

**Conservation Agriculture: New
Promises for Sustainable Farming**
**CIMMYT: International Maize and Wheat
Improvement Center**
El Batán, Mexico
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INTRODUCTION TO THE WORLD FOOD PRIZE

During the winter of 2002, when I was 11 years old, my parents took my brother and me from the comfort of our home in Ames, Iowa, on a trip to the sprawling and crowded city of Mumbai, India. The last time I had been to India was at the age of 5 and the only thing that filled my mind when I tried to remember the experience was the banana-shaped couch in my uncle's home. I had no idea what to expect. As we exited the airport and looked for my grandma among the hundreds of Indian citizens, a thick layer of dust caked the air and I started to feel the differences between this city and the city I called home. What I saw during those 3 weeks changed my life in more ways than one. I saw miserable poverty. I saw people living in small huts with barely enough food to eat. I saw children my age dying on the streets. I also saw eyes filled with hope. They say that kids have a strong sense of social injustice, and I certainly was not the same person after that trip.

When I entered high school, I started reading books about poverty, famine, disease, illiteracy, and social injustice, and began figuring out just how complex these problems really were. I continued to read books and articles and I joined clubs at my school so I could talk to other students about what drives these issues and how we could help. I found out about the World Food Prize Youth Institute from a teacher at my school and was ecstatic to see that such a program existed. When my faculty sponsor told me that I had been selected from my school to attend, I was elated and immediately began thinking of a possible region and factor on which to focus my youth institute paper.

By researching the role of education and effective water management in rural India, I learned a lot more about the dilemmas faced by the country that had truly opened my eyes as a young girl. The Youth Institute gave me an expanded view of the role that science could play in solving issues of food security, and solidified my desire to work on the research front to help solve issues of poverty and hunger. Seeing World Food Prize Laureates from different backgrounds and countries working together on issues of food security made me realize the importance of cooperation and sharing information to fulfill Dr. Borlaug's aim in founding the World Food Prize: to promote improvement in the quality, quantity, and availability of food in the world. It was refreshing to interact with such distinguished and passionate individuals at meal times and hear about their many accomplishments and their visions for the future.

On Saturday morning, after hearing the 2007 Borlaug-Ruan Interns present their 8-week internships, I was positive I was going to apply. The interns had each had unique and fascinating

experiences researching wholly different topics – everything from photophthora and late blight disease in potatoes to the effect of education on food security in rural households. But although each intern had a distinctive experience, all agreed on one thing: the internship changed their lives. After a long application process and a nerve-racking interview, I checked the mail everyday as I waited anxiously for the outcome. I was absolutely thrilled to hear that I would be spending my summer at the International Maize and Wheat Improvement Center (CIMMYT) in El Batán, México, as a Borlaug-Ruan International Intern. Nothing I read or imagined could prepare me for the experience I was about to have.

HISTORY OF CIMMYT

In 1944 Dr. Norman Borlaug was appointed geneticist and plant pathologist assigned to organize and direct the Cooperative Wheat Research and Production Program, a pilot program sponsored by the Government of Mexico and the Rockefeller Foundation. The program was dedicated to conducting research in a multitude of disciplines, including plant breeding, entomology, cereal technology, genetics, agronomy, plant pathology, and soil science so that the wheat shortages present in Mexico could be addressed. At that time, Mexico's farmers raised less than half of the wheat necessary to meet the demands of the population, frequently losing much of the harvest to rust disease.

After working for 13 long and difficult years, Dr. Borlaug and his team managed to develop shorter wheat varieties that were rust-resistant and produced higher yields, while responding better to fertilizer than the older varieties. His work led Mexico to become self-sufficient in wheat production by 1956 – a tremendous feat for the developing nation. Dr. Borlaug's wheat sparked what came to be known as the Green Revolution – suggesting that plant breeding could end world hunger. In the 1960s, other countries adapted the so-called “Mexican innovation model,” hoping for the same success.

In the late 1960s, the Rockefeller Foundation and the Government of Mexico expanded the Cooperative Wheat Research and Production Program into the International Maize and Wheat Improvement Center, or known in Spanish as Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT). CIMMYT is committed to improving livelihoods in developing countries by sharing knowledge and technology to increase food security, improve the productivity and profitability of farming systems, and sustain natural resources.

In 1963, Dr. Borlaug became director of the Wheat Research and Production Program at CIMMYT. In that position, he devoted most of his efforts to research in wheat production and

productivity, and the training of young wheat scientists on a global basis. In the 1960s, both India and Pakistan faced problems with poor harvests. As a young scientist at the Indian Agricultural Research Institute in the 1960s, Dr. Monkombu Sambasivan Swaminathan learned of Dr. Borlaug's recently implemented Mexican dwarf wheat variety and invited Dr. Borlaug to India. The two scientists worked together to develop wheat varieties that would yield higher levels of productivity as well as have higher disease resistance and nutritive value. The evidence of success was colossal – in India, yields increased from 12.3 million tons in 1965 to 20.1 million tons in 1970. By 1974, India was self-sufficient in the production of all cereals. Pakistan also began importing Dr. Borlaug's improved wheat varieties. Once again, the new varieties proved successful – wheat yields nearly doubled, from 4.6 million tons in 1965 to 8.4 million tons in 1970; Pakistan was self-sufficient in wheat production by 1968. The Green Revolution was spreading around the world.

Dr. Borlaug's accomplishments in India and Pakistan were recognized when he was awarded the Nobel Peace Prize in 1970, and dubbed the "Father of the Green Revolution." The next year, multiple development organizations, private foundations, and national sponsors organized the Consultative Group on International Agricultural Research (CGIAR). The CGIAR mission is to achieve sustainable food security and reduce poverty in developing countries. They do this through scientific research and research-related activities in agriculture, forestry, fisheries, and environment, and in policymaking. CIMMYT was one of the first international research centers to be supported through CGIAR. In total, there are 15 CGIAR centers located around the world.

Through clear-eyed understanding of strong science and social and economic systems, CIMMYT does an excellent job of staying true to its mission statement: "To help the poor by increasing the productivity of resources committed to maize and wheat in developing countries while protecting natural resources."

CAPACITY BUILDING, TRAINING, AND CONSERVATION AGRICULTURE

Although the Green Revolution has been very successful in several developing countries, "it has not transformed the world into a Utopia," as Dr. Borlaug himself put it. Because most of the world's poor rely on agriculture for income and sustenance, CIMMYT has developed a variety of approaches to increase agricultural productivity and fulfill its mission statement. From the long-term point of view, one of the most powerful tools for helping a country meet its national food security and resource conservation goals is capacity building.

CIMMYT has been involved in human capacity building for the last 40 years. More than 10,000 researchers from many different countries are alumni of CIMMYT's human resource development efforts. CIMMYT shares knowledge with its partners through the Knowledge Sharing and Capacity Building Office, a department housed in the Impacts Targeting and Assessment Unit (ITAU) with which I had the opportunity to work during my two-month internship.

Through the ITAU, CIMMYT trains and mentors researchers, provides technical information that helps researchers, policymakers and development workers all over the world, advocates appropriate policies to foster food and income security, and through the networks of partners, teaches farmers and rural communities how to use new farming practices and produce seed. The activities supported by the ITAU are essential to help nations become self-sustainable and to foster development.

For about 20 years CIMMYT has been conducting research and numerous capacity-building activities in the area of Conservation Agriculture (CA). One of the main efforts to spread this knowledge is a 5-week-long course held in Mexico annually. Because the course is relatively long and intensive, it has the most impact on the trainee. CA is a relatively new approach to farming which is a complete change from conventional practices. It is a method of farming that stresses resource-saving agricultural crop production and strives to achieve an adequate level of profits with high and sustained production levels while concurrently conserving the environment. There are three basic principles to CA: (1) continuous minimum mechanical soil disturbance, (2) permanent organic soil cover, and (3) diversified crop rotations.

There are a number of advantages to using CA. It provides a truly sustainable system, in that it conserves and enhances natural resources by increasing the variety of soil biota, fauna, and flora without sacrificing high yields. Soil erosion is reduced under CA – if crop residues on the soil surface are kept, they protect the soil from heavy rainfall and help capture and channel water, which prevents runoff and soil erosion. The no-till fields act as a sink for CO₂ – meaning that if CA was applied on a global scale it could provide a major contribution to control air pollution and global warming. Using CA also lowers overall production costs. Soil tillage is among all farming operations the single most energy-consuming – by not tilling the soil, farmers can save between 30 and 40% of time, labor, and fossil fuels as compared to conventional cropping.

For the farmer, CA is attractive because it allows a reduction in production costs, reduction of time and labor, and in mechanized systems it reduces the costs of investment in and maintenance of machinery in the long term. Although CA would seem like a natural choice for subsistence

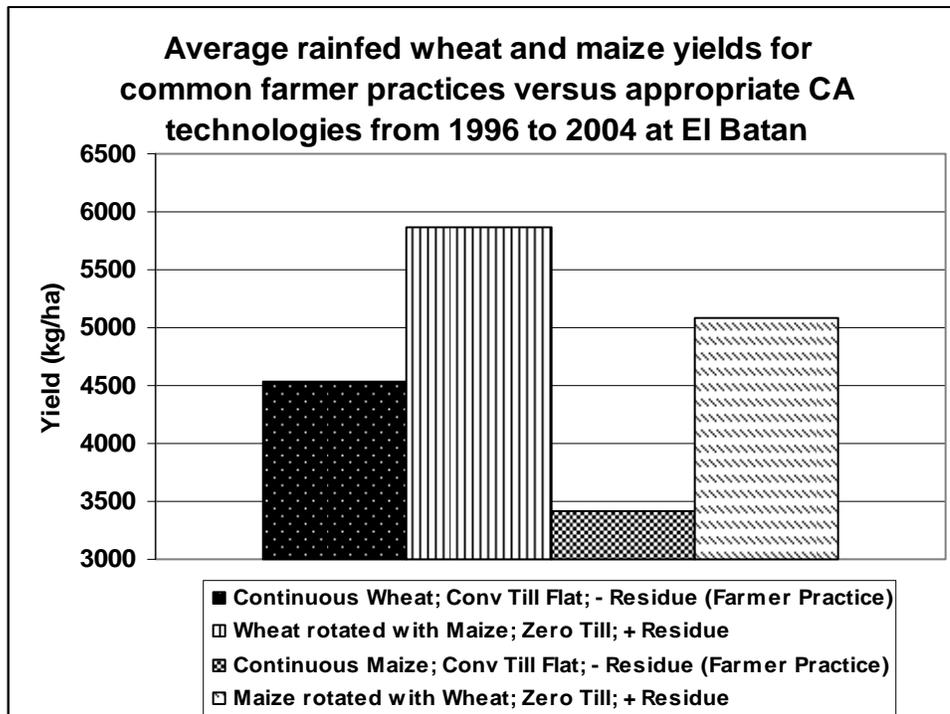


Figure 1. *Wheat and maize grain yields*

farmers in developing countries, few practice it because it is a total change from conventional farming. That is why it is extremely important to have continued financial support to research agronomical practices and to conduct capacity-building activities to continue the spread of CA.

During my first three weeks at CIMMYT, the annual Conservation Agriculture training course was taking place. Bram Govaerts, cropping systems management specialist who was in charge of the course, and Antonio Castellanos, a soil scientist who also played a major role in conducting the course, were kind enough to allow me to participate. The visiting scientists included 5 from Romania, 1 from Ethiopia, and 2 from China, all of whom warmly welcomed me into their group and were extremely genial and patient, always answering my questions and explaining technical procedures I was not familiar with. Their intelligence and kindness not only helped me gain a greater understanding of CA, but also helped me effortlessly adjust to life at CIMMYT – they were a group to eat dinner with, a group to travel with on the weekend, a group to have late night discussions with (everything from plant pathology and rust resistance to the way school systems are set up in our respective countries), a group to play ping-pong with, a group to make jokes with, a group of friends. Some of the best memories of my internship occurred within those first few weeks, and when I think back, it was most certainly because of the people I met. Being part of the course not only helped me gain a greater understanding of how training was conducted

Picture 1. *Conservation Agriculture Trainees*



at CIMMYT, but also solidly helped me learn about CA. Instead of imparting only theoretical knowledge to trainees, a largely hands-on and specialized aspect is also emphasized so that course participants are able to deal with practical problems seen in maize and wheat fields. The course included a number of lectures by scientists from various departments of CIMMYT, visits to various on-farm

experiments with collaborating farmers, cropping systems management evaluation, and soil quality assessment at farm level in the field. From the lectures I learned a lot about CIMMYT's activities and the collaboration that is necessary to come up with tangible solutions to problems. I heard lectures about the plant nutrition laboratory, the wheat germplasm bank, experimental design and statistical analysis, geographical information systems, the wheat quality laboratory, biofuels and their impact on sustainable agriculture, maize entomology, pests, and diseases, and research in an international competitive environment and how to deal with science politics. CIMMYT has so much diversity in the topics it researches, but a pervading message of the course was the absolute necessity of integration. Each topic and perspective offered is equally important and necessary to create a system that works for the people to whom CIMMYT is ultimately accountable – the farmer.

After three weeks, my main adviser, Dr. Petr Kosina, originally from the Czech Republic and Coordinator of Knowledge Sharing and Capacity Building, returned from conducting a training course in Nairobi, Kenya, and began giving me instruction for my research. An impact assessment of training on CA over the last 15 years had to be done, and it wasn't going to be an easy task.

PROJECT DESCRIPTION AND METHODOLOGY

When I arrived at CIMMYT, the ITAU was gathering information on training programs done in Conservation Agriculture so that an impact assessment study could be completed. It is very difficult to find information about training that was conducted over the last 20 years outside headquarters. Funding for capacity building was abundant until about the mid-1990s when funding started to see a declining trend. The Rockefeller foundation would earlier ask CIMMYT scientists to implement technology or train scientists in a specific country, and they would fund the entire operation. But in the 1990s the situation changed dramatically. Donors started requiring Impact

Assessment Studies so they could better understand how money was being spent. Unfortunately, there was not very strict documentation of the projects CIMMYT had completed in the past. To this day, it has become increasingly difficult for CIMMYT to find funding for its capacity-building activities. Proposals have to be drafted with specific milestones for each activity, timelines for meeting the goals of the project have to be made, and after implementation impact assessments have to be done so that donors can see whether or not the money they provided truly made a change. And even with all these checks in place, the center still faces problems with receiving sufficient funding, particularly for capacity building.

My task at CIMMYT was to help with the current ongoing Impact Assessment of training programs in Conservation Agriculture. We wanted to find out if CIMMYT, by having trained several hundreds of scientists and extension workers in the area of CA, has significantly contributed to the adoption and spreading of technology among farmers in developing countries in a relatively fast and flexible manner. My project involved several components. I had to systematically collect the names of past participants of the training courses held both at CIMMYT and abroad over the last 15 years, compile a list of scientists who had worked in the ITAU at CIMMYT in the past, make a list of all courses and events, find the contact details of the past trainees, and then develop a questionnaire that would be sent to them. At the beginning of July, Jirina Svitakova, an economics PhD student from the Czech Republic arrived at CIMMYT and she immediately started helping me with the work that I had been doing the previous weeks.

We first had to compile a database of contact information for scientists who attended courses in Mexico, scientists who attended courses in other countries, visiting scientists and degree students, and we also had to create a database of events (field days and demonstrations) that were conducted both in Mexico and abroad. The scientists who had worked in the ITAU were sent e-mails asking if they recalled any information we didn't have in our database. It is important to have as complete a database as possible so that there is a large enough response group from which to draw valid conclusions. A method of correct information collection still has to be perfected at CIMMYT – they are continually struggling to make sure they have all the contact information after each course, apart from keeping this updated. The communication between headquarters and country offices needs to be strengthened. While, for the most part, the information for courses conducted in Mexico was complete, that for the other categories was incomplete. We looked through CIMMYT's annual reports, country office reports, program reports, and the archives to try and salvage any additional information for the database.

After updating the database with the information we found (see Appendix), we proceeded to develop the surveys – a seemingly simple task, but actually quite the contrary. The study of training programs can be approached in different ways. There is a distinction which needs to be made between examinations as a way to measure what the trainees have learned, and impact assessments to evaluate how useful a CIMMYT course has been for making changes in farmers' fields around the world. Pre- and post-course examinations had been given to the trainees, but this was not a way to measure the impact of the courses. The most common procedure for doing an impact assessment is to examine the effectiveness of training programs by measuring how well trainees have absorbed the specific concepts, information, and skills taught.

The research Jirina and I did is based on a participant follow-up study of former trainees, research leaders, and partners. The research included obtaining and analyzing information about three aspects of training in Conservation Agriculture. First, the respective training program was assessed from the standpoint of the personal development and constraints of the trainees – the usefulness of the technical skills they developed, the needs of research and extension workers, and problems faced once the trainees returned to their home countries. Second, the training program was assessed from the standpoint of the institutions – how the training worked as a building tool to make improved agricultural technology available to agricultural producers in their respective countries. And as the last standpoint, we analyzed possible secondary benefits received by course participants – their ability to change the way their institutions work or partnerships that were created with CIMMYT.

Jirina and I created 2 different surveys – one for trainees and visiting scientists and one for partner institutions (see Appendix). Developing the surveys took a lot of time and many revisions. The first thing we did was divide the questions we wanted to ask into broad categories, and then moved to develop specific questions within those categories. The categories included personal information, the trainee's perception of the course, the impact of training on the trainee's professional career and personal growth, and the impact of training on the trainee's organization or research institute. After creating the first draft with questions, we met with Roberto La Rovere, an Impacts Specialist in the ITAU. He helped us revise the questionnaire to make it more precise and remove some of the unnecessary questions.

After revising the first draft, we met with Petr, who improved it further, then once again with Roberto, then with Bram Govaerts, and then with Petr several more times. Finally, after 6 or 7 iterations, we sat in Petr's office and he cut up all the questions into sheets of paper so we could map out a sequence. It was extremely important to get the perspectives of Roberto, Bram and Petr

because they were all looking at the questionnaire from different viewpoints – Roberto as a specialist in Impact Assessment, Bram as a specialist in Conservation Agriculture, and Petr as a specialist in Capacity Building. Developing a questionnaire is an art; the questions have to flow in the correct order, be logical, and be understandable. In addition to our English version, we also had to create a Spanish version of the questionnaire for some of the trainees. After many drafts and corrections, we were finally able to settle on a final version. The whole process of creating the questionnaire took two weeks.

We were then ready to send the questionnaire to the course participants. We sent it to the participants of the long-term courses here in Mexico, because the contact information for these was the most complete. However, out of the 80 participants in the database, 60 had e-mail addresses, and out of those, about 20 worked. Outdated information is a constant obstacle for the center, because it makes it near impossible to obtain feedback. Petr had to search and e-mail other CIMMYT offices and partners to ask if they could provide a contact for each trainee, which was a very tedious task. Eventually he found more e-mail addresses, and altogether we were able to send the questionnaire to about 50 people. In order to maximize the number of responses, we provided a variety of options for filling out the questionnaire. Participants could fill it out on SurveyMonkey (online), as a Word document, or in PDF format.

RESULTS

Once I returned to Iowa, I kept in contact with Jirina to obtain the results from our study. The survey sample consisted of participants from “Bed and Zero Till Conservation Agriculture Technologies for Irrigated and Rainfed Wheat and maize Production Systems” courses and visiting scientists. The data set includes participants during a ten-year period, 1996–2006.

In Mexico, during this period there were 15 courses which focused on training in Conservation Agriculture and sustainable resource management. They were held at the center’s headquarters outside Mexico City in El Batán and in its research station near Ciudad Obregón, Sonora state, Mexico. Total participation was 80 trainees from 24 different countries and 11 visiting scientists in the area of conservation agriculture for more than 14 days’ stay.

Table 1 shows the number of trainees and visiting scientists and the response rate by training events. The questionnaire was distributed to a total of 59 course participants and one visiting scientist. Thirty-three participants and visiting scientists were not reachable. Forty-two responses were received and the overall response rate was 71%.

<i>Year</i>	<i>Number of participants</i>	<i>Gender male/female</i>	<i>Distributed surveys</i>	<i>Received surveys</i>
1996 (Obregón)	5	5/0	0	0
1998 (Obregón)	2	2/0	1	1
1999 (Obregón)	3	3/0	2	1
1999 (El Batán)	4	4/0	2	2
2000 (Obregón)	7	7/0	6	0
2001 (Obregón)	5	5/0	4	4
2001 (El Batán)	5	4/1	3	2
2002 (Obregón)	9	9/0	7	6
2002 (El Batán)	8	8/0	7	5
2003 (Obregón)	6	6/0	4	4
2003 (El Batán)	8	8/0	6	5
2004 (Obregón)	2	2/0	1	0
2004 (El Batán)	9	8/1	8	5
2005 (El Batán)	5	5/0	5	4
2006 (El Batán)	2	2/0	2	2
Visiting scientists	11	10/1	1	1
Total	91	88/3	59	42

Table 1. *Survey response rate by training event*

I. Perceptions about the course

Considering the participants' previous background and experience at the time of training, the level of training was in most cases (37 respondents or 88%) considered as satisfactory. The survey asked trainees if they had been using the learning (support) materials distributed during the training. Almost all respondents (93%) of CA courses said that they used the materials (books, publications, CDs, etc.). The next survey question addressed infrastructural or socioeconomic constraints in participants' organization that made it difficult for them to use what they learned during the CA courses (Figure 2).

- 67% of participants presented a problem of machinery or equipment being unsuitable for the application of CA methods.
- About half the respondents (51%) reported limitations in financial resources and resources for providing further training (classrooms, publications, etc.).
- For about a third of the participants the constraints were lack of technical assistance staff, laboratory space and research plots, environmental constraints in the region, and insufficient access to farmers' fields to apply the methods learned during the training.

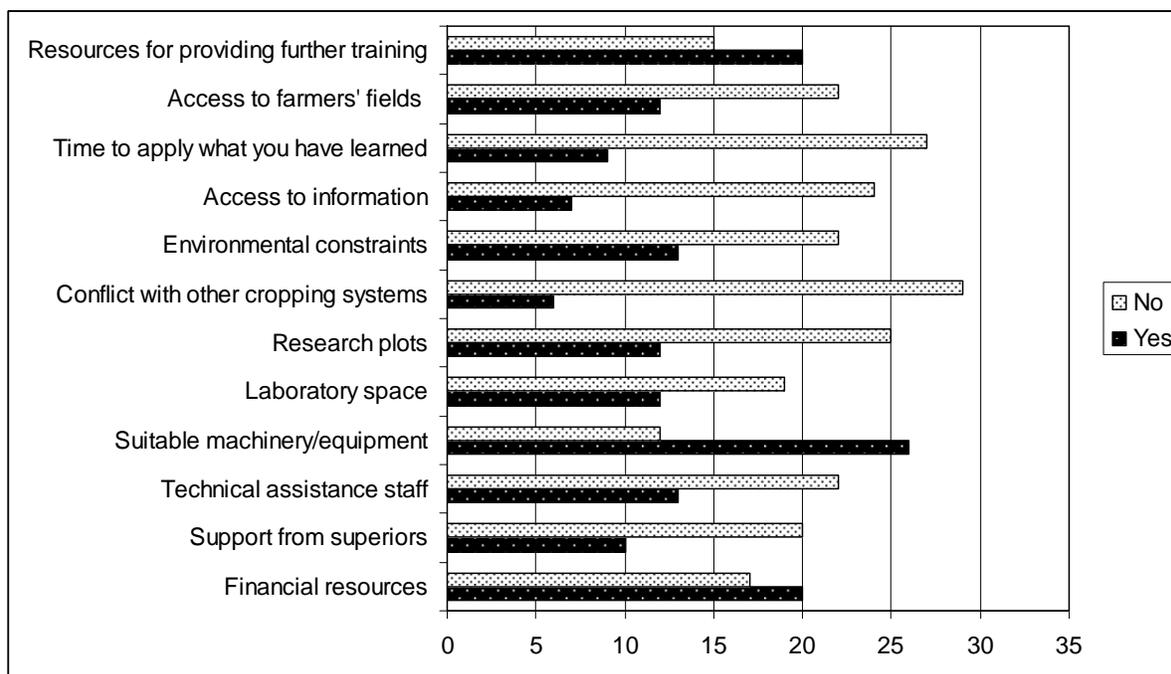


Figure 2. *Infrastructural or socioeconomic constraints in trainees' organizations*

One-third of the respondents did not indicate the need for any improvement in the CA courses at CIMMYT. Half the respondents said that certain improvements were needed, which include the following:

- Training should cover a longer period of time (2-3 months) so that trainees fully understand all agronomic practices under CA from planting till harvest.
- CIMMYT and the organization of the trainee or visiting scientist should collaborate on projects related to the subject of the course.
- The course should teach CA approaches for different farming and production systems and how to adopt CA when two crops in the system differ completely in their biophysical requirements.
- The course needs to be more practical on field research and machinery.
- The investigative-experimental applied programs should be carried out with more farmer involvement. For this reason, people who are able to transmit knowledge and experience to farmers should participate in the courses.

II. Impacts of training on professional and personal growth

Twenty-seven (64%) respondents evaluated their level of confidence as “much higher” and thirteen participants (32%) evaluated it as “somewhat higher” after the course. There were no trainees who considered that their level of confidence had decreased.

Respondents were asked to identify attitudes or behavior (the way they manage things, undertake research, approach problem, etc.) adopted and used as a result of the training program. Examples of the comments are provided in Table 2.

<i>Attitudes / behavior</i>	<i>Sample comments / example suggestions</i>
Knowledge sharing	<ul style="list-style-type: none"> ▪ Demonstrating of bed planting & zero tillage (Turkey, Spain, Mexico). ▪ Ability to provide better training to farmers and scientists (Pakistan, Morocco). ▪ CA demonstration trial in farm land (Uzbekistan). ▪ Helping the GO/NGO to conduct bed planting system (Bangladesh). ▪ Presentations at conferences about CA and permanent bed planting system (Morocco).
Behavior changes	<ul style="list-style-type: none"> ▪ Working and communicating with farmers honestly and sincerely about CA and their problems (Bangladesh). ▪ Checking twice before starting any activity, to see if it's likely to function (Bangladesh). ▪ Spending more time in practical field research (Malawi). ▪ Being better able to approach and synthesize a problem and identify priorities (China, Nepal, Azerbaijan). ▪ Feeling secure about presentation of the knowledge to farmers (Pakistan, Malawi, Nepal, Tajikistan, Australia, Sudan, Mexico, India). ▪ Being more demanding in experiment design and precision (Georgia, Argentina).
Undertake research	<ul style="list-style-type: none"> ▪ Experiment on "Effect Of Planting Methods and Seeding Rates on Grain Yield and Yield Components of Durum Wheat in Harran Plain" (Turkey). ▪ Establishing CA experimental trials in cotton/wheat and rice/wheat systems (Uzbekistan). ▪ CA experiment on the basis of CIMMYT training, collecting the field data personally without any technician's assistance (India, Morocco, Malawi, Sudan). ▪ Conducting research program at farmers' fields (Bangladesh).
Skills and machinery	<ul style="list-style-type: none"> ▪ Developing of machinery, bed planters, wheel tractor zero tillage drill, wheel tractor driven potato planter, two wheel tractor driven bed planter (Bangladesh, Tajikistan, Australia). ▪ Upscaling in crop residue management (Iran). ▪ Developing bed planting of cultivation of a winter wheat in irrigated condition, and presently developing zero-technology cultivation of corn and Soya (Kazakhstan).
Results	<ul style="list-style-type: none"> ▪ Bed planting has already been adopted on 1500 ha in Kyrgyzstan. ▪ Course encourages participants to follow in their work (Argentina). ▪ Ministry of Agriculture in Turkey supports CA.

Table 2. *Attitudes, behavior and skills acquired, as reported by trainees*

When asked whether their training had affected their motivation to do hands-on work, 23 respondents indicated that CIMMYT training motivated them “a lot” to increase the amount of hands-on work, while 12 reported that the training had given them “some” motivation to do so.

III. Helpfulness of the training program in furthering participants’ careers

Thirty-three respondents (79%) indicated that the training program was “very helpful” for their career and for nine (21%) it was “somewhat helpful.” No respondent reported zero or negative effect of the training course at CIMMYT. A summary of the comments describing why the training program was helpful follows:

- Course helped to start and reinforce investigation and validation of respondents’ actions in bed planting and zero tillage in local conditions (Pakistan, Turkey, Morocco, Bangladesh, Kazakhstan, and México).
- Course helped to increase cooperation with scientists from other countries (India, China).
- After the training program at CIMMYT, participants became even more involved in the CA specialization.
- Authority of respondents has grown (Georgia).

IV. Promotion and salary increase

As Figure 3 shows, almost half the respondents (19 or 45%) were promoted and CIMMYT training was a factor contributing in the promotion. Ten respondents (24%) indicated that their salary had increased as a consequence of their training at CIMMYT.

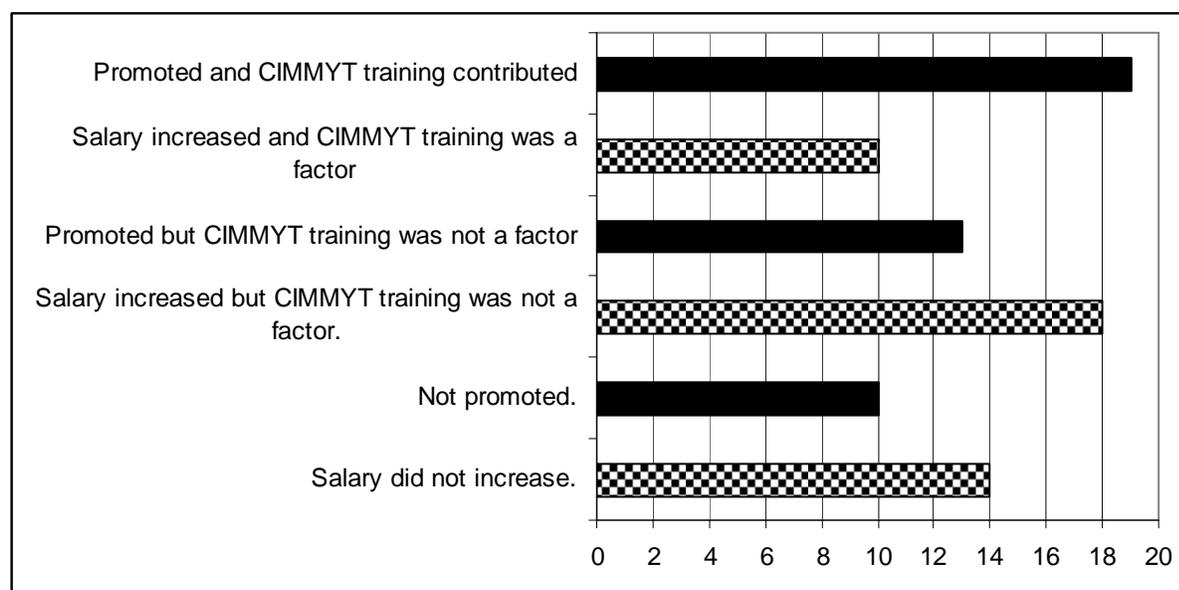


Figure 3. Promotion and salary increase after the CIMMYT training

The respondents were asked to describe any other impact on them personally that was not covered in the previous questions. A summary of their responses is given below:

- The personal impact consists in recognition of the fact that the base of the agronomic problems is the same everywhere. It is necessary to be interested in the conservation of natural resources and the quality of life of poor people. All these things can lead to a different world, with less poverty and more social justice (Argentina).
- Scientific knowledge was gained from CIMMYT experts (Afghanistan, India, Iran, Kazakhstan).
- Level of technical English rose (China, Tajikistan).
- The training broadened the vision, enabling the participant to understand CA globally and develop confidence and expertise to become a recognized scientist in the institution at home. CIMMYT's training program improved the skill and knowledge of many researchers and enhanced the quality of research in their respective fields. It helped to build a better image in the eyes of authorities, farmers and technicians (Malawi, Nepal, Mexico).
- Sharing information with fellow scientists was beneficial (Bangladesh, India).
- Training had a positive impact on how participants looked at any problem and considered all the factors in its solution (Sudan).

V. Impacts of training on trainees' organizations and research

Relevance and use of training: 33 (79%) respondents answered that the training was "very relevant." An additional 9 (21%) reported that the training was "somewhat relevant."

Conducting research in new areas: 37 (88%) respondents agree that the CIMMYT course helped their organization to conduct research in new areas. Examples are summarized below:

- Not only our organization but our government started a country-wide project on bed planting after the training at CIMMYT (Turkey, Morocco).
- Currently the Malawi government has formed a Task Force on CA.
- Many ongoing zero tillage experiments were modified after CIMMYT training (India).
- Since the experience with CIMMYT, some experiments and farm trials in permanent bed planting have been conducted (Spain).
- Our university recommended bed planting in intercropping system of sugarcane with various other crops for higher income (India).
- Zero tillage and minimum tillage with power tiller and other aspects of natural resource management are a priority area of research these days in NWRP (Nepal).

- Now studies/ researches on development of the minimal and zero technology of cultivation of varieties of winter wheat, corn and soya are taking place (Kazakhstan).

Conducting research differently: 31 (74%) respondents agreed that the training at CIMMYT helped to conduct research differently, four trainees (10%) did not agree and three (7%) didn't know. Respondents were asked to provide examples. These are summarized below:

- Long-term trials, fertility experiments, zero tillage and crop establishment trials, response to fertilizers, raised bed planting, layer land leveling, crop residue management, experiments with straw management (Turkey, Malawi, India, Pakistan, Spain, Iran, Nepal, Ethiopia, Georgia, Bangladesh, Mexico).
- Zero tillage and bed planting research work on farmers' fields (Bangladesh, Argentina).
- Trials on permanent raised beds in rice-wheat system (Pakistan).
- Implementation of permanent bed planting in rice-wheat-mungbean cropping system (Bangladesh).
- Development of a protocol of sharing of technology is in progress (Mexico).

Having spent several weeks at CIMMYT, trainees were asked, whether the training program was a good investment for their organization. Thirty-two (85%) respondents answered "yes." Only three participants (8%) answered "no," stating that their organization was not interested in using their new knowledge. Examples of how the training was good are provided below:

- It benefited my country in giving new direction to research in bed planting (Pakistan).
- Training provided helpful information, new technology and new ideas for CA experts (Sudan, Mexico, China, Kazakhstan, Ethiopia, Iran, Malawi, India, Turkey).
- Training provided a basis for diverting the research system toward CA for increase of sustainable productivity and livelihood of people (Argentina, Tunisia, Bangladesh, Nepal, India).
- Trainees can easily present knowledge about CA to the farmers (Mexico).
- Government policy was influenced (India).

Any other impact on their organization that was not covered by the previous questions is summarized below:

- CIMMYT has contributed a lot to strengthen research qualities of our organization. Many wheat researchers have visited CIMMYT either as trainee or visiting scientist and all have improved their knowledge, skill and efficiency to work more aggressively for the purpose in the organization (Nepal).

- The training at CIMMYT helped in broadening the outlook and readjusting research priorities (India).
- IRRI (International Rice Research Institute) was encouraged to work with rice under CA. Pulses Research Centre started working closely with Wheat Research Centre. People from NGOs come forward to learn about CA (Bangladesh).
- Now Wheat Research Centre, BARI carries out extensive CA research work in farmers' fields at various locations in Bangladesh.
- By adopting the methods taught during the training program our organization was benefited and new technologies were spread through CA (Bangladesh).

SUMMARY AND CONCLUSIONS

Overall, respondents were very satisfied with the level of training and support materials distributed during the course and saw them as useful for further training and research. Most participants would have liked this course to be of longer duration, because the processing of such large amounts of information was exhausting and the longer course would be more practically oriented to farmers' fields. When the trainees applied the knowledge gained during the training course, the main constraints were lack of suitable machinery for CA, lack of financial resources, and of resources for providing further training.

The majority of respondents increased their level of confidence to perform their job as a result of the training course at CIMMYT. Most trainees feel more confident and motivated to undertake hands-on work in the field and in the laboratory. In many cases the training was very helpful in furthering their career and it contributed to their promotion. Many of them point out that after their participation in training at CIMMYT, they were perceived as experts in the field of CA in their countries.

The content of the training was considered very relevant as the trainees use most of the skills and knowledge learned at CIMMYT in their current job. Training of their employees at CIMMYT led most organizations to conduct research in new areas and allowed them to conduct research differently than before. The trainees agree that having spent several weeks at CIMMYT participating in the CA course was a good investment for their organization.

FARMERS' PERSPECTIVES

During my stay at CIMMYT, I had the opportunity to visit a few farms in the surrounding areas of Texcoco–Tlaxcala as part of the training course. Accompanied by Augustín Limón, CIMMYT's colleague from the National Agricultural Research Institute of Mexico (INIFAP), we saw various projects, on-farm experiments, and collaborating farmers – all of which had some stage of CA implemented. After reading and learning about CA for weeks, I was excited that I was finally going to get to observe the direct impact of science and technology on improving the lives of rural farmers.

All three farmers we visited live in the state of Tlaxcala. The first farm we visited, about 40 hectares in size, belongs to Hector Mijares. This is the first year that he is trying to implement CA by planting on permanent beds (as opposed to flat beds as is done with conventional tillage) for wheat and oat production. Although he has been somewhat successful in that soil erosion has been markedly reduced, the main hurdle in implementing this part of CA is the lack of equipment for permanent beds. I didn't anticipate that this would be that much of a problem. But as we talked to the farmers, it became clear that it is extremely difficult to find the proper machinery in the market. For this reason, he has modified his equipment by installing a sort of furrow opener that can drill and open the furrow simultaneously without using conventional tillage. If machinery becomes available in the market, he will be able to fully adopt the technology for permanent beds with CA.

The next farm we visited, 100 hectares in size, belongs to Marcial Huerta. This is also the first year that he is trying to implement CA on his farm by planting on permanent beds. As we spoke to him, he also mentioned the difficulties with finding the proper technology for permanent beds. He too has a sort of furrow opener that works in the same way as Hector Mijares', and has started to see the benefits of CA.

In addition to the soil erosion being reduced, he has seen that the crops grow more uniformly, the grain yields are the same, and the initial soil crusting on the top of the beds is greatly reduced.



Picture 2. Augustín Limón and Farmer Hector Mijares



Picture 3. *Marcial Huerta's farm*

Even if the machinery becomes available in the market, it may be too expensive to implement on his entire farm. The method he is using now, with the furrow opener, has given him promising results. He has also found soil erosion and soil crusting to be reduced, grain yields to increase.

The trend for the day seemed to be that the proper technology was not present. Each of the farmers said that they had trouble finding and implementing the new machinery required for CA. I was shocked to see that something that seemed so successful in textbooks and papers could be so difficult to apply on actual farms. My trip to the farms taught me the importance of integration of science, economics, and social systems to develop methods to help

He is waiting for equipment to become available in the market so that he can apply CA on a greater scale. The third and final farm we visited, 150 hectares in size, belonged to Miguel Nava. Again, this was his first year trying to implement CA on his farm. And just like the other two farmers, he has trouble finding the proper technology to implement permanent beds.



Picture 4. *Augustín Limón, Mythili Prabhu, and farmer Miguel Nava*

improve the lives of farmers. Simply telling the farmers to use CA won't suffice; technology needs to be available, guidance and assistance needs to be accessible, a sense of security needs to be present. When I later talked with Antonio Castellanos about why there were problems with implementing CA, he said, "When you cut up a problem and try to solve part of it with only science, it's like cutting up a wheel into 5 distinct parts – you know the information in each of those 5 parts, but without using them together you can't make the wheel spin. You lose a lot of information in the process." I had always prided myself on wanting to be a scientist – it was only by successful achievement in science that the world's problems were going to be solved, I thought. In previous internships I had done, I loved to break up the dilemmas, form a hypothesis, test the

predicate, and come up with quantitative results that would lead to a steady conclusion. It seemed only logical that by doing that for all problems, most of them could be fixed.

It is clear to me now though, that research done in seclusion will have little practical application. One needs to also consider political and socio-economic factors. It is ironic that the next day, I saw a sign in a CIMMYT building with a quote from Dr. Borlaug that was an eloquent statement of my feelings: “No matter how excellent the research done in one specific discipline, its application in isolation will have little positive effect on crop production. What is needed are venturesome scientists who can work across disciplines to produce appropriate technologies and who have the courage to make this case with political leaders to bring advances to fruition.”

REFLECTIONS

During my two months in Mexico, I had the chance to meet people from all over the world, all of different ethnicities, cultures, and religious views, but what moved me the most was the kindness exhibited by everyone. Kindness is indeed a universal language – though I was faced with multiple communication barriers, I could always understand the countless kisses on the cheeks, the Romanians bringing me medication when I had a cold, invitations to go sight-seeing with Belgian students, and the hospitality demonstrated by my “Mexican family.” My summer in Mexico has shown me that the divisions in race, gender, religion, and social status that we frequently make should not take away from the fact that people are people, and it has reaffirmed my belief in the philosophy that the only real nation is humanity.

Around the second week of my internship, Allison Gilles, a CIMMYT employee in communications, introduced me to a Mexican family with whom she was friends – the Sainz Jaspeado family. Tere, the mother of the family who teaches Spanish here at CIMMYT, and Miguel, her 22-year-old son, came to pick me up at CIMMYT one Saturday after inviting me to eat lunch with them and meet some of their family. I was ecstatic that I would be able to meet some people my age and learn a bit more about Mexican culture. On arriving at their house, I was met by Veronica, the 18-year-old daughter, and Miguel Sr., the father of the family. The whole family welcomed me to their home, gave me a quick tour, and immediately started treating me as if I were related to them. I met two of Veronica and Miguel’s cousins, Carlos and Gris, and the five of us talked from 3 in the afternoon until 9 at night. They told me a little about Mexican history and how Mexico gained its independence in 1821, after Miguel Hidalgo y Costilla declared its independence from Spain in 1810. We also compared education systems in the United States and Mexico, discussed the current war in Iraq, immigration policies, and the Mexican government and current,



Picture 5. *The Sainz Jaspeado family*

President, Felipe Calderón. I had the opportunity to spend time with the Sainz Jaspeado family on many occasions after that day. The next weekend I went to a family gathering with Veronica at her grandmother's house. I met many of her aunts, uncles, cousins, as well as her grandparents – all of whom were extremely warm and made me feel like I was part of

their family. The hospitality was something I was unused to – I cannot imagine a family in the United States welcoming a stranger with such warm affection. The next weekend I went to a family gathering at Veronica's grandmother's house. In total, there were 17 people at this gathering, and when I remarked to Veronica about how large this was, she replied that this was nothing in comparison to the gathering that takes place once a year with her mom's side of the family. She said that at that gathering, there are almost 1,000 people. Family seems like such an important aspect of Mexican life, and I was touched that they allowed me to be part of their family.

I've realized that the old Mexican saying “mi casa es su casa” is completely true, as wherever I went – whether it was Veronica's house, her grandmother's or her uncles' – everyone always treated me like a member of the family and told me that I might ask for or take whatever I wanted, as if this house were my own.

Although I was blessed with such a wonderful Mexican family, I briefly saw the other side of the spectrum as well. During my internship, I visited two orphanages in the Texcoco area and all the stories I heard were heart-wrenching. At the first orphanage there are around 80 kids. The boilers are broken as well as the windows, so the kids don't have hot water and are cold at night. The orphanage is severely understaffed and many of the kids have disabilities so they are all over the place and it's hard to control them. As I was talking to one girl at the first orphanage who is 14 and she used to live in Mexico City, but her mom used to beat her . . . a lot she said. So she had to run away and finally came to the orphanage. When she was talking to us she started crying – an extremely sad moment for me.

The second orphanage was a bit better in terms of resources and help, but it was still not adequate. The lady who runs it has such a good heart – she doesn't refuse entry to anyone. There are about 200 kids, and two-thirds of them have disabilities, both mental and physical, which is very

difficult to deal with. A lot of the kids there have awful stories – horror stories almost. One of the kids was found as a baby in a dumpster and maggots had crawled into his throat and infested his stomach and internal organs. He has been sick a lot and is 5 years old now but has “refused to die,” as they say. A lot of the kids were beaten when they were young, so they have psychological problems. The first 4 years of life are critical to get proper nutrition, and since a lot the kids didn’t, they have both physical and mental disabilities.

I was shocked to see the number of children present in these orphanages. I couldn’t stop thinking about what would drive a mother to leave her child in a culture where family is all-important, where motherhood is so valued. My first inclination was to ask the question: how could any parent abandon their child like that? But what would I have done in their shoes? If a child is born with health problems and the mother doesn’t have the money to deal with them, then is there any other option? I certainly gained an appreciation of my own family and the privileges I’ve been given. It was a re-realization of how easy my life is.

My internship has had a powerful influence on shaping my view of the world. My time in Mexico was the biggest challenge of my life thus far. It has radically changed my perspectives and has helped me solidify my goals in life. I expected to come back from Mexico with answers, but my internship only gave rise to more questions. I don’t ever expect to stop asking questions. I don’t ever expect to know very much. But this internship has helped me focus my energy and realize that I have much more to learn with every experience I undergo from this point on.

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APPENDIX

Survey for participants of CIMMYT courses and visiting scientists in the area of CA

This questionnaire asks your opinion about the CIMMYT Capacity Building Program in the field of Conservation Agriculture that you have attended. Your views are needed so that CIMMYT can get an accurate picture of the strengths and weaknesses of this specific training program and present it to donors to secure further financial support. Please complete the following questions and return the questionnaire by July 31. Thank you very much for your time!

What CIMMYT course have you participated in:

Name of course: _____
 Year: _____
 Place: _____
 Course leader (s): _____

I. GENERAL QUESTIONS

What is your present age? _____ years

What is your gender? male female

In which country do you work? _____

Your current job is in the area of:

plant breeding plant pathology
 agronomy biotechnology

other – Please specify: _____

What type of organization did you work for and what was your position at the following times?

Before CIMMYT training _____

Currently _____

What type of work do you do?

active researcher professional trainer
 researcher / administration professor

extension specialist
 other – Please specify: _____

18. Since the training program, how frequently have you communicated with any of the training instructors?

- not at all
 less than once per year
 more than two times per year

Explain for what purpose or give examples of the collaboration: _____

19. Are you currently collaborating with CIMMYT?

- yes Explain how: _____
 no

20. Looking back, is there something to improve in the CA course at CIMMYT?

- no
 don't know
 yes Explain what: _____
-

21. Are you aware of an alternative provider where your organization could go for similar kinds of training? (Please check all the answers that are true for your organization)

- Other International agricultural research center(s) Please specify: _____
 National university or research center(s) Please specify: _____
 private company (or companies)
 nowhere: similar kinds of training are not available elsewhere
 other Please list: _____

22. Have you provided any training based on the knowledge and skills you developed at CIMMYT?

- yes, within my institution
 yes, outside
 no (If no, skip to question 24)

23. If you provided training, please specify for which profession it was. (Please check all answers that are true for you)

- researchers extension workers
 technicians farmers
 Other Please specify: _____
-

24. How do you obtain updated information about the current research in the area of Conservation Agriculture? *(Please check all answers that are true for you)*

- I do not obtain updated information by attending conferences or workshops
 from the web site of CIMMYT through television or radio
 from different web sites
 Other Please specify: _____

25. Please describe any other impact on you personally that has not been covered in this survey. *(Feel free to attach extra pages if you need more room to write)*

26. Please describe any other impact on your organization that has not been covered in this survey. *(Feel free to attach extra pages if you need more room to write)*

Thank you for your time and thoughtful reply!