Beneficiary Impact Assessment of Parasitic Weed IPM Pilot Sites in Cereal-Legume Systems: Northern Guinea Savannah, Nigeria

Prepared by

C. C. Asiabaka
Federal University of Technology Owerri, Nigeria

B. D. James
International Institute of Tropical Agriculture, Cotonou, Benin

O. Coulibaly
International Institute of Tropical Agriculture, Cotonou, Benin

A. Emechebe
International Institute of Tropical Agriculture, Kano, Nigeria

I. Kureh (deceased)
Institute of Agricultural Research, Ahmadu Bello University, Zaria, Nigeria

T.K. Atala
Institute of Agricultural Research, Ahmadu Bello University, Zaria, Nigeria

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Acknowledgments

The CGIAR Systemwide Program on Integrated Pest Management (SP-IPM) launched its pilot site initiative in 2000. The initiative was funded by the CGIAR Finance Committee for SP-IPM to remove communication bottlenecks between researchers and farmers; introduce IPM options to farming communities; and help participating organizations gain experience in developing effective research-farmer-extension partnerships for increased adoption of IPM research results. The first set of sites focused on parasitic weed management in cereal-legume systems in selected agroecologies in Africa. The activities lasted 3 years, from 2000 to 2002. In 2007, the SP-IPM carried out beneficiary impact assessment of the pilot site in the Northern Guinea Savannah of Nigeria, approximately five years after SP-IPM exit of the sites. The SP-IPM is grateful to CGIAR Finance Committee for funding support, pilot sites villages for enthusiastic participation, and to the International Institute of Tropical Agriculture (IITA), Institute of Agricultural Research (IAR) Ahmadu Bello University (ABU) in Zaria, Nigeria, Kaduna State Agricultural Development Programme (KADP), Nigeria and the NGO Sasakawa Global 2000 in Nigeria and all other collaborating technical support groups for providing resources, advice, information and materials in the execution of the activities.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

This report summarizes Beneficiary Impact Assessment (BIA) findings for the SP-IPM parasitic weed IPM pilot site in the Northern Guinea Savannah (NGS), Kaduna State, Nigeria. Recommendations on the overall value of the pilot site initiative will be reviewed in the context of results from the second case study in Morocco. The following testimony captures the value of the SP-IPM intervention to the farming communities in Nigeria:

> "I feel very happy to see you back here again. My people are so happy about the good things you brought to this village and they have been talking about it. You brought prosperity in this community. You brought to the people a solution to their Striga problem and they no longer face that problem and they are having fantastic crop yields now. You have uplifted the name of this village especially through the cowpea variety introduced to our farmers, which has spread all over the area and even beyond the State. Because of this project even BBC radio carried the name of this village to the entire world and put it on the world map if I may put it this way. I very much appreciate what you did to this village and I hope that you have come back to do more. May the Almighty Allah bless you and crown your efforts. Amen". Chief, Kayawa village

The NGS pilot site made great strides in pre-requisite areas for sustainable community growth. IPM is the art of combining various options to manage a problem. It is evident that to NGS pilot site farmers, use of improved maize varieties and inorganic fertilizers are no longer options, but the given. Where cropping patterns such as maize-cowpea, maize-soybean rotations or double cropping may have long terms benefits in *Striga* management, it is yet difficult for the farmers to fully rely on such options. By routinely applying inorganic fertilizers to maize fields they live nothing to chance. However, by embracing the concept of combining various options (compared to baseline practices), the pilot site have farmers clearly demonstrated that SP-IPM contributed greatly to increase scientific literacy on *Striga* and its IPM in their communities.

Farmers' perceptions of pilot site results demonstrated that with appropriate partnerships and community ownership of IPM processes, beneficial maize crop yields are highly probable in hitherto Striga infested land. Technology impact of the best-bet Striga management options offered farmers opportunities to use land that would have otherwise been abandoned for maize production because of risks from the parasitic weed. This was expressed by highly significant shifts towards larger size maize farms. Trained farmers also reported significant maize yield increases with a net return of up to $540 per ha. The benefit-cost ratio was 2.4, double that estimated for 2001 baseline operations for which a net loss in return on investments was estimated in cases of low market price for maize.

The SP-IPM clearly set the stage for rapid expansion of maize, and food legume crops used as Striga trap in the NGS of Nigeria. The pilot site also added value to IPM research and outreach mandates of participating organizations at the site.

With this background, the following recommendations are made

Recommendation 1: Concerted efforts should be made by national programs to fully embrace the pilot site approach for technology testing and dissemination, and by SP-IPM partners to invest in the pilot site approach their IPM implementation strategy. In these efforts, the BIA tools, results and database will serve as working documents to assist research managers and development agencies to initiate the development of historical profiles of key variables affecting Striga IPM and prioritize areas needing further attention.

Recommendation 2: The long-term effects of the rotation and double cropping technologies need detailed research in order to fully quantify their respective benefits in Striga IPM. However by providing additional income for same plot of land, the nitrogen fixing leguminous Striga trap crops were key economic attractants to farmers in their efforts to manage the parasitic weed.

Recommendation 3: Membership of farmer associations provides excellent opportunities for peer interactions, experiential learning and sustainable farmers' access to technical support groups. This promotes participatory extension for horizontal spread of information, increased community awareness and appreciation of extension messages, trustworthy information exchange in the communities. This element should be strengthened at pilot sites so as to take full advantage of the inherent value in a sustainable exit strategy.

Recommendation 4: The BIA exercise need to be incorporated in IPM projects' planning, especially to benefit those who would take over primary responsibility for increasing impact at scale and to help in justifying current and future projects.

1. BACKGROUND

THE CGIAR SYSTEMWIDE PROGRAM ON INTEGRATED PEST MANAGEMENT

The Systemwide Program on Integrated Pest Management (SP-IPM) of the Consultative Group on International Agricultural Research (CGIAR) was launched in 1996 as a global partnership programme whose task is to draw together the Integrated Pest Management (IPM) research efforts of the international agricultural research centers and their partners and to focus these efforts more clearly on the needs of resource-poor farmers in the developing world. The International Institute of Tropical Agriculture (IITA) serves as SP-IPM Convening Center. SP-IPM membership is open to all CGIAR centers. Other partners engaged in IPM research-for-development are members by invitation from SP-IPM Steering Committee.

The SP-IPM has its origins in the 1992 Earth Summit which recognized that attempts to raise living standards through conventional development approaches were only having a limited impact on hunger and poverty in developing countries, and that inappropriate development strategies were destroying the planet's ecological life support systems. In the 'Agenda 21' action plan of the Summit, Integrated Pest Management (IPM) was identified as a key part of the solution to this problem, as it allows more food to be produced with minimal damage to agricultural and natural ecosystems. To the SP-IPM, IPM means

"…an approach to enhancing crop and livestock production, based on an understanding of ecological principles, that empowers farmers to promote the health of crops and animals within a well-balanced agro-ecosystem, making full use of available technologies, especially host resistance, biological control and cultural control methods. Chemical pesticides are used only when the above measures fail to keep pests below acceptable levels, and when assessment of associated risks and benefits (considering effects on human and environmental health, as well as profitability) indicates that the benefits of their use outweigh the costs. All interventions are need-based and are applied in ways that minimize undesirable side-effects"

Towards this aim, the SP-IPM pursues strategic alliances between researchers and pertinent stakeholder groups (e.g., government, NGO, private sector, agricultural development agencies and networks), for IPM research-for development to increase agricultural productivity while minimizing the use of inappropriate plant protection regimes to promote health, trade and environmental quality[1]. In its activities, the SP-IPM tackles those areas where research promises to provide solutions to pressing problems in sustainable agricultural development but where impact has so far been limited, usually due to fragmentation of efforts among different organizations or in different regions of the world, or due to inadequate links between researchers and farmers[2]. The SP-IPM expects to achieve rapid progress by alleviating such constraints, breaking down barriers to information exchange, filling research gaps where necessary and developing effective models of researcher-extension-farmer partnerships to promote adoption of IPM technologies.

PROMOTING IPM THROUGH PILOT SITES

With funding by the CGIAR Finance Committee in 1999, the SP-IPM established its pilot site initiative in 2000 to remove communication bottlenecks between researchers and farmers; introduce IPM options to farming communities; and help participating organizations gain experience in developing effective research-farmer-extension partnerships for increased adoption of IPM research results. The pilot sites focus on field-level collaboration between pertinent stakeholder groups to promote complementarities between research and experiential learning so as to enable farmers make informed decision in solving location-specific pest problems. The initiative would also contribute to SP-IPM advocacy efforts to demonstrate the benefits of IPM to decision-makers and thereby help encourage the development of IPM-friendly policies.

At a planning workshop[3] in 2000, the SP-IPM developed criteria to guide selection of pilot sites and provided the basis for launching pilot site activities. Candidate pilot sites exemplify major cropping systems or agroecologies, where pests (*sensu lato*) have already been identified by farmers as a principal concern; other bio-physical and socioeconomic features of the site have already been characterized; promising new IPM options have the potential to achieve a decisive improvement; existing research and development activities provide a platform for pilot site development; opportunities exist for achieving new synergies by closer collaboration between

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[1] Anderson, P. and B. James. 2004. Increasing the quality and usefulness of integrated pest management research: an overview. 2004. Page 53 *in* Proceedings of the 15th International Plant Protection Congress, 11–16 May 2004, Beijing, China

[2] James, B., Neuenschwander, P., Markham, R.H., Anderson, P., Braun, A., Overholt, W., Khan, K., Makkouk, K., and Emechebe, A. 2003. Bridging the gap with the CGIAR Systemwide Program on Integrated Management. In: Maredia, K, Dakouo, D. and Mota-Sanchez, D. (eds), 2003b. *Integrated Pest Management in the Global Arena. Pp 419-434.* CABI International, Wallingford

[3] In January 2000, the SP-IPM convened a planning workshop at ICIPE, Nairobi to refine pilot sites objectives,, prioritize among possible sites, and develop accompanying action plans. Workshop participants (14) represented CABI, CIMMYT, ICARDA, ICIPE, ICRISAT, IITA/SP-IPM Secretariat and the national programmes INERA-Burkina Faso, INRA- Morocco; IRAD- Cameroon, and KARI- Kenya.

IARCs and partners; a wide extrapolation domain can be identified for results of pilot activities; strong partners can be identified to take primary responsibility for propagating the results.

The pilot sites selected were in Mid-Altitude Ecology in Kenya, Northern Guinea Savannah in Nigeria, Sahel Ecology in Burkina Faso and Mali and Dry/Rain Fed Ecology in Egypt and Morocco. The sites focused on cereal-legume systems where farmers had, prior to SP-IPM interventions, identified poor soil fertility, parasitic weeds (Striga in sub-Sahara Africa and Orobanche in North Africa) and insect pests (e.g., stem borers in maize and Hessian fly in wheat) as the major production constraints[4]. In the targeted cropping systems, farmers' local crop varieties succumbed easily to the weeds and insect pests. Traditional hand pulling of Striga and Orobanche was ineffective. In a few cases herbicides were used but without good long-term results. Farmers did practically nothing against insect pests and diseases. Those who could afford inorganic fertilizers commonly did so without advice based on soil tests.

At each pilot site, research-farmer-extension teams agreed on 'entry points', i.e., pressing crop production problems for which IPM research can offer 'plausible promise' of a solution, and then selected 'best-bet' options to evaluate in participatory field experiments with farmers on their own fields. Farmers were also trained in the principles of farm ecology and encouraged to go beyond the formal evaluation of suggested IPM options to develop and adapt innovations to their own needs. The SP-IPM produced a public awareness video, "Breaking the cycle" to highlight pilot site activities and gains. Site achievements had also attracted the attention of key national decision makers. In Morocco, for example, high-powered site visit by the country's Minister of Agriculture, Research Directors, media houses, and international visits by World Bank Officials helped set the scene for scaling-up the activities nationally. Similarly in Egypt, pilot site results provided the necessary encouragement to revitalize farmers' confidence in faba bean as a profitable crop. Mass farmers' field days in Nigeria and Kenya had equally publicized the IPM "goodies" to public officials and the press.

PROFILE OF NORTHERN GUINEA SAVANNAH PILOT SITE, NIGERIA[5]

The profile of the site is given at http://www.spipm.cgiar.org/ComLearn/SPIPMWP%203.htm

Site characterization: The pilot site is located in the Northern Guinea Savannah Benchmark Area of the Ecoregional Programme for Humid and Sub-humid Tropical Africa (EPHTA). The benchmark area had been selected by EPHTA as representative of humid tree savannas which

[4] http://www.spipm.cgiar.org/PDFs/IPM%20brief%201_Parasitic%20weeds.pdf

[5] Partners: Institute for Agricultural Research (IAR), Ahmadu Bello University (ABU), Sasakawa Global 2000, IITA and ICRISAT

stretch right across West Africa between the forest and the Sahel. The benchmark area extends between Zaria and Kano, representing a gradient from maize-cowpea dominated systems in the south to predominantly sorghum-cowpea systems in the North, with a strong livestock component. A wide range of biophysical and socioeconomic characterizations of the locality had been undertaken under the auspices of EPHTA. A number of IPM research and implementation projects were already working in this area prior to the SP-IPM pilot site initiative.

Communities near Zaria, which were already engaged in validation of Striga management options, formed the core of the SP-IPM pilot site. The operational sites were in Kayawa, Layin Taki and Detu villages. Participatory problem analysis had repeatedly identified Striga and declining soil fertility (which are functionally linked) as the issues of prime concern to farmers in localities. Researchers had also drawn attention to alarmingly high levels of aflatoxin contamination in stored maize in this zone, though farmers are, for the most part, unaware of this problem and its serious health implications. Cowpeas are a vital subsistence and cash crop - providing both high value food for people and fodder for cattle. The cowpea pest problems were being tackled by IITA-PRONAF regional network promoting IPM approaches to cowpea.

Many years of research by IITA and other IARCs has produced a range of options of proven effectiveness for Striga management. These are based on reducing seed contamination and reducing the seed bank in the soil. Ahmadu Bello University (ABU), Zaria, is the organization responsible for management of the EPHTA benchmark area. The University's Institute for Agricultural Research already operates a research station in Kano jointly with IITA, ICRISAT and ILRI. The pilot site initiative built on these kinds of research collaborations established over many years. Links with ABU's training programme, the national extension service and (increasingly) with NGOs, offered good prospects for wider propagation of IPM approaches.

Entry points

- Striga on cereals (maize and sorghum): tolerant varieties, selected legume rotations
- Soil fertility: legume rotations, residue management (including livestock use)
- Cowpea pests: resistant varieties, botanicals, solarization.

Table 1 shows agreed 'best-bet' clusters of IPM options investigated at the pilot site

Table 1: Agreed 'best-bet' clusters of IPM options at Zaria, Nigeria

Problems encountered	**Research options**	**Farmers coping strategies**
Striga in maize	• Use of Striga - free seeds: Minimizes infestation of Striga-free fields & introduction of new strains of Striga • Striga resistant/tolerant maize varieties, e.g., Across 97-TZL Comp. 1-W (tall, late maturing, OP); IWD STR-CO (shorter,, medium duration, OP); Oba Super 1; Oba Super 2 (9022-13, N-efficient) • Cultural practices: Mechanical weeding (hoeing and hand-pulling); moulding (earthening-up) • Rotation of maize with non-host legumes (soybean, cowpea and groundnut); at least 2 years of legume followed by 1 year of cereal under light to moderate Striga infestations • Double/relay cropping: Short duration cowpea followed by short duration maize/sorghum • Short duration maize followed by dual purpose cowpea • Intercropping cereals and legumes • Strip cropping cereal: legume in 2:4 ratio • Transplanting of sorghum grown in Striga- free nursery • Use of FYM/organic manure: Annual application of 4 tons/ha of FYM as supplement to 50kg N/ha • Use of inorganic fertilizer: Application of NPK, urea and SSP • Chemical control: Apply recommended rates of 2,-4-D, glyphosate or paraquat	• Striga tolerant Maize varieties, e.g., Red tassel maize (probably Oba Super 1) • Cultural practices: Hoeing and hand-pulling; earthening up of the weeds • Rotation with soybean and groundnut; not systematic; planting soybean or groundnut for 3-5 years after crop of severely infested cereal • Relay cropping of maize followed by cowpea • Use of farm yard manure: FYM applied as/when available • Use of inorganic fertilizer: Application of urea • Crop rotation (3-5 years of soybean or groundnut subsequent to severe Striga infection of cereal. • If current maize crop is severely infected, remold entire crop and then; (a) plant cowpea or sweet potato or (b)plant 'red tassel maize variety" (probably Oba Super I)
Striga and soil infertility sorghum	• Resistant/tolerant sorghum varieties, e.g., ICSV111 (early maturing; sow early August, to follow short duration cowpea (e.g., IT93K-452-1) with only 2 insecticide sprays)	• Resistant/tolerant sorghum varieties e.g., Gezarnera (local); Mai masaba (improved) • Apply urea fertilizer (routine agronomic practice for increased productivity) and then earthen-up to cover weeds and Striga • Rotating with soybean or groundnut

BENEFICIARY IMPACT ASSESSMENT

The SP-IPM envisioned a series of pilot sites in key agroecologies around the world. These would serve to develop and implement new models of partnership to bring scientific results to the attention of a wider public. For this vision to attract significant donor interest, the program needed to assess the beneficiary impact of its pilot site initiative, pin point conditions for success and highlight lessons for national programs that would be central in pilot site exit strategy. In 2007 Beneficiary Impact Assessment (BIA) of the pilot site initiative was prompted by the Center Commissioned External Review (CCER[6]) of the SP-IPM.

Table 2 summarizes the BIA purpose which guided the assessment. In technology testing and dissemination projects, such as the IPM pilot sites reported here, some impacts can be predicted with mathematical accuracy whilst others can only be predicted on the basis of subjective information. BIA helps to identify those social phenomena whose substance cannot be unambiguously captured in mathematical formulae. BIA is also generally important in the behavioural or political context. A limitation can come when BIA is conducted by researchers who are not indigenes, who are not familiar with the cultural and social architecture of the communities. These challenges were born in mind in the design and application of BIA tools.

Table 2: The purpose of BIA

Ex-ante BIA	**Ex-post BIA**
Determine the perceptions, needs, problems, fears of and risks to the communities and stakeholder groups likely to participate in and be affected by the project.	Provide the necessary feedback to research managers, planners and policy makers, communities and pertinent stakeholder groups.
Formulate project priorities by examining the relative benefits of different aspects of potential project activities to address the needs identified	Specify lessons learnt and can be used to improve the management and decision making process with respect to priority setting implementation, and management of project activities
Formulate the likely mitigation measures for identified problems	Provide accountability by project leaders on project partnerships, results and gains to a wider audience;
Assess the likely impact of the proposed project	Establish credibility for public sector project
Establish the framework for ex-post monitoring and evaluation	

[6] http://www.spipm.cgiar.org/PDFs/SPIPM.%202007%20CCER%20report.pdf

2. METHODOLOGY

Community consultation

This report covers the Northern Guinea Savannah (NGS) pilot site[7]. The NGS pilot sites were located in Kayawa, Layin Taki and Detu villages in Kaduna State of Nigeria. The pilot site implementation lasted 3 years, from 2000 to 2002, and BIA was initiated approximately five years after SP-IPM exit of the sites. BIA was conducted in July 2007 by a team of agricultural economists, social scientists, agronomists, Striga IPM specialists from national and international organizations that participated in the site activities. A combination of community consultations and group interaction techniques were used to collect Ex- and post-ante data from the host communities. The specific tools were:

- Reconnaissance site visits for site validation and sensitization of community leaders.
- Focus group discussions with up to 20 participants including at least one State or NGO/SG 2000 extension agent.
- Key informant interviews with 95 farmers (85% men and 15% women) comprising 33 SP-IPM trained pilot site farmers, 37 SP-IPM farmers-to-farmer (f-f) trained farmers, and 25 non pilot site farmers in the neighbourhood; and
- Direct observations.

The combined use of these techniques helped to provide a sharper validation of previous data and information collected. Other baseline information was derived from reports provided by SP-IPM and national agricultural research and extension systems[8],[9].

Adoption and impact analyses

For adoption analyses, the econometric Logit model (multiple regressions) was used to determine key factors that affect adoption of Striga IPM options. Logit modelling has been used

[7] For NGS pilot site profile visit http://www.spipm.cgiar.org/ComLearn/SPIPMWP%203.htm

[8] http://www.spipm.cgiar.org/PDFs/SPIPM%20Nigeria%20pilot%20site%20report%202001b.pdf

[9] Emechebe, A.M., B. James, T.K. Atala, I. Kureh, M.A. Hussaini, B.B. Singh, A. Menkir, A.C. Odunze, J.P. Voh, S.G. Ado, and S.O. Alabi. 2004. Farmer-participatory on-farm evaluation of *Striga hermonthica* management options in the Nigerian northern Guinea savanna pilot site of the SP-IPM. Page 51 *in* Proceedings of the 15th International Plant Protection Congress, 11–16 May 2004, Beijing, China

by other researchers[10],[11] to analyze the effects of factors like agro-ecological and socio-economic characteristics, demand characteristics of new technologies on the likelihood of adoption of these technologies.

The conceptual model decision of adopting the technologies is defined as:

$$\mathbf{P(Y_i = 1) = e^{(\alpha + X_i \beta_i)} / (1 + e^{(\alpha + X_i \beta_i)})}$$

Where:

Y_i = the dependent variable that takes the value of 1 for the i^{th} farmer adopting the IPM option

P = the probability of adoption by a farmer

β_i = is a vector of the parameters/variables to be estimated

$X_{i =}$ are explanatory variables related to the adoption of Striga IPM options

e = the exponential function for logistic functional form.

The variables tested in the Logit model were membership of farmer associations; access to off-farm income; agricultural incomes; training received; contacts with extension/technical support; use of improved varieties; use of mineral and/or organic fertilizers; use of botanicals; and availability of other inputs. Appropriate sample size for the Logit model is about 120 respondents. A final recommendation on adoption will be available after Morocco site conducts its BIA in 2008 and that data included in the adoption analyses.

With regards shifts in farmer practices for each category of respondents, the Chi-square (χ^2) statistic was used to test significance of changes in impact variables[12] observed in 2007 over 2001 baseline data. Net return per investment and associated benefit-cost ratio were calculated for the categories of respondents.

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[10] Adesina A. A. & Sirajo S. 1995. Farmers' perceptions and adoption of new agricultural technology: analysis of modern mangrove rice varieties in Guinea-Bissau. Q. J. Int. Agric 34 (4), 358-371.

[11] Adesina, A. A., D. Mbila, G. B. Nkamelu, and D. Endamana. 2000. Econometric analysis of the determinants of adoption of alley farming by farmers in the forest zone of southwest Cameroon. *Agricultural, Ecosystems and Environment* 80:255-265.

[12] Carley, M.J. and Bustelo, E.S. 1984. Social Impact Assessment and Monitoring: A Guide to the Literature. Social Impact Assessment Series, Number 7. Westview Press, Boulder

3. RESULTS – PILOT SITE IMPACTS

The NGS pilot site added value to IPM research and outreach mandates of participating organizations at the site. Farmers' perceptions of activity results demonstrated that with appropriate partnerships and community ownership of IPM processes, beneficial maize crop yields are highly probable in hitherto Striga infested land. The NGS site set the stage for informed decisions on Striga IPM enabling farmers to engage in rapid and economic expansion of maize and food legume crops production in the three pilot site villages.

Technology adoption

In the years following SP-IPM interventions, there was a noticeable shift in farmers' practice to manage Striga at pilot site localities. Table 3 summarizes changes observed for key productivity variables.

Table 3: Shifts in productivity variables

Variables	Change on baseline 2001 figures:							
	SP-IPM trained framers				Farmer-to-farmer training			
	Increase	Decrease	χ^2	P	Increase	Decrease	χ^2	P
1. Use of improved varieties	++		45.07	< 0.001	++		32.26	< 0.001
2. Seed treatment	++		49.65	< 0.001	++		26.60	< 0.001
3. Use of mineral fertilizers	++		30.25	< 0.001	++		11.32	< 0.001
4. Use of herbicides	+		5.86	0.015	+		6.17	0.013
5. Number of weedings	+		5.01	0.025		ns	2.26	0.133
6. Use of organic/FYM		ns	2.21	0.137	ns		0.65	0.418
Observed change in area (ha) under crop	+		**5.54**	**0.018**	**ns**		**2.09**	**0.148**

Key: Level of shift
+ = Moderate increase
++ = Substantial increase
Ns = Insignificant increase

Improved and Striga resistant maize varieties (hybrid and open pollinated) now predominate over traditional varieties. Seed treatment and use of mineral fertilizers at researcher recommended rate (six 50kg bags of recommended inorganic fertilizer NPK, urea and SSP per ha of maize) increased significantly by 2007. The proportion of SP-IPM trained farmers who used over 5bags mineral fertilizer per hectare of maize increased from 16% (in 2001) 59.4% in

2007 and to 68% for farmer-to-farmer trained farmers. Fertilizer application methods are as crucial as is type and quantity applied. The recommended post planting application period is two weeks after planting, but only 38.1% of the farmers applied fertilizers 2 WAP in 2001. The pilot sites increased this to 73.3% and 84.2% for SP-IPM trained and farmer-to-farmer trained farmers. The corresponding figure for non trained farmers was 75%. Herbicide use was mainly for large farms, however for all categories of respondents the percentage of farmers who weeded maize field only once dropped drastically (Figure 1).

There was significant increase in the ability of SP-IPM trained, f-f trained farmers and non-trained farmers to manage Striga. In 2007, the reported decrease in *Striga* infestations (Figure 2) was significantly substantial for SP-IPM trained farmers (χ^2 = 37.31, P <0.001) and f-f trained farmers (χ^2 = 41.37, P <0.001) and moderate for non trained farmers (χ^2 = 9.47, P <0.002). Whilst many variables contributed to Striga IPM adoption, (positive **β** Coefficient of economic logit model), the most important drivers were membership of farmers' association (inherent capacity building, access to technical resources, peer interaction in decision making) and access to off-farms income (χ^2 = 15.91, p <10 %). Amongst the best-bet options introduced to reduce in Striga infestations, farmers unanimously perceived seed treatment, use of improved maize varieties (hybrid and open pollinated) and inorganic fertilizers as the key practices (χ^2 values at P <0.001) to rely on.

In 2007, 41% more SP-IPM trained farmers rated two seasons of cowpea-maize rotation as moderately effective against Striga (Figure 3). However, the percentage of f-f trained farmers who believed the practice was ineffective was 33% more than in 2001 baseline figures. Farmers' opinion on effectiveness of double cropped cowpea technology was also divided. In 2007, 8.3% more SP-IPM trained farmers rated double cropping of cowpea as effective against Striga, and the percentage of SP-IPM and f-f trained farmers who rated the practice as ineffective was 14.1% and 8.3% more that in 2001 baseline figures respectively (Figure 4). Only 2.7% more f-f trained farmers rated the practice as effective. The trap crops, brought along with them increased IPM challenges, notably insect pest control in cowpea. There was a significant shift in pesticide use with volume of spays increasing mostly1litre/ha in 2001 to 3l/ha in 2007.

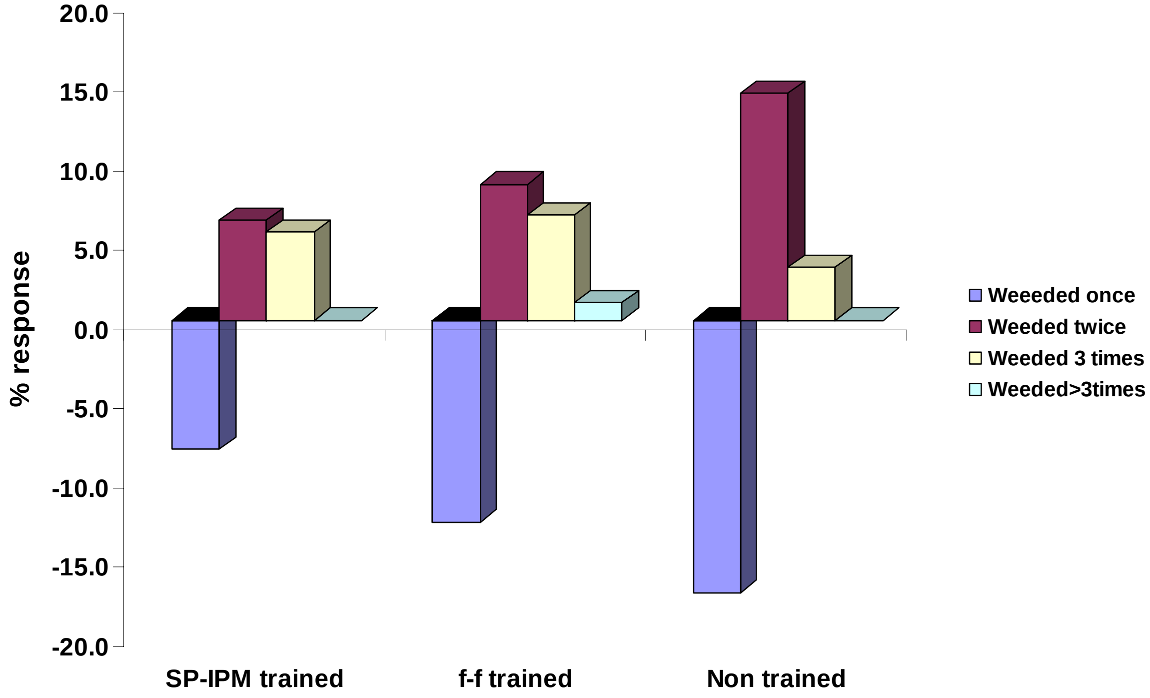

Figure 1: 2007 changes on farmers' baseline perception of weeding maize fields

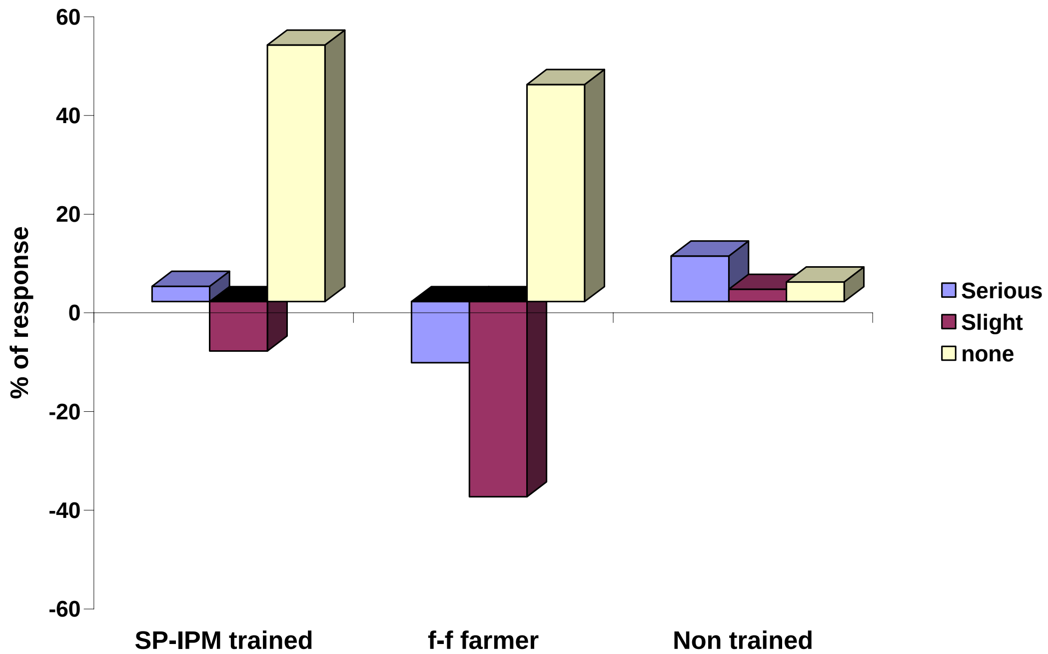

Figure 2: 2007 changes on farmers' baseline perception of Striga as a problem

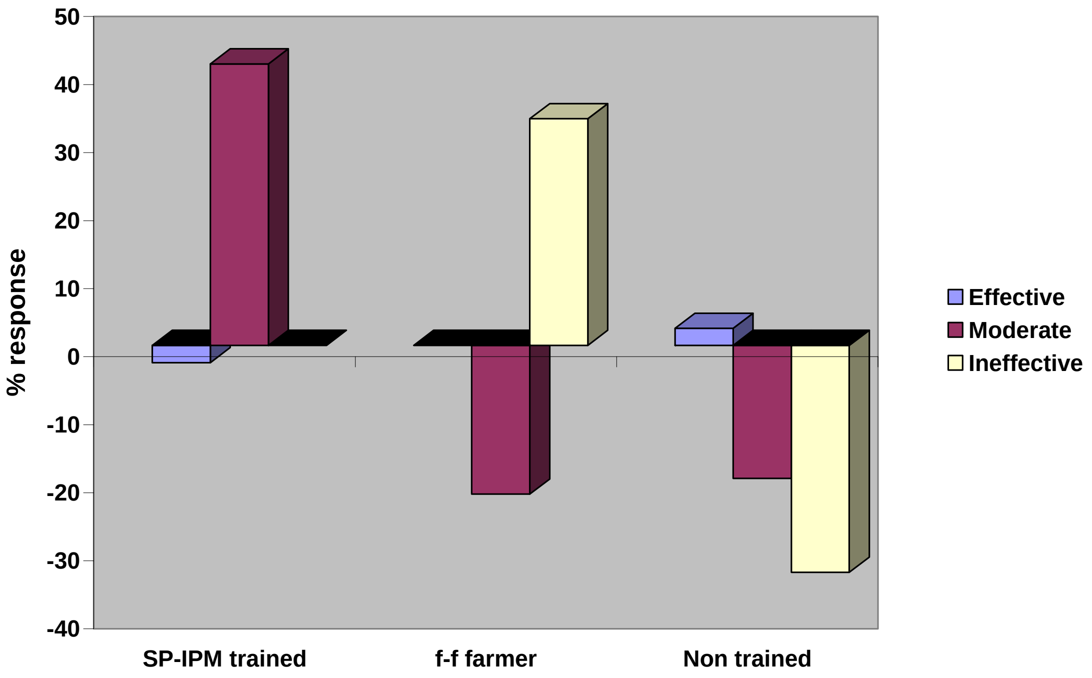

Figure 3: 2007 changes on farmers' baseline perception of 2 season cowpea-maize rotation in Striga IPM

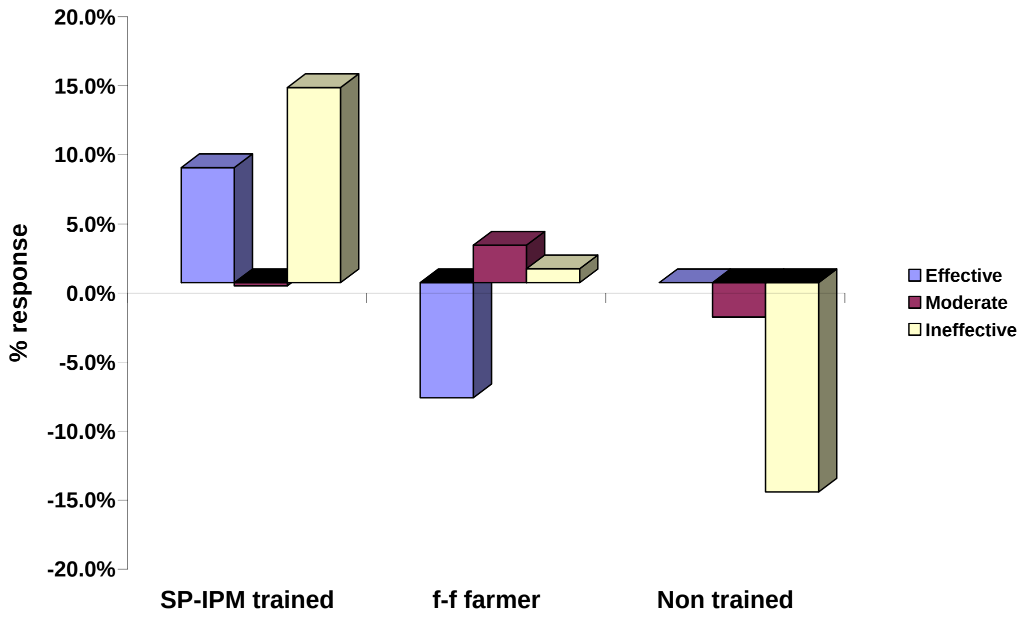

Figure 4: 2007 changes on farmers' baseline perception of effect of double crop cowpea in Striga IPM

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Economic impact

The technology impact offered opportunities for use of land that would have otherwise been abandoned for maize production because of risks from Striga infestations. This was expressed as highly significant shifts in the land area cropped to maize. In 2007 the percentage of farmers with 1ha maize dropped by 14%, 15.3% and 7% on 2001 baseline figures for SP-IPM trained, f-f trained and non-trained farmers respectively and in favour of larger size farmers (Figure 5). The observed shift towards larger maize farms was significant for SP-IPM trained farmers ($\chi^2 = 5.54$, P = 0.018), but insignificant for other categories of farmers (Table 2)

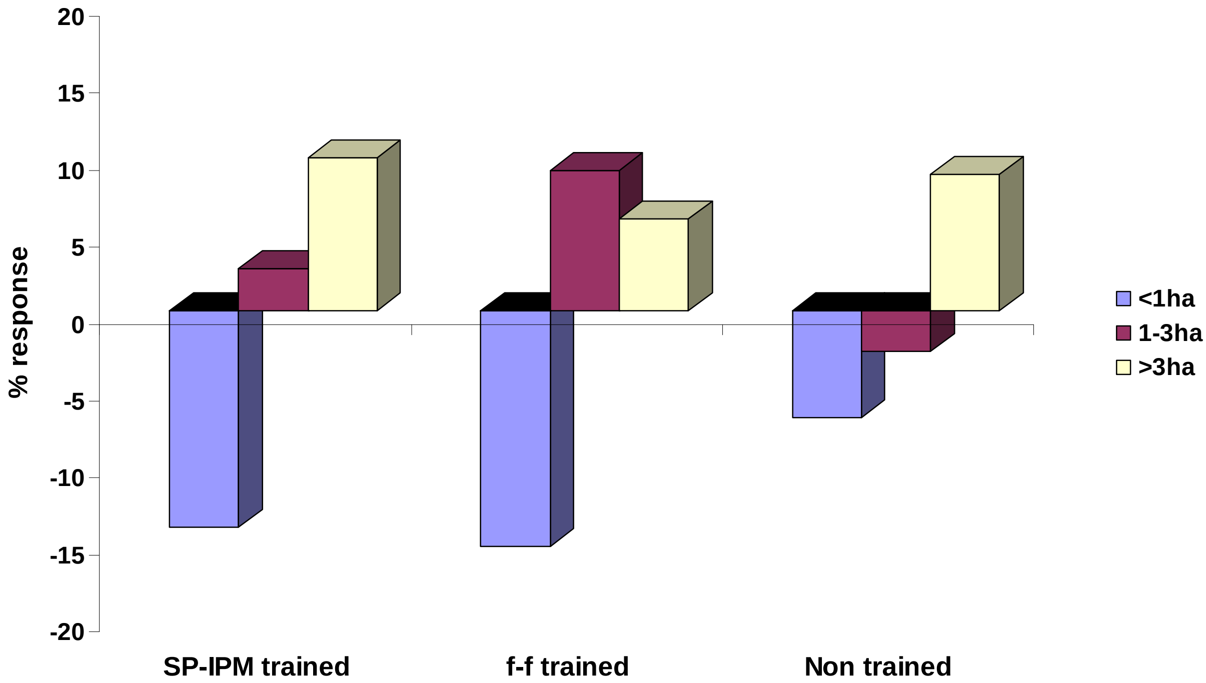

Figure 5: 2007 changes on farmers' baseline estimates of area under maize

SP-IPM trained farmers made a net return of $540 per ha of maize, with a 2.4 benefit-cost ratio, double that estimated for 2001 baseline operations The benefit-cost ratio doubled that estimated for 2001 baseline operations for which a net loss in return on investments was estimated in cases of low market price for maize (Table 4). Such gains could also help explain the marked shift from >1ha maize farms to farms of 3ha or more. In terms of market access to pilot site farmers, the proximity of the pilot villages to Zaria town was an asset. The road net work is much improved and thus market access and distribution channels were improved.

In terms of spill over benefits, access to off-maize farm income was particularly related to income gained from double cropping of early maturing/short duration cowpea variety IT93K-

452-1 to induce suicidal germination of Striga at potential maize cropping sites. By providing additional income for same plot of land, the Striga trap crops were good economic attractants for farmers in their efforts to manage the parasitic weed.

Table 4: Income gains of best practices on maize production (SP-IPM trained farmers)

Line item	2001 baseline	2007 post training
1. Average yield (kg/ha)		
a) Lowest	546.5	1,896.7
b) Highest	768.4	2,764.6
2. Average farm gate price/ha (Naira)		
a) Lowest	10,930.8	47,416.3
b) Highest	23,050.5	110,582.0
3. Material inputs/ha		
Land, seeds, herbicides, fertilizers, pesticides	*11,191.8*	*32,649.6*
4. Labour		
Planting, weeding, fertilizer and pesticide applications, crop, harvest, threshing/winnowing	*6,386.7*	*13,729.4*
5. Other inputs/Association fee	0.0	0.0
6. Grand total inputs [#2+#3+#4]	17,578.5	46,379.0
7. Net return/ha		
a). Lowest (= #2a less # 5)	-6,647.7	1,037.2
b). Highest (= #2b less # 5)	5,472.0	64,203.0
8. Benefit-cost ratio		
a). Lowest [#2a divide by #5]	**-**	**1.02**
b). Highest [#2bdivide by #5]	**1.3**	**2.4**

Community and institutional impacts

Community impact was felt at several levels. Firstly, farmers at pilot site villages were satisfied with the results of best-bet Striga management options. The percentage of farmers who rated the results as very good, good and unsatisfactory was 59%, 4% and 37% for SP-IPM trained, f-f trained, and untrained farmers respectively. Non SP-IPM trained farmers accounted for most (18%) of the response under "unsatisfactory". The household income gains due to the intervention enabled SP-IPM trained farmers to acquire other household assets such as motor cycles and wheel barrows. The cultural setup of the pilot villages made it difficult to ascertain direct actual benefits of the projects on women.

Farmers were particularly grateful for the early maturing cowpea variety used in double cropping to cause suicidal germination of Striga. According to the farmers, this variety helped to reduce effects of the traditional a hunger period (July) during which the majority of farmers ran out of food and at a time when there was urgent need for farm inputs and labour. With the short duration cowpea variety, farmers used the first cowpea harvest in July for food and income. Ripple beneficial effects were noticed in neighbouring villages. Notably, the short duration cowpea variety has spread from the pilot site villages to neighbouring villages and even beyond from Kaduna State to neighbouring Katsina State (village of Gazari) in the country. Inhabitants of the pilot site village Detu claim to have built a primary school with income from the cowpea variety as a major contributor. This variety is now widely called "Dan Kayawa" after the SP-IPM parasitic weed IPM pilot village "Kayawa".

Collaborating institutions (IITA, IAR, KADP and the NGO Sasakawa Global 2000) were excited about the results of the intervention. The SP-IPM pilot site contributed to the establishment of other Striga projects which helped to keep the pilot site momentum going towards impact at scale in the NGS. These other inter-institutional Striga projects include Striga and *Imperata* control project funded by DFID; African Maize Stress Project funded by IFAD/UNDP; WECAMAN maize network project funded by USAID; BNMS Project funded by Belgian government; and Crop-livestock project funded by GATSBY Foundation.. Institutional pilot site participants have now pioneered integration of aspects of the site approach and methodologies in research programs at IAR, extension activities at KADP and Sasakawa Global 2000 and in the teaching curriculum of the Agricultural Degree Programs of ABU.

The overall community benefit attributed to SP-IPM and subsequent Striga projects is captured in a testimony by the Chief of Kayawa village[13]. The BBC-Africa broadcast increased pride in the villagers and to their participation in the projects. There additional political leverage which the pilot site villages are enjoying from State government agencies which proudly refer to Striga control projects and results by the communities.

Environmental impacts

The pilot site methodologies and technologies were environmental friendly. Immediate or long term negative impacts on soils, underground water, and functioning of biodiversity can be expected to be low.

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[13] "I feel very happy to see you back here again. My people are so happy about the good things you brought to this village and they have been talking about it. You brought prosperity in this community. You brought to the people a solution to their Striga problem and they no longer face that problem and they are having fantastic crop yields now. You have uplifted the name of this village especially through the cowpea variety introduced to our farmers, which has spread all over the area and even beyond the State. Because of this project even BBC radio carried the name of this village to the entire world and put it on the world map if I may put it this way. I very much appreciate what you did to this village and I hope that you have come back to do more. May the Almighty Allah bless you and crown your efforts. Amen". Chief and Head of Kayawa village

5. DISCUSSION AND RECOMMENDATIONS

Institutional development is a *sina qua non* of successful projects. Not only that it ensures better implementation of projects but also better management and the sustainability of the project. Experience has also shown that community participation is an important ingredient in the success of projects in and/or around their communities. The more a community contributes to and benefits from projects, the more sustainable the community development. Community participation could range from project planning, implementation, information dissemination, grass root networking, linkages with external partners, and evaluation to decision making on type of assistance required. In short, lack of community ownership of process and results affects the projects negatively. Additionally, technical support agencies and the quality of interaction between them and the target community are key ingredients to project success.

The SP-IPM parasitic weed IPM pilot site in Northern Guinea Savannah of Kaduna State, Nigeria made great strides in these pre-requisite areas for sustainable community growth. IPM is the art of combining various options to manage pest problems. It is evident that to NGS pilot site farmers, use of improved maize varieties and inorganic fertilizers are no longer options, but the given! Where cropping patterns such as maize-cowpea, maize-soybean rotations or double cropping may have long terms benefits in Striga management, it is yet difficult for the farmers to fully rely on such options. By routinely applying inorganic fertilizers to maize fields they live nothing to chance! However, by embracing the concept of combining various options (compared to baseline practices), the pilot site have farmers clearly demonstrated that SP-IPM contributed greatly to increase scientific literacy on Striga and its IPM in their communities.

Farmers' perceptions of pilot site results demonstrated that with appropriate partnerships and community ownership of IPM processes, beneficial maize crop yields were highly probable in hitherto Striga infested land. Technology impact of the best-bet Striga management options offered farmers opportunities to use land that would have otherwise been abandoned for maize production because of risks from the parasitic weed. This was expressed by highly significant shifts towards larger size maize farms. Trained farmers also reported significant maize yield increases with a net return of up to $540 per ha. The benefit-cost ratio was 2.4, double that estimated for 2001 baseline operations for which a net loss in return on investments was estimated in cases of low market price for maize.

The SP-IPM clearly set the stage for rapid expansion of maize, and food legume crops used as Striga trap in the Northern Guinea Savannah of Nigeria. The pilot site also added value to IPM research and outreach mandates of participating organizations at the site.

With this background, the following recommendations are made

Recommendation 1: Concerted efforts should be made by national programs to fully embrace the pilot site approach for technology testing and dissemination, and by SP-IPM partners to invest in the pilot site approach their IPM implementation strategy. In these efforts, the BIA tools, results and database will serve as working documents to assist research managers and development agencies to initiate the development of historical profiles of key variables affecting Striga IPM and prioritize areas needing further attention.

Recommendation 2: The long-term effects of the rotation and double cropping technologies need detailed research in order to fully quantify their respective benefits in Striga IPM. However by providing additional income for same plot of land, the nitrogen fixing leguminous Striga trap crops were key economic attractants to farmers in their efforts to manage the parasitic weed.

Recommendation 3: Membership of farmer associations provides excellent opportunities for peer interactions, experiential learning and sustainable farmers' access to technical support groups. This promotes participatory extension for horizontal spread of information, increased community awareness and appreciation of extension messages, trustworthy information exchange in the communities. This element should be strengthened at pilot sites so as to take full advantage of the inherent value in a sustainable exit strategy.

Recommendation 4: The BIA exercise need to be incorporated in IPM projects' planning, especially to benefit those who would take over primary responsibility for increasing impact at scale and to help in justifying current and future projects[14],[15].

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[14] Asiabaka, C.C, Morse, S. and Kenyon, L. 2002. The Development, Dissemination and Adoption of Technologies Directed at Improving the Availability of Clean Yam Planting Materials In Nigeria and Ghana. A Report of a Study Mission Commissioned by the UK Government Department for International Development(DFID) Crop Protection Programme

[15] Asiabaka, C.C. 2005. The Methodologies for Social Impact Assessment. Paper presented at the Environmental Impact Assessment (EIA) Capacity Building Workshop for Project Managers of Shell Petroleum Development Company of Nigeria. Port Harcourt, Presidential Hotel, June 1-14, 2005