Rice value chain development in Fogera woreda based on the IPMS experience

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Acknowledgements

This paper documents interventions, results and lessons learned for rice commodity development in Fogera *woreda*, based on a participatory market-oriented value chain approach. The approach was introduced by the IPMS project/staff, who not only facilitated the introduction of the approach (technically and financially), but also played an important role as partners in the development process. The credit for the development results obtained goes, however, to all the partners involved in this endeavour especially the seed producing farmers, staff of the Fogera OoARD and Adet Agricultural Research Centre (AARC).

Besides the authors, several people contributed to the realization of the report including Dr Moti Geleta who compiled and analysed the baseline data and Aklilu Bogale, Rebeka Amha and Abraham Getachew, who summarized the baseline data while Yasin Getahun provided maps. Dr Tesfaye Lemma also contributed during the stakeholder analysis.

Above all, the work of Ato Getachew Afework, who was actively involved during the introduction phase of rice in the *woreda* while he was working for South Gondar Department of Agriculture was special. He was the founder of the popular rice variety, X-Jigna, when he worked as lead rice researcher for AARC. Many households depend on this variety for their livelihoods both in the region and outside.

Finally, our appreciation goes to the project Field Assistant Ato Dessalew Kassa who collected data for this report and served as a bridge between the project and the rice growers. The Fogera *woreda* OoARD staff Ato Nigussie, Agronomist, and Worku Mulat, Head of OoARD, who provided information to validate the primary data collected in the field, were also acknowledged.

Abstract

Rice is a staple food crop for more than half of the world's population. The Asian rice, *Oryza sativa* and African rice *O. glaberrima* are the two most cultivated species. The discovery of wild rice in the Fogera plain in the early 1970s was the basis for rice introduction in the *woreda* as well as in the Amhara region. In the early 1980s through the technical support of North Korean experts, rice cultivation in the seasonally flooded plains started as a pilot in Jigna and Shaga cooperatives in Dera and Fogera *woredas*, respectively. By 2004, through various development activities, the rice production area had increased to about 6000 hectares. In the rapid rural appraisal conducted by IPMS and various stakeholders in 2004/05, farmers in seasonally flooded areas wanted to increase their rice acreage by addressing bottlenecks in the value chain, in particular excessive weed growth. At the same time farmers in the upland areas were also interested in introducing rice into their farming system. During the intervention period, the price of rice tripled, which further stimulated the interest in rice production. In 2010, the rice area had increased to around 15,500 ha, of which over 5000 ha was in the uplands. This increase has also contributed significantly to employment opportunities for weeding due to area expansion and increased weeding intensity. Project efforts concentrated on the testing/introduction of upland varieties New Rice for Africa (NERICA) and its seed system to complement the already existing X-Jigna variety, commonly used in Fogera. While seed multiplication has been started, further development of the upland varieties in Fogera should be carefully monitored. Data clearly indicated that most farmers have used the X-Jigna variety to expand rice into in the upland system, probably because of better yield potential, especially at times and locations when and where water availability was not limited. Following the increase in rice production, private traders and processors responded by increasing their capacity in terms of number of grinding mills. It was observed that now over 70% of the rice produced was sold as white rice outside the *woreda*. As a result of this, many processing and marketing challenges need to be addressed. First of all, the issue of grain breakage during processing has to be tackled to improve quality—this issue, was less important in the past when most grain was processed into flour for making *injera*. Differences in breakages have been observed between the NERICA and X-Jigna varieties, which require adjustments in processing. Also, consumer preferences in urban centres should be considered since X-Jigna has stickiness character as compared to the NERICA varieties. Rice straw and industrial by-products like hulls and bran are becoming increasingly important as a source of livestock feed and linkages with dairy and fattening in the *woreda* can be further developed.

Key words: Flood rice, GIS, upland rice, NERICA, PRA, X-Jigna

1 Introduction

The IPMS project, funded by the Canadian International Development Agency (CIDA), was established to assist the Ministry of Agriculture and Rural Development[1] in the transformation of smallholder farmers from a predominantly subsistence-oriented agriculture to a more market (commercial) oriented agriculture. The project adopted a 'participatory market-oriented commodity value chain development' approach, which was based on the concepts of innovation systems and value chains. Crucial elements in the approach are the focus on all the value chain components instead of only a production technology focus; the linking and capacitating of value chain partners and the assessment, and synthesis and sharing of knowledge among the partners. The project introduced this approach in 10 Pilot Learning *Woredas* (PLW) in Ethiopia with the objective of testing/adopting the approach so that it can be promoted nationwide. An integral part of the approach was the identification of marketable commodities and the value chain constraints and interventions. This was accomplished through a participatory process in all PLWs.

This case study focuses on the development of rice in Fogera *woreda* with the objectives of documenting diagnostic results and value chain interventions, and providing evidence of concepts, challenges and lessons learned to be considered for scaling out.

Following the introductory section, the remaining sections are structured as follows. Section 2 deals with methods and approaches used in the study, while Section 3 presents background information, including description of the PLW and the history and diagnosis of rice development. In section 4 value chain approaches and interventions—extension, production, input supply; marketing and credit issues are presented. Section 5 dwells on results and discussion on production/income, input supply/marketing, gender/environment/labour use, organizational and institutional aspects, while Section 6 deals with challenges and lessons learned.

1. Now Ministry of Agriculture.

2 Methods and approaches

To start the development of a commodity, IPMS used a *woreda* level participatory market-oriented value chain planning approach, aimed at identifying (i) main farming systems, (ii) potential marketable crop and livestock commodities at farming system level, (iii) constraints, potentials and interventions for each value chain component, and (iv) value chain stakeholder assessment with potential (new) roles and linkages. Different value chain stakeholders were involved and consulted in this planning exercise. Secondary biophysical and socio-economic data were also collected, followed by open ended interviews with focus groups and key stakeholders. The results were presented in a stakeholder workshop in which priority marketable commodities were decided upon together with key intervention areas and partners. This initial rapid assessment was followed by some more detailed studies on selected commodities. Such studies were conducted by partner institutions and/or students and/or IPMS staff using formal surveys, interviews and observations. For example, three studies dealt with analysing rice profitability and marketing (Astewul 2010), identifying suitable areas for upland rice (Endaweke 2007) and effectiveness of farmer to farmer upland rice seed production and exchange system in Fogera (Tesfaye 2009).

To implement the program at *woreda*, Peasant Association (PA) and community levels, the project facilitated different knowledge management and capacity development approaches and methods to stimulate the introduction of the value chain interventions by the actors concerned. The various value chain interventions were documented by project staff in the six monthly progress reports and the annual Monitoring and Evaluation (M&E) reports.

To quantify the results from individual and/or combination of interventions, the project established baseline data, conducted household and impact assessment surveys and documented changes. This case study also used data generated from these sources and others.

Baseline information

To establish baseline, data from a formal baseline study and special diagnostic studies were used. The initial PRA study also contributed to the quantitative and qualitative baseline information. Amongst others, the formal baseline study used PA level interviews and records to collect information on the number of households involved in rice production; and number and performance of polishers/millers in the *woreda*. This information was used to compile *woreda* level information on rice development in general.

2.1 Documenting change processes and results

Several sources were used for regular documentation of change processes and results, including six monthly progress reports, annual M&E reports, MSc theses researches, and records in the OoARD, personal observations and diaries.

In 2009, the project also developed a set of guidelines for the PLW staff to systematically collect relevant information for the case studies including history, changes in extension services, value chain interventions (production, input supply, marketing and credit), results, challenges and lessons learned. Part of the information was obtained through (i) key informant interviews, and (ii) village and Woreta town level polishers/millers survey (111 households, based on stratified random sampling) and other sources

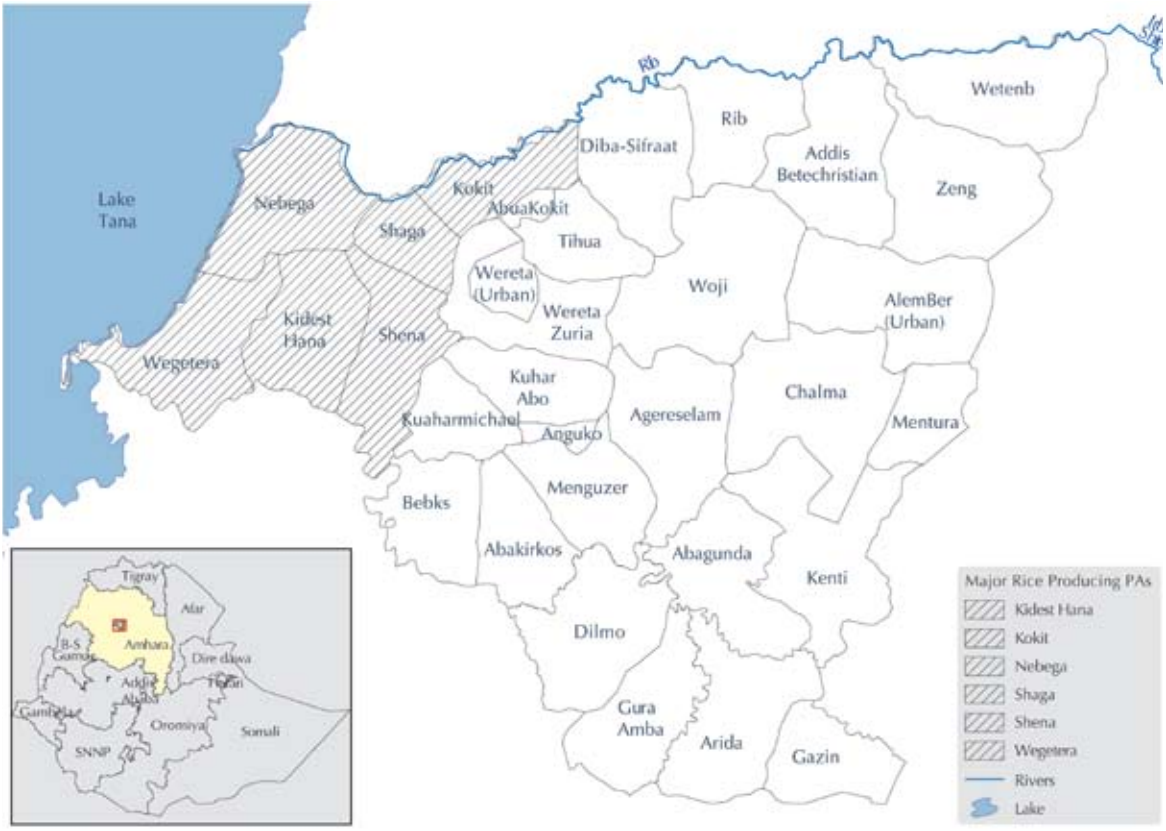
Following the collection of all relevant information, a write-shop was organized to present information in a systematic manner. Drafts of the PLW specific commodity case studies were then reviewed and a household survey was conducted by experts at the IPMS headquarters. To assess impact a household survey was conducted in 10 *kebeles* (Hagere Selam, Woji, Alember Zuria, Zeng, Woreta Zuria, Kidest Hana, Kuhar Mikael, Tihua Abua, Shina, Nabega and Aboakokit) where both flood and upland rice were grown. Finally an impact survey was conducted in 2010 in the whole *woreda*.

3 Background to rice commodity development

3.1 Description of Fogera woreda

Fogera *woreda* is one of the 151 *woredas* of the Amhara Regional State found in South Gondar Zone (Figure 1). It is situated at 11º46 to 11º59 latitude North and 37º33 to 37º52 longitude East. Altitude ranges from 1774 to 2410 metres above sea level (masl) and is predominantly classified as Woina-Dega. Based on the existing digital data, mean annual rainfall was 1216 mm ranging from 1103 to 1336 mm from both the short (March and April) and long rains (June to September). Farmers depend on long rainy (Kremt) season for crop production.

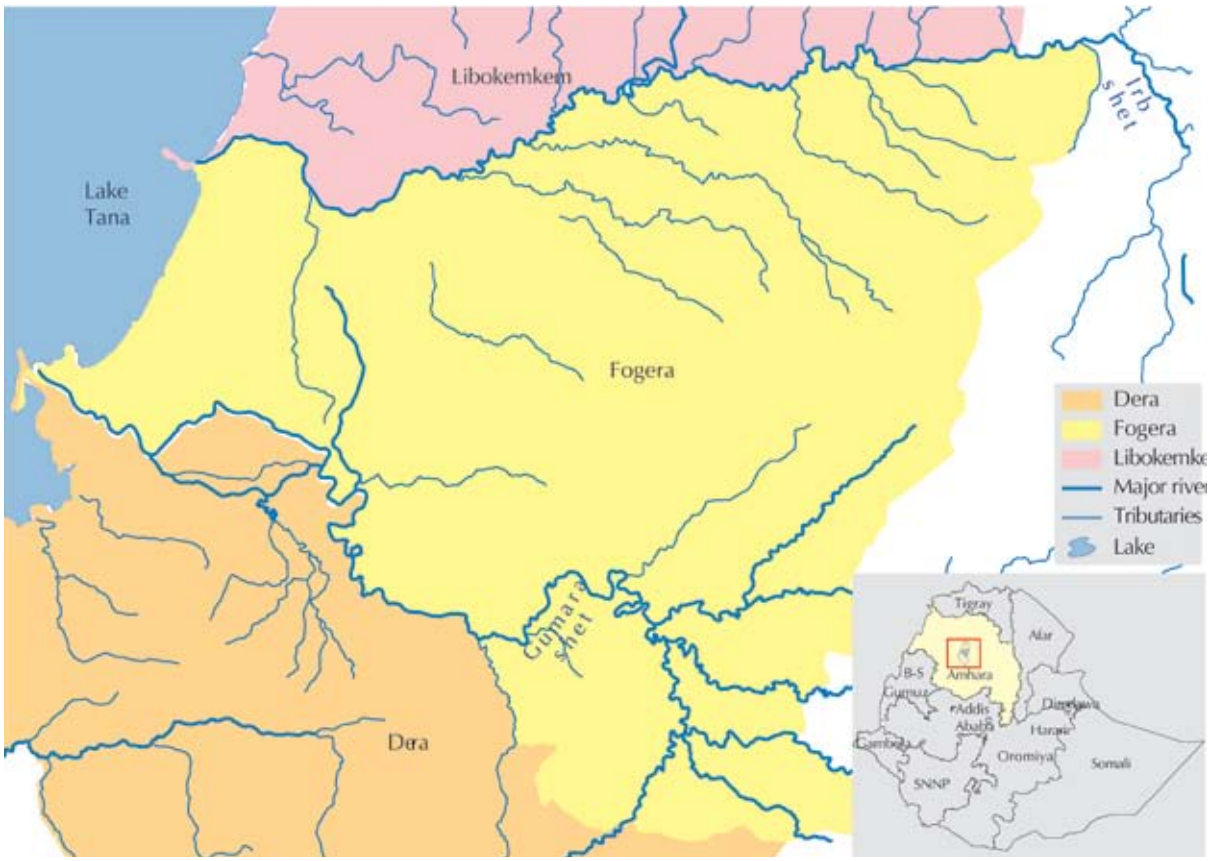
Figure 1. *Location of Fogera* woreda *with major rice growing areas*



Woreta is the capital of the *woreda* and was located 625 km northwest of Addis Ababa and 55 km from the regional capital, Bahir Dar. Woreta and Alember were two major towns in the *woreda*. The *woreda* was divided into 26 rural *kebeles* and 5 urban *kebeles*. The total land area of the *woreda* was 117,405 ha of which flat

lands account for 76% while mountains and hills and valley bottoms account for 11 and 13%, respectively. An interesting characteristic of Fogera *woreda* was the seasonal flooding of the six *kebeles* (Shaga, Shina, Nabega, Wagetera, Kidest Hana, Aboakokit) bordering Lake Tana because of overflow of the lake (Figure 2). Rib and Gumera were the two major rivers that recharge Lake Tana. As a result, the flooded plains were the major rice production areas. In addition, two rivers were of great economic importance to the *woreda* because they were used for irrigating vegetables during the dry season. Both rivers cross many of the *kebeles* before entering into Lake Tana (Figure 2).

Figure 2. *Fogera* woreda *and the two major rivers*



Average land holding was about 1.4 ha with a minimum and maximum area of 0.5 and 3.0 ha, respectively. The total human population of the *woreda* was 233,529. The rural population was estimated at 206,717. The proportion of male and female population was almost similar in both rural and urban areas. The number of agricultural households was 42,746. (IPMS 2005).

Fogera *woreda* was endowed with diverse natural resources and can grow a number of annual and perennial crops. The *woreda* was one of the eight *woredas* bordering Lake Tana with estimated water body of 23,354 ha (IPMS 2005) and was also one of the surplus food producing *woredas* in the region. According to the *woreda* Office of Agriculture the dominant soil type on the Fogera plains was black clay soil (ferric Vertisols), while the medium and high altitude areas were orthic Luvisols (IPMS 2005).

3.2 History of rice development

Rice (*Oryza sativa*) was staple food crop for more than half the world's population and was grown in an area of 150 million hectares (Reddy 2004). The Asian rice, *O. sativa* and African rice *O. glaberrima* were the two most cultivated species (Reddy 2004). The discovery of wild rice in the Fogera plain in the early 1970s was the basis for rice introduction in the *woreda* as well as in the Amhara region (Astewul 2010). In the early 1980s through the technical support of North Korean experts', research on rice was initiated in Jigna (Dera *woreda*) and Shaga (Fogera *woreda*) cooperatives. This was, however, discontinued when farmers' cooperatives were dismantled in 1991 (Getachew 2000).

Following this Getachew Afework who was initially an expert in South Gondar Department of Agriculture started to collect seed locally from the previous introductions. Initial seeds were therefore obtained from a farmer in Jigna *kebele* and that was why it was named as X-Jigna. After multiplication, seed was again distributed to other farmers for demonstration and research purposes under his supervision.[2] Following his efforts, Adet Agricultural Research Centre released three other rice varieties called Gumera, Kokit and Tigabe. Adet Agricultural Research Centre has recently released Gumera (IAC 164) but its red colour made it unacceptable by many producers and consumers who were not used to prepare red *injera*, and hence the low market demand within and outside the *woreda*.

In the 1990s, rice extension service was one of the major focus areas at both Fogera and the region. However, all attention was given to the lowland paddy rice variety in the six *kebeles* (Figure 1).

As indicated above, during the early days of rice introduction, the extension system was geared towards promoting rice production to more farmers. Farmers were, therefore, provided with free inputs (seeds and fertilizer) and more farmers were also trained on the agronomic practices. Despite all these efforts, there was resistance due to wrong perception that rice causes infertility in humans. This, however, ceased as time went by because both extension and research system pursued aggressively.

Producers used rice to prepare *injera*, bread and alcoholic drinks like Tela and Arekie. Rice was also a cash crop. Rice straw and stubble were also used as source of feed and house construction. Using rice bran which was very important as livestock feed was not well known.

Rice production and expansion

In 1993, 30 households (HHs) in 2 *kebeles* planted 6 ha of land and produced 16 t with an average yield of 2.67 t/ha using the X-Jigna variety. In 2005 the area expanded to around 6871 ha producing about 28,877 t (4.0 t/ha), while the number of farm HHs increased to 12,770. With the continuous engagement of both the research and extension systems, rice production was expanding in the low lying areas (Table 1).

However, weed was a major problem and identified as the major challenges for rice production and expansion. Although majority weeding activities have been carried out by family labour, there were some producers who were paying Ethiopian birr (ETB)[3] 8/person plus covering food and drink as incentives. Three times weeding was highly recommended for maximum production.

In 2004, IPMS and partners conducted rapid assessment which revealed that there was a demand by farmers in the non-flooded areas to produce upland rice. Later, using GIS analysis, potential of upland rice production for the *woreda* was studied. To accommodate such expansion, testing of new varieties was essential to

2. This researcher was originally an agronomist in North Gondar zone office of agriculture before he became a rice researcher at Adet Agricultural Research Centre.

3. At 13 March 2012, USD 1 = ETB 17.4180.

complement the existing X-Jigna. Key informants agreed that the quality of rice polishing was linked on how it was produced (adequate soil nutrient, stage of maturity during harvest, availability of water at all stages of plant growth and post-harvest handling and appropriate moisture content of the grain).

Table 1. Rice production, no. of HHs and area coverage (1993–2004) in Fogera *woreda*

Year	No. of HHs	Area (ha)	Production (t)	Productivity/ha (t)
1993	30	6	16	2.67
1994	256	65	163	2.50
1995	494	130	164	1.26
1996	1374	487	1451	2.98
1997	2957	1113	1613	1.45
1998	4445	1670	4191	2.51
1999	6158	1968	6041	3.07
2000	9413	2907	6041	0.37
2001	9796	3037	10,630	3.50
2002	11,032	3346	11,711	3.50
2003	11,583	3980	13,930	3.50
2004	12,162	6378	28,877	4.53

Source: Fogera WOA (2005).

Processing and marketing

After harvesting, rice (paddy) was usually stored without processing in houses and taken to local assemblers and/or processors for sale or household consumption. The following three channels were used during processing in both rural and urban areas (Figure 3).

1. Rural processing for local consumption and sale

2. Urban processing for local consumption

3. Urban processing for sale outside *woreda*

1. Rural processing (for local consumption and sale): In the rural areas, paddy rice was taken to grinding mills where the hull was removed (dehulled) by coarse grinding. Afterwards, farmers manually clean and separate the brown rice grain and the hulls by winnowing. What remains was brown rice, which still has the brown bran layer. Majority of this brown rice was converted into flour by grinding mills from which *injera* was made. Some of this brown rice could, however, be retained and sold to other households in other *kebeles* where rice was not grown. Hull was the by-product which will end up being used as a source of energy. Conversion to white rice under the rural settings was not possible. In rural areas, farmers pay a grinding fee to the grinding mill owner.

2. Urban processing (for local consumption): Some rice producing households also directly take their paddy rice to urban processors and were charged grinding fees. Dehulling,[4] polishing[5] and grinding were performed based on demand by farmers. In this process, hull and bran were removed to get white rice. Finally, this white rice was ground to make flour for making *injera*. Hull and bran were the by-products during this process. Farmers could sell their bran to the processors or take it back home for their own livestock, while the hull was left around the processing facilities. If the farmers decide to sell the bran, they receive ETB 0.2/kg while the machine processors sell it for ETB 1.50/kg.

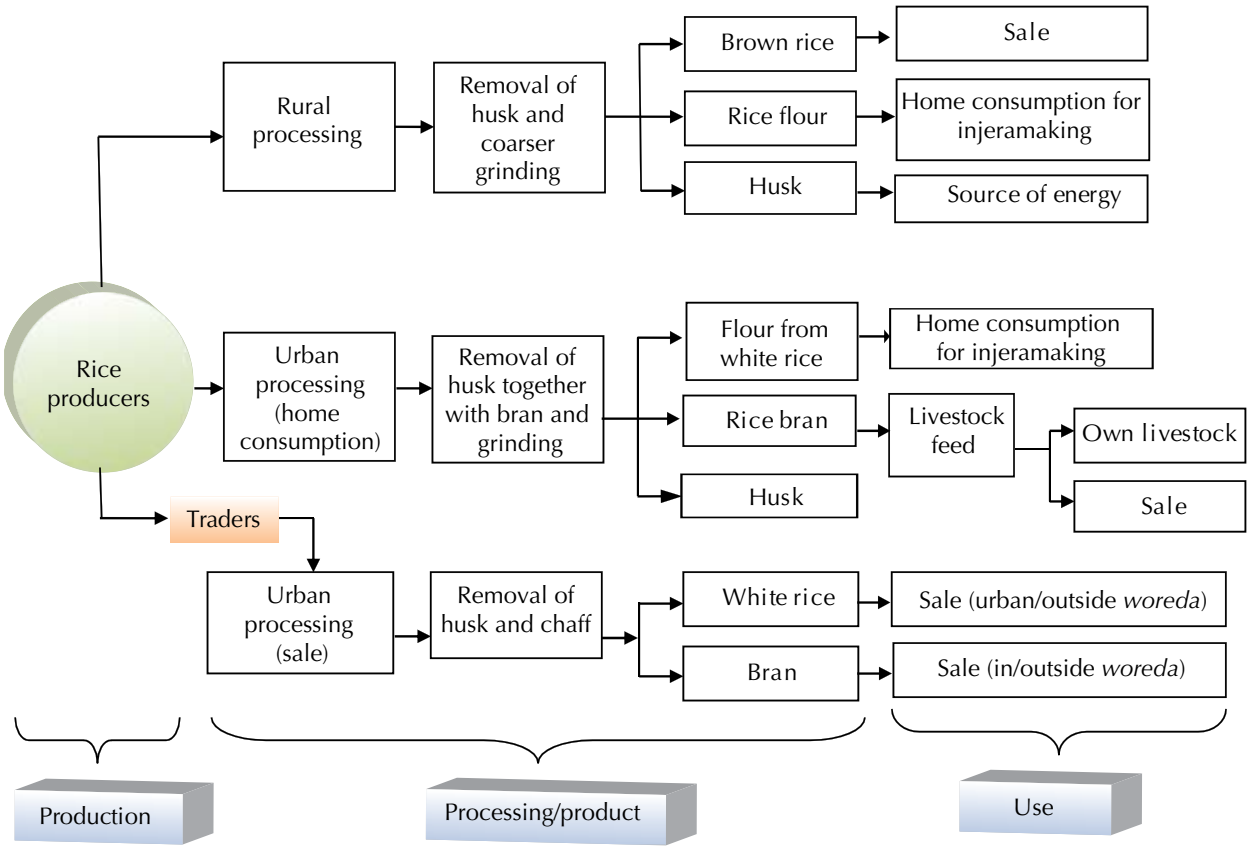
4. Dehulling refers to the removal of hull which then converts the paddy rice to brown rice.

5. Polishing refers to the removal of the inner seed coat to convert it to white rice.

Urban processors (for sale outside of *woreda*): In this case, rice producers sell their paddy to rural assemblers traders, which will transport and sell it to wholesalers/processors in Woreta town. Rural assemblers use carts with 7–8 quintal capacity and donkey pack with 0.9–1.1 quintals capacity for transporting. During peak times in Kidest Hana *kebele* alone, up to 40–50 carts' loads paddy rice was transported to Woreta every Wednesday and Saturday. About 100 to 120 carts transport rice during these market days in Woreta, The wholesalers process the paddy rice in preparation for sale. During processing, hull and bran were removed at once to get white rice. Bran produced in this way was not the proper bran because it contains ground hull mixed with bran and some broken rice grain. Hulls/bran were sold to dairy farmers in and outside the *woreda* while the white rice grain were sold to urban dwellers in and outside of the *woreda*.

In all cases, removal of hull, bran and grinding was done using the same machine using various adjustments. However, because of lack of appropriate processing machines and harvesting of most of the rice before full maturity, breakage during processing was very common. Despite this, rice grading, for example, using various sieves was not practised by the wholesalers. Figure 3 illustrates the channels in processing rice in both rural and urban areas.

Figure 3. *Rice processing in rural and urban areas in Fogera*



Fluctuation in rice price was visible during harvesting period (November–January) because many farmers take the grain to market which results in market glut and hence every year the price decreases during that period. In 2004, 100 kilo of de-hulled rice was sold at ETB 180/quintal while paddy rice was ETB 80/quintal. The price of de-hulled rice during low supply (July–September) was ETB 300/quintal in 2004. Service charge for de-hulling was ETB 10/quintal while cost of milling was ETB 15/quintal in rural *kebele* processors. In Woreta, the service charge was lower by half. And the price of rice bran (hull and bran mixed) at Woreta was ETB 3/quintal. Hull from processors in the rural *kebeles* was not used for livestock feed because it was of poor palatability. Rice bran from Woreta and hull from rural *kebele* processors were not considered as valuable by-products at the time of the diagnostic study.

4 Value chain development interventions

To develop rice value chain, the project partners addressed constraints and potentials in production, supply of inputs and services and marketing/processing, using new extension approaches/tools. Various components of the value chain were described below.

4.1 Extension

The project introduced a participatory market-oriented commodity value chain development approach in which emphasis was put on knowledge management, skills development and linking producers with public and private sector actors along the value chain.

Following the diagnostic results, the extension service focused on introducing various improved agronomic practices in order to maximize production area and productivity on both rice types (flood and upland rice). For the first time, knowledge and skill development work by project partners on upland rice was conducted. This new focus was coordinated by the WALC (*woreda* Advisory and Learning Committee), which brought together important stakeholders, including AARC, OoARD and SG2000.

IPMS, in partnership with the main stakeholders (OoARD and AARC), also conducted practical training, demonstrations and field days on the newly introduced upland rice varieties which were suitable to a wide range of agro-ecological zones and short maturing types. Given that all farmers involved in upland rice seed production and exchange system were new, training to all participants were important. Two trainings at different stages of growth were provided in one production season. Moreover, field days were organized for the *woreda* officials, zonal agricultural office representatives, farmers in various *kebeles* and *woreda* offices of agriculture experts. Based on the demand and agreement made by WALC meeting a total of 127 participants have attended on 25 August 2008. Another field day was also organized for 53 people on 31 August 2008.

The project also facilitated various stakeholders meeting with the rice producers and processors to exchange knowledge and identify new interventions.

4.2 Production intervention

X-Jigna was the dominant rice variety grown in the *woreda* on the flooded plain (IPMS 2005). IPMS in collaboration with AARC facilitated on-farm trials of four upland varieties (NERICA-3, NERICA-4, SUPERICA-1 and PAWE-1) based on initial agreement with local partners. Farmer to farmer seed production and exchange system was devised to speedup scaling out process and to reach many farmers within a short period of time. Moreover, it was also possible to increase rice yield by improving the agronomic practices, (weed control, use of fertilizers and pest and disease control).

Since weeds associated with rice were mainly grass types (*Pennisetum* and *Cynodon* species), the amount of labour required was considerable and often compromises yield because complete hand removal of these weeds was difficult. Taking this problem into account, IPMS conducted an on-farm trial using systemic herbicide (roundup) with 25 farmers in 2006 and the result was successful (Yirgalem 2006). According to the trial results and farmers' reflection on the use of this herbicide during field days and platform, they called it 'Roundup is God sent'. Use of this herbicide did not only reduce weed infestation but also loosen the soil that made it easy for ploughing and also improved its fertility. Price of roundup (ETB 70/lt) for a '*timad*' (0.25 ha) or ETB 280/ ha was cheaper than the labour cost for the same operation. However, based on subsequent discussions with stakeholders and partner institutions, the use of Roundup was not prompted for fear of negative environmental effects on the Lake Tana ecosystem. Roundup was not used by many farmers following the trial because the project later did not want to promote it because of the unknown long term effects on Lake Tana ecosystem.

The already existing fertility management practice of crop rotation with legumes was promoted. Farmers plant grass pea (*Lathyrus sativus*) and chick pea (*Cicer arietinum*) immediately after harvesting rice using the residual moisture. These leguminous crops were capable of fixing atmospheric nitrogen to the soil. For example, grass pea can fix 25–50 kg nitrogen/hectare (Brink and Belay 2006) while chick pea can fix between 90 and 180 kg nitrogen/hectare (Werner 2005).

Farmers also believe that the low lying areas were fertile enough because of the silt deposited on the plots every year. As a result, fertilizer was not applied even on the fields which were repeatedly under rice. These farmers argue that whenever they apply fertilizer, there will be excessive vegetative growth and rice will lodge which will lead to poor seed setting.

Organic fertilizer (compost) was a recent introduction to the *woreda*. WoA was working extensively with many farmers to adopt this technology. Farmers were encouraged to prepare their own compost from locally available materials including household wastes.

The Fogera rice in the market was known for poor quality because of fractured and stickiness when boiled. The fracture grain was attributed by poor agronomic practices, post-harvest handling and low standard rice processing machine. In order to avoid breakage, farmers were advised not to harvest prematurely.

In addition to grain production, straw and rice bran are by-products which have become the main sources of livestock feed but also generated household income through sale.

4.3 Input supply/service/credit

Farmer to farmer seed system

Following the results of the variety trials in the uplands, farmer-to-farmer seed multiplication and exchange system was designed to ensure sustainable supply of seeds. Interested farmers were identified for seed multiplication and agreements made between the *woreda* Office of Agriculture (WOA) and the individual farmers. Farmers had agreed to follow appropriate agronomic practices including recommended seeding rate, proper weeding, harvesting at the right time among others, as suggested by experts (Tesfaye 2009). Initial seed and fertilizer was provided by the project, the seed was repaid in-kind during harvest whereas the fertilizer was a free input. Seed supply system for X-Jigna was, however, well established and farmer to farmer based. This system was effective considering the rate of expansion over the years.

4.4 Processing and marketing interventions

The project in collaboration with SG2000 and Adet Agriculture Research Center (AARC) introduced parboiling technology to hotels and restaurants in Fogera and Bahir Dar. Parboiling helps to reduce breakage during processing but was also nutritionally rich. Besides, rice value addition trainings were also provided to one women's association and one ex-soldiers and military returnees associations at Alember town in collaboration with Fogera *woreda* small and micro trade enterprise office.

Various platforms were facilitated in collaboration with small and micro trading office, office of agriculture and urban processors to use better machine for processing though they were highly reluctant.

The project in collaboration with SELAM technical and vocational training centre also introduced different mesh size sieves (2.2, 2.4, 2.7 mm) in order to introduce rice grading to satisfy the urban consumers. With these sieves it was possible to separate the fractured grain and full grain. The result was demonstrated in exhibitions and bazaars conducted at Woreta and in farmers festival at Bahir Dar. There was a high demand by restaurant owners and individuals who have been consuming boiled rice.

5 Results and discussion

5.1 Varieties, areas, households, production, productivity, income by HH and woreda

Varieties

Based on one year preliminary results (NERICA-3, NERICA-4,) were grown at altitudes of up to 1900 masl on deep cracking Vertisols in the uplands *kebeles* in Addis Betechristian, Tihua Zakena and Woje Arba Amba. SUPERICA-1 showed better performance in lowland *kebeles* at Kidest Hana which has excess moisture. Based on farmers' analysis, NERICA-4 was superior in yield in the uplands. However, none of the varieties were successful at Alember *kebele*, probably due to low soil temperature which lead to poor seed setting. Vegetative growth was, however, good at the initial stages.

Other than the upland varieties, X-Jigna was also found to be suitable for uplands by farmers themselves. They normally plant this variety on the uplands when rainfall starts early in the season and when they perceive that it will stay longer than normal. This was because farmers know that X-Jigna requires staying in water for long period of time.

Fertility management

The main strategy to manage fertility in the flood rice area was through crop rotation. According to the OoA, about 7,758 ha (4,400 ha grass pea and 3358 ha chick pea) of land was under these legumes during 2011/12 cropping season. Applying additional nitrogen source fertilizers to rice will likely cause lodging of the rice crop and that may be why farmers were reluctant to apply fertilizer. Farmers close to Rib and Gumera rivers were, however, used to transplanting onion seedlings immediately after harvesting rice. These farmers were used to applying fertilizer when growing onions. Both the area under the legumes and onions will later in the season be used for growing rice because it becomes flooded during the main rain season.

In the upland areas where NERICA was grown, farmers apply inorganic fertilizer. The use of manure was not widespread. Astewul (2010) reported that out of the total target household only 4% of them applied manure in their rice field.

Area

Rice was a major crop in the six flooded *kebeles*. According to data provided by OoARD, the area of rice increased considerably from 2005 to 2011 (Table 3). As a result of the introduction of upland rice varieties to non-rice growing areas in the uplands since 2008 and increased rice price, rice has extensively expanded in the *woreda*. The main benefit, however, was that the introduction of these upland varieties triggered farmers in the uplands to test the low land rice (X-Jigna) for the first time. This also substantially contributed to the expansion of rice production in the low lying areas where rice was not grown before. Farmers in the uplands started growing X-Jigna when rains start early enough in the season as this crop requires staying under water for extended period of time for good production. However, if the rain starts late and farmer predict that there will be shortage of rain, then they grow NERICA-4 instead.

To study upland rice production potential and identify the possible expansion areas in the non-rice growing *kebele*, an MSc study was made using GIS analysis. The results showed that, 13,054 ha and 25,238 ha were highly and moderately suitable, respectively (Table 2), for upland rice production (Endaweke 2007).

Table 2. Suitability level and their respective area coverage

Suitability level	Area (ha)	The total area (%)
Highly suitable	13,054	12.52
Moderately suitable	25,238	24.20
Marginally suitable	36,171	34.68
Not suitable	17,669	16.94
Permanently not suitable	12,166	11.66

Source: Endaweke (2007).

Hence, more of the increase in area has taken place in the flooded areas but also uplands where the lowland variety was also grown extensively (Table 3). Growing of rice in general and X-Jigna in particular resulted in better income of households compared to the traditional cereals (sorghum, teff) grown in the uplands. Another major contributing factor to the area expansion was improved price (Table 4), which was in part the results of increased demand, where rice has now become one of the major staple food crops consumed frequently within and outside the *woreda*.

In the year 2011, area under rice increased to 15,547 ha. According to the impact survey conducted by the project in 2010, average yield was around 4.4 t/ha. Based on this, total production was around 68,400 t.

During this time nearly all restaurants and hotels at Woreta use rice *injera* because of this many customers are complaining. In January 2012, price of teff, finger millet and rice was 700, 600 and ETB 825/quintal, respectively. This discouraged restaurant owners to mix rice with teff and hence customers were not complaining at the moment.

Farmers were considering rice as a cash crop and hence sell rice and buy maize and finger millet which were cheaper in price, for making *injera* and local drinks.

A household survey conducted in 2009 on farmers growing rice showed that households on average produced about 3324 kg with a value of about ETB 13,065 (Table 5).

Table 3. Rice production data for lowland and upland rice varieties during 2005 and 2011

	Baseline (2004/05)	2011		
Kebeles	X-Jigna (ha)	X-Jigna (ha) lowland	NERICA-4 (ha) upland	Total (ha)
Wotemb		6.00		6.00
Zeng		1.25		1.25
Alember		0.25	0.75	1.00
Addis Betechristian		74.25	1.25	75.50
Rib		373.17	6.83	80.00
Woje Arba Amba		119.50	0.50	20.00
Diba		348.25	27.75	76.00
Chalma		6.00	1.00	7.00
Kenti		29.55	0.45	30.00
Arida			1.00	1.00
Guramba		285.00		285.00
Gazin		20.75	1.25	22.00
Dilmo		84.38	1.625	86.00
Bebeks		80.00		80.00
Menguzer		514.75	0.25	515.00
Agereselam		137.00		137.00
Kuhar Mikael		597.30	3.70	601.00
Angukok		37.75	0.25	38.00
Kidest Hana	867.25	2000.00		2000.00
Wagetera	1231.00	1551.00	1.00	1552.00
Shina	900.00	1664.00	1.00	1665.00
Nabega	912.00	1648.62	1.385	1650.00
Aboakokit		1506.20	2.80	1509.00
Shaga	893.00	1065.00		1065.00
Aba Kiros		243.25	1.75	245.00
Abagunda		700.00		700.00
Tihua Zakena	605.50	849.75	0.25	850.00
Kuhar Abo	62.00	656.00		656.00
Woreta Zuria		894.00		894.00
Total	5,408.75*	15,492.96	54.79	15,547

*Discrepancy between this area and the area in Table 1 (for 2004) because of use of different sources of information.

Source: Baseline (2005) and impact (2010) surveys.

Table 4. White rice retail price/kg from 2005–2011 during peak supply and short supply

Year	Peak supply (February–April)	Short supply (August–November)
2005	1.80	3.00
2006	2.00	3.50
2007	2.60	4.00
2008	5.00	5.70
2009	5.50	10.50*
2010	5.50	6.80
2011	6.00	8.25

* This price was exceptionally high and not only for rice, but also for all other food items at that time.

Source: IPMS staff assessment (2011).

Table 5. Household survey results of rice production, productivity and income for flood rice

Variable	Obs.	Mean	Std. dev.	Min	Max
Plot size (timad)	74	3.19	1.52	0.25	7.0
Production per household (kg/year)	74	3324.32	2251.75	250	12,250
Rice productivity (kg/timad)	74	1105.92	754.77	200	6000
Rice productivity (kg/ha)	74	4423.70	3019.08	800	24,000
Value of rice produced per timad (ETB/timad)	74	4346.28	2966.25	786	23,580
Value of rice produced per hectare (ETB/ha)	74	17,385.13	11,864.99	3,144	94,320
Total cash outlay for rice production (ETB/hh)	74	104.29	466.72	–	3900
Cash outlay per timad (ETB/timad)	74	32.60	91.23	–	557.14

Source: Household survey (2009).

Table 6. Rice cost/benefit study, Fogera *woreda* 2011

Benefits	Unit	Quantity	Price	Value
Paddy rice	t	4.4	5000	22,000
Straw	t	6.8	400	2720
Bran (hulls, bran together)	t	1.25	1500	1875
Total value				26,595
Cost				
Land rent	ha	1	7000	7000
Labour				
Ploughing (3 times)	Person-day	12	20	240
Weeding (3 times)	Person-day	132	35	4620
Harvesting	Person-day	16	25	400
Threshing/winnowing	Person-day	32	20	640
Subtotal		192		5900
Animal power cost				
Ploughing (3 times)	Hectare	1	1120	1120
Threshing	Hectare	1	560	560
Transport home	Hectare	1	120	120
Subtotal				1800
Seed	kg	200	5	1000
Total cost				15,700
Profit (benefit–cost)				10,895

Source: IPMS project staff assessment (2011).

5.2 Input supply and marketing improvements

Improved seed multiplication

Following the screening of varieties suitable to different agro-ecologies, farmer-based seed production and exchange system was designed to respond to the seed demand. Accordingly, four years after the first demonstration in 2006, the number of households who participated in upland rice production reached 238 households in 2009 (Table 7). Table 7 presents details of upland rice seed production expansion from 2005–2011.

Table 7. Upland rice introduction, scaling out and seed production 2005–2011

No.	Year	Participants			Area (ha)	Production (quintal)	Remark
		M	F	T			
1	2005						Four varieties (NERICA-3 and 4, Pawe-1, Superica-1, at 5 *kebeles*) tested
2	2006	30	0	30	4.625	83.25	30 farmers for seed multiplication
3	2007	63	4	67	12.5	288	48 farmers for seed multiplication, 19 for trials in new sites
4	2008	147	49	196	29	841	For seed multiplication
5	2009	209	29	238	55.63	1418	Seed multiplication and part of scaling out to more *kebeles*
6	2010				55.53	1650	Seed multiplication and part of scaling out
7	2011				54.79	1644	
Total seed production					212	5924	

Source: Compiled from IPMS six monthly progress report (2011).

The total production of upland varieties since its introduction was estimated at 5924 quintal in an area of about 212 ha. This results in average yield of 27 quintal/ha which was low as compared to the average yield data from the PLW, which was based on the X-Jigna variety.

The total upland rice seed harvested in the *woreda* from 2006–2011 was estimated at more than 50 t which could be sufficient to cover 250 ha at the current seed rate of 200 kg/ha (Table 6).

Distribution of seeds of the upland varieties followed three systems; i) direct farmer to farmer exchange, ii) sale of seeds through the WOA who distributed seeds to new PAs (identified with the help of GIS) within the *woreda*, and iii) sale of seeds by private farmers to various buyers outside of the *woreda* through. No data were available on the distribution of seeds through the farmer to farmer exchange system, however, informal observations indicate that some of the seeds were sold as grain and/or consumed.

Below was an overview of some of upland rice seed sold outside the *woreda* over the years (Table 8).

Table 8. Upland rice seed sold outside Fogera *woreda* for seed, 2009

	Organization	Seed purchased (quintal)	Seed source (*kebele*)	Price/quintal	Amount sold (ETB)
1	Oromia NGO	2.60	Tihua	800	2080
2	Bure IPMS	2.00	Aboakokit	1000	2000
3	Libokemkem *woreda* Office of Agriculture	12.70	Aboakokit, Tihua	875	11,112
4	Adet Research Centre	4.96	Tihua	700	3472
5	Dera WOA	14.05	Aboakokit	875	12,293.75
6	Fogera WOA	8.30	Bebekis, Woji	600	4980
7	Maksegnit WOA	10.00	Aboakokit	900	9000
8	Indian Company	50.00	Woji, Aboakokit	800	40,000
		104.61			84,936

Source: Compiled from IPMS six monthly progress report (2011).

Table 8 deals with the amount of upland rice sold in the presence/knowledge of the WOA staff. More has, however, been sold without the knowledge of the WOA people through farmer to farmer exchange system.

The demand for upland rice seed has been increasing within and outside the *woreda*. The price also increased by 50–60% more compared to grain price. In 2010 one Indian company that secured 5000 ha land from Oromia region for rice production approached the *woreda* to purchase 300 quintals of upland rice. During the same period 1000 quintal seed of NERICA-4 was requested from Metema *woreda* even though seed did not meet the quality of the buyers. It was noted that only a small part of the rice expansion in Fogera was due to the upland rice varieties. The bulk was due to farmer to farmer seed exchange of X-Jigna.

Processing and marketing

As a result of increase in area and production, the number of processors in the *woreda* has been growing. In 2006, the number of polishers was nine which were owned by six individuals (Yirgalem 2006).

A study was conducted in 2011–12 to quantify the number of processors and volume processed. The number of processors at Woreta had increased dramatically and was estimated to be 120–150 and the volume of processed rice was estimated at 82,148.2 82,782.6 t annually. This accounts to about 93% of the total production. Growth in rural *kebeles* was hampered by seasonal inaccessibility and higher fuel price (petroleum) as compared to urban processor which used electricity. The rural mills were more expensive to run and also less efficient when compared to those in Woreta town. The service charge at rural *kebele* processors ranged from ETB 20/quintal during the dry season to ETB 60–70/quintal in the rainy season.

Table 9. Location and number of processing machine, estimated volume of rice processed, locally consumed and exported outside the *woreda*, 2011

Location by *kebele*	No. of processing machine	Estimated volume processed (t)	Grain (t)	Hull (t)	Rice bran (t)	Estimated locally consumed (t)	Estimated export (t)
Nabega	15	3168.0	2217.6	950.4	–	2217.6	
Kidest Hana	11	2257.2	1580.0	677.2	–	1580.0	
Woreta town	120–150	82,782.6	53,803.7		23,179.1*	14,671.1	18,543
Kuhar Mikael	2	410.4	287.3	123.1	–	287.3	
Kuhar Abo	3	129.0	90.3	38.7	19.4*	90.3	
Wagetera	4	820.8	574.6	246.2	–	574.6	
Tewuha	2	410.4	287.3	123.1	–	287.3	
Total	157–187	89,978.4	58,840.8	2158.7	23,198.5	17,908.2	18,543

*Even though majority of this was hull, it also includes bran and broken rice but was sold as bran to retailers and users.

Source: Compiled from IPMS six monthly progress report (2011).

Usually rice sold outside the *woreda* was in the form of white rice. As the *woreda* was serving as sources of seed for many parts of the country, there was also more paddy rice sold outside the *woreda* every year. In 2011 the amount of export of rice outside the *woreda* was estimated to be 18,543 t (Table 8). About 2000 quintals of X-Jigna rice seed has also been exported to neighbouring *woredas* and regions from Fogera.

Before 2005, farmers used to bring rice for sale immediately after harvest, because price becomes very low after about three to four months time because of market saturation. Then price picks up later on because of shortage of supply. Nowadays before farmers bring rice to market they ask for market information and if the price was low they do not sell their rice, then the price increases soon afterwards. Currently, (January 2012) the price of paddy rice was ETB 500 and white rice was ETB 825/quintal (Table 4).

It was observed that grain from X-Jigna was short and thick and has an oval shape while NERICA has elongated and thin grain. Since machine settings/operators were more used to the processing of X-Jigna, more breakage in

NERICA processing was observed. This would reduce the market potential for white rice. Furthermore, it seems that NERICA was softer than X-Jigna, resulting in more fracturing at processing.

Unless better and advanced processing machines were introduced, NERICA may not be suitable for the existing types of processing machines. This probably might be one of the reasons for its less adoption. It was noted that parboiling rice—introduced by the project partners to women associations—before taking it to processing machine causes less damage at processing.

From the marketing side, possibilities to pilot and promote consumer-targeted grading according to grain size were raised. In this regard the processors responded that wholesalers from Gondar, Dessie and Mekelle consider the existing quality is fine because of its cheaper price. Rice grading was introduced using three types of mesh size (2.2, 2.4 and 2.7 mm) and attempted to meet the different market needs. Using these sieves, it was possible to separate the fractured and full size rice grain. However, the sieve was working manually; and has high labour cost. Unfortunately, the sieve could not fit to the existing processing machines and was unable to use them extensively. Hence, unless extensive promotion targeted at consumers and wholesalers was made, it will be difficult to make any improvements in quality through grading (Tesfaye 2009).

Rice for consumption

Increased volume of production enhanced rice consumption in the *woreda*. Based on a rapid assessment, Fogera *woreda* total annual rice consumption was estimated to be 17,538 t or 68.74 kg per capita. This level of rice consumption places the *woreda* above most of sub-Saharan African countries which was 18 kg. The average annual rice consumption for nine major rice growing countries was 128 kg (Abdullah et al. 2005).

Use of rice for making *injera,* with or without mixing with other cereals like finger millet, outweighed other forms of use by rice growers. The urban consumers' preference was, however, dictated by the level of fracture. Less fractured rice was used in boiled form while the highly fractured was used for making *injera* mixed with Teff. These consumers gave feedback to processors on the difficulty of preparing fractured rice from X-Jigna in its boiled form because it sticks. NERICA was less sticky when compared to X-Jigna.

In collaboration with AARC and SG2000, about 23 different types of rice dish recipes were also demonstrated to Bahir Dar and Woreta town hotels and restaurants during a rice dish training program. This also included parboiling to show the variety of products. A total of 57 participants attended and the training was for three days in each site and fully practical. Participants also developed good interest to promote their business. However, given the parboiled rice was brown in colour, which was different from the normal white rice, this might, however, be a challenge to get ready market unless aggressive promotion of this product was made.

5.3 Other indirect effects

Labour: Rice production requires high labour input for weeding. Expansion of rice in the *woreda* has created job opportunities for many daily labourers from within and outside the *woreda*. In 2011, labour wages during rice weeding season (July–August) reached to ETB 35/manday. As a result, some labourers who were intending to go to Humera for weeding in the commercial sesame farms stayed back in Fogera for weeding rice. As indicated in Table 6, about 69% of the total labour required was used for weeding. This result was in line with Astewul (2010) which was 67.4%.

Private business people who have millers, mule pulled carts (transporters), urban assemblers and wholesalers etc. have also been involved in the *woreda* rice value chain (see details for the major stakeholders income who were involved in rice value chain).

Gender: The involvement of women in rice production and processing was very high, except in ploughing, which was usually a men's job. All other activities like weeding, harvesting, threshing and marketing are carried out by both men and women. Two to three times weeding was necessary for good result and women's involvement was much higher than men in this regard. Rural assemblers buy rice door to door in the villages and both husband and wife were equally involved in selling. However, if the quantity for sale exceeds 70 kg, it will often be sold outside of the village, and the husband will be responsible. Most paddy transaction that takes place in Woreta town was handled by husbands, whereas most activities related to rice for household consumption like milling, refining and flouring and sale of smaller quantities at village level were handled by women.

Environment: Nearly all areas in the bottomlands which were now under rice were grazing areas. There were some observations that erosion was occurring and active gullies were also being formed. This will have a long term impact for silting the lake.

On the other hand, the project had organized stakeholders consultative and annual workshop in early 2007. In this workshop one of the agenda was about the effects of roundup and the long term impact on the flora and fauna of the Lake Tana ecosystem. Some professionals explained that roundup was environment-friendly while others expressed their concern on the unknown and long term effect especially on Lake Tana ecosystem. At the end, it was agreed that neither the project nor the Fogera WOA should be involved in promoting round up.

5.4 Institutional/organizational changes

Various actors have been involved in rice value chain development and played different roles. Table 10 presents the type of actors and roles they played overtime.

Five main actors that provide various services to rice growers were identified, among others, who played for the rapid expansion of upland rice varieties through providing extension services, credit and first input for demonstration. These were cooperatives, Adet ARC, ACSI, WOA and IPMS. Table 11 presents the five actors involvement in their order of importance from 1 (highest) to 5 (lowest).

Regarding the various actors' level of involvement has been studied by an MSc student by taking 65 farmer respondents. Accordingly, the highest score was given for Fogera WOA followed by IPMS (Table 11).

Table 10. Actors and roles in rice value chain development in Fogera *woreda*

Actors	Roles
Small-scale rice producers	Participated in new varieties demonstration and seed multiplication
	Seed exchange through their own traditional systems
	Selling seeds to credit providers
Rice processing mill owners	Providing rice polishing/processing service
	Serving as retailers
	Selling rice bran for animal feed
Rice assemblers	Collecting rice in the village and transport to Woreta town
	Linking wholesalers at Woreta and rice processers
ANRS-BoARD	Introducing and disseminating new technologies (rice varieties)
	Monitoring and evaluation (South Gondar Zone ARD)
South Gondar OoARD	Providing technical support for *woreda* experts
	Planning, evaluation and overall follow up, and scale out/up across *woredas* in the Zone
Fogera WOA	Sharing knowledge among rice producers
	Targeting of innovative farmers to participate both on demonstration and seed multiplications and exchange
	Enhancing input provision, market information exchange and scaling out in various *kebeles*.
Cooperative promotion office	Technical support and facilitation of input and credit supply
	Providing market information service for agricultural inputs
ARARI and Adet Agricultural Research Centre	Developing new varieties, conducting formal on station and on farm trials/test, data generation documentation and varieties development and realizing
	Capacity building and knowledge sharing to OoARD staff through TOT
	Involving in designing farmer-to-farmer seed multiplications and exchange system
ACSI	Credit provision for agricultural inputs
SG 2000 (SAA)	Adaptation trial of varieties onsite
	Demonstrating harvesting technologies like threshing
	Rice processing and value additions and market promotions
ILRI/IPMS project	Developing linkage among research institutes, extension providers and rice growers
	Enhancing value chain approach:
	Initiating farmer to farmer seed multiplication and exchange system design
	Providing inputs for demonstration
	Facilitating various trainings, field visits, demonstrations
	Value addition and grading and market promotions

Source: Synthesised from Tesfaye (2009) and IPMS project staff assessment (2010).

Table 11. Grading perceived level of support on upland rice development by different actors (No. = 65)

Actors working with upland rice seed producers	Frequency	%	Relative importance rate
Cooperatives	30	46	3
Adet ARC	24	37	4
ACSI	8	12	5
WOARD	52	80	1
IPMS	45	69	2

Source: Tesfaye (2009).

6 Lessons learned and challenges

- The tripling of the rice price coupled with the project's participatory market-oriented value chain approach was very successful in Fogera, as can be seen from the dramatic increase in area coverage and production.
- An interesting lesson was the farmer response to the introduction of rice in the uplands. While the project partners tested and introduced new upland varieties, much of the expansion in area coverage (both in flood and upland areas) was due to expansion of the X-Jigna variety.
- While the upland varieties do have potential, introduction of these varieties should be carefully examined in light of yield potential (as compared to X-Jigna), availability of soil moisture during the growing season, its processing/market potential as white rice as compared to X-Jigna (breakage, stickiness). While marketing of NERICA as a grain was still in its early stages, indications were that it may fetch a higher price because of urban preference.
- While the farmer to farmer seed exchange system works well for X-Jigna, multiplication and sale of seeds of upland varieties needs to be improved to reduce the use of seeds as grains for sale and/or consumption. It was observed, however, that farmers use large amounts of seeds of X-Jigna (up to 200 kg/ha) even though what was recommended was lower (80 kg/ha). This may be due to poor seed quality and needs attention.
- The expansion of rice in the uplands should be accompanied with appropriate fertility management measures, since crop rotation with legumes which require residual moistures may not be feasible. It was noted that inorganic fertilizers (DAP and Urea) were supplied by five cooperatives in the *woreda* through loan and cash payment. However, since 2008, the number of farmers using inorganic fertilizers reduced because farmers were asked to pay 100% cash unlike the previous years which allowed credit.
- While the service providers, in particular the OoA with support of research and the project, contributed to the increase in area and production, processors responded automatically (without support) by increasing their capacity. However processors and producers should discuss further the processing of rice of both varieties, to improve quality. This may include machinery used as well as machine operation.
- The existing rice varieties were long maturing types, and when rains stop early in the uplands, supplementary irrigation to complete the growth cycle was needed. Farmers could also transplant seedlings so that it will reduce the length of growing period in the field and make full benefit of the rainy season.
- Introduction of parboiling technology will reduce the proportion of grain fracture and should be widely practised. Promotion of parboiling so as to get brown rice was essential and the extension system should promote this technology.

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