The Extent and Nature of Adoption and Impact of CRP-Wheat Related Research Outputs, 2004-2014

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1. Introduction

The present paper reviews studies which assess/evaluate the adoption and impact of CRP-Wheat related research outputs over the last decade.[2] The reviewed studies typically have various objectives, including scholarship as well as justifying agricultural research programs. A challenge is that the latter two objectives are not always compatible – and it can be challenging to find a recognized journal outlet for some of the mundane adoption and impact studies. The research covered herein includes adoption/process studies, *ex ante* and *ex post* impact assessments, and reviews. The reviewed studies provide a wide coverage of the wheat growing areas of the developing world: including Ethiopia, Turkey, India, Pakistan, Bangladesh, Nepal, Kazakhstan, Syria, and Mexico.

A total of 105 relevant studies were identified for the 2004-14 period – including 74 with a focus on CRP-Wheat and 31 studies across-CRPs. The vast majority of these studies directly involved CIMMYT and/or ICARDA scientists as (co-)authors. Only a few were fully external, published and available in the public domain, examples including ACIAR's commissioned external impact assessment of CIMMYT implemented projects in Afghanistan (Jilani et al., 2013) and an independent journal paper evaluating CIMMYT achievements in NW Mexico – the cradle of the green revolution (Nalley et al., 2010). There are also hybrid publications – published by the CG centre but written by external scholars (e.g. Gollin, 2006).

Most studies relate to adoption and impact studies of technological interventions associated with CIMMYT, ICARDA and/or CRP-Wheat by producers and to a more limited extent consumers. Only few studies look at intermediate beneficiaries – including capacity building. The review identified several additional studies that included references to adoption and impact in the title and/or abstract – but these were generally excluded if they did not cover these themes from a more impact assessment perspective.

The 105 studies over the entire period to date amount to an average of 9.5 publications per year.[3] Of the 105 studies about half (47%, 4.5 p.a.) were peer reviewed and a third (32%, 3.1 p.a.) were published in recognized journals (Table 1). Contrasting the pre-CRP years (2004-11) to the CRP-years (2012-14), the total number of annual publications increased with a modest 17% from 9.1 p.a. to 10.7 p.a. The number of peer reviewed publications however doubled (from 3.5 to 7.0 p.a., representing respectively 38% and 66% of the period's publications) although the number of recognized journals increased more modestly (from 2.9 p.a. to 3.7 p.a. , representing respectively 32% and 34% of the period's publications – Table 1). Table 1 summarizes the publication metadata per year and period. The full details of all considered publications are listed separately in Annex 1.

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[2] The present document is in response to the IEA request to CRP-Wheat to provide a narrative statement describing the extent and nature of the impact of CRP-related research outputs documented since the last EPMR of the lead center and main participating centers.

[3] At time of writing we are mid-2014. For ease of presentation we will include the currently in press publications to the 2014 totals (Table 1) and use this as the estimated 2014 total – which thus is likely an underestimate of the actual 2014 totals after year end. Also for ease of reference the CRP is taken to start 2012.

Table 1 Selected metadata for CRP-Wheat related adoption/impact studies identified for the 2004-14 period

Year	# Peer reviewed publications p.a.	# Papers in recognized journal p.a. (Scopus/Thompson)	Total # publications p.a.
2004	2	2	4
2005	2	1	5
2006	3	3	15
2007	5	3	15
2008	5	5	9
2009	5	4	14
2010	6	5	9
2011	0	0	2
2012	7	2	9
2013	8	5	11
2014* (a+b)	6	4	12
a. 2014 till June	3	2	8
b. in press June 2014	3	2	4
Grand Total	49	34	105
Averages			
2004-14*	4.5	3.1	9.5
2004-11	3.5	2.9	9.1

Source: Annex 1, which includes full details of all publications.

Due to space and time limitations, the remainder of this paper will primarily focus on the peer-reviewed journal studies amongst the relevant studies identified. For each such study we review the available evidence on adoption rate, determinants of adoption, and impacts on outcome variables. The outcome/impact variables considered are yield, area under cultivation, greenhouse gas emissions, income, poverty, and food security. Research outputs covered are modern/improved seed and conservation agriculture technologies, mainly zero tillage. The reviewed studies focus heavily on the study of adoption and impacts using observational data or cross-section analyses, although estimation methods also include spatial analysis using remotely-sensed data. The survey data used across the studies were collected using different survey instruments and the studies sometimes define key terms differently. Results across the studies are therefore not necessarily directly comparable, and this should be kept in mind in interpreting the study findings.

2. Adoption and impacts: A summary

2.1 Zero tillage wheat

The majority of peer-reviewed studies on adoption/impacts of CRP-Wheat research outputs concern zero tillage wheat. Several CIMMYT studies examine adoption of zero tillage wheat in India and Pakistan. Four adoption studies (Erenstein, 2010a; Erenstein, 2009a; Erenstein & Farooq, 2009; Erenstein et al., 2008) share a focus on a survey of wheat farmers in Haryana, India ($n = 400$) and Punjab, Pakistan ($n = 458$). Among the sampled farmers in Haryana and Punjab, respectively, adoption was 35% and 19%, dis-adoption was 10% and 14%, and non-adoption was 56% and 67%. The diffusion of zero tillage wheat had increased since 2000, but the surveys show a much slower uptake and subsequent stagnation in the Pakistan Punjab study area compared to Haryana.

Erenstein 2010b illustrates the utility of village surveys to rapidly and reliably monitor agricultural technology uptake. Two case studies are presented: one study revisits 50 communities in Haryana state, India surveyed previously (Erenstein et al., 2007); a second case study uses new data from a representative sample of 120 villages across Haryana and Punjab states, India. The case studies show that after an initial rapid spread of tractor-drawn zero tillage drills for wheat seeding in these intensive systems, the zero + reduced tillage area seems to have stabilized there at between a fifth and a quarter of the wheat area. Conventional tillage for wheat continues to decline, with an increased use of rotavators making up the difference – but its intensive shallow tillage goes against the conservation agriculture tenets.

Erenstein & Farooq (2009a) and Krishna et al. (2012) study the determinants of zero tillage adoption and found the following variables strongly associated with zero tillage adoption: household wealth such as cattle ownership, land tenure, availability of seed drills, and access to agricultural extension information. A study of Pakistani farmers provides insights on how wealth, as measured by agricultural landholding, can influence both adoption and impact of wheat technologies (Ali et al., 2013). The study finds that agricultural extension services played a significant role in promoting adoption of improved agricultural technologies like laser levelling and improved wheat varieties, and receipt of agricultural extension services was associated with higher wheat yields. The results also indicate that large farmers had better access to agricultural extension services compared with small-scale farmers.

Singh et al. (2012) uses survey data from farmers in rice-wheat cropping systems of Bangladesh, India, Nepal, and Pakistan (56 villages) and investigate adoption of integrated crop and resource management practices, including zero and reduced tillage wheat, laser land levelling, and leaf color chart. More than one-third of farm households had adopted at least one of the technologies, with considerable variation across regions. The highest adoption rate (about 50%) was in the northwest Indo-Gangetic Plains, where farmers adopted mainly zero tillage, reduced tillage, and laser levelling. As expected, adoption was generally higher in project vs. control villages. The study also shows that better endowed farmers tended to be first to adopt.

As for impacts of zero tillage wheat, the studies in Haryana and Punjab discussed earlier indicate that, compared to conventional tillage, zero tillage was associated with significant resource-savings effects in farmers' fields for diesel, tractor time, and cost of wheat cultivation. Water savings were, however, less pronounced than anticipated from on-farm trials data. It was only in Haryana, India that there were significant zero tillage-induced water savings in addition to significant yield enhancement. The higher yield and water savings in Haryana, India resulted in significantly higher water productivity indicators for zero tillage wheat. In another *ex post* impact study, Krishna and Veettil (2014) use survey data for 180 wheat farmers in Haryana, India to estimate a wheat production function and to measure technical efficiency with semi-parametric methods. Results show cost savings (14%), productivity increases (5%), and technical efficiency of production increases (1%) associated with the adoption of zero tillage wheat. One issue the authors mention, but fail to empirically explain, is that, despite the apparent benefits of zero tillage wheat, adoption remained low in the study area.

A further *ex post* impact assessment of zero tillage wheat involved participatory field trials at 40 sites for three consecutive years in four rice-wheat districts of Haryana state of India (Aryal et al., in press). Results show that farmers saved approximately US$ 79 per ha in terms of total production cost and had increased net revenue of about US$ 97.5 per ha under zero tillage compared to conventional tillage. Similarly, the benefit-cost ratio under zero tillage was 1.43 vs. 1.31 under conventional tillage. In terms of environmental impacts, the study estimates that shifting from conventional to zero tillage wheat production reduced greenhouse gas emissions by 1.5 Mg CO_2-eq per ha per season.

The one *ex ante* study of zero tillage wheat that is part of our review focuses on India's Indo-Gangetic Plains and highlights the high potential gains from successful adaptive research, even if the main effect is only to accelerate technology deployment (Erenstein & Laxmi, 2010). Specifically, the study concludes that the ability of zero tillage to combine cost savings and yield gains, its wide applicability, and significant research and development spill-ins contributed to the estimated high returns.

2.2 Improved wheat germplasm

Several recent review papers provide an overview of adoption/impacts of improved wheat germplasm in developing countries. Reynolds and Borlaug (2006) describe how thousands of modern wheat varieties have been bred for high yield potential, disease resistance, and challenging environments, and released for use in both favorable and marginal environments. Millions of farmers in the developing world have benefited through increased yields and incomes. For example, data from extensive international yield trials in both semi-arid and heat-stressed environments indicate yield progress of 2-3% per annum between 1979 and 1995. At the same time, the increased yields have reduced the need to bring natural ecosystems under cultivation, by as much as a billion hectares. A rough estimate of economic gains associated with adoption of modern varieties of spring bread wheat between 1977 and 1990 indicate their association with an extra 15.5 million tons of wheat in 1990 alone, worth about US$3 billion, while the estimated investment in all international wheat research was US$100-150 million annually in 1990.

Dixon et al. (2006) also review literature on adoption of improved wheat varieties in the developing world. The authors conclude that adoption is highly influenced by how well the new varieties fit with existing wheat farming systems. Other factors found to matter to adoption were input shortages, speed of change (i.e. how different are improved varieties from existing), and farmers' risk aversion. The review finds that adoption was associated with increased average yields, decreased yield instability, increased income, and reduced food insecurity.

A more recent review by Shiferaw et al. (2013) describe how modern wheat varieties have been widely adopted and now cover about 90% of the developing world's wheat area. The authors stress, however, that continuous improvements in wheat germplasm will be needed to sustain wheat intensification and ensure future food security. In particular, varieties must be resistant to disease, pests, and climatic changes at a time when labor, fertilizer, fuel, and water are scarce.

We now turn to several original papers on adoption and impacts of improved wheat germplasm. Shiferaw et al. (2014) use nationally representative data for Ethiopia (n = 2,000 farm households) to study adoption and impact of improved wheat varieties. The adoption rate was measured at 70%. An adoption analysis reveals that wheat prices, prices of competing crops, sources of information on new varieties, input costs, agro-ecology, and geographical location influenced adoption of improved wheat varieties. As for *ex post* impacts, econometric analyses find that adoption of improved wheat increased the probability of food security by 2.7% for adopters and 4.5% for non-adopters.

In Turkey, adoption of modern wheat varieties has remained somewhat low, 49% of wheat area was cultivated in old varieties, according to a recent survey of 781 farmers in 5 provinces of Turkey (Mazid et al., in press). The low adoption of new wheat varieties is in spite of evidence of the advantage of modern wheat over landraces. In the same survey, farmers reported that, compared with landraces, the new wheat varieties had yields that were higher on average (3,541 kg/ha vs. 1,654) and were also more stable. The average gross margin per unit of land was almost 2.2 times higher for the new varieties compared with the older ones.

A survey of 323 farmers in Haryana, India indicates that the rate of wheat varietal turnover in India has slowed: 10 years ago that rate was about 9-10 years, whereas in 2010 the estimated rate was 13-14 years (Krishna et al., 2014). Wheat farmers in Haryana reported a preference for the wheat cultivars released 9-10 years ago. While wheat breeding and seed delivery systems may be the primary explanations of this slowdown in wheat varietal turnover, household level factors also constrain farmers from adoption of the newer wheat varieties. These results are consistent with a survey of 1,200 wheat farmers in 5 states of the Indo-Gangetic Plain of India (Ghimire et al., 2012). This study found that various socio-economic factors like farmer age and education and farm size strongly influenced the choice of whether to grow new wheat varieties in India. But the most important determinant of adoption of modern wheat varieties was access to seed from different sources.

CIMMYT research on impacts of improved wheat germplasm has mostly been *ex post*. One recent *ex ante* study measured global impacts of improved wheat varieties resistant to wheat rust (Pardey et al., 2013). The expected average total global losses in this 1961–2009 counterfactual world without durable stem-rust resistance was estimated at 306 million metric tons (MT) from a total production of 23 billion MT (i.e., a loss of US$ 54.7 billion when valued at 2010 average U.S. wheat prices) with a 90% chance of losing at least 275 MT (or US$ 49.3 billion). This expected 306 MT total loss equates to average annual losses for the counterfactual period of 6.2 MT (or US$ 1.12 billion per year) from annual average production of 470 MT.

Nalley et al. (2010) assess *ex post* the economic impact of the CIMMYT wheat breeding program in the Yaqui Valley, Sonora, Mexico. The results suggest that CIMMYT cultivars contributed a 0.46% annual increase (about 38 kg/ha annually) to wheat yields in the Yaqui Valley, which raised local wheat producers' revenue by an average of US$ 4 million annually for the period 1990 to 2002, and by approximately US$ 9 million in 2002.

Finally, we review two papers that describe CIMMYT-led farmer outreach activities that proved successful in increasing the impacts of CRP-Wheat research outputs in South Asia. Page et al. (2009) describe an improved strategy for disseminating heat and disease tolerant wheat varieties. CIMMYT piloted this technology dissemination strategy with 45 farm households and then scaled up to 545 mainly marginal, farming families in Dinajpur district of northwest Bangladesh. The technology dissemination approach involved whole-family trainings and follow-up visits, and seed promotion mainly with distribution of flyers and displaying posters in prominent locations. Profits from selling wheat grain and (mostly) wheat seed averaged 51 euros per family, and the majority of families earned more than 50% of the annual income to reach the poverty line. The increase in profits was attributed to (a) an increase in wheat grain yield (average yield was 3,138 kg/ha) when farmers switched from the old Kanchan variety to newer, heat and disease-tolerant varieties, (b) higher demand and therefore higher price received for seed and grain due to promotion activities, and (c) farmers storing and then selling their seed later than had been previously done and thereby receiving a higher price for the seed.

Ortiz-Ferrara et al. (2007) describe collaboration between CIMMYT, farmers, and NARS in South Asia to promote improved wheat varieties and new resource conservation technologies. This collaboration has been associated with considerable improvement in farmer access to new technologies. Importantly, yield increases of 15-70% and monetary gains have been achieved by resource-poor farmers through the adoption of new varieties and resource conservation technologies.

2.3 Impact of improved wheat management

The last two studies we review here assess how sowing date or weeding influence wheat yields. Lobell et al., 2013 examine the association between sowing date and wheat yields in India. They find statistically significant shifts toward earlier sowing of wheat in Haryana and Uttar Pradesh, with insignificant changes in Punjab. On average, wheat was sown one week earlier by 2010 than it was in 2000. The authors estimate a yield gain of 5% averaged across India due to the sowing date trend.

Ortiz-Monasterio (2007) investigate how planting date and weeding influence wheat yield in Yaqui Valley, Mexico. Satellite estimates of planting date agreed well with farmer reported dates in 100 fields. Comparison of planting dates with remotely sensed yields indicates only small yield reductions with planting outside of recommended planting date. By contrast, the weed assessment study reveals substantial yield losses when weeds were in the field during the summer prior to planting.

3. Discussion

The reviewed studies provide coverage of wheat growing areas in particular countries throughout the developing world (Ethiopia, Turkey, India, Pakistan, Bangladesh, Nepal, Kazakhstan, Syria, and Mexico). Studies vary considerably in terms of the quality of the data and empirical methods used. Nearly all studies used cross-sectional, observational data, thus requiring special econometric approaches to enable assessment of causal effects, which is particularly important in the case of impact assessment. The recent Ethiopia study stands out in terms of data quality (a large, nationally representative survey was used) and the use of special econometric techniques to assess causal impacts of technology adoption (Shiferaw et al. 2014).

To better enable comparison across studies, it is recommended that CRP-Wheat develop a uniform, core set of questions to measure adoption and impact of CRP-Wheat research outputs. This adoption/impact module would be short to allow Wheat scientists to add the module on to their surveys, thereby generating a comparative dataset across countries. It is also recommended that CRP-Wheat collect longitudinal data and conduct randomized control trials to increase the quality of their impact assessments, although we recognize that such surveys entail much higher cost and time to implement.

Also encouraged is the use of high quality, existing datasets that are large and nationally representative to complement the smaller, focused datasets that CIMMYT and ICARDA generally collect. The Living Standards Measurement Study's Integrated Surveys on Agriculture (LSMS-ISA) presents an opportunity in this regard. The LSMS-ISA is a 6-year project in seven countries in sub-Saharan Africa, to generate panel datasets with detailed and accurate agricultural information. The data are public access and geo-referenced to allow linking up with climate and other geographic data sources as well as crop model results. Although wheat is not a major crop in most of the sub-Saharan target countries of LSMS-ISA, it is of interest to CRP-Wheat that the World Bank is interested to add questions about wheat variety cultivation to future rounds of LSMS-ISA surveys.

Finally, the present review focused on the finalized/published studies during 2004-14 – and thereby fails to capture some of the work initiated during the CRP years or yet to be published in recognized journals. Furthermore, the CRP years allow to potentially select more representative study areas and to link the different levels of adoption/impact assessment. In the pre-CRP years project funding became the prime source for funding CG research. Although some projects include levels of adoption monitoring and studies, this is typically limited to the target intervention areas and constrains impact assessment during the project implementation years. ACIAR now provides an interesting alternative by implementing post-project impact studies (e.g. Jilani et al., 2013) – although limited to their project portfolio.

The BMGF has initiated worthwhile studies to document adoption and impacts across-CRPs, first for Africa with the "Diffusion and Impact of Improved Varieties in Africa" (DIIVA) and more recently in Asia through the "Strengthening Impact Assessment in the CGIAR System" (SIAC) – and the CRP-Wheat was/is an active participant in both, particularly for the Asia study given the still limited wheat production in sub-Saharan Africa. The CRP years with new W1/W2 funding started to provide an opportunity to complement the project based studies – both geographically and by linking the studied levels. For instance, CRP-Wheat initiated in 2014 the currently on-going global study on current status of adoption of improved wheat varieties – a long overdue update of Lantican et al (2005). CRP-Wheat also initiated and supported several country studies that will be published over the coming years, including China, Morocco, Uzbekistan, Iran, Sudan and a revisit of Ethiopia panel study. However, overall CRP-Wheat funding has been relatively limited and thereby constrained the ability to capitalize on this opportunity- reflected inter alia in only a modest increase in adoption/impact publications during the CRP years. Still, the current stock of adoption/impact studies provide a robust basis for the CRP-Wheat transition years and second phase and with adequate funding for such studies provides a stepping stone towards even more rigorous adoption studies and impact assessment of this critical food security crop.

3. References

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Annex 1. A complete listing of impact CRP Wheat-related impact studies, 2004-14.

Most of the publications with CIMMYT authors may be accessed through the [CIMMYT publications repository].

No.	Responsible center	CRP	Study / publication title	Author(s)	Publication year
1	CIMMYT	Wheat	The economic impact in developing countries of leaf rust resistance breeding in CIMMYT-related spring bread wheat	Marasas, C.N.; Smale, M.; Singh, R.P.	2004
2	ICARDA	Wheat	Wheat farming in Syria: an approach to economic transformation and sustainability	Pala, M., et al.	2004
3	CIMMYT	Wheat	Occurrence and impact of a new leaf rust race on durum wheat in Northwestern Mexico from 2001 to 2003	Singh, R.P, et al.	2004
4	CIMMYT	Wheat	Socio-economic impact of zero-till technology of wheat in the State of Uttaranchal	Thakur, T. C., et al.	2004
5	CIMMYT	Wheat/ Maize	Conservation agriculture and resource conserving technologies - A global perspective	Harrington, L. and O. Erenstein	2005
6	CIMMYT	Wheat	An initial assessment of the potential impact of stem rust (race UG99) on wheat producing regions of Africa and Asia using GIS	Hodson, D.P.; Singh, R.P.; Dixon, J.	2005
7	CIMMYT	Wheat	Impacts of International Wheat Breeding Research in the Developing World, 1988-2002	Lantican, M. A., et al.	2005
8	CIMMYT	Wheat	The effect of sunn pest (Eurigaster integriceps) damage on durum wheat: impact in the marketplace	Ozberk, I., et al.	2005
9	CIMMYT	Wheat	Evaluation and performance of permanent raised bed cropping systems in Asia, Australia and Mexico	Roth, C. H., et al.	2005
10	CIMMYT	Wheat/ Maize	CIMMYT's Formal Training Activities: Perceptions of Impact from Former Trainees, NARS Research Leaders, and CIMMYT Scientists	Cooksy, L.J.; Arellano, E	2006
11	CIMMYT	Wheat	Adoption and economic impact of improved wheat varieties in the developing world	Dixon, J., et al.	2006
12	CIMMYT	Wheat/ Maize	Analyzing technology adoption using microstudies: limitations, challenges, and opportunities for improvement	Doss, C.R.	2006
13	CIMMYT	Wheat/ Maize	Impacts of International Research on Intertemporal Yield Stability in Wheat and Maize: An Economic Assessment	Gollin, D.	2006
14	CIMMYT	Wheat/ Maize	Economic impact of water-limited conditions on cereal grain production	Heisey, P.W.; Morris, M.L.	2006
15	CIMMYT	Wheat/	Participatory research: A catalyst for	Hellin, J., et al.	2006

		Maize	greater impact		
16	CIMMYT	Wheat	Pakistan's Final Report to DfID. Reaping the Benefits: Assessing the Impact and Facilitating the Uptake of Resource Conserving Technologies in the Rice-Wheat Systems of the Indo-Gangetic Plain.	Jafry, T., et al.	2006
17	ICARDA	Wheat	Targeting research for enhanced impact on poverty in marginal areas: The representative case of the dry areas of Syria	La Rovere, R.; Aw-Hassan, A.	2006
18	CIMMYT	Wheat/ Maize	Analysis of Participatory Research Projects in the International Maize and Wheat Improvement Center	Lilja, N. and M. Bellon	2006
19	CIMMYT	Wheat/ Maize	New avenues in impact assessment of participatory research and gender analysis	Lilja, N., et al.	2006
20	CIMMYT	Wheat/ Maize	Overview: New avenues in impact assessment of participatory research and gender analysis	Lilja, N., et al.	2006
21	ICARDA	Wheat	The impact of international and national agricultural research in achieving wheat food security in Syria	Mazid, A., et al.	2006
22	CIMMYT	Wheat	Bangladesh's Final Report to DfID. Reaping the Benefits: Assessing the Impact and Facilitating the Uptake of Resource Conserving Technologies in the Rice-Wheat Systems of the Indo-Gangetic Plain.	Page, S. L. J.	2006
23	CIMMYT	Wheat	Impacts of breeding on international collaborative wheat improvement	Reynolds, M. P. and N. E. Borlaug	2006
24	CIMMYT	Wheat	Assessment of Farmer Adoption of Surface Seeded Wheat in the Nepal Terai	Tripathi, J., et al.	2006
25	CIMMYT	Wheat	U-impact pathway for diagnosis and impact assessment of crop improvement	Dixon, J.; Hellin, J.; Erenstein, O.; Kosina	2007
26	CIMMYT	Wheat	Adoption and impacts of zero tillage as a resource conserving technology in the irrigated plains of South Asia	Erenstein, O.; Farooq, U.; Malik, R.K.; Sharif, M.	2007
27	CIMMYT	Wheat	Adoption and impacts of zero-tillage in the rice-wheat zone of irrigated Haryana	Erenstein, O.; Malik, R.K.; Singh, Sher.	2007
28	CIMMYT	Wheat	Adoption and impacts of zero-tillage in the rice-wheat zone of irrigated Punjab, Pakistan	Farooq, U.; Sharif, M.; Erenstein, O.	2007
29	CIMMYT	Wheat	Evaluating the nutritional impact of maize varieties genetically improved for protein quality	Gunaratna, N. S.	2007
30	CIMMYT	Wheat	India's (NDUA&T) Final Report to DFID. Reaping the Benefits: Assessing the impact and facilitating the uptake of resource-conserving technologies in the rice-wheat systems of the Indo-Gangetic Plain.	Jafry, T.	2007
31	CIMMYT	Wheat	India's (BHU) Final Report to DFID. Reaping the Benefits: Assessing the impact and facilitating the uptake of resource-conserving technologies in the rice-wheat systems of the Indo-Gangetic Plain.	Joshi, A. K., et al.	2007
32	CIMMYT	Wheat/ Maize	Operational guidelines for assessing the impact of agricultural research on livelihoods: Good practices from CIMMYT	La Rovere, R.; Dixon, J. El Batan	2007

33	CIMMYT	Wheat	CIMMYT, assessing the impact of natural resource management research: the case of zero tillage in India's rice-wheat systems	Laxmi, V.; Erenstein, O.; Gupta, R.K.	2007
34	CIMMYT	Wheat	Impact of zero tillage in India's rice-wheat systems	Laxmi,V.; Erenstein, O.; Gupta, R.K.	2007
35	CIMMYT	Wheat	Economic impact of maize research in Tanzania.	Moshi, A. J., et al.	2007
36	CIMMYT	Wheat	Partnering with farmers to accelerate adoption of new technologies in South Asia to improve wheat productivity	Ortiz-Ferrara, G., et al.	2007
37	CIMMYT	Wheat	Remote sensing assessment of regional yield losses due to sub-optimal planting dates and fallow period weed management	Ortiz-Monasterio, J. I. and D. B. Lobell	2007
38	CIMMYT	Wheat	Nepal's Final Report to DFID. Reaping the Benefits: Assessing the impact and facilitating the uptake of resource-conserving technologies in the rice-wheat systems of the Indo-Gangetic Plain.	Page, S. L. J., et al.	2007
39	CIMMYT	Wheat	Conservation agriculture in the steppes of Northern Kazakhstan: The potential for adoption and carbon sequestration.	Wall, P.C., et al.	2007
40	CIMMYT	Wheat	Zero Tillage Impacts in India's Rice-Wheat Systems: A review	Erenstein, O. and V. Laxmi	2008
41	CIMMYT	Wheat	On-farm impacts of zero tillage wheat in South Asia's rice-wheat systems	Erenstein, O., et al.	2008
42	CIMMYT	Wheat/ Maize	Participatory technology development in agricultural mechanisation in Nepal: how it happened and lessons learned	Goodrich, C. G., et al.	2008
43	CIMMYT	Wheat/ Maize	Reflections on the process of developing and enriching impact assessment culture at CIMMYT	La Rovere, R.; Dixon, J.	2008
44	CIMMYT	Wheat/ Maize	Developing a new paradigm for impact assessment at CIMMYT: Institutionalizing impact assessment at CIMMYT	La Rovere, R.; Dixon, J.; Hellin, J	2008
45	CIMMYT	Wheat/ Maize	Responding to the challenges of impact assessment of participatory research and gender analysis	Lilja, N.; Dixon, J.	2008
46	CIMMYT	Wheat/ Maize	External review and impact assessment of the African Highlands Initiative (AHI). Program evaluation report	Mekuria, M.; La Rovere, R.; Szonyi, J.A.	2008
47	CIMMYT	Wheat/ Maize	Strategic guidance for ex post impact assessment of agricultural research	Walker, T., et al.	2008
48	CIMMYT	Wheat/ Maize	Transforming impact assessment: beginning the quiet revolution of institutional learning and change.	Watts, J., et al.	2008
49	CIMMYT	Wheat	Zero Tillage in the Rice-Wheat Systems of the Indo-Gangetic Plains: A review of impacts and sustainability implications	Erenstein, O.	2009
50	CIMMYT	Wheat	Specification effects in zero tillage survey data in South Asia's rice-wheat systems	Erenstein, O.	2009
51	CIMMYT	Wheat	Adoption and impact of conservation agriculture-based resource conserving technologies in South Asia.	Erenstein, O.	2009
52	CIMMYT	Wheat	Factors affecting the adoption of zero	Erenstein, O., and U.	2009

			tillage wheat in the rice-wheat systems of India and Pakistan	Farooq.	
53	CIMMYT	Wheat	A survey of factors associated with the adoption of zero tillage wheat in the irrigated plains of South Asia	Erenstein, O., et al.	2009
54	CIMMYT	Wheat	The Rice-Wheat Consortium and the Asian Development Bank: A History	Harrington, L. W. and P. H. Hobbs	2009
55	CIMMYT	Wheat	Adoption of conservation agriculture in Kazakhstan	Karabayev, M.; Suleimenov, M.	2009
56	CIMMYT	Wheat/ Maize	Learning through Impact Assessment the case of Sasakawa Africa/SG2000	La Rovere, R.; Aredo, D	2009
57	ICARDA/CIMMYT	Wheat	Adoption and Impacts of Improved Winter and Spring Wheat Varieties in Turkey	Mazid, A., et al.	2009
58	CIMMYT	Wheat	Economic Analysis of Diversity in Modern Wheat	Meng, E. C. H. and J. P. Brennan, Eds.	2009
59	CIMMYT	Wheat	Impact of wheat breeding at ICARDA and the status of Ug99 resistance	Osman, A., et al.	2009
60	CIMMYT	Wheat	Putting the poorest farmers in control of disseminating improved wheat seed: a strategy to accelerate technology adoption and alleviate poverty in Bangladesh	Sam L. J. Page, Md Elahi Baksh, Etienne Duveiller, Stephen R. Waddington	2009
61	CIMMYT	Wheat	Socio-economics of integrated crop and resource management technologies in the rice-wheat systems of South Asia: Site contrasts, adoption and impacts using village survey findings	Singh, R.P., et al.	2009
62	CIMMYT	Wheat/ Maize	Impacts of CIMMYT's International Training Linked to Long-term Trials in Conservation Agriculture, 1996-2006	Svitáková, J., Kosina, P., La Rovere, R.,	2009
63	CIMMYT	Wheat	Accelerating the adoption of UG99 resistant wheat cultivars in Nepal	Bhatta, M.R., et al.	2010
64	CIMMYT	Wheat	Zero Tillage in the Rice-Wheat Systems of the Indo-Gangetic Plains: A Review of Impacts and Sustainability Implications	Erenstein, O.	2010
65	CIMMYT	Wheat	Triangulating technology diffusion indicators: Case of zero tillage wheat in South Asia's irrigated plains	Erenstein, O.	2010
66	CIMMYT	Wheat	Village surveys for technology uptake monitoring: Case of tillage dynamics in the Trans-Gangetic Plains	Erenstein, O.	2010
67	CIMMYT	Wheat	Assessing the impact of adaptive agricultural research on accelerating technology deployment: The case of zero tillage wheat in India.	Erenstein, O., et al.	2010
68	CIMMYT	Wheat	Livelihoods-based impact assessment in the rice–wheat farming system of South Asia	Hellin, J., et al.	2010
69	CIMMYT	Wheat/ Maize	Catalyzing learning, change, and increased effectiveness through impact evaluation: The Case of Sasakawa for Africa.	La Rovere, R., et al.	2010
70	CIMMYT	Wheat	The genetic and economic impact of the CIMMYT wheat breeding program on local producers in the Yaqui Valley, Sonora Mexico	Nalley, L. L., et al.	2010
71	CIMMYT	Wheat/	Conservation agriculture based systems	Wall, P., et al.	2010

		Maize	and their impact on climate change, food security and the poor		
72	CIMMYT	Wheat/ Maize	Diffusion and impact of improved maize and wheat varieties in East and Southern Africa	De Groote, H., Gitonga, Z., Mugo, S.	2011
73	CIMMYT	Wheat	Overview of winter and facultative wheat in Central and West Asia and North Africa; impact of international winter wheat improvement program.	Keser, M., et al.	2011
74	CIMMYT	Wheat/ Maize	Re-orienting participatory plant breeding for wider impact.	Badstue, L.B., et al.	2012
75	CIMMYT	Wheat/ Maize	Conservation Agriculture in Maize- and Wheat-Based Systems in the (Sub)tropics: Lessons from Adaptation Initiatives in South Asia, Mexico, and Southern Africa	Erenstein, O., et al.	2012
76	CIMMYT	Wheat	Influence of sources of seed on varietal adoption behavior of wheat farmers in indo-gangetic plains of India.	Ghimire, S., et al.	2012
77	CIMMYT	Wheat/ Maize	Climate change and food security in the developing world: Potential of maize and wheat research to expand options for adaptation and mitigation	Hellin, J., et al.	2012
78	CIMMYT	Wheat	Farmer access and differential impacts of zero tillage technology in the subsistence wheat farming systems of West Bengal, India	Krishna, V., et al.	2012
79	CIMMYT	Wheat	Determinants of adoption and spatial diversity of wheat varieties on household farms in Turkey.	Negassa, A., et al.	2012
80	CIMMYT	Wheat	Improved wheat variety adoption, price dynamics, and farm households' income in Ethiopia: Applications of quasi-experimental approaches	Negassa, Asfaw, et al.	2012
81	CIMMYT	Wheat	Adoption analysis of resource-conserving technologies in rice (Oryza sativa)-wheat (Triticum aestivum) cropping system of South Asia.	Singh, R., et al.	2012
82	CIMMYT	Wheat/ Maize	Role of institutional and socio-economic factors on adoption, dis-adoption and non- adoption of soil and water conservation technologies: Empirical evidence from the North Western Ethiopia highlands	Teshome, A., et al.	2012
83	CIMMYT	Wheat	Impact of agricultural extension services on technology adoption and crops yield: empirical evidence from Pakistan.	Ali, A., et al.	2013
84	CIMMYT	Wheat	Impact of zero tillage adoption on household welfare in Pakistan.	Ali, A., et al.	2013
85	ICARDA	Wheat	The impacts of an improved technology package on production efficiency: the case of wheat farms in the northern state of Sudan	Fageer et al.	2013
86	CIMMYT	Wheat/ Maize	Shifting the goalposts-from high impact journals to high impact data.	Gassner, A., et al.	2013
87	CIMMYT	Wheat/ Maize	ACIAR wheat and maize projects in Afghanistan	Jilani, A., et al.	2013

88	CIMMYT	Wheat	Adoption of conservation Agriculture in Kazahstan	Karabayev, M., et al.	2013
89	CIMMYT	Wheat	Satellite detection of earlier wheat sowing in India and implications for yield trends	Lobell, D. B., et al.	2013
90	CIMMYT	Wheat	Right-Sizing Stem-Rust Research	Pardey, P. G., et al.	2013
91	CIMMYT	Wheat	Crops that feed the world 10. Past successes and future challenges to the role played by wheat in global food security	Shiferaw, B., et al.	2013
92	CIMMYT	Wheat/ Maize	Adoption of conservation agriculture in the Mexican Bajio.	Van den Broeck, G., et al.	2013
93	CIMMYT	Wheat	Analysis of Adoption and Diffusion of Improved Wheat Technologies in Ethiopia	Yirga, C., et al.	2013
94	ICARDA	Wheat	Measuring the impacts of conservation tillage (CT) on household income and wheat consumption: a Syrian case	El-Shater, T., et al.	2014
95	CIMMYT	Wheat/C CAFS	An Assessment of the Impact of Laser-Assisted Precision Land Levelling Technology as a Component of Climate-Smart Agriculture in the State of Haryana, India	Gill, G.J.	2014
96	CIMMYT	Wheat	Impact of CIMMYT Wheat Germplasm on China's Wheat Productivity	Huang, J. et al	2014
97	CIMMYT	Wheat	Productivity and efficiency impacts of conservation tillage in northwest Indo-Gangetic Plains	Krishna, V. V. and P. C. Veettil	2014
98	CIMMYT	Wheat	An empirical examination of the dynamics of varietal turnover in Indian wheat	Krishna, V. V., et al.	2014
99	ICARDA	Wheat	Implications for adoption of zero tillage (ZT) on productive efficiency: a Syrian case	Mugera, A., et al.	2014
100	CIMMYT	Wheat	Adoption of improved wheat varieties and impacts on household food security in Ethiopia	Shiferaw, B., et al.	2014
101	ICARDA	Wheat	Decision and duration analysis of the adoption of zero tillage among Syrian cereal producers	Yigezu, Y. et al.	2014
102	CIMMYT	Wheat	On-farm economic and environmental impact of zero-tillage wheat: a case of northwest India	Aryal, J. P., et al.	in press
103	ICARDA/CIMMYT	Wheat	Measuring the impact of agricultural research: the case of new wheat varieties in Turkey	Mazid, A., et al.	in press
104	CIMMYT	Wheat/ Maize/Others	Measuring the Effectiveness of Crop Improvement Research in Sub-Saharan Africa from the Perspective of Varietal Output, Adoption, and Change: 20 Crops, 30 Countries, and 1150 Cultivars in Farmers' Fields	Walker, T. et al	in press
105	ICARDA	Wheat	Explaining adoption and measuring impacts of conservation agriculture on productive efficiency, income, poverty, and food security in Syria	Yigezu, Y. et al.	in press