USAID
FROM THE AMERICAN PEOPLE

Amazon Malaria Initiative

STORY FROM THE FIELD

INTERMITTENT RICE IRRIGATION (IRI) FOR MALARIA CONTROL IN PERU: A WIN-WIN INTERVENTION BASED ON A MULTI-SECTOR AND TRANS-DISCIPLINARY APPROACH.

Author: O. Jaime Chang N., MD, MSc CHDC, Health and Education Office, USAID/Peru

Sustained and sustainable reduction of malaria transmission can only be attained through interventions equally sustained and sustainable. Arguably, the only type of intervention that fits such description is environmental alteration to reduce the population of malaria vectors, e.g. decreasing breeding potential of rice pads (Tadei *et al.* 1998; Herrel *et al.* 2001, Killeen *et al.* 2002, Koudou *et al.* 2005, Ponçon *et al.* 2007, Liu *et al.* 2004, Yasuoka *et al.* 2006).

Despite a recent decline in prevalence, malaria continues to pose a significant public health threat in Peru, with an estimated 26% of Peru's population in the coast and jungles of Peru at moderate to high ecological risk of transmission. In the arid coast, where agriculture depends on scarce water managed under irrigation schemes, an initial empiric observation of the association of rice and malaria and a few reports on such an association elsewhere led to implementing in 1999 a study on the feasibility of introducing intermittent rice irrigation for malaria control in Peru, as part of a Ministry of Health of Peru (MINSA) and the United States Agency for International Development (USAID) project.

The study showed that in the rice growing region of Piura, the correlation between area cultivated with rice and malaria cases reported for a year was very strong (0.95), and that introducing IRI was feasible from economic, agricultural, and social standpoints; it verified that IRI (alternating flooded and dry periods in rice pads, from few days after transplanting to the end of the vegetative phase) could reduce vector production by up to 92%, while reducing the volume of water used for irrigating pads and increasing productivity (reference Salud y Agricultura Sostenibles). Shortly after, a five-fold higher malaria incidence was reported in villages with houses in close proximity to irrigated fields and irrigation canals as compared to villages in the non-irrigated area in Piura (Guthmann *et al.*, 2002).

In 2005, based on such information, the Regional Government of Lambayeque (RGL), Peru's Ministries of Health and Agriculture, USAID, civil society and rice farmers associations signed an agreement to begin the Iniciativa Nacional para Introducir el Riego con Secas Intermitentes en el Cultivo de Arroz para el Control Vectorial de la Malaria (National Initiative for the Intermittent Irrigation of Rice for the Control of Malaria Vectors). This multi-sector, public-private alliance approach was later replicated in other regions.

Initial implementation of a technology transference package including IRI improved use of agrochemicals and using certified seeds, with 19 pioneer farmers from the district of Pitipo, showed in treated pads a reduction in vector breeding and in volumes utilized of water,

Continued

Pan American Health Organization — Regional Office of the World Health Organization | CDC SAFER·HEALTHIER·PEOPLE | msh Management Sciences for Health | USP U.S. Pharmacopeia The Standard of Quality | LINKS MEDIA Creating a Culture of Learning | RTI INTERNATIONAL pesticides and fertilizers; while productivity increased. Unlike other cases in which community members are involved in disease control, there was a concrete gain for them. By this time, public health, biology, and agricultural professionals from the Ministries of Health, the Ministry of Agriculture, and USAID - the national level initiative implementing partners - started referring to it as a sustainable development initiative (and not a health one).

Following these results, in 2006 the RGL formally IRI into their development policies, declared its implementation a priority, and modified agriculture regulations to allow rice cultivation the 500 meter band around villages if IRI is used (Reference Regional regulation). In 2007 staff from the ministries and USAID obtained support from the International Development Research Centre (IDRC) for operational research deemed necessary to complement knowledge and experience gained so far. This study allowed to better define the communication needs, the time rice pads should remain dry, and verified once more positive results in terms of rice productivity, vector breeding, and water and agrochemicals utilization.

It is noteworthy that since 2007, except for IDRC funding for the above mentioned project, the initiative funded and led by the Ministry of Health of Peru, through its Directorate for Environmental Health; and that there is no subsidy to farmers, who receive technical assistance but participate by investing their own capital and work.

IRI is currently being implemented in four regions (Lambayeque, Piura, Tumbes and San Martin) of Peru, where 403,787 hectares were cultivated with rice in 2009 (http://www.cepes.org.pe/prueba_site.shtml?apc=cepes~S~-~1-&x=96638&cmd[537]=i-537-513adfc334722959469bfaad85377e53&s=R). Positive results have been obtained in all sites (see table below and next page), and Regional Governments of Lambayeque and of San Martin planning for regional scale up in collaboration with farmers associations, other local organizations, Ministries of Health and Agriculture, and USAID.

BENEFITS OF INTERMITTENT IRRIGATION OF RICE

- **Reduction in mosquito larval density due to decreased breeding**
- **Higher crop yields**
- **Decreased water consumption for irrigation**
- **Increased availability of water for drinking and other purposes**
- **Preservation of soil fertility**
- **Alternative to chemical-based mosquito control methods**

Views of rice pads under permanent flooding and during dry stage of Intermittent Rice Irrigation

AVERAGE RESULTS OF IMPLEMENTING INTERMITTENT RICE IRRIGATION IN 3 REGIONS IN PERU

Region	Reduction of vector production in intervened pads	Reduction in utilization of water	Increase in yield
Lambayeque	87%	57% to 6,007 m3/Ha	25%
Piura	70%	26% to 13,876 m3/Ha	20%
San Martin	93%	60% to 9,620 m3/Ha	21%

Continued

To better illustrate these results, we may refer to the volume of water saved by applying IRI in only 55 hectares in Piura last rice season: it would have been enough to provide 27,945 people with 25 L/person/day for one year; or to see illustrative estimated results of applying IRI in 40,000 hectares in San Martin:

ESTIMATED RESULTS OF APPLYING INTERMITTENT RICE IRRIGATION IN SAN MARTIN REGION (AVERAGE AREA CULTIVATED WITH RICE 40,000 HECTARES, TWO CROPS PER YEAR)

Item (data for one campaign)	Variation	Illustrative figures (if IRI applied in 40,000 has.)
Decrease in vector proliferation in treated rice pads	90%	90%
Decrease in water used for irrigation (Volume normally used is 16,000 cubic meters per ha.)	27% - 40%	256,000,000 liters of water saved
Decrease in fertilizer (urea) used (Normal volume used is 200 kg per ha.)	50%	4,000,000 kgs of fertilizer saved
Decrease in use of pesticides (Normal volume used is 14 liters per ha.)	29%	400,000 liters of pesticide (and 400,000 one lt. containers not left in the environment)
Decrease in number of person/hours allocated to spraying pesticide with powered pump (Normal cumulated time is 12 hours per ha)	71%	320,000 person/hours of exposure to pesticide avoided (if only powered pumps were used)
Decrease in number of person/hours allocated to spraying pesticide with manual pump (Normal cumulated time is 24 hours per ha)	66%	640,000 person/hours of exposure to pesticide avoided (if only manual pumps were used)
Increase in productivity (Reference productivity is 6.4 tons per ha.)	20% (average)	Productivity could increase by 48,000 tons

Rice cultivation will continue to be an important economic activity in Peru, particularly for many small scale farmers for whom it is the main source of income. It is estimated that 350,000 hectares of rice were to be cultivated between August 2009 and June 2010 (http://www.portalagrario.com.pe/estadisticas.shtml), and IRI could be applied to a large proportion of them resulting in large reductions in the volume of water, fertilizer and pesticides used, and in a significant improvement in productivity.

Most reports on the relationship between malaria and agriculture are on observations of a positive correlation between rice cultivation and risk for malaria transmission (Hill and Cambournac 1941, Doannio *et al.* 2006, Jacob *et al.* 2007, Jarju *et al.* 2009, Tyagi 2004, Yasuoka *et al.* 2006). Few use a more comprehensive perspective, i.e. including environmental and economic variables (Ministerio de Salud del Peru 2002, van der Hoek *et al.* 2001, Keiser et al. 2002)

We consider the referred experience as an example of multi-sector and trans-disciplinary approach to decrease the risk of malaria transmission through a sustainable intervention producing health, economic and environmental gains.

References

Doannio, J.M.C., J. Dossou-Yovo, S. Diarrassouba, M.E. Rakotondraibé, G. Chauvancy, and F. Rivière. 2006. Comparaison de la composition spécifique et de la dynamique des populations de moustiques dans deux villages du centre de la Côte-d'Ivoire, avec et sans périmètre de riziculture irriguée. *Bull. Soc. Pathol. Exot.* 99(3).

Guthmann, J.P., A. Llanos-Cuentas, A. Palacios, and A.J. Hal. 2002. Environmental factors as determinants of malaria risk. A descriptive study on the northern coast of Peru. *Tropical Medicine International Health* 7(6)**:** 518-525.

Herrel, N., F.P. Amerasinghe, J. Ensink, M. Mukhtar, W. Vanderhoek, and F. Konradsen. 2001. Breeding of *Anopheles* mosquitoes in irrigated areas of South Punjab, Pakistan. *Medical and Veterinary Entomology* 15(3): 236-248.

Hill, R.B. and F.J.C. Cambournac. 1941. Intermittent irrigation in rice cultivation, and its effect on yield, water consumption and Anopheles production. *American Journal of Tropical Medicine* 21: 123-144.

Jacob, B.G., E. Muturi, P. Halbig, J. Mwangangi, R.K. Wanjogu, E. Mpanga, J. Funes, J. Shililu, J. Githure, J. L. Regens, and R.J. Novak. 2007. Environmental abundance of *Anopheles* (Diptera: Culicidae) larval habitats on land cover change sites In Karima Village, Mwea Rice Scheme, Kenya. *Am. J. Trop. Med. Hygiene* 76(1): 73-80.

Keiser, J., J. Utzinger, and B.H. Singer. 2002. The potential of intermittent irrigation for increasing rice yields, lowering water consumption, reducing methane emissions, and controlling malaria in African rice fields. *Journal of the American Mosquito Control Association* 18(4): 329-340.

Killeen, G.F., U. Fillinger, B.G.J. Knols. 2002. Advantages of larval control for Africa malaria vectors: Low mobility and behavioural responsiveness of immature mosquito stages allow high effective coverage. *Malaria Journal* 1: 8.

Koudou, B.G., Y. Tano, M. Doumbia, C. Nsanzabana, G. Cisse´, O. Girardin, D. Dao, E.K. N'goran, P. Vounatsou, G. Bordmann, J. Keiser, M. Tanner and J. Utzinger. 2005. Malaria transmission dynamics in central Côte d'Ivoire: The influence of changing patterns of irrigated rice agriculture. *Medical and Veterinary Entomology* 19(1): 27-37.

Lamin. B.S. Jarju, U. Fillinger, C. Green, V. Louca, S. Majambere and S.W. Lindsay. 2009. Agriculture and the promotion of insect pests: Rice cultivation in river floodplains and malaria vectors in The Gambia. *Malaria Journal* 8: 170. doi:10.1186/1475-2875-8-170
This article is available at: http://www.malariajournal.com/content/8/1/170

Ministerio De Salud Del Peru. Proyecto Vigia. 2002. Salud y Agricultura sostenibles: Un reto del Futuro- Riego Intermitente en el cultivo del arroz para el control vectorial de la malaria en la costa norte peruana. Estudio de Factibilidad. Ministerio de Salud, DIGESA, Proyecto Vigía, Lima. p. 200.

Ponçon, N., T. Balenghien, C. Toty, J. Baptiste Ferré, C. Thomas, A. Dervieux, G. L'Ambert, F. Schaffner, O. Bardin, and D. Fontenille. 2007. Effects of local anthropogenic changes on potential malaria vector *Anopheles hyrcanus* and West Nile virus vector *Culex modestus*, Camargue, France. *Emerg. Infect. Diseases* 13(12): 1810-5

Qunhua, L., K. Xin, C. Changzhi, F. Shengzheng, L. Yana, H. Rongzhi, Z. Zhihua, G. Gibson, K. Wenmin. 2004. New irrigation methods sustain malaria control in Sichuan Province, China. *Acta Tropica* 89: 241–247.

Tadei, W.P., B. D. Thatcher, J.M. M. Santos, V.M. Scarpassa, I. B. Rodrigues, and M. S. Rafael. 1998. Ecologic observations on anopheline vectors of malaria in the Brazilian Amazon. *Am. J. Trop. Med. Hyg.* 59(2): 325-335.

Tyagi, B.K. 2004. A review of the emergence of *Plasmodium falciparum*-dominated malaria in irrigated areas of the Thar Desert, India. *Acta Tropica* 89: 227–239.

van der Hoek, W., R. Sakthivadivel, M. Renshaw, J. B. Silver, M. H. Birley, F. Konradsen. 2001. *Alternate wet/dry irrigation in rice cultivation: A practical way to save water and control malaria and Japanese encephalitis? Research Report* 47. Colombo, Sri Lanka: International Water Management Institute.

Yasuoka, J., R. Levins, T. W. Mangione, A. Spielman. 2006. Community-based rice ecosystem management for suppressing vector anophelines in Sri Lanka. *Transactions of the Royal Society of Tropical Medicine and Hygiene* 100(11): 995-1006.