Institution: Aberystwyth and Bangor Universities - Biosciences, Environment and Agriculture Alliance (BEAA)
Unit of Assessment: 6: Agriculture, Veterinary and Food Science
Title of case study: New rice varieties improve livelihoods of millions of households in India and Nepal

1. Summary of the impact

Research led by Prof. John Witcombe at BEAA used novel participatory varietal selection (PVS) to improve adoption of popular rice variety BG1442 in Nepal and developed 10 new rice varieties using his pioneering, innovative method client oriented breeding (COB) in India and Nepal. The new varieties are improving the livelihoods of over 5M households. They are grown on at least 500,000 ha and provide a 15-40% yield advantage over the varieties grown traditionally. In India, the two Ashoka rice varieties alone (200F and 228) are estimated to provide benefits of £17M annually to the poorest farming households.

2. Underpinning research

Since 1996, research led by Professor John Witcombe (at Bangor 1990-present), produced and developed 10 new rice varieties in India and Nepal by means of client-orientated breeding (COB), a concept developed by Witcombe (method formally reported subsequently by Witcombe et al. (2005)) that has participatory varietal selection (PVS) as an integral component. PVS was developed by Bangor University research in 1996 as a new innovative method of collaboration between scientists and farmers in field-evaluation of varieties (Witcombe et al. 1996; Joshi & Witcombe 1996). It has been incorporated into national and international agricultural research and extension systems. In Nepal, Witcombe has used PVS to improve the dissemination and adoption of crop varieties with great success (Joshi & Witcombe 1996). One of the best examples involves the promotion of high-yielding rice variety *BG1442* through PVS: between 1996 and 2002, Bangor researchers led by Witcombe undertook farm-based PVS trials in 20 lowland districts in Nepal to improve knowledge of, and access to, suitable rice varieties for resource-poor farmers. Farmers chose *BG1442* from these trials because of its high yield and suitability to grow during the fallow season. DFID-funded projects since 2001 further advanced the promotion of this variety in collaboration with the Local Initiatives for Biodiversity in Research and Development (LI-BIRD) and the Forum for Rural Welfare and Agricultural Reform for Development (FORWARD) (Joshi et al. 2012).

In addition to PVS on *BG1442*, between 1996 and 1998, Bangor research (DFID funded) developed ten new rice varieties from crosses identified for their advantageous properties. For Nepal, eight COB varieties were derived from three crosses between 1996 and 1998. For India, *Ashoka* varieties *200F* and *228* were created (Virk et al. 2003) through COB and PVS in Jharkhand state (Witcombe et al. 2013).

The resulting new varieties were superior in their good taste, drought tolerance and high pest-resistance properties and consistently higher grain and straw yield across a wide environmental range in India and Nepal. The success of the varieties led to two major grants for their dissemination. A Rockefeller Foundation (RF) grant to Bangor (2005-2009) funded dissemination of the two drought-tolerant Ashoka rice varieties in four states in Northern India, and two subsequent DFID grants (Innovation Challenge Fund 2008-2010, Best Bets 2010-2012) funded the scaling-up of these varieties and the COB varieties from Nepal in a 30-partner project in India and Nepal. For India, local collaborators were the Gramin Vikas Trust (GVT) Ranchi and Birsa Agricultural University (BAU); for Nepal, the NGOs LI-BIRD and FORWARD.

3. References to the research

BEAA authors are in **bold**. Citation counts obtained through Google Scholar (October 2013).

Witcombe, J.R., Joshi, A., Joshi, K.D. & Sthapit, B.R. (1996). Farmer participatory crop improvement. 1. Varietal selection and breeding methods and their impact on biodiversity. *Experimental Agriculture* **32**: 445-460. DOI: 10.1017/S0014479700001526. Published in a peer-reviewed journal, 274 citations, submitted to RAE 2001

Joshi, A. & **Witcombe, J.R.** (1996). Farmer participatory crop improvement. 2. Participatory varietal selection, a case study in India. *Experimental Agriculture* **32**: 461-477. DOI: 10.1017/S0014479700001538. Published in a peer-reviewed journal, 163 citations

Sthapit, B.R., Joshi, K.D. & **Witcombe, J.R.** (1996). Farmer participatory crop improvement. 3. Participatory plant breeding, a case study for rice in Nepal. *Experimental Agriculture* **32**: 479-496. DOI: 10.1017/S001447970000154X. Published in a peer-reviewed journal, 151 citations.

Virk, D.S., Singh, D.N., Prasad, S.C., Gangwar, J.S. & **Witcombe, J.R.** (2003). Collaborative and consultative participatory plant breeding of rice for the rainfed uplands of eastern India. *Euphytica* **132**: 95-108. DOI: 10.1023/A:1024674422343. Published in a peer-reviewed journal, 54 citations

Witcombe, J.R., Joshi, K.D., Gyawali, S., Musa, A.M., Johansen, C., **Virk, D.S.** & Sthapit, B.R. (2005). Participatory plant breeding is better described as highly client-oriented plant breeding. I. Four indicators of client-orientation in plant breeding. *Experimental Agriculture* **41**: 299-319. DOI: 10.1017/S0014479705002656. Published in a peer-reviewed journal, 82 citations

Joshi, K.D., Devkota, K.P., **Harris, D.**, Khanal, N.P., Paudyal, B., Sapkota, A. & **Witcombe, J.R.** (2012). Participatory research approaches rapidly improve household food security in Nepal and identify policy changes required for institutionalisation. *Field Crops Research* **131**: 40-48. DOI: 10.1016/j.fcr.2012.03.001. Published in a peer-reviewed journal

Witcombe, J.R., Gyawali S., Subedi M., **Virk, D.S.** & **Joshi K.D.** (2013). Plant breeding can be made more efficient by having fewer, better crosses. *BMC Plant Biology* **13**: 22. DOI: 10.1186/1471-2229-13-22. Published in a peer-reviewed journal

4. Details of the impact

Adoption and dissemination of BG1442 variety in Nepal

The history of *BG1442* perfectly illustrates the impact of PVS on identifying varieties farmers will likely adopt. Although *BG1442* had been introduced in Nepal in 1987, it had never been promoted or officially identified. Bangor-led PVS trials with local farmers (1996-2006) and large-scale seed distribution (2001 onwards), resulted in rapid gain in popularity of the variety and its official release as *Hardinath1* in 2004 – a process that had been completely stagnant prior to the PVS trials. Surveys from 2008 show the magnitude of this popularity: 14-22% of surveyed households in 10 districts grew the variety in 2008, compared with none in 1997 [5.2,5.7]. Because it is grown in the fallow season, the variety drastically improved not only income and food availability, but also provided additional jobs. Rice self-sufficiency increased on average by over 2 months (25%) and grain sales of families with surplus by 900 kg per family (24%), [5.2,5.7].

Growth area and adoption of Ashoka varieties in India

The spread of the *Ashoka* varieties started in 2001 in four states in northern India, and continues during the period 2008-2012 (*Figure 1*) [5.3,5.4] extending to three additional states. In 2003, the varieties were officially released for the first time in Jharkhand State and were recommended for cultivation in Gujarat and Rajasthan through the State Agricultural Universities by 2005. These varieties have been adopted for certified seed production and, through the dissemination grants

(RF, DFID) secured by Bangor, expansion of seed distribution continues throughout northern India and seed production levels since 2008 represent over 40% of the total recorded seed production of the *Ashoka* varieties (*Figure 1*). By 2012, more than 900 t of seed had been distributed to over 226,000 farmers in villages throughout northern and central India (over 50% of these farmers were reached since 2008) [5.3, 5.4].

A survey in 2008 [5.1] showed that 95% of farmers who had been given seed 4-6 years earlier, continued to grow *Ashoka* despite no further outside intervention, revealing its high acceptability. Farmers had distributed seed within their villages and to other villages over distances of up to 500 km. Many of these recipient villages had as high a level of adoption as villages in which seed had been initially supplied [5.1]. Seven years after its release, *Ashoka* was grown on 40-76% of the available land of adopting farmers in the five study districts in four states; while, for comparison, the popular public-sector variety Vandana was grown on just 0-5% of available land 16 years after its release [5.1 (Table 27)]. By 2008, in the five surveyed districts an estimated 177,000 farmers were growing *Ashoka* varieties on approximately 26,600 ha. Since seed of *Ashoka* had already been distributed in over 1,000 villages by 2007 [5.1 (Figure 1] and high farmer-to-farmer spread had been found, it was assumed (conservatively by using low-end estimates) that adoption rates could be extrapolated across the upland rice areas in all of the districts in the four states. Hence, it was estimated that 420,000 ha were planted to Ashoka varieties by 2.8M households by 2008 [5.1(Table 26)]. There is no post-2008 survey, but since the number of farmers that was reached by subsequent dissemination projects more than doubled (*Figure 1*) [5.4,5.5] and in view of the expected substantial farmer-to-farmer spread, it is deduced that the areas and households have substantially increased by 2013 from the 2008 levels. Moreover, the varieties have been widely distributed in the neighbouring, but not surveyed, states of Madhya Pradesh, Chattisgarh, and Uttar Pradesh.

Economic and welfare benefits of growing Ashoka

The *Ashoka* varieties are popular for their high yield (~15% higher [5.1]), grain quality, superior taste, and fodder yield. Their early harvest provides food during lean periods and pest- and drought-resistance result in low costs and labour requirement. 83% of surveyed Ashoka users reported increased rice availability in 2008, with a mean increase in rice self-sufficiency of almost one month (17%). These direct benefits can allow farmers to plant an additional crop or devote time to non-agricultural activities, providing extra income and permitting them to send their children to school [5.1]. Grain sales also increased by on average 150 kg (46%) and farmers benefited from more, higher-quality grain receiving a better price. Based on an additional 15% yield on 700 kg grain/ha, and a conservative market value of £400/t, the Ashoka varieties in India were estimated to provide a financial benefit of about £17M per annum in 2008 - a benefit that would have accrued annually from 2009-2013 [5.1 (page 33),5.4].

Growth area and adoption of COB varieties in Nepal

The first Bangor COB variety (*Bharke-3004*) was officially released in Nepal in 2006, the second (*Sunaulo Sugandha*) in 2008, and the third *Barkhe-3010* in 2009. *Barkhe-1027* and *Barkhe-2014* followed in 2012 and by that time these, together with the unreleased varieties, had spread over 18 districts across the Terai. Between 2008 and 2012, seed kits were distributed to over 146,000 households [5.5] and were more popular than varieties developed by Nepal Agricultural Research Council (NARC) released in the same period: 10-16% of surveyed households adopted the COB varieties, as opposed to 6-8% for the NARC varieties [5.6]. 75% of the COB-variety users reported additional yields of 1 t/ha, equivalent to two months of rice self-sufficiency, bringing approximate rice grain self-sufficiency to the poorest farmers, or a 12% increase in sales (300 kg on average) for more affluent farmers [5.2]. By 2012, the varieties were grown on at least 50,000 ha by 275,000 households in Nepal, thereby directly benefitting over 1M people [5.2, 5.5]. This highlights the benefits of Witcombe's COB approach compared with traditional breeding of new varieties: despite its simplicity and low costs, its adaptability to farmers' needs makes it highly successful, far-reaching and significant in impacting on farmers' livelihoods.

Combined, the rice varieties developed through the Bangor research and disseminated widely in Nepal and India by our partners, have **improved the livelihoods of millions of people**; they are

grown on at least 500,000 ha in India and Nepal and provide higher yields of better quality with no need for greater agronomic inputs, to the poorest farmers across a wide range of rice-growing environments.

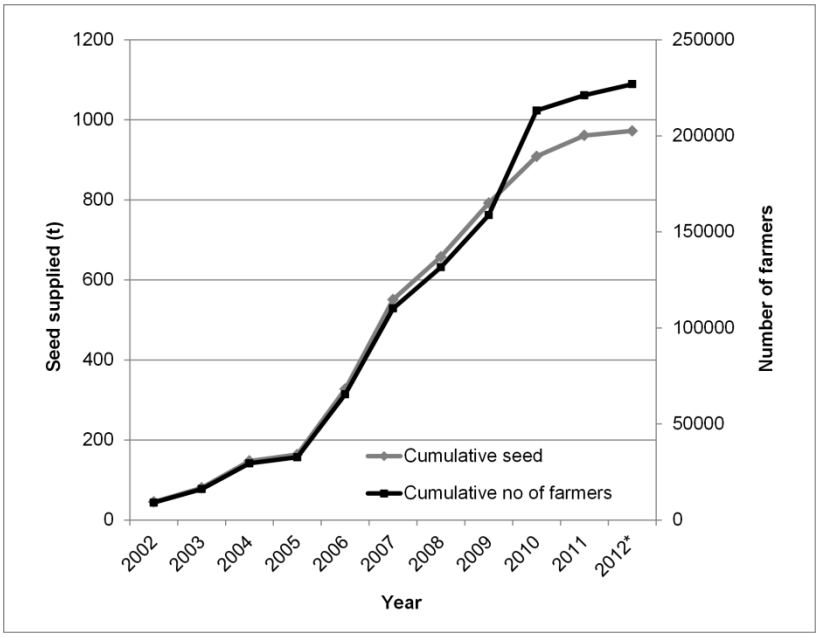

Figure 1. Cumulative Ashoka seed distribution (t) (diamonds, grey line) and number of seed receiving farmers (squares, black line in over 1000 villages throughout central India (over 50% of farmers were reached since 2008). Data summarised from: [3 (Tables 5, 11)], [4 (Annexure 1)]. Because farmers were given seed amounts ranging from 2 to 20 kg and shared excess seed with relatives and neighbours, the number of beneficiaries shown here is highly conservative.

***** For 2012, the amount of seed distributed was derived from the number of seed-receiving farmers, assuming 2 kg per farmer.

5. Sources to corroborate the impact

5.1 New Upland Rice Varieties for India. *Rainfed Agriculture Impact Study No. 1.* 2009. Monitoring Impact Assessment and Learning Component (MIL) 2.2 of the Research into Use Programme. Available at: http://www.biomedcentral.com/content/supplementary/1471-2229-13-22-s2.pdf

5.2 New Rice Varieties for Nepal. *Rainfed Agriculture Impact Assessment Study No. 2.* 2009. Monitoring Impact Assessment and Learning Component (MIL) of the Research into Use Programme. Available at: http://www.biomedcentral.com/content/supplementary/1471-2229-13-22-s3.pdf

5.3 Final Technical Report Rockefeller Foundation funded project, Grant No. 2005 FS011. April 2005 to June 2009 (*Not online but can provide copy*)

5.4 Gramin Vikas Trust, 2012. Research into Use end of project report. (*Not online but can provide copy*)

5.5 End of Project Report for Participatory Crop Improvement in South Asia. 2012. Research into Use (RiUP) Best Bets Projects. (*Not online but can provide copy*)

5.5 Learning from RiUP Initiatives on Rice. End of Project Workshop. Khumaltar, Lalitpur, November 2012. (*Not online but can provide PowerPoint copy*)

5.6 Joshi, K.D., Devkota, K.P., Harris, D., Khanal, N.P., Paudyal, B., Sapkota, A. & Witcombe, J.R. (2012). Participatory research approaches rapidly improve household food security in Nepal and identify policy changes required for institutionalisation. *Field Crops Research* **131**: 40-48. DOI: 10.1016/j.fcr.2012.03.001.