk of unfinished work having to be redone (for example, if earthworks are undertaken but lining is not completed during a closure then earthworks will likely have to be repeated).

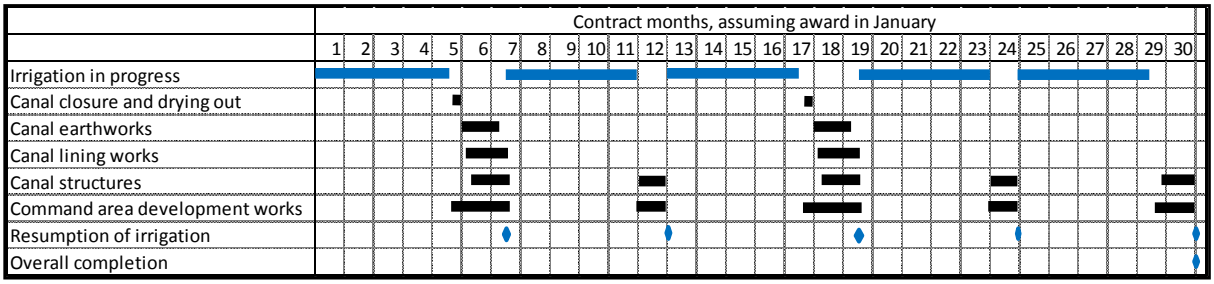
14. The overall division of construction activities could be:

Longer closure periods: Canal earthworks and lining; some canal structures; command area development works.

Shorter closure periods: Canal structures; command area development works.

15. An indicative schedule for a 30 month construction period is shown in Figure 2. This shows two each of long and short closure periods will be available. A further closure period may be available depending on the exact timing of the contract.

Figure 2: Indicative Construction Schedule



16. While, ideally, construction work would progress from upstream to downstream, this is only logistically feasible on the left main canal. The longer right main canal will need to be subdivided into a number of separate sections defined by the overall output of the resources applied during the available construction period.

ANNEX 10: PILOT WUCS STRENGTHENING STUDY IN GONDHI CHANNEL

1. Summary Findings and Recommendations
2. Introduction
3. WUCS Establishment and Administration
4. Water Management
5. Operation and Maintenance
6. Agriculture Development

Prepared by

JalaSpandana - South India Farmers Organisation for Water Management

2012

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SUMMARY FINDINGS AND RECOMMENDATIONS

WUCS as Platform

Although, the conditions of WUCS in terms of engagement in water management and O&M as perceived in the Irrigation Act and the MOU is not to be seen, the CADA has created a platform of WUCS on which the further developments could be initiated. The jurisdiction of Bhadra CADA is too vast and needs further strengthening with adequate man power and technology to cater to the needs of the WUCS. Training and Capacity building elsewhere has not shown any significant changes in on farm and off farm practices including WUCS management. The farming conditions show potential scope for irrigated agriculture improvement. KNNL, CADA, WUCS and Farmers welcome modernization in the wider concept and show strong interest to engage in water management including water distribution at various levels, internal administration, agriculture production, environmental concerns and gender empowerment. The concept of Integrated Water Resources Management (IWRM) including integrating different water bodies like main canal, Gondhi channel, ground water and river is widely accepted and welcomed by the concerned authorities and farmers. Thus, it can be said that the modernization of Gondhi Channel encompassing IWRM components planned and executed effectively could bring in desired results by transforming WUCS as multi functional organization with central attention on water management.

Internal Administration of WUCS

The internal administration of WUCS in terms of book keeping, transparency and accountability through regular General and Governing Body meeting and annual auditing is lagging behind. This is one of the reasons why the membership has not reached 100 per cent even after decadal existence of WUCS. Although, we see some move taken up by the CADA, especially after the visit of PPTA team to Bhadra CADA, to put these items in place, there has not been significant progress in ensuring transparency and accountability.

Water Management

Gondhi Channel to a large extent is dependent on regenerated water from Bhadra main canal. This is because the gondhi channel is in bad shape and cannot carry the water drawn from the annicut till the tail end. Most of the DPOs and Branches do not have shutters and the water flows unutilized in the command area and reaches the river. Farmers do patrolling on the channel during scarcity and there is no On & Off system of water distribution. At secondary and tertiary level farmers distribute water one after another without major conflicts.

The MOU signed between the KNNL and WUCS is only for sake of name and has no practical use. It is evident that the water management appears as business as usual and no changes after the formation of WUCS. There are no measuring devices and no crop water requirement assessment, in other words there is no procurement of water in bulk by WUCS and distribute among them. The purpose of the construction of godown is not serving the real intended objective and is not put to its maximum utilization.

Operation and Maintenance

At present, the O&M is being carried out by KNNL with its non plan budget. The allocation to O&M works include the works like repair, desiltation, jungle cutting, greasing the escapes and annicut shutters and most importantly the payment to the people hired for water regulation during the scarcity. It is said that in the upper reach i.e. under Bhadravathi sub division office, there is only an allocation of Rs 12 lakh during 2011-12 to carry out all the above works in 45 Kms length of the channel.

There are instances, where the Gram Panchayats have taken up 1800 meters of canal cleaning work in 8th Branch to the tune of Rs 50,000/-. Although, the MOU reads that the WUCS could retain money for O&M from the water charges collected as per the specifications, but the WUCS is not in a position to collect, remit and retain the money for O&M.

Agriculture Development

The major crops cultivated under the Gondhi Channel are Arecanut, Sugarcane and Paddy. Farmers are cultivating with their age old practices and many farmers complain that there is lack of extension services. The field situation shows that there exists a potential scope to improve the productivity, crop intensification and diversification (mixed cropping like turmeric, ginger and flower in arecanut). WUCS could play constructive role in agriculture development by providing support services including soil testing and collective action.

Recommendations

General

1. Campaign on modernization and IWRM concept at various levels
2. Organisational Strengthening of CADA and KNNL by technical and man power support
3. Process Documentation of the planning and implementation and the results by external agency
4. Feasibility study for establishing project level WUCS federation for Gondhi

Formation and Internal Administration of WUCS

1. Preparation of Manuals and Guidelines for strengthening of WUCS in the context of Karnataka Irrigation Act and Cooperative Act and IWRM clearly enlisting organisational sustainablility including financial sustainability
2. Draw up action plan for the formation of WUCS with emphasis on community mobilization, canal hydraulics, agriculture development and support system with clear roles and responsibilities of different departments related to WUCS functions.
3. Preparation of Guidelines for Participatory Self Assessment

Water Management

1. Preparation of Guidelines for Water Management on Volumetric Supply, Memorandum of Understanding, Operation and Maintenance by WUCS and Concerned Departments.
2. Constructive approach towards Memorandum of Understanding
3. Convergence Manuals for concerned authorities
4. Installation of Telemetry and partial flumes (Cut throat flumes)
5. Modernisation of main channels and FICs before handing over to WUCS

Operation and Maintenance

1. Standardised Work Book exercise for micro planning and project level planning and implementation (Work Book used by JalaSpandana during field study)
2. Detailed training manual on water rates, water charges assessment, collection and remittance and carry out O&M

Agriculture Development

1. Develop organizational arrangement to plan and implement irrigated agriculture plan

2. Agriculture Plan to carry out Farmers Field School emphasizing on crop intensification, diversification, soil fertility enhancement and support services.
3. Crop based Drip, Sprinkler and Pipe System of irrigation methods plans

2

INTRODUCTION

Profile of Gondhi Channel Project

Gondhi annicut is constructed across Bhadra river at Gondhi village at 11.56 km from Bhadravathi at a latitude of 13°46'N and longitude of 75°41'E. Gondhi annicut is situated at 14.5 km from Bhadra reservoir downstream and started construction in 1916 and completed in 1926 with an estimated cost of Rs. 16 lakhs. The right bank canal of the annicut was commissioned in the year 1926 and completed in 1927 and similarly the left bank canal was commissioned in 1951 and completed in 1953-54.

The project has Gross Command Area of 5060 ha, with the cultivable command area of 4600 ha of which the sanctioned command is 4465 ha. The length of the right bank channel is 74.40 km with 16 distributaries and 130 Direct Pipe Outlets with a discharge of 265 cusecs providing water to 4388 ha. The length of the left bank channel is 14.5 km with a discharge of 20 cusecs (7.5 cumecs) and has 20 Direct Pipe Outlet providing water for 212 ha. Gondhi Channel is designed for two crops i.e. kharif and rabhi season.

Study Area and Methodology

This study was carried out as part of Asian Development Bank assisted TA7954 IND Karnataka Integrated and Sustainable Water Resources Management Project (43253-012). The study was carried out by JalaSpandana- South India Farmers Organisation for Water Management and supported by the TA consultants DHV-India Pvt. Ltd., New Delhi.
The WUCS pilot strengthening study was carried out in two selected WUCSs namely Barandur WUCS and Kagekodamage WUCS out of total nine WUCS in Gondhi Channel. These two WUCS fall in the selection criteria of representing head and middle reach and with and without MOU.

Table 1: WUCS selected for the study

Sl. No.	Name of WUCS	Channel	Reach	Area (ha)	MOU Date
1	Barandur	Right Bank	Head	442.65	
2	Kagekodumagi	Right Bank	Middle	324.74	20-07-2002 & renewed August 2012

The study was carried out eliciting primary and secondary information from the Bhadra CADA, KNNL and the WUCSs. Conversational interviews, participatory observation method including walk through surveys and focused group discussion were carried out intensively to understand the dynamics of water management, agriculture practices, operation and maintenance, WUCS formation and administration, etc. Most importantly the study focused on the identification and assessing the feasibility and scope for improvements under the modernization program in an IWRM approach.

3

WUCS ETABLISHMENT AND ADMINISTRATION

WUCS in Gondhi

The total CCA under Gondhi Channel amounts to 4388 ha according to KNNL Schematic Diagram (4515) ha according to Detailed Project Report. With regard to WUCS, as per the available information from the Bhadra CADA, there are 9 WUCS formed under Gondi

Annicut (all the 9 WUCS are under the Gondi Right Bank Channel and no WUCS has been formed in the Gondhi Left Bank Channel, although, there is an area of 220 ha under it). According to WRD/KNNL, originally 13 WUCS were proposed to be formed under Gondi Annicut (left and right bank), at present only 9 WUCS are formed. The reduction in number of WUCS is due to part of the command area developed into urban settlement, industries and no WUCS in the Left Bank Channel.

Table 2: WUCS formed under Gondhi Annicut Project

Sl. No	Name of WUCS	River Bank	Area Irrigated *	MOU
1	Barandur	Right Bank	510.52	
2	Baballi	Right Bank	491.09	
3	Seegebagi	Right Bank	387.04	
4	Kage Kodumagi	Right Bank	324.73	20-07-2002 / Got renewed on 2012 after the visit of PPTA WUCS consultants
5	Tallikatte	Right Bank	453.44	09-09-2003
6	Hollehonnur	Right Bank	340.08	
7	Dasara Kallahalli	Right Bank	458.82	
8	Nagathi Belagallu	Right Bank	485.82	
9	Koppa-Doddakere	Right Bank	278.87	03-05-2012 / There is confusion among CADA whether this is part of Gondhi Channel or not.

***** *Source: Bhadra CADA, Shimoga*

WUCS Administration

In this section an attempt is made to understand the present administration of WUCS by analyzing the membership pattern, general body meetings, audit, etc also in the context of the training and capacity building. The exercise is to suggest measures for the improvement of the same.

Membership

The process of enhancing membership has not made major improvement in bringing farmer under its jurisdiction to become members. In Barandur WUCS the membership has stood where it started with the 48 members with a sum of Rs 5,406 as share capital deposited in the DCC Bank. These are only A category share holders and there is no contribution from B Category share holders in the WUCS (like CADA and Nigams). Even in WUCS which have entered into MOU, the membership at the end of 2008-09, the membership was 141 which increased to 151 in 2009-10 and 152 in 2010-11 this means to show that over the last four years, the increase in the membership is only 13. The total share capital progress accordingly is raised to Rs 15,400/- which means there is an increase of 0.01 % over the last 4 years.

> *Thus, calls for community mobilization exercise to induce rest of the farmers to seek membership in WUCS and make irrigation everybody's concern.*

General Body Meeting

In Barandur WUCS, there is no General Body since the inception and the reason is that there is no real activity whatsoever carried out the by the WUCS and also no response from

KNNL and CADA to encourage any activity says one of the former Directors of the WUCS. WUCS has not maintained minute book of General Body and Executive Body Meetings. It is found during the discussion that the previous WUCS has not handed over the records to present president. The entire registers are in small plastic carry bag.

Whereas Kagekodamage WUCS is having Annual General Body meeting regularly before the irrigation season to fulfill the requirement of the Cooperatives auditing procedure. As per the minutes book of the General body meeting shows that there were about 65 members participated in the GB of 2011-12. This year the WUCS plan to have its GB meeting on September 24th. The issues discussed in the meeting are the schemes that the CADA have indicated to come up in its jurisdiction. The previous General Body meeting also shows that the discussion on the works to be proposed under NREG program. In 8th branch there is jungle cutting and desiltation of the canal undertaken under NREG program.

Auditing

The auditing of the WUCS is carried out through the registered nominated auditor in each of the taluk. The WUCS have to get their auditing from the designated auditor. The format of the audit report clearly states the income and expenditure, the sources, etc. One of the significant observation in the audit report is the comments given by the auditor on several issues like status of membership and what needs to be done, water charges collection, maintenance of records, etc. Barandur WUCS has only registration certificate and the audited report of 2010 which reads the audit report from the year 1-4-2000 to 31-3-2010. This shows that there is no audit carried out every year.

Works by WUCS

In order for WUCS to carry out works, it appears that there is a rule that it should possess PAN and TIN number. It is reported that the WUCS incur an expenditure of about Rs. 5000/- to get PAN and TIN and the expenses include Form Fee, Auditors fee, PAN Card fee, NSC Bond (Rs 3000/-) and other miscellaneous costs. WUCS need to be trained on the procedure on how to register for PAN and TIN with the assistance of CADA.

Godown Construction

Kagekodamage WUCS has constructed a godown under CADA scheme and the Barandur WUCS has received supporting grant from the CADA for the construction of a Milk Dairy Building. The construction of godown building at Kagekodamage is at the cost of Rs. 4,20,000 of which the farmers contribution is Rs. 60,000 and the CADA grant is of Rs. 3,60,000. The financial assistance of Rs 2,37,000/- was given for construction of building for Barandur Milk Society in 2003. The milk society is making good business, at present it is collecting nearly 1700 liters per day. It was reported that during those period CADA gave financial assitance to Village Seva Sahakara Niyamita (VSSN) and Milk Societies.

Kagekodamage WUCS godown building is at present being used for office purposes. However, the premises could very well be used as a training center, soil sample testing centre, fertilizers and pesticides dealing centre and for storing of nearly 1000 bags of paddy during the slump season when the price is low to enable farmers to sell during period of normal or better price. At present however no plans or linkages have been established for making better use of the godown space. However, it is worth mentioning here that the existence of Barandur WUCS itself is a question mark, as a result, the milk society has rented out the first floor to a studio and a computer shop.

Federation of WUCS at Gondhi Channel

The representatives of WUCS said that in 2002 a brief attempt was made by a few representatives of

the WUCS to form an informal federation of all Gondhi Channel WUCS to engage effectively in water management both at minor and main canal level. This did not materialize as there was no consistent support from CADA and KNNL. The WUCS express that there is a need for establishing such a federation for meaningful water distribution in the Gondhi command area.

Potential to Form WUCS in Left Bank

Gondhi Left Bank has 220 ha command, which is less than the standard area of a WUCS ranging from 350–500 ha. Since, there is no other possibility of incorporating and extending the command area, it is suggested that a WUCS be formed in the left bank for the existing area.

CADA Support to Gondhi WUCS

CADA support to WUCS is only partial and infrequent. While CADA has formed 9 WUCS, enabled 3 of them to even enter into MOU with KNNL and provided financial grant to WUCS for construction of godowns and milk dairy building, it has since not provided further support in terms of trainings and CAD works. There is a need for more systematic support from CADA to the WUCS for their institutional strengthening and effective functioning.

Gender

The mere existence of Barandur WUCS was a question mark. The members despite several efforts have lost faith in the future of the WUCS. However, in the WUCS there was one women member who was found to be interested and knowledgeable on the WUCS affairs. She is at the moment taking lead in rejuvenating the WUCS. In addition to this, the discussion with women farmers in other places do send clear signal that the empowerment program should indeed focus on women in general and already existing women members of the WUCS.

4

WATER MANAGEMENT

Irrigation Supply

The Gondhi annicut has right and left bank channel with a design discharge of 265 cusecs providing water to 4388 ha and 20 cusecs (7.5 cumecs) for 212 ha, respectively. As per the DPR of Gondhi Channel, it has an allocation of 3 TMC of water from the river. It is said that after the modernisation, there would be saving of 0.45 TMC of water. During the discussion, it is learnt that the release to Gondhi from Bhadra Reservoir is not known as an allocation to the Gondhi Project. According to one of the Engineers, the ICC meeting decides how much water should be let into the river to support Gondhi Annicut. In practice, Gondhi channel also receives water from Bhadra main canal only when it is in flowing due to poor water management in Bhadra min canal ayacut. Further, durig water crises, KNNL engineers carry out water regulation in the Bhadra main canal and distributaries, during patroling on the bhadra canal, they lower the shutters of the bhadra distributary outlet and push more water to the tail end water course of the distributaries which brings water to the gondhi channel. In other words, the issue that how much volume of water should be given as river assistance is not clear to the engineers at sub division and also at the farmers' level.

It is seen that the regenerated water and some times water directly flowing from sluices to the field channels and entering nala through the ayacut in bhadra right and left bank canal also feeds into Gondhi channel. The excess water from these canals come to Gondhi as regenerated water due to improper water management in BRBC and BLBC. It is said that some of the farmers after irrigating their plots do not close the shutters and the water flows into natural drains and into Gondhi channel. The distributaries from Bhadra Right Bank Canal which connect to Gondhi Right Bank are 7 to 22. As the tail end command area of Bhadra Command Area itself is deprived water, it is difficult to call this water flowing from Bhadra Canal as excess water. It is nothing but seepage and unused water added with rain water.

In addition, as and when there is a demand for irrigation water from the farmers of the Gondhi Channel, the engineers of WRD/KNNL patrol on the BRBC main canal and distributaries and bring water to Gondhi Channel. This is done by closing the gates of the pipe outlets in the above distributaries in BRBC.

Gondhi channels receive water directly from the river and this water flows only upto about 20 km (about 1000 ha). In the remaining 54 km, water does not flow from the channel even when there is water in it and when the upstream farmers do not use the water. This is due to weeds, siltation, improper shape of the channel including improper bed level. The study team during the walkthrough survey along with farmers' saw that a large volume of water flowing into river through DPOs and branches both at Barandur (upper reach) and Kagekodumagi (middle reach) villages (see picture below).

Main Canal Condition

The main canal is in poor condition with no proper shape of the canal, lot of weeds (these weeds are called majige balli, which grows faster) and at several points the water over flows and spills over the channel. One of the reasons for the fast growing weeds is the water carrying fertilizers from the fields under Bhadra main canal on both left and right bank. The channel is unlined and with embankment of different sizes and lands below the channel

service road, it is said that there is lot of seepage and leakage which causes damage to the houses down blow and lands (water logging). It is observed that there are no shutters and gates for many of the distributaries. There are no measuring devices as to make out how much water is actually flowing in the canal. This means that there is a need to install measuring devices, caliberate the canal network at different places and provide data to the engineers, representatives of WUCS and CADA authorities.

Canal Lining

During the study, representatives of WUCS, CADA and KNNL express that the lining of the canal helps many folds, firstly it helps water flow in the channel, it prevents seepage and negative effects on the crop yield, save water to the lower reach of the channel. It also helps reliability of water and no need to rush for the irrigation in shorter intervals even when the crop do not require water. At present, there is intense irrigation in certain times due to un certainty in water availability.

Right Sizing the Main Canal

The discussion with the farmers' show that under modernization program, right sizing the channel from the present existing size to actual required size is not a problem to them. The farmers express that when the channel is lined and the bed is leveled the water will flow and reach the tail end. The dissize of the channel at certain points further creates problem for the farmers to move on the channel to reach their farms, gate operations and villages.

Gate Operation at Annicut

The gates at the annicut are kept open and as and when the water flow reaches the annicut level, the inflows into the Gondhi right bank and left bank channel automatically happens. The WRD/KNNL engineers go for gate operation at the annicut only when the rainfall increases in the command area. The gates are lowered during the rainy days to prevent the damages to Gondhi channel. The gates of the escape gates are opened and the excess water is let into escapes to prevent breachs. There is one escape gate just before the aqueduct and at this escape shutter, on the other side, the Bhadra canal water also joins the Gondhi annicut.

Shutters Operation at Branch Canal & DPOs

It is said that the shutters are not operated in Gondhi channel and the water simply flows into the DPOs and branches and falls into the river. The 7th and 8th branches and DPOs 67 to 70 have no shutter, the water simply flows into the branch canal and goes to the river. During the rains, even if farmers want to stop the water flow into the branches and DPOs when water is not required, it is not possible as there are no shutters and thread gate to raise and lower the canal.

CAD & On Farm Works

According to Bhadra CADA Annual report it is reported that in Tunga and Gondhi 5688 ha is affected due to lack of drainage system leading to water logging, salinity and alkalinity. During 2009-10, 891 ha and 2010-11 389.10 ha of reclamation works has been achieved (the reclaimed area covers Tunga,

Gondhi, Jambadahalla, Anjanapura and Ambligola projects under Badra CADA). These drainage works are carried out through Watershed Department under the state budget. The technology used for drainage system is installation of perforated pipes in the ground in a depth of 1 m and cover it with coir, sand and mud. There are also series of chambers provided to check the drainage flow. The water seeps into the ground and into perforated pipes and drains out into river or nala.

It is said that similar work was taken up in Kagekodamage WUCS area by Watershed Department without any discussion and involvement of WUCS. The representatives of WUCS opine that any works related with soil and water needs to be brought to the notice of WUCS. This helps WUCS to participate in the program constructively and also builds confidence among the farmers towards WUCS.

Water Release Information

The discussion with the engineers in KNNL/WRD shows that the date of release of water from Bhadra project into the main canals is made available to farmers through the newspaper and electronic media. During the Irrigation Consultative Committee (ICC) meeting, the press reporters will also be present and the CADA will also give information to press on the date of release of water to the main canals. There is no direct communication network for the WUCS on the releases.

Need for Exclusive Communication Strategy

The water inflows into Gondhi Channel happen as and when there is water in the river. It is quite evident from the discussion with the engineers that the channel gates at the annicut are kept open and as the water flows in the river, inflows into Gondhi Channel starts happening. Since, the Gondhi channel inflows is directly dependent on the river flows, an exclusive communication strategy to the WUCS may be put in place which updates the farmers as to the time and date of inflows. Thus, establishment of a Telemetry based flow monitoring system and the access to the information of the river flow and inflows in to channel may be provided to the WUCS through the mobile technology.

Using Mobile Technology

Most farmers use mobiles and the information on canal network flow data could be sent to KNNL engineer, WUCS and CADA officials to regularly monitor the water distribution at the main channel and at WUCS level.

Volumetric Supply

Although, 3 out of the 9 WUCS formed in the Gondhi command have entered into MOU with the Executive Engineer, Bhadra Project, it is found that there is no mention of how much water is allocated to each of these WUCS. In the first place, there are no measuring devices in Gondhi Channel at any location of the channel to assess how much water is coming from the Gondhi annicut and the left and right main canal of Bhadra Project and river pumping. Further, the installation of telemetry or partial flumes (manual guage reading) to measure the water flows which clears the ambiguity in assessing the volume of water supplied and water rate.

Crop Planning & Water Budgeting

One of the primary functions of the WUCS is to procure water in bulk and distribute it among the farmers as per the crop area, crop water budgeting and through the indenting procedure. The water allocation to the WUCS which have entered in to MOU with KNNL has not been discussed with the represetatives of WUCS. The process of micro plan preparation i.e. crop water budgeting is one of the primary task of WUCS. The representatives of WUCS says that neither the CADA nor the KNNL have shown the WUCS how to calculate the crop water

requirement and calculate total water requirement for different crops under paticular WUCS. Hence, the training programs have to start with making WUCS put their hands on actually assessing the crop water requirement using simple ready made formats. This will enable the WUCS to prepare crop wise water demands which collectively will constitute the seasonal water demand for the WUCS. The project level plan that is to be prepared by the WUCS Federation and KNNL will be a aggregation of the WUCS water denand plans thus prepared.

Cropping Pattern and Water Supply

During focused group discussion, farmers express that the crop like arecanut and sugarcane cultivated under Gondhi Channel, which are perennial crops, get badly affected when the canals at Bhadra dam are closed during summer (April, May and June - varies some months). As most of Gondhi channel command is dependent on the excess water flow from Bhadra Main Canals (Right and Left), it stops receiving water when these canals are closed and so the perennial crops gets affected impacting their yields.

5
OPERATION & MAINTENANCE

Preparation of O&M Plan

Firstly, the concerned Irrigation Sub-divisions carry out the O&M works with limited budget they receive from KNNL. It is said that the allocation for one sub division (there are 2 sub divisions) is around Rs. 12 lakhs in which they have to do jungle cutting, desiltation and pay wage for the labors taken on nominal muster role (daily wage) for water regulation. One of the engineer asked how it is possible to cover 40 km of channel and wage of the temporary staff in this amount?

Although, the WUCS are expected to be trained on the preparation of O&M Plan, the discussion with the representatives of WUCS clearly shows that there is no training was given on how to prepare the O&M Plan and what works to be included under it. It is worth mentioning here that the field engineer, who is also one of the Directors in the Governing Board of the WUCS, has also never attempted to prepare the O&M Plan for the WUCS.

Ambiguity in Demand, Collection and Remittance

In the Gondhi Channel, the practice of preparing the water charges (demand) and water rate (volumetric basis) is contradictory to the existing procedures detailed in the MOU. In principle, WUCS should be getting the water rate bill based on the volume of water used by it at the rate of Rs 12/1000 cubic meter of water. In turn the WUCS have to collect the water charges based on the crop area per acre fixed by the government like for instance, Rs 100/acre/season and Rs 400/acre/year. WUCS cannot collect the water charges less than this stipulated water charges, however the WUCS is empowered to fix and collect the water charges above the stipulated water charges based on the crop area. Further, the WUCS is entitled to retain 20 % of the water rate collection to itself for administration cost, Rs 40/hectare for O&M, and 2% as bonus for timely remittance.

However, what is significantly found is that the KNNL is sending the demand to WUCS based on the crop area charges per acre fixed by the State and the WUCS is expected to retain only 20 per cent of the total collection and remit 80 per cent of the collection to the designated bank account of KNNL through the chalan given by Executive Engineer.

The discussion with the WUCS, CADA authorities and KNNL makes it evident that there is high degree of ambiguity in interpreting the how much is to be collected and remitted to KNNL. The principles of water rates and charges are not being practiced in terms of what is envisaged in the MOU. Further, CADA is also not clear about how much should WUCS collect and extent of remittance and the extent of the amount out of collection, which WUCS can retain for administration, O&M, and bonus. The capacity building program should encompass these fundamental elements which act as base for the financial sources for WUCS and should also cover the various actors directly involved in the issue of water rate and charges assessment, collection, retain and remittance. The WUCS express willingness to collect the water charges when the KNNL starts implementing the ratio of collection of water charges and remittance of water rates. They express that the present water demand makes no meaning in terms of financial viability to collect and remit 80 percent and retain only 20 percent. There is no incentive for WUCS to enter into collection business.

The confusions over the water charges collection and remittance is quite evident from Table 3 that the KNNL sends the total demand based on the crop area and the WUCS is instructed to remit 80 per cent to KNNL. Further, for last three years, KNNL is not sending the demand to Kagekodamage WUCS. However, the WUCS goes on collecting the water charges and the remittance in 2012 a sum of Rs 9818/- (added up from 2008-09, kept in WUCS account) as an amount to adjust against the previous demand sent by KNNL.

Table 3: Water Charges Demand, Collection, Remittance and Balance

Year	Kharif / Rabi	Total Demand	Collection	Remittance to Department	Balance
2002-03	Kharif	201,068.25			201,068.25
	Rabi	7,667.75			7,667.75
2003-04	Kharif	191,897.30			191,897.30
	Rabi	10,279.00			10,279.00
2004-05	Kharif	187,318.60			187,318.60
	Rabi	26,790.50			26,790.50
2005-06	Kharif	188,093.50			188,093.50
	Rabi	11,045.50			11,045.50
2006-07	Kharif	188,093.50			188,093.50
	Rabi	11,045.50			11,045.50
2007-08	Kharif	151,435.70			151,435.70
	Rabi	11,337.00			11,337.00
2008-09	Kharif	142,287.90	200.00		142,287.90
	Rabi	12,598.50	900.00		12,598.50
2009-10	Kharif	142,721.00	600.00		142,721.00
	Rabi	12,788.50			12,788.50
2010-11	Kharif	Demand Not Given	482.00		
	Rabi	Demand Not Given	4,828.00		
2011-12	Kharif	Demand Not Given	5,380.00		
	Rabi	Demand Not Given	3,048.00	9,818.00	

Water Charges in Two Sample WUCS

The following table gives the demand assessment for the two sample WUCS studied under Gondhi Channel. While the amount for Kagekodamage is the actual demand raised by KNNL for crop year 2011-12, the amount for Barandur is calculated based on the Kagekodamage demand. As the larger area under irrigation in Gondhi Channel is perennial crop like sugarcane and arecanut, the demand assessment is made for one year while considering charges for paddy for two seasons. The exercise of assessing the demand i.e. water charges by WUCS were carried out with the representatives of WUCS.

Table 4: Approximate water charges assessment under sample WUCS

Name of WUCS	Per Season	Per year (Rs)
Kagekodamage	1,03,703.52	2,07,407.05
Barandur	1,40,626.50	2,81,253.00

Similarly, for the crop pattern information available from WUCS, the Gondhi Sub Project could generate water charges as detailed below:

Table 5: Crop Wise Water Charges for Gondhi Channel (Annual)

Crops	Kharif	Rabi	Total
Paddy	408056	408056	816113
Areacanut			330856

Sugarcane			573484
		Total	**1720453**

Willingness to Pay

The farmers during the discussion and walkthrough survey said explicitly that they are willing to pay the water charges to WUCS. It was also recorded during the discussion that at present, farmers are incurring indirect expenses like sluice guarding and patrolling on the canal. Farmers also suggested that there is a need to do awareness and motivation campaign in villages to improve the water charges collection. At present there are confusion among the farmers whether or not to pay to the WUCS. On the one hand, the Revenue Department is not making it clear to the farmers as to who should the water charges be paid to and at the same time, the CADA authorities too have no clear understanding of the issue and are therefore not in a position to clarify the matter to the farmers. Thus, the conclusion from the discussion over water charges collection is that the farmers would pay to whomsoever they are asked to pay authentically be it WUCS or KNNL or Revenue Authority on a condition that the water charges collected will br used for maintenance of canal system.

There are also examples where farmers, due to non availability of Gondhi Channel water in time, have installed lift irrigations from the Bhadra River and also attempted to bore tube wells. The cost of installation of tube well and pumping motors range from 1 to 2 lakhs and the annual maintenance cost is about Rs. 3000 (electricity free upto 10 HP) depending on the capacity of the motor and the distance of the pipe line to be laid. In other words, farmers are incurring expenditure in one way or the other to get the water to their fields. Hence, when water is made available to them through the channels, paying the water charges of Rs 100 per acre for paddy crop and Rs 60 per acre for garden crop and Rs 400 per acre for sugarcane is not at all a problem for them.

NREG and Irrigation Works

During the walkthrough survey and group discussion with the farmers and representatives of WUCS and department staff it is found that there are other sources of resources that support canal maintenance work. There are instances where the National Rural Employment Guarantee Scheme (MGNREGS) funds have been used for the maintenance of the branch canals. The 8th branch canal was in poor condition and the farmers made several requests to KNNL for maintenance work but in vain. Finally they approached their Gram Panchayat and passed a resolution to carry out deweeding and desilting under MGNREGS funds in the 8th branch, which is under the jurisdiction of Kagekodamage WUCS. The total amiunt spent on the works was about Rs. 50,000 and the length of the canal work undertaken was 1800 m.

6
AGRICULTURE DEVELOPMENT

Crop Pattern in Gondhi Channel

The major crops grown in Gondhi Channel are arecanut, paddy and sugarcane. There are stray cases of inter cropping in the arecanut with turmeric, ginger and flowers. These fetch additional benefits in terms of income and employment generation in the declining land holding size. The order of crop area is about, arecanut 2232 ha (50%) and 1652 (37%) and sugarcane (13 %). Intercropping like floriculture (jasmine, marigold,pink jasmine), turmeric, maize is also cultivated.

Potential Crop Productivity

During the study, farmers were asked about the yield of different crops namely paddy, sugarcane and arecanut. The lowest, highest and potential yields were collected from the farmers with the percentage of farmers falling in each category (given in parenthesis in the table). It is found that there is a high scope for improvement in yield right across the farmers

and across the crops. This is possible by improving yields from the lowest to the highest level within the WUCS and further to the highest potential yields possible as projected by the agriculture extension experts.

Table 6: Yield, Potential Yield and Scope to Improve for three major crops in Gondhi Channel (per acre)

Sl. No	Crop	Lowest Yield (% of Farmers)	Highest Yield (% of Farmers)	Potential Yield	Maximum Scope to Improve
1	Paddy	18 Qtls (42)	25 Qtls (58)	35 Qtls	17 Qtls
2	Sugarcane	35-40 tons (80)	50 tons (20)	60 ton	20 tons
3	Arecanut	40-50 Qtls (75)	70 Qtls (25)	80 Qtls	30 Qtls

In addition, the cost of cultivation can also reduce by 30% with improved agriculture inputs and extension service opines most of the WUCS representatives. This in turn will increase the net returns to the farmer and improve their livelihoods thereby adding real benefit to the farmers frrom modernization of Gondhi channel.

Agriculture Extension

Soil testing: Farmers express that they have so far not conducted any type of soil testing and the cropping pattern and agriculture practices are just continuity of what was being practiced since ages. Application of fertilizer and pesticide dosage at different stages of plant growth right from sowing, nursery and till harvest is based mostly on the general practice. It is also said that when there is poor growth they apply more dosages of fertilizers. None of the farmers present during the discussion had any idea on the important of soil testing and that application of fertilizer is directly related to the soil quality. Thus, soil testing needs to be taken up on priority basis from agriculture extension point of view. It is also suggested that the WUCS could provide the soil testing service to the farmers with the required soil testing kits being provided to them and by training the WUCS secretary in testing soils.

Crop Demonstration and Farmers Field School

Farmers say that there are no crop demonstrations either by the KVKs or by Agriculture Extension Services in their area. They feel that there is a need for such crop demonstrations on inter-cropping arecanut with ginger, turmeric and flowers and also on SRI paddy method. Farmers said that they have heard about SRI paddy method, but never seen it and also never tried it. During the discussion farmers urged the modernization program to incorporate agriculture extension component and asked for local farmers field schools for training on productivity enhancement of certain crops like mixed cropping, SRI, drip irrigation in sugarcane rather than going for training elsewhere.

Exposure visits

Quite a few farmers have been to training in WALMI and RICM on water users cooperative society and water management. But they express that the training they received was neither contextual nor based the ground reality of water distribution methods and problems faced by them. Further, there were no follow up to the training at the field level by either KNNL, Agriculture Department or CADA in a coordinated manner.

Raith Samparka Kendras: At present the Raitha Samparka Kendras are established in each Hobli, which is a cluster of villages. Farmers have to approach these RSKs to get solution to

their crop diseases. The farmers said that at present the system is only giving solution to the diseases after its attack breaks out and that too when the farmers approach the RSKs with the infected plants. The farmers, on the other hand, urged for preventive extension service before the disease broke out. They also said that the agriculture training and extension should be holistically and locally provided.

Taluk Level Agriculture Training Center

There is one Agriculture Training Center at Hallikere village which is about 2 km from Barandur village. The representatives of Barandur WUCS said that the Centre provides no training or extension service to the local farmers though farmers from different places are brought occasionally to the Center to conduct trainings. Relationship between the Centers and the loacl farmers need to be established under the modernization programme.

Agricultural Environmental Issues

Representatives of WUCS and farmers expressed that they needed training on the actual application of fertilizers and pesticides and the precautionary measures in handling these chemicals. At present, they are not aware of the direct damages caused by application of these fertilizers and pesticides. Further, training courses should also include information on alternate environmental friendly inputs and their applications and about their viability and sustainability.