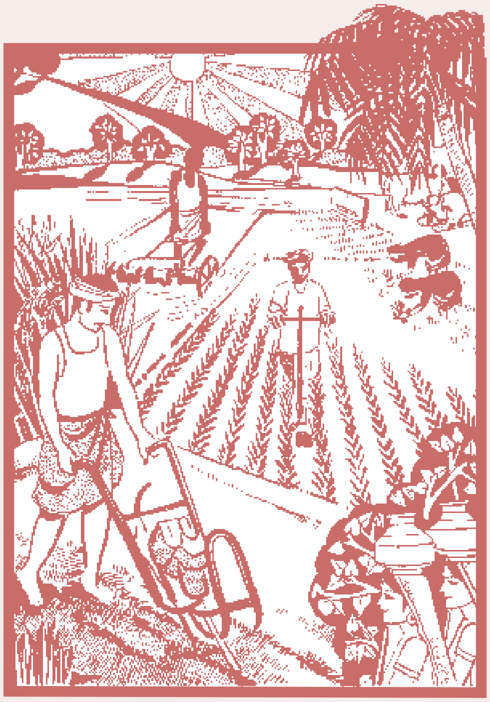

The System of Rice Intensification (SRI) - a package of practices designed to grow more rice with less water - is being widely promoted by governments and NGOs in India. In 2010-11, IWMI-Tata Program, in collaboration with local partners, undertook a study covering 2234 rice farmers in 13 major rice growing states to analyze the adoption level and impact of various SRI practices. The results confirm that SRI adopters, on the whole, displayed comparatively higher yield, higher gross margin and lower production costs. However, most 'SRI farmers' in the study sample did not adopt the full package of practices due to several constraints. In fact, only 20 percent could be classified as 'full adopters' while the rest were 'low adopters' or 'partial adopters'.

This highlight argues that a targeted approach that offers farmers flexibility in adopting a sub-set of SRI practices in accordance with the local resources conditions can have a significant impact on paddy productivity.

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IWMI-TATA
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Water Policy Research
HIGHLIGHT

Impact of the System of Rice Intensification (SRI)

Analysis of SRI Practices in 13 States of India

K.Palanisami,
K.R.Karunakaran and
Upali Amarasinghe

Impact of the System of Rice Intensification (SRI)
Analysis of SRI Practices in 13 states of India[1]

Research highlight based on a paper with the same title[2]

Introduction

The System of Rice Intensification, an improved package of rice cultivation practices, is claimed to greatly enhance yield and substantially reduce water and other input use in the context of smallholder farming (Uphoff 2003). Since the system was first documented in Madagascar during the second half of the 1990s it is reported to have spread to nearly 50 countries across Asia, Africa and South America. Although reliable data on actual levels of adoption and the impact of SRI practices are not available for India, information which is available has attracted the attention of the policy makers and planners and efforts have been made in different states to promote SRI. In spite of the spread of SRI, the claims of actual adoption levels and yield increase are still being debated in different circles including among researchers and extension officials. There are questions on profitability and inconsistent results of the field trials (Glover 2011). There are even questions on SRI productivity claims going beyond the physiological yield potential of rice (Dobermann 2004). However, the issue facing Indian agriculture is not whether SRI should be adopted but how it should be adopted across different regions.

Study area and sample

The study was conducted during 2010-11 covering 13 states and 2234 sample farmers with their SRI and non-SRI fields (Table 1). Data relating to the adoption of the SRI core components, costs, returns and constraints were collected through personal interviews with the farmers using pretested survey schedule. In addition, 70 local extension officials and NGOs, 60 scientists associated with SRI programs and 120 key farmers were contacted for getting an overall picture of the SRI in their locality.

SRI involves four core components viz., using a single seedling per hill, transplanting seedlings at a younger age (less than 15 days), square planting (25 x 25 cm spacing), and using cono weeding (a small equipment drawn manually along the rows to remove the weeds). Even though water use under SRI is said to be less, this is not covered in this study as most of the farmers could not follow the perfect land leveling to facilitate water saving irrigation. In order to account for the level of adoption of the four core components, farm samples were classified based on the degree to which the four core components were applied. 1-3 points were given to each component based on the degree of adoption and a total score was arrived at based on the sum of points for each component. Farm samples were classified as 'full adopters' if the sum of the scores is 12, and 'low adopters' if the sum of scores is 6 and below. Scores between 7 and 11 were categorised as 'partial adopters'.

Table 1 Distribution of sample across different states

Region	Area	Number of sample farmers studied
Southern region	Andhra Pradesh	200
	Karnataka	100
	Tamil Nadu	500
	Kerala	200
Western region	Gujarat	50
	Rajasthan	27
	Maharashtra	200
Eastern region	Orissa	130
	Chattisgarh	102
	Uttar Pradesh	62
	West Bengal	212
Central region	Madhya Pradesh	251
North Eastern region	Assam	200

[1]This IWMI-Tata Highlight is based on research carried out under the IWMI-Tata Program (ITP) with additional support from the International Water Management Institute (IWMI), Colombo. It is not externally peer-reviewed and the views expressed are of the authors alone and not of ITP or its funding partners – IWMI, Colombo and Sir Ratan Tata Trust (SRTT), Mumbai.

[2]This paper is available on request from p.reghu@cgiar.org

Yield, income and cost difference between SRI and non-SRI fields

Generally, SRI fields have significantly higher yields, but with different patterns across most states. Average yield in SRI parcels in all states is 8.5 quintals/ha (0.85 tonnes/ha) or 22 percent higher than the non-SRI fields (Table 2). Madhya Pradesh, Gujarat and Orissa have significantly higher yield in SRI parcels in percentage terms (52, 54 and 33 percent respectively), but they have some of the lowest yields among the non-SRI parcels. Maharashtra, Chhattisgarh, Andhra Pradesh and Karnataka have the next highest: 27, 24, 23 and 25 percent yield increments with SRI. Among the other major rice growing states, only Rajasthan and Assam have low absolute yield increases, but they still recorded more than 12 percent yield increment compared to the non-SRI parcels. Kerala, Tamil Nadu and West Bengal have recorded only moderate yield increase. Overall, only 6 states have experienced higher yield increase above the national average due to SRI (Figure 1).

The difference between the average gross margins (gross income minus variable costs) due to SRI and non-SRI was Rs. 6971/ha with the highest in the Central region (Rs. 11184/ha) and the lowest in the North Eastern region (Rs. 3504/ha). Assam, Chhattisgarh, Maharashtra and Rajasthan had the lowest income possibly due to high operating costs. The cost of production (COP) per quintal of rice indicates the real profitability of the rice cultivation. Overall, COP of SRI over non-SRI was less by Rs. 178/quintal. Both Western and Southern regions were observed to have comparatively lower COP. Rajasthan has the highest COP due to the cultivation of basmati rice varieties with higher input costs and low yields (Palanisami and Karunakaran 2012).

Yield differences by different adoption levels

The adoption of just the number of SRI components alone cannot indicate the exact the level of SRI adoption as some may follow the exact recommendations and some may deviate from the recommendations. First, not all the

Table 2 Differences of yield, cost and gross margin between SRI and Non-SRI fields

	Region and State	Yield (q/ha)			Gross margin (Rs/ha)			Cost (Rs/q)		
		Non SRI fields	Difference (SRI - non SRI)		Non SRI fields	Difference (SRI - non SRI)		Non SRI fields	Difference (SRI - non SRI)	
			Total	Percent		Total	Percent		Total	Percent
	Southern region									
1	Andhra	56.8	13.0	22.9	54490	10094	19	560	-146	-26
2	Karnataka	56.7	14.1	24.8	56277	12885	23	370	56	15
3	Kerala	47.1	6.4	13.6	51613	7044	14	857	-244	-28
4	Tamil Nadu	45.5	6.8	14.9	41879	5786	14	675	-223	-33
	Average	51.0	9.2	18.0	49552	8290	17	617	-168	-27
	Western region									
5	Gujarat	18.7	10.0	53.6	17274	8973	52	757	-234	-31
6	Maharashtra	27.9	7.5	26.9	26904	4266	16	527	-253	-48
7	Rajasthan	20.9	2.7	12.9	41145	5327	13	2068	-201	-10
	Average	25.6	7.3	28.5	27597	6585	24	715	-220	-31
	Eastern region									
8	Chhattisgar	48.7	11.9	24.5	53451	1257	2	581	-167	-29
9	Orissa	36.2	12.0	33.1	33929	12111	36	669	-151	-23
10	Uttar	54.5	8.5	15.5	53655	8334	16	655	-41	-6
11	West Bengal	36.0	5.9	16.5	32885	5400	16	507	-14	-3
	Average	40.9	9.0	22.0	38446	7474	19	585	-71	-12
	Central region									
12	Madhya	19.3	10.0	51.9	12530	11184	89	430	-56	-13
	Northeastern region									
13	Assam	34.1	4.1	12.0	32188	3504	11	674	-380	-56
	All India	37.9	8.5	22.4	37845	6971	18	621	-178	-29

Source: Authors' estimates based on sample survey 2011

Figure 1 SRI yield increase in different states

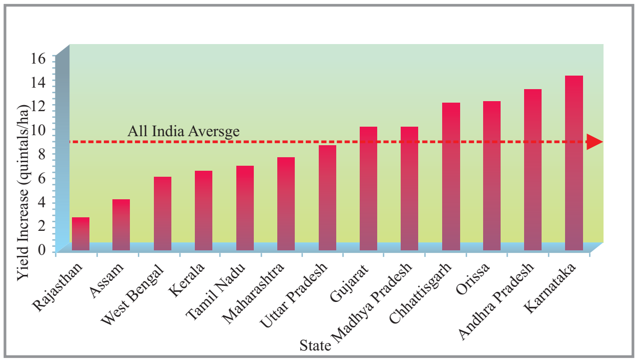
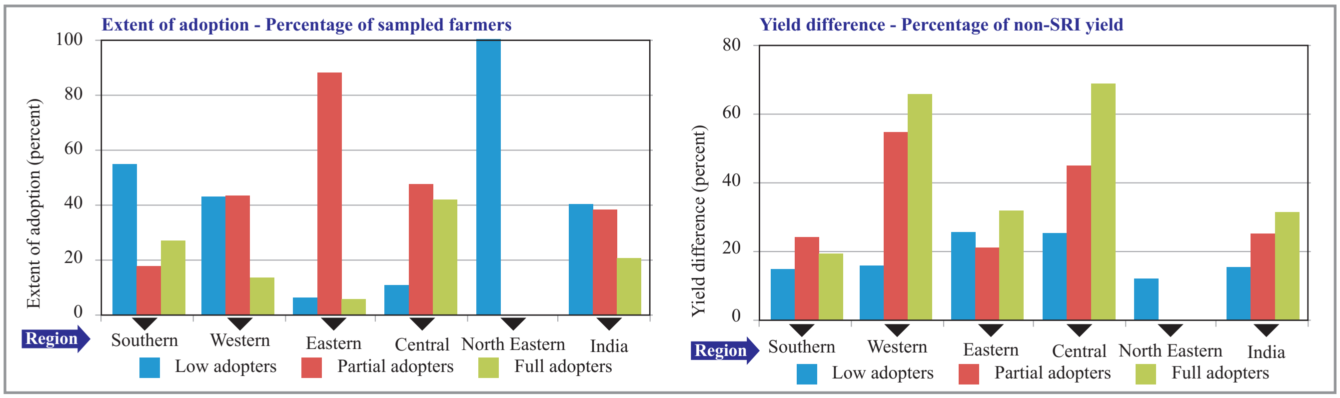


Figure 2 Adoption levels and yield increase of SRI in different regions



farmers adopted all four core SRI components. The adoption of a combination of only two to three components was mostly observed in all the regions. Low adopters are 41 percent of all the adopters, while 39 and 20 percent are partial and full adopters respectively. The adoption level varied from region to region where the North Eastern region had only low adopters and the Eastern region had mostly partial adopters (Table 3).

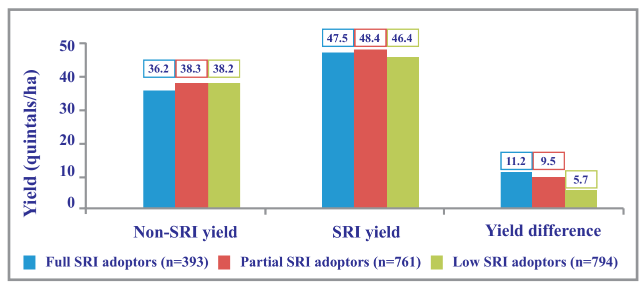
Second, full adopters of SRI recorded the highest difference of yields between SRI and normal practices (31 percent) followed by partial (25 percent) and low adopters (15 percent). This indicates that the selection of different components of SRI for adoption has significant bearing on yield increase. The yield difference also varied across regions where it was the lowest in North East region and highest in Central region (Figure 2).

As expected, the average yield level was higher when the percent of full adopters was higher and lower when the percent of partial and low adopters was higher thus confirming that full adoption had resulted in higher yields (Figure 2; Figure 3).

Yield difference by core SRI components

The yield observed under different SRI components over the non-SRI parcels also varied across regions. For example, the yield difference for all the four SRI components as well as single SRI component (C3 - square planting) was 11.2 quintals/ha (Table 4). Much of the yield difference was realized by partial adopters in the Southern region, low adopters in the North Eastern region and full adopters in other regions. Maximum yield difference of 17.5 quintals/ha was observed for C1, C2, and C4 combination i.e., single seedling, young seedling and cono weeding. Overall, only mixed responses of yield for different combinations of the SRI components were noticed. It is interesting to note that about 31 percent of the farmers, who had deviated in all the four SRI components, realized a yield increase of 6.6 quintals/ha

Figure 3 Yield differences at different level of SRI adoption



indicating that any improvement from the existing rice cultivation practices will also enhance the rice yield. The overall change in COP due to SRI adoption also varied across the combinations of the SRI components where, in most cases cost reduction was observed.

Transaction costs and SRI adoption

Transaction costs refer to the costs associated with the efforts made by the farmers in mobilizing the needed resources such as labour for timely operations, nursery management, release of timely water supplies and cono weeding which are not included in the cost calculations. Most of the farmers expressed their concern that mobilizing these 'quality inputs' consumed extra time and money. Hence, transaction costs were worked out using the imputed values of the farmers' time and money spent (Table 5). The calculated costs were also cross checked

Table 3 Adoption levels of SRI in different regions

Region	Percentage of farmers at different adoption level			Yield in non-SRI parcels at different adoption level (quintals/ha)			Yield increase in SRI parcels over non-SRI yield at different adoption level (percent)		
	Low	Partial	Full	Low	Partial	Full	Low	Partial	Full
Southern	55	17	27	45.5	54.4	51.6	15.2	24.3	19.5
Western	43	43	14	22.7	17.6	19.3	15.8	53.9	65.0
Eastern	6	89	6	46.3	40.6	39.7	25.4	21.2	31.4
Central	10	48	42	15.4	21.6	17.8	24.7	44.1	68.0
North Eastern	100			34.1			12.0		
All India	41	39	20	38.2	38.3	36.2	15.0	24.8	30.9

with farmers in several locations. It is seen that the transaction costs account for an additional 1.5 percent of the total operation cost with single SRI component (low adoption), 2 percent with 2-3 components (partial adoption) and 2.5 percent with all components (full adoption). Even though, it is argued that higher transaction cost is constraining the adoption, the results from the study could not confirm this, as it is difficult to quantify exactly the 'quality of the efforts' made by the farmers in mobilizing resources like skilled labourers for perfect land levelling, transplanting young and single seedling, cono weeding and maintaining a thin layer (2.5 cm depth) of water in the fields.

Suggested SRI components and soil types by states

The SRI components that give higher yields in different states can be recommended for scaling up provided that the concerned states are interested to do so (Table 6). The results revealed that sandy loam to clay loam with ground water or conjunctive irrigation system had resulted in higher SRI yields. The Geographic Information System (GIS) mapping of these locations will be useful for possible SRI/ modified SRI concentration.

Constraints in the adoption of SRI components

The Constraints Analysis revealed that though planting of young, single seedlings is important in realizing additional yield in SRI, farmers relaxed the adoption of this practice mainly to avoid any risk to the establishment of young seedling due to water logging, scarcity of water by intermittent power supply (in groundwater irrigated situations), poor land terrain (slope) causing water logging and drainage problem etc. One fourth of the farmers reported lack of knowledge of SRI practices. Labour problem was reported by half of the SRI farmers particularly for cono weeding operation, as labourers found moving cono weeders in hard soils a drudgery. About one third of the farmers reported non availability of

Table 4 Differences in yield, cost and gross value of outputs under SRI components

Fully adopted components	Sample size (No.)	Differences between average of SRI and non-SRI fields		
		Yield (quintals/ha)	Cost of production (Rs./quintal)	Gross value of output (Rs./ha)
C1,C2,C3,C4	393	11.2	-179	9592
C2,C3,C4	76	8.7	-110	8027
C1,C3,C4	47	9.6	-119	11252
C1,C2.C4	35	17.5	-18	8478
C1,C2,C3	93	13.1	-190	10384
C3,C4	185	6.7	-7	6064
C2,C4	10	10.3	87	5051
C2,C3	38	11.0	-91	12270
C1,C4	14	8.7	-82	9874
C1,C3	29	12.8	-93	11459
C1,C2	97	10.4	-213	-1104
C4	20	9.6	21	14108
C3	41	7.2	-14	7178
C2	41	9.2	-310	14631
C1	138	6.1	-190	3869
Non adoption of any component	691	5.5	-294	4695

Source: Authors' estimates based on sample survey 2011.
Note: C1: young seedling; C2: single seedling; C3: square planting; C4: cono weeding.

Table 5 Transaction costs for adopting SRI core components (Rs./ha)

Fully adopted components	Southern region	Western region	Eastern region	Central region	North Eastern region	All India
C1,C2,C3,C4	653		640	710		655
C2,C3,C4	610		495			564
C1,C2,C4	613		630	680		630
C1,C2,C3	600	580	650	670		621
C3,C4	610					610
C2,C4	550	630	475	360		513
C2,C3	540		410			508
C1,C3	570	610	517	560	640	569
C1,C2	425	560	437	560	420	463
C4	408		435			417
C3	415	320	370	218	230	336
C2	260	460	462	540	230	386
C1	400	235	279		340	322
Non adoption of any component	280	190	230	310	200	250

Note: C1: young seedling; C2: single seedling; C3: square planting; C4: cono weeding.

suitable marker as the major reason for deviation from square planting (Palanisami and Karunakaran 2012).

Conclusions and recommendations

At present, mostly low adoption (41 percent) and partial adoption (39 percent) of SRI have been observed in all the regions. However, the yield increase under full adoption (incorporating all 4 core SRI components) is significantly higher (31 percent) than the yield increase under partial (25 percent) or low adoption (15 percent). SRI/modified SRI practices have a higher gross margin (Rs. 7000/ha) and lower production cost (Rs. 178/quintal) compared to non-SRI parcels. Major constraints in the adoption of SRI or modified SRI practices are lack of timely and skilled manpower for planting operations, poor water control in the fields and unsuitable soils. Farmers felt that the transaction (managerial) cost, though insignificant is also constraining the full adoption of SRI due to difficulties in mobilizing the resources for SRI or modified SRI. Hence, necessary interventions are needed to address these constraints. The key message is that whether it is SRI or modified SRI, there is an increase in yield compared to conventional practices. But the question to be addressed is where and how the SRI should be looked into.

Given the current rice area of about 42 million ha in the country, using the difference in yield due to SRI as observed from the results of the study, it is possible to get

Table 6 Suggested SRI components and soil types

States	SRI components	Soil type
Andhra Pradesh	C1,C2,C4	Sandy loam
Karnataka	C1,C2,C4	Black
Kerala	C1,C2,C3,C4	Red
Tamil Nadu	C1,C2,C3,C4	Clay
Gujarat	C1,C2,C3	Black
Rajasthan	C3	Black
Maharashtra	C1	Clay loam
Orissa	C2	Clay loam
Chhattisgarh	C1,C2,C4	Black
Uttar Pradesh	C1,C3	Clay loam
West Bengal	C2,C3,C4	Sandy loam
Madhya Pradesh	C1,C2,C4	Clay loam
Assam	C1	Sandy loam

Note: C1: young seedling; C2: single seedling; C3: square planting; C4: cono weeding.

Though the irrigation source (such as surface or groundwater) is important for better SRI adoption, it varies from location to location due to poor water control and hence no inference can be made about the suitability of a particular irrigation source for SRI adoption.

an additional rice production of about 30 million tonnes where the Eastern region alone could account for about 56 percent increase followed by the Southern region (27 percent). Hence region specific focus can be given to boost rice production using SRI or modified SRI practices.

In this context, the following are suggested:

1. Selective SRI components: As most of the farmers are low and partial adopters, in order to get maximum yield under SRI, focus should be on the selective components of SRI to suit the regions.
2. Doing it differently: Farmers can be encouraged to do SRI in their own way instead of forcing them to adopt the defined SRI core components. This way, these modified SRI or improved management practices will enhance the rice yield compared to the conventional practices.
3. SRI target regions (hot spots): Using GIS mapping, areas suitable for SRI - locations with suitable soils, crop seasons (*kharif* or *rabi*) and irrigation sources (surface, groundwater or rainfed) - can be marked and attention can be given for popularizing SRI only in those regions.
4. Machine transplantation: Machine transplanting can be introduced in all regions using the concept of wider spacing, young seedling and one to two seedlings per hill.
5. Capacity building programs: Focused field based training to farmers on those SRI components which are important to their regions is important.
6. Long term field experimentation: As the yield varies across regions as well as under different soil and irrigation sources, long term field experimentation with different SRI practices is important so that concrete recommendations about the sustainability of SRI practices can be drawn.
7. The 12th Five Year Plan approach paper highlights the importance of SRI practices in improving the crop productivity (GoI 2011). The drivers of SRI adoption can be examined and incorporated in the agricultural development programs such as *Rashtriya Krishi Vikas Yojana* (RKVY) etc.

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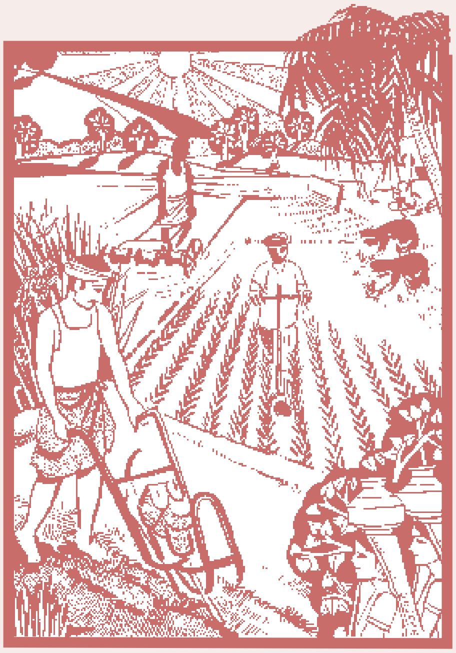

About the IWMI-Tata Program and Water Policy Highlights

The IWMI-Tata Water Policy Program (ITP) was launched in 2000 as a co-equal partnership between the International Water Management Institute (IWMI), Colombo and Sir Ratan Tata Trust (SRTT), Mumbai. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resource management. Its objective is to help policy makers at the central, state and local levels address their water challenges – in areas such as sustainable groundwater management, water scarcity, and rural poverty – by translating research findings into practical policy recommendations. Through this program, IWMI collaborates with a range of partners across India to identify, analyze and document relevant water-management approaches and current practices. These practices are assessed and synthesized for maximum policy impact in the series on Water Policy Highlights and IWMI-Tata Comments.

Water Policy Highlights are pre-publication discussion papers developed primarily as the basis for discussion during ITP's Annual Partners' Meet. The research underlying these Highlights was funded with support from IWMI, Colombo and SRTT, Mumbai. However, the Highlights are not externally peer-reviewed and the views expressed are of the author/s alone and not of ITP or either of its funding partners.

IWMI OFFICES

IWMI Headquarters and Regional Office for Asia
127 Sunil Mawatha, Pelawatte
Battaramulla, Sri Lanka
Tel: +94 11 2880000, 2784080
Fax: +94 11 2786854
Email: iwmi@cgiar.org
Website: www.iwmi.org

IWMI Offices

SOUTH ASIA
Hyderabad Office, India
C/o International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
401/5, Patancheru 502324, Andhra Pradesh, India
Tel: +91 40 30713735/36/39
Fax: +91 40 30713074/30713075
Email: p.amerasinghe@cgiar.org

New Delhi Office, India
2nd Floor, CG Block C, NASC Complex
DPS Marg, Pusa, New Delhi 110 012, India
Tel: +91 11 25840811/2, 65976151
Fax: +91 11 25842075
Email: iwmi-delhi@cgiar.org

Lahore Office, Pakistan
12KM Multan Road, Chowk Thokar Niaz Baig
Lahore 53700, Pakistan
Tel: +92 42 35299504-6
Fax: +92 42 35299508
Email: iwmi-pak@cgiar.org

SOUTHEAST ASIA
Southeast Asia Office
C/o National Agriculture and Forestry Research Institute (NAFRI)
Ban Nongviengkham,
Xaythany District,
Vientiane, Lao PDR
Tel: + 856 21 740928/771520/771438/740632-33
Fax: + 856 21 770076
Email: m.mccartney@cgiar.org

CENTRAL ASIA
Central Asia Office
C/o PFU CGIAR/ICARDA-CAC
Apartment No. 123, Building No. 6, Osiyo Street
Tashkent 100000, Uzbekistan
Tel: +998 71 237 04 45
Fax: +998 71 237 03 17
Email: m.junna@cgiar.org

AFRICA
Regional Office for Africa and West Africa Office
C/o CSIR Campus, Martin Odei Block,
Airport Residential Area
(Opposite Chinese Embassy), Accra, Ghana
Tel: +233 302 784753/4
Fax: +233 302 784752
Email: iwmi-ghana@cgiar.org

East Africa & Nile Basin Office
C/o ILRI-Ethiopia Campus
Bole Sub City, Kebele 12/13
Addis Ababa, Ethiopia
Tel: +251 11 6457222/3 or 6172000
Fax: +251 11 6464645
Email: iwmi-ethiopia@cgiar.org

Southern Africa Office
141 Cresswell Street, Weavind Park
Pretoria, South Africa
Tel: +27 12 845 9100
Fax: +27 86 512 4563
Email: iwmi-southern_africa@cgiar.org

IWMI SATELLITE OFFICES
Kathmandu Office, Nepal
Jhamsikhel 3, Lalitpur, Nepal
Tel: +977-1-5542306/5535252
Fax: +977 1 5535743
Email: l.bharati@cgiar.org

Ouagadougou Office, Burkina Faso
S/c Université de Ouagadougou Foundation
2iE 01 BP 594 Ouagadougou, Burkina Faso
Tel: +226 50 492 800
Email: b.barry@cgiar.org

IWMI-Tata Water Policy Program
c/o INREM Foundation
Near Smruti Apartment, Behind IRMA
Mangalpura, Anand 388001, Gujarat, India
Tel/Fax: +91 2692 263816/817
Email: iwmi-tata@cgiar.org

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