Summary brief for the case of "**Rainfed Upland Rice**" *ex post* – **Rainfed upland rice in Madagascar**

Louis-Marie Raboin, Paloma Breumier, Marie-Hélène Dabat, Catherine Marquié, Alain Ramanantsoanirina, Kirsten Vom Brocke

I - The innovation story (from 1980 to 2015)

The study's geographic scope covers the highland area of the Vakinankaratra region (over 1 300 m above sea level). The region is densely populated (102 inhabitants per km^2, Gastineau et al. 2010) but remains very rural. Given the tremendous pressure on land and the limited development opportunities, the rice fields that have been passed down and divided for generations are diminishing in size (Andrianantoandro and Belières, 2015). Thus, in 2011, the average farm size in the Vakinankaratra highlands was 0.46 ha, which includes 0.2 ha of rice paddies (485 farms surveyed in 16 villages; Raboin et al., 2014). Given the scarcity of productive resources and food insecurity, agriculture is putting increasing pressure on land in Tanety[1]. In this context of subsistence farming, rice production is the primary goal. Rice is considered to be the only satisfying food, because "a meal without rice is a meal of nothing" (Serpantié et al. 2007). Tubers are merely substitutes used during the hunger gap, in particular, and as a side dish. Therefore, growing rainfed upland rice appears to be an interesting strategy to complement irrigated rice production and improve rice self-sufficiency on highland farms in this region.

In the early eighties, farmers had already attempted to grow rainfed rice at high altitudes around Antsirabe. These first initiatives were soon discouraged by low and irregular yields, because of the absence of suitable varieties (Rakotoarisoa, 1997). Research on rainfed upland rice began in 1984 within the framework of a partnership between Antananarivo University and CIRAD, which was broadened in 1985 to include FOFIFA[2]. The research was financed by three successive European projects from 1984 to 1996. Initially, they focused simultaneously on the genetic improvement of irrigated upland rice and rainfed rice. In order to provide a quick response to farmers' requests for adapted rainfed rice varieties, the FOFIFA varieties 62, 64 and 116 were selected from Mid-West plant material and proposed for distribution from 1990. Although these varieties were not destined for highland regions, they were still better than those previously used by farmers. On-farm trials were set up to assess these varieties in partnership with different organizations (AVEAMM, Ferme Kobama, IREDEC, Tsimoka and ODR). ODR distributed these varieties from a network of demonstration plots established on farms, where the farmers were known as "contact landowners" and FIFAMANOR[3] started working with CIRAD and FOFIFA on seed production (Chabanne and Dechanet, 1991). In parallel, during the first phase of the breeding programme, until 1995, the progenitors for cold resistance belonging to the group Japonica (from very varied geographic regions, including Japan, Korea, China, Madagascar, etc.) were used for crossbreeding. However, only the crosses that included "Latsika", the local population of irrigated upland rice, produced well-adapted rainfed varieties (Dechanet et al., 1997).

The first two varieties of rainfed rice, FOFIFA 133 and 134, specifically created for highland zones, were proposed for distribution in 1994, followed by four additional varieties in 1995 (FOFIFA 151, 152, 153 and 154). FOFIFA and CIRAD started working with VMMV[4] and pursued the partnership with FIFAMANOR in view of seed production. In 1996, with a major reduction in European funding, the activities were geared specifically to rainfed rice production. However, Europe continued to fund the programme until 1999 (Dzido, 2000). From 2000 to 2003, the Aventis Foundation provided funding. Between 1998 and 2003, the varietal development activities were stopped. The objective then shifted to focus on improving the lines that had already been developed and encourage the distribution of new varieties alongside suitable cropping techniques. Numerous on-farm trials were set up with different partners (the NGO TAFA[5], FIFAMANOR, CARITAS, VFTV[6]) to assess the varieties using a participative approach (Ahmadi et al., 2004). New varieties were proposed for distribution (F157, 158, 159 in 2001 and F161 in 2003). In 2003, following the rice blast epidemic that affected most of the first varieties that had been distributed, the multiplication of seeds from the varieties F152 and F154 was stopped. In 2004, the varietal development programme was launched once more with a primary objective:

[1] Hill or mountain land that may be a plateau or a slope. Land that is not prone to flooding.
[2] FOibem-pirenena ho an'ny FIkarohana ampiharina ho Fampandrosoana ny eny Ambanivohitra – National research centre for rural development
[3] FIompiana FAmbolena MAlagasy NORvéziana – Malagasy and Norwegian agency for agricultural development cooperation
[4] Now VKMMV Vondrona kooperativa Miray Manakaiky Vahoaka – cooperative of seed producers in Vakinankaratra
[5] Non-Governmental Organization TAny sy FAmpandrosoana
[6] Vondrona Fifandrombonan'ny Tantsaha eto Vakinankaratra – farmers' collective organization in Vakinankaratra

resistance to rice blast. CFAMA[7] was involved in the production of certified seeds from 2004. At that time, rainfed rice production was already well established in the region. A survey conducted in 2005 on 843 farms in 26 villages situated above an altitude of 1 250 m showed that rainfed rice was already cultivated on 36% of farms. The most commonly grown varieties were F154 (53% of farms), F133 (21%), F134 (10%) and F152 (7%) (Raboin et al., 2013).

Rainfed upland rice production really took off in 2006. It can be linked to the fast adoption of the variety Chhomrong Dhan (CD). CD is a Nepalese variety of irrigated rice, introduced by researchers in the nineties for use in crosses (Vales and Razafindrakoto, 1997). It proved to be very productive in rainfed conditions at a high altitude. This variety was proposed for distribution in 2006 along with two other varieties (F171 and F172). Farmers adopted it rapidly. In 2011, it was already grown on 83% of land. That year, 71% of farmers grew rainfed upland rice (Raboin et al., 2014). The development of rainfed upland rice was clearly encouraged by the poor harvest in 2004, which was caused by cyclones, and the subsequent increase in the price of rice (David-Benz et al., 2009), in addition to the disease problems affecting potatoes. The plant breeding activities continued and from 2006 they were partly funded by GSDM (a Malagasy group for direct seeding, AFD) and new varieties were proposed for distribution (F173 in 2011, F180 and F181 in 2014). Between 2010 and 2013, multi-site networks for participative varietal assessment were set up on farms in partnership with the BVPI SE/HP development project (funded by AFD). In 2013-2014, they were set up with the partnership between VFTV and CEFFEL[8] and financed by the regional fund for agricultural development (FRDA-AFD). Since 2013, farmers in the CPM-FTM[9] network have been multiplying rainfed rice seeds using pre-basic seeds supplied by FOFIFA, with FRDA funding as well. Between 2014-2015, the PAPriz project (a project to improve rice yields in the Central Highlands of Madagascar, financed by the Japanese Development Agency) also contributed to the distribution of rainfed upland rice.

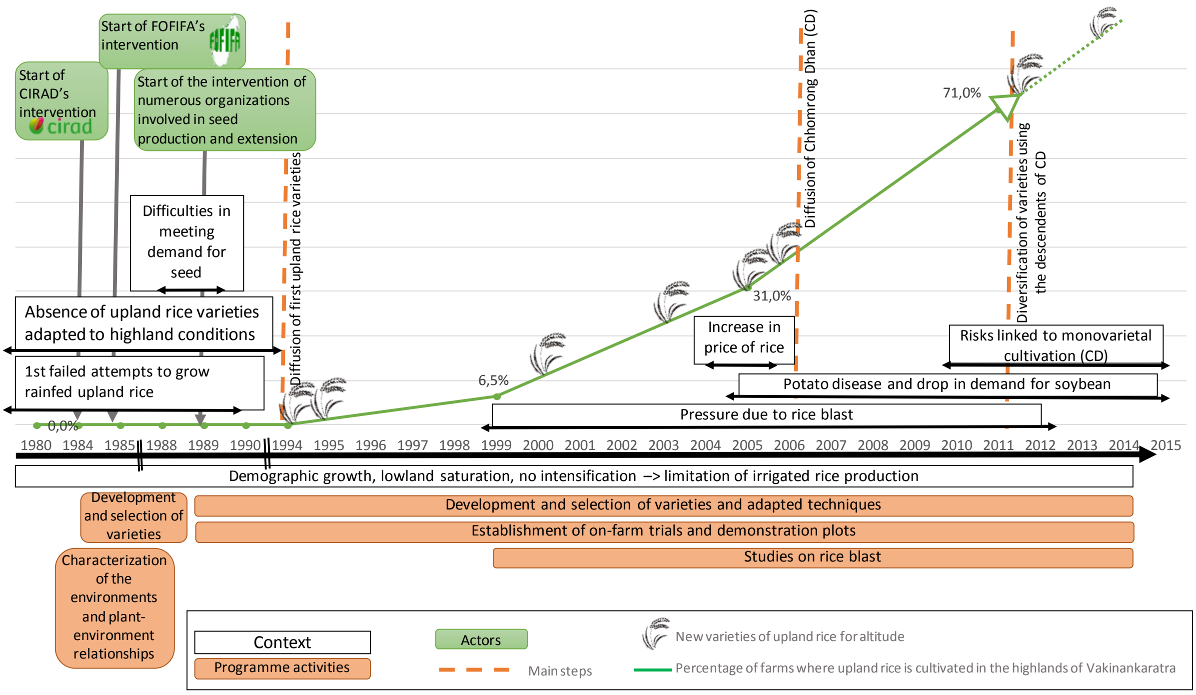


Figure 1 - Timeline

[7] Centre de Formation Agricole et de machinisme Appliqué, a training centre for agriculture and applied mechanics
[8] Centre d'Expérimentation et de Formation en Fruits et Légumes, a horticultural research and training centre
[9] Farmer coalition in Madagascar - Firaisankinan'ny Tantsaha eto Madagasikara

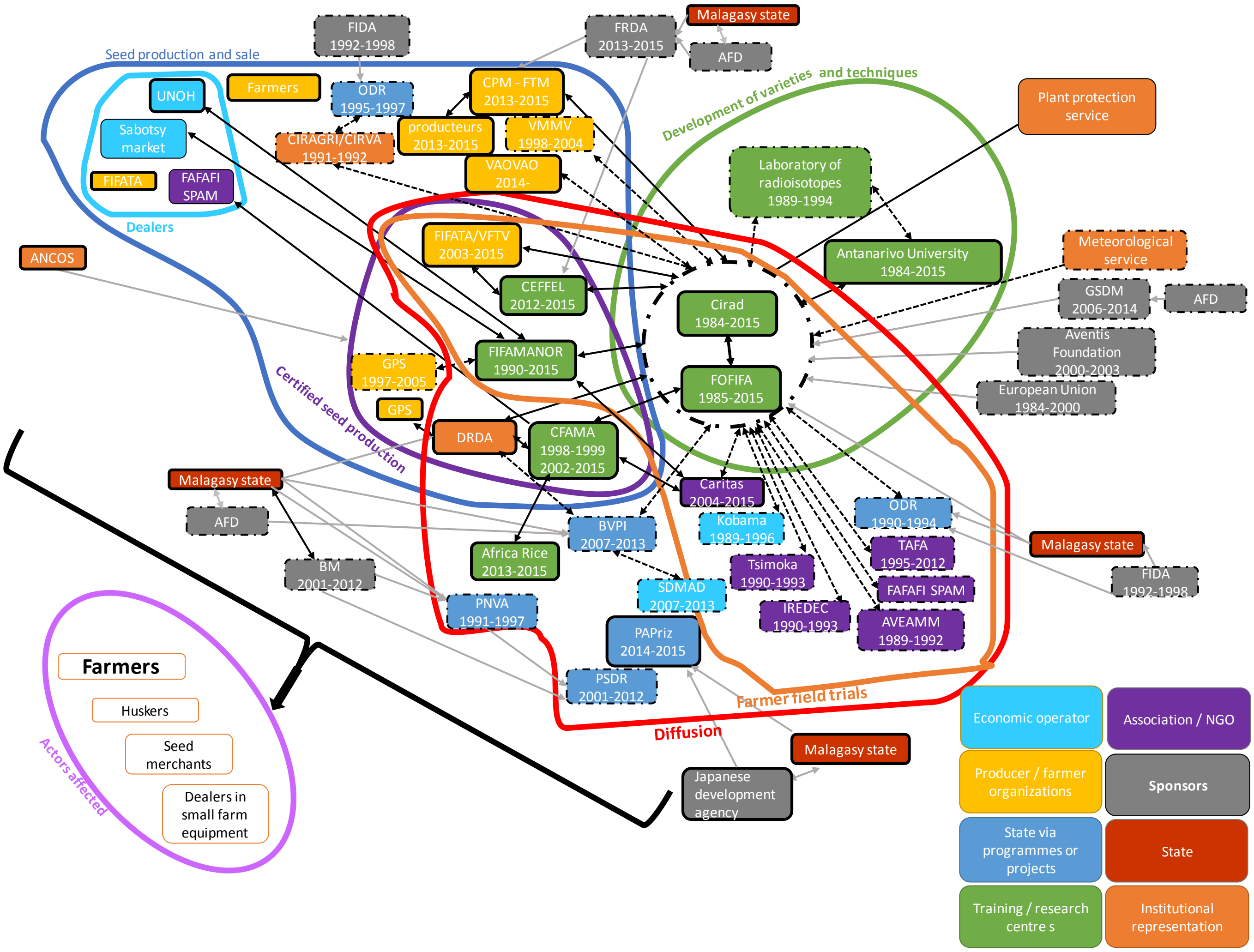


Figure 2 - Map of actors

II- The findings from the analysis of the impact pathway

Numerous partnerships were established between researchers and other actors with the aim of encouraging the distribution of new varieties and good production practices. Over time, there was a regular turnover of partners that were involved alongside research. However, the networks for participative assessment or varietal demonstration were always maintained on farms. A large number of trials or demonstration sites were also set up directly by the institutions, development projects and farmer organizations (with no involvement from research). In addition, they organized most of the communication on the varieties (radio broadcasts, taking part in fairs, etc.). All these initiatives in rural areas are important for launching the distribution process. However, most subsequent seed exchanges were direct, from farmer to farmer. Nonetheless, a formalized organization was established to produce seeds. It involves CIRAD and FOFIFA, which supply pre-basic seeds. It also involves the research institution FIFAMANOR and a training institution CFAMA, which guarantee the multiplication of basic seeds that are multiplied, in turn, by groups of seed producers or individual farmers. ANCOS, a government service, is responsible for control and certification.

In the distribution process, the role of research soon becomes invisible. However, the variety (the innovation developed by the research partnership) is central to the impact pathway. All the outcomes converge towards the use of varieties supplied by research and the primary impact, namely, higher rice yields and an increase in the area cultivated with rice. All the other outcomes stem from the primary impact. Farmers seemed to be unanimous about the most important impact (or change), namely, a shorter hunger gap and less pressure to buy rice. “Greater peace of mind” was a rather unexpected outcome that emerged during the workshops and interviews. The descriptors of change collected in the villages put considerable emphasis on mental well being (fewer worries, problems) than on economic well being (purchase of consumer goods). This general feeling is due to the improvement in self-sufficiency in rice, the reduced pressure to work off-farm in order to buy rice and greater disposable income. The combination of all these elements gives farmers more scope to invest in their own farms. It is important to note that the current situation is very tense and some families are still obliged to sell their rice in order to pay for basic essentials (salt, oil, soap, school fees, etc.) or unexpected costs. Later, they have to buy back rice at a high price during the hunger gap. Representatives from institutions, farmer or research organizations mentioned the potential negative environmental changes caused by an increase in the area of land cultivated with rainfed rice on *tanety* type land prone to erosion. However, most farmers did not consider the issue or else did not consider it to be important.

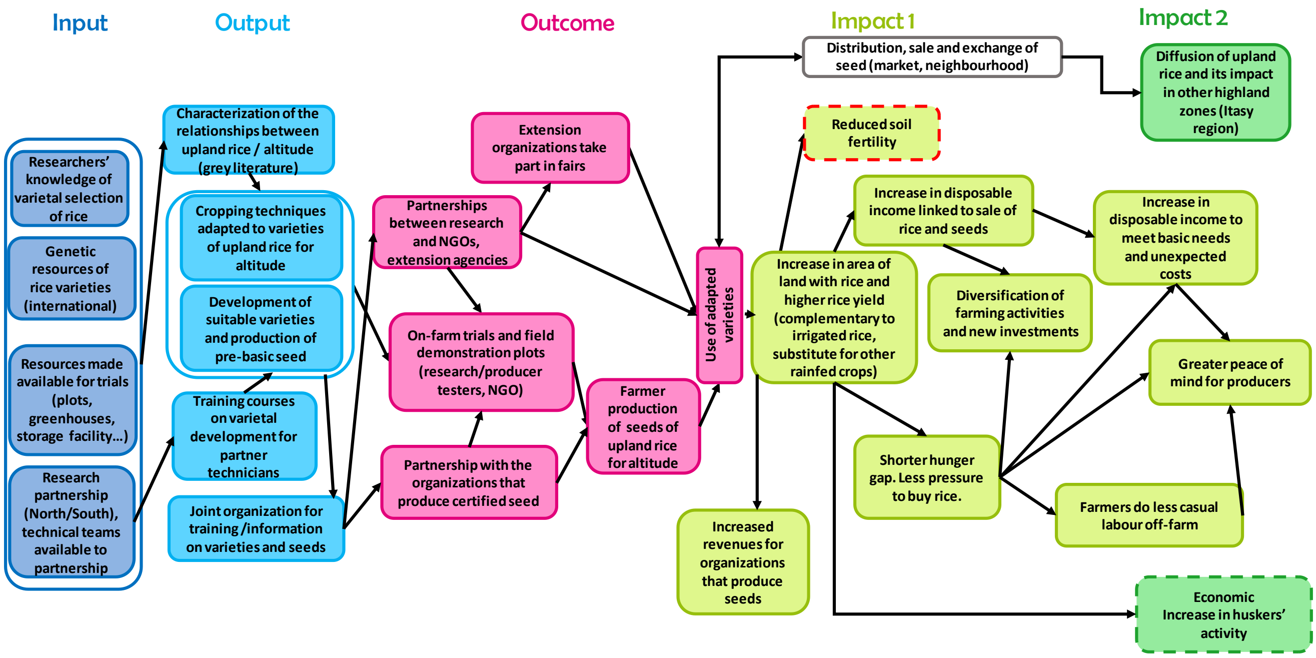
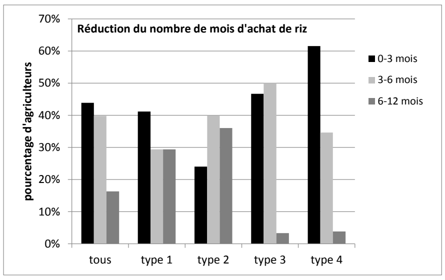


Figure 3 – The impact pathway

III- Measuring the impacts

A survey was conducted on 112 farms in four villages in order to measure the impacts. The sample is not representative of the region as a whole. In fact, the average area of land cultivated per person was 35 ares, whereas the agricultural survey (MAEP, 2007) indicated 11 ares for the entire Vakinankaratra region in 2005. Four classes of farmers were identified in the sample as a function of the quantity of rainfed rice produced per person: class 1 >150 Kg, class 2 between 80 and 150 Kg, class 3 between 30 and 80 Kg and class 4 less than 30 Kg. Therefore, the farms in classes 3 and 4, which were generally smaller, were more representative of the majority of farms in the region. These class differences are used as a baseline to assess the relative importance of the impacts.

		Farm type					
Impacts	Indicators	1	2	3	4	all	Comments
Increase in area of land cultivated with rice and higher rice yields	Evolution in the production of irrigated rice since the cultivation of rainfed upland rice	-	-	-	-	-	Complementarity and independence of upland rice in relation to irrigated rice. Only 2 out of 112 farmers claimed that they had reduced their irrigated rice production as a result of upland rice. Overall the situation for irrigated rice hardly changed. 32% of farmers claimed to have seen a change, which was positive for 61% and negative for 39%. The changes are due to purchases or legacy gifts.
	Increase in the production of rice per person linked to rainfed upland rice (Kg)	304	105	52	19	108	
	Area of land with rainfed upland rice per person (are)	21	7,8	3,4	1,5	7,5	Much higher than the regional average estimated in 2011 (Raboin et al., 2014), except for group 4.
	Area of land with irrigated rice per person (are)	12	6,1	3,6	2,6	5,6	
	Irrigated rice produced per person (Kg)	198	120	80	46	107	
	Evolution in the areas of land with upland rice	-	-	-	-	-	85% of farmers questioned have increased the area of land cultivated with upland rice since they first started growing it.
Shorter hunger gap, less pressure to buy rice	Reduction in the number of months when rice is bought	4,9	4,8	3,0	2,8	3,7	
	Self-sufficiency (% who never buy rice)	50	13	7	0	16	
	Reduction in rice purchases during the period when the price is at its peak at the end of the hunger gap (%)	-	-	-	-	65	Impact linked to the fact that upland rice is relatively early compared to irrigated rice. Therefore, it depends on the calendar for irrigated rice and the villages' location. In our survey, in the 3 villages where upland rice was earlier, 90% of farmers reduced their purchases at peak price. Only 8% reduced their purchases in the village where the harvest dates are similar.
Increase in rice sales	Increase in quantities sold (Kg)	844	137	58	9	264	The most important change concerns type 1 farmers. Before rainfed upland rice, they sold other crops. However, the change is the least significant for type 4 farmers. They are still obliged to sell in order to pay for unexpected costs or for basic necessities (oil, salt, scholar fees, etc.).
	% farmers who sold rice before growing upland rice	9	13	21	38	20	
	% farmers who sold rice after growing rainfed upland rice	86	53	59	58	61	
Diversification of farming activities	% farmers who developed livestock production partly due to upland rice	77,0	70,0	70,0	58,0	69,0	48% of farmers who developed their livestock production activity (essentially in types 2, 3 and 4) were able to invest in livestock production after saving money on buying rice. In addition, 29% mention that upland rice directly contributes to feeding animals (straw).
Greater peace of mind	%	-	-	-	-	100,0	This improvement is largely associated to the reduced need to buy rice (62%) and to an increase in home-consumption (15%), which means they can develop other activities (14%), invest (14%) because they can sell rice (14%) and have less need to seek alternative sources of income (6%) or do casual off-farm labour (7%).

The distribution of rainfed upland rice has secondary level impacts. These extend beyond the perimeter of research activities to other highland areas and, surprisingly, to zones at lower altitudes, such as the Mid-Western zone.

4 - References

Ahmadi N., Dzido J-L., Vales M., Rakotoarisoa J., Chabanne A. 2004. Upland rice for the highlands: new varieties and sustainable cropping systems to face food security. Promising prospects for the global challenges of rice production the world will face in the coming years? Montpellier, 14p.

Andrianantoandro V., Bélières JF. 2015. L'agriculture familiale malgache entre survie et développement : organisation des activités, diversification et différenciation des ménages agricoles de la région des Hautes Terres. Revue Tiers Monde, 2015/1 (n° 221): 69-88.

Chabanne A. and Dechanet R. 1991. Rapport de campagne 1990-1991. (Volet agrophysiologie). Antanarivo, 143p.

David-Benz H., Rakotoson J., Rasolofo P. 2009. Les politiques de stabilisation des prix du riz à Madagascar. Grema. 13 p.

Dechanet R, Razafindrakoto J, Valès M, 1997. Résultats de l'amélioration variétale du riz d'altitude Malgache.p 43-48. In Poisson C., Rakotoarisoa J. editors, 1997, Rice for highlands. CIRAD. Proceeding of the international conference on rice for highlands, 29/03-05/04/1996, Antananarivo, Madagascar. Montpellier, France. 269pp.

Dzido JL. 2000. Programme Riz d'altitude à Madagascar. Compte rendu technique campagne 1999-2000. Madagascar, 98p.

Gastineau B., Gubert F., Robilliard A., 2010. Madagascar face au défi des objectifs du millénaire pour le développement. IRD Editions. 335p.

Ministère de l'Agriculture, de l'Élevage et de la Pêche, République de Madagascar, 2007. Recensement de l'agriculture. Campagne agricole 2004-2005. Parcelles et superficies de culture. Vol. III. , 343 pp

Raboin L.M., Ramanantsoanirina A., Dzido J.L., Frouin J., Radanielina T., Tharreau D., Dusserre J., Ahmadi N. (2013) Création variétale pour la riziculture pluviale d'altitude à Madagascar : bilan de 25 années de sélection. Cahiers de l'agriculture (22): 450-458.

Raboin LM., Randriambololona T., Radanielina T., Ramanantsoanirina A., Ahmadi N. and Dusserre J. 2014. Upland rice varieties for smallholder farming in the cold conditions in Madagascar's tropical highlands. Field crops research, 169 :11-20p

Rakotoarisao J. 1997. Caractéristiques et contraintes de la riziculture d'altitude à Madagascar.p11-15. In Poisson C., Rakotoarisoa J. editors, 1997, Rice for highlands. CIRAD. Proceeding of the international conference on rice for highlands, 29/03-05/04/1996, Antananarivo, Madagascar. Montpellier, France. 269pp.

Vales M. and Razafindrakoto J. 1997. Caractéristiques et contraintes de la riziculture d'altitude à Madagascar.p145-151. In Poisson C., Rakotoarisoa J. editors, 1997, Rice for highlands. CIRAD. Proceeding of the international conference on rice for highlands, 29/03-05/04/1996, Antananarivo, Madagascar. Montpellier, France. 269pp.

Serpantié G., Rasolofoharinoro, Carrière S. 2007. Le « corridor» Ranomafana – Andringitra (Madagascar). [On-line]. Madagascar: CITE, IRD, 278 p. [2015/09/05]. <URL: http://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers09-03/010042175.pdf>.